

# Consensus-driven model to establish paediatric emergency care measures for low-volume emergency departments

Katherine E Remick <sup>1</sup>, Krystle A Bartley,<sup>1</sup> Louis Gonzales <sup>1</sup>, Kate S MacRae,<sup>2</sup> Elizabeth A Edgerton<sup>1</sup>

**To cite:** Remick KE, Bartley KA, Gonzales L, *et al.* Consensus-driven model to establish paediatric emergency care measures for low-volume emergency departments. *BMJ Open Quality* 2022;11:e001803. doi:10.1136/bmjopen-2021-001803

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-001803>).

Received 12 January 2022  
Accepted 19 June 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Pediatrics, The University of Texas at Austin Dell Medical School, Austin, Texas, USA

<sup>2</sup>Gonzaga University College of Arts and Sciences, Spokane, Washington, USA

## Correspondence to

Dr Katherine E Remick;  
[kate.remick@austin.utexas.edu](mailto:kate.remick@austin.utexas.edu)

## NARRATIVE Background

Engagement in quality improvement (QI) work is essential to ensuring emergency departments (EDs) are meeting the needs of all patient populations. In the USA, children represent approximately 27% (35 million) of all ED visits.<sup>1</sup> Over 50% (18 million) of these children are seen in EDs that see fewer than 10 000 paediatric patients per year, with only 7% of children seen in extremely high-volume EDs (>50 000 paediatric patients per year).<sup>1</sup> Among the 5000 EDs in the USA, 39% see fewer than 5 children per day, 30% see 5–14 children per day and 17% see 15–25 children per day.<sup>2</sup> In the absence of repetitive performance and measurement, as seen in high-volume centres (greater than 10 000 paediatric visits annually), it may be difficult to assess the quality of care processes.<sup>3</sup> In the USA, less than 50% of EDs report the inclusion of paediatric-specific elements in a department-wide QI plan.<sup>2</sup> The aim of this manuscript is to identify a series of paediatric emergency care quality measures that would be valuable for low-volume EDs (<10 000 paediatric patients per year).

The National Paediatric Readiness Project applies a systems approach (care coordination, QI, policies and procedures, staff competencies, patient safety and equipment and supplies) to ensuring high-quality emergency care for children among diverse EDs.<sup>2</sup> Paediatric readiness, as determined by the National Paediatric Readiness Assessment using a weighted 100-point scale, is associated with decreased paediatric mortality among critically ill and injured children.<sup>2 4–10</sup> Facilities that incorporate paediatric-specific QI initiatives demonstrate a 26-point increase in their paediatric readiness score.<sup>11</sup> Engagement in paediatric readiness efforts is high, yet integration of paediatric QI efforts in EDs is lagging.<sup>2</sup>

While over 400 paediatric emergency care performance measures have been proposed and prioritised, widespread uptake has been limited.<sup>2 12–14</sup> Infrequent paediatric patient encounters make it difficult to assess the cause and effect of care processes. Furthermore, process and outcome measures within the paediatric emergency care landscape often require complex data extraction which may be especially difficult to implement in lower-resourced facilities.<sup>12–14</sup> To date, no comprehensive assessment of the quality of paediatric emergency care delivery exists in low-volume EDs (<10 000 visits/year). The National Pediatric Readiness Quality Initiative (NPRQI) focuses on the undifferentiated patient experience that encompasses standard phases of care in the ED: assessment, interventions, diagnostics and disposition. We describe the development of a core set of NPRQI quality measures targeting common paediatric patient reports for adoption in low-volume EDs.

## METHODS

NPRQI conducted a five-phase modified Delphi process from November 2019 through January 2021.<sup>15</sup> The study consisted of two content arms. Arm 1 included the cross-cutting clinical assessment and four clinical reports. Arm 2, which focused on behavioural health, was added 6 months into the study due to the evolving behavioural health crisis among children. The Delphi process included an initial meeting (Arm 1—in-person, synchronous; Arm 2—virtual, synchronous), a confidential online survey (Arm 1, Arm 2) and subsequent virtual meetings (Arm 1, Arm 2, synchronous). Both arms followed the same series of steps and were only separated by time.

## Consensus panel

The panel consisted of 41 members who were either identified by their respective national

**Table 1** Characteristics of consensus panel

Characteristic	Participants, % (N) N=41
Pediatric Emergency Care Applied Research (EA, EK*, CM, RS, SD*, TC*)	14.6 (6)
Emergency Medical Services for Children (CM, CN, EL, HH, MGH)	12.2 (5)
Quality Experts from National Professional Societies	26.8 (11)
American Academy of Family Physicians (DF)	
American Academy of Pediatrics (RP, SJ)	
American College of Emergency Physicians (IB, JA, KG)	
American College of Surgeons Committee on Trauma (AJ)	
Emergency Nurses Association (RK, SS)	
National Association of State Emergency Medical Services Officials (AV)	
Pediatric Trauma Society (LG)	
Quality Improvement Data Registries (BM)	2.4 (1)
Health System Networks	4.9 (2)
US Acute Care Solutions (SI)	
Hospital Corporation of America (HCA) Healthcare (AY)	
Regulatory body	2.4 (1)
The Joint Commission (TE)	
Federal partners	4.9 (2)
Health Resources and Services Administration (LL)	
National Highway and Traffic Safety Administration, Office of Emergency Medical Services (EC)	
Physician specialty	65.9 (27)
Paediatric emergency medicine (CM, HH, LA, MG, RP, RS, SI, SJ)	
Emergency medicine (BM, CN, IB, JA, JL†, KG, KS†)	
Trauma (AJ)	
Family medicine (DF)	
Behavioural health* (BZ, EK, JH, KD, NU, SD, SP, SR, TC, VF)	
Nursing background	19.5 (8)
Emergency medicine (AR†, AY, BW, CR, CT, DG, RK, SS)	
Trauma (CT, LG, SS)	
Practice in low-volume ED setting (AR†, AY, CT, DG, JL†, KG, KS†)	17.1 (7)
Panellist affiliations are listed in online supplemental appendix A.	
*Arm 2 panellist, members of the Emergency Medicine Quality Improvement Collaborative for Kids (EMQUICK). Co-chaired by Drs Susan Duffy and Tom Chun, EMQUICK works collaboratively to assist in the development and implementation of rigorous, evidence-based quality improvement measures for paediatric mental healthcare in EDs.	
†Measurement feasibility assessment in low-volume EDs.	
EDs, emergency departments .	

professional society as a content expert or were selected based on the following criteria: expertise in paediatric emergency care applied research, emergency medical services for children, QI, QI data registries, specific areas of clinical practice, clinical practice setting, healthcare system networks, regulatory agencies and federal partners (table 1, online supplemental appendix A).

### Phase 1—determination of measures for consideration

The study team (KR, EE, KB, LG) and a subset of research panellists (ARM 1: AJ, CM, HH, LA, RS, BM; ARM 2: TC, SD) collated existing paediatric emergency care quality measures,<sup>10–12</sup> specialty-specific professional guidelines,

consensus statements and evidence-based reviews to identify measures for the ED setting. A total of five clinical reports ('domains') were identified based on the prevalence of clinical reports among ED visits, availability of evidence-based guidelines, alignment with national priorities and presence of validated screening tools.<sup>16 17</sup> The five clinical domains selected for inclusion were: blunt head trauma, respiratory reports, seizures, behavioural health and vomiting. Cross-cutting measures for clinical assessment and interfacility transfer were included to capture foundational processes of care delivery, independent of the clinical report. Additional clinical domains were

excluded due to scope. All proposed measures were characterised by clinical domain, the six domains of quality, phase of ED care (assessment, interventions, diagnostics, disposition) and measure type (process or outcome).<sup>18–20</sup> Structural measures were excluded as they are the focus of the National Paediatric Readiness Assessment.<sup>5</sup> Structural measures for behavioural health, proposed by the Emergency Medicine Quality Improvement Collaborative for Kids behavioural health consortium, are included in online supplemental appendix B for future consideration and consensus building; however, they were deemed outside of scope for NPRQI. This initial set of process and outcome measures were presented to the larger consensus panel for review and approval. Measures with a vote of greater than 50% were included in an online survey instrument (Research Electronic Data Capture; Vanderbilt University).

### Phase 2—evaluation of measures

The consensus panel was charged with rating each measure based on the National Quality Forum (NQF) Measure Evaluation Criteria: feasible for data collection in a low-volume, low-resourced ED setting, usable to an ED care team, important for patient-centred outcomes and scientifically acceptable.<sup>21</sup> The goal was to identify fewer than six measures per clinical domain (assessment, inter-facility transfer, clinical reports and behavioural health). Arm 1 added three additional stakeholders (AR, JL, KS) from low-volume facilities to assess feasibility, usability and importance of the measures in the ED setting. Each member completed a confidential, online survey rating each measure using the NQF Criteria on a 3-point Likert scale.<sup>21</sup> Aggregate responses were compiled and the mean score was calculated for each measure (online supplemental appendix C). Measures with a mean score of greater than 2 or greater than 1.8 for behavioural health, were included in Phase 3.

### Phase 3—panel feedback: usability and importance

On completion of the survey, the panel was reconvened to share aggregate results: group mean and SDs for each measure (Arm 1 in-person; Arm 2 virtual). Panellists participated in open discussions regarding usability and importance. An importance statement was developed for each of the measures as further validation of usability and importance. Panellists had an opportunity to champion the inclusion of a measure or provide justification for exclusion. Those measures that did not achieve consensus (typically less than 80%) were excluded.

### Phase 4—measure feasibility assessment

The feasibility of measures was determined based on viability of data extraction, accessibility of variables for each measure and complexity to implement. For both arms, the NPRQI leadership team (KR, EE, KB, LG) conducted a feasibility assessment based on whether discrete variables existed in emergency medical records for proposed measures and for Arm 2, whether the information would

be accessible due to behavioural health privacy concerns and if discrete variables existed. Feedback was obtained from a subset of research panellists (AJ, BM, CM, HH, LA, RS, SD, TC) with respect to feasibility. Measures were presented to the consensus panel (virtual) and refined for clarity of interpretation and feasibility.

### Phase 5—final review

The final list of measures was reviewed in totality with the panel (virtual) to review the final list of measures and importance statements, and ensure consensus. Each measure was further categorised by its Donabedian classification (process or outcome measure) and according to the phase of care in the ED (assessment, diagnostics, interventions and disposition).<sup>19</sup>

## RESULTS

The breadth of measures considered reflected NPRQI's approach to identify cross-cutting care processes and common ED reports among undifferentiated paediatric patients. The seven clinical domains included two cross-cutting domains (recognition of the sick or injured child (8 measures) and effective transfer (4 measures)) and five clinical domains (blunt head trauma (10 measures), seizures (11 measures), respiratory reports (12 measures), vomiting (8 measures) and behavioural health (17 measures)). Based on these clinical domains, 70 total measures were proposed for inclusion in NPRQI.

A total of 65 measures (53 for Arm 1 and 12 for Arm 2) were included in Phase 1 of the modified Delphi process (online supplemental appendix B). All measures were categorised according to the four phases of ED care: assessment, interventions, diagnostics and disposition. Behavioural health measures were categorised as follows: assessment (7 measures, 58.3%), interventions (1 measure, 8.3%), diagnostics (1 measure, 8.3%) and disposition (3 measures, 25%). The remaining clinical domain measures were categorised as follows: assessment (14 measures, 26.4%), interventions (19 measures, 35.8%), diagnostics (11 measures, 20.8%) and disposition (9 measures, 17%). In Arm 1, six measures scored 2.0 or less and were excluded from subsequent phases. In Arm 2, six measures scored 1.8 or less and were eliminated from subsequent phases. Phase 3 and 4 panel discussions resulted in the exclusion of 18 and 5 additional measures, respectively, from Arm 1 and the exclusion of 0 and 2 additional measures, respectively, from Arm 2. Measure exclusion during phases 3 and 4 was due to: lack of a validated screening tool (eg, human trafficking screening), lack of clarity in interpretation (eg, intubation following head trauma), outside locus of control for ED implementation (ED length of stay for mental health patients), redundancy with cross-cutting care process measures and/or complexity of data collection (table 2). Measures excluded based on complexity or feasibility to implement included: percentage of patients with abnormal vital signs included in provider notification process, percentage of

**Table 2** Modified Delphi process for measures selection

Clinical domain	Proposed measures	Measures in each phase				
		Phase 1: review and approve	Phase 2: National Quality Forum evaluation <sup>21</sup>	Phase 3: measure usability and importance	Phase 4: measure feasibility	Phase 5: final review
Cross-cutting care processes						
Assessment	8	8	8	6	5	5
Transfer	4	4	4	3	3	3
Clinical report						
Blunt head trauma	10	10	9	5	4	4
Seizures	11	11	9	5	3	3
Respiratory reports	12	12	10	6	6	6
Vomiting	8	8	7	4	3	3
Behavioural health	17	12	6	6	4	4
Total	70	65	53	35	28	28

families who received transfer packets, percentage of CTs that used appropriate weight-based dosing, percentage of patients with return precautions, medication dosing errors and behavioural health follow-up after discharge.

A final review by a subset of research panellists (AJ, BM, CM, HH, LA, RS, SD, TC) confirmed the 28 final quality measures for inclusion in NPRQI: cross-cutting care processes (8 measures, 28.6%), blunt head trauma (4 measures), seizures (3 measures), respiratory reports (6 measures), vomiting (3 measures) and behavioural health (4 measures) (table 3). All were classified as process measures. By phase of care in the ED the measures are characterised as follows: assessment (8 measures, 28.6%), interventions (13 measures, 46.4%), diagnostics (3 measures, 10.7%) and disposition (4 measures, 14.3%).

## DISCUSSION

Twenty-eight measures that capture five common clinical presentations and two cross-cutting processes of care were developed by the NPRQI with the participation of a diverse panel of experts and national organisations. These measures encompass the four phases of care in the ED: assessment, diagnostics, intervention and disposition. This approach allows for a prospective, feasible and patient-centred focus to paediatric-specific QI efforts. Low-volume EDs may never have sufficient patient encounters to focus on final diagnoses for timely QI efforts. By targeting critical cross-cutting processes and common clinical presentations, EDs can assess quality of care among a larger undifferentiated paediatric population.<sup>18</sup> The patient experience model, as highlighted within the Institute for Healthcare Improvement's Triple Aim, is based on the care provided in response to a clinical presentation, not a specific diagnosis.<sup>22</sup> The measures within each clinical domain were derived from evidence-based research that links early and appropriate assessment, targeted diagnostics, timely interventions and disposition to improved outcomes.

The NPRQI represents a new framework for the inclusion of quality measures for all categories of paediatric care divided across four phases of care: assessment, diagnostics, interventions and disposition. Assessment serves as the foundation for paediatric patient safety. For example, early recognition of altered mental status is essential to timely management of head trauma.<sup>23–25</sup> Early recognition of tachycardia and hypotension are core components of sepsis recognition.<sup>26</sup> In turn, early recognition of the critically ill or injured child leads to timely administration of evidence-based interventions linked to improved outcomes. For example, early administration of steroids are associated with decreased hospitalisation among children with moderate and severe asthma and, among children with seizures, treatment delays can result in prolonged seizure activity.<sup>27 28</sup> In addition to improved outcomes, timeliness of interventions improves patient experience.<sup>29</sup> Diagnostic testing should be undertaken judiciously and in conjunction with family-centred care. Unnecessary exposure to radiation in the paediatric patient is both costly and associated with potential harm.<sup>30 31</sup> Invasive procedures and unnecessary testing, too, can adversely impact patient experience and cost.<sup>32</sup> Adherence to standardised, site-specific transfer criteria and processes promotes timely access to necessary resources and may minimise unnecessary cost to patients and families.<sup>33</sup> A first step to adhering to evidence-based guidelines in specific populations is optimising care processes across all phases of ED care.

The past decade has fostered significant growth in the development of evidence-based guidelines as research in paediatric emergency care has shifted from single-centre data to multicentre studies enabling researchers to address low frequency, high-risk conditions in a more systematic manner. Multicentre research has also allowed for creation of evidence-based guidelines and validated decision rules for common paediatric reports. This approach is exemplified by the Emergency Medical Services for

**Table 3** National Pediatric Readiness Quality Initiative quality measures

Intervention bundle	Donabedian classification	Phase of care	Quality measures
Recognition of a sick or injured child	Process	Assessment	Percentage of paediatric patients with weight documented in kilograms only. Percentage of paediatric patients with pain assessed. Percentage of paediatric patients with vital signs re-assessed.
		Intervention	Median time from collection of first set of vital signs to first intervention (eg, oxygen, medication).
		Disposition	ED length of stay (ED arrival to discharge*).
Timely and effective transfer to appropriate resources	Process	Disposition	Percentage of transferred paediatric patients who met the site-specific criteria for transfers. Time from arrival to transport. Percentage of transferred paediatric patients that were discharged from the receiving centre <24 hours of arrival.
		Assessment	Percentage of paediatric patients with a full set† of vital signs obtained. Percentage of paediatric patients with a Glasgow Coma Scale reassessment.
			Intervention
Adherence to evidence-based guidelines† for management of blunt head trauma	Process	Assessment	Percentage of paediatric patients with a neurologic reassessment.
		Intervention	Percentage of paediatric patients that received at least one additional class of antiepileptics (for patients requiring ≥2 doses of benzodiazepines).
		Diagnostics	Percentage of paediatric patients who underwent invasive diagnostic assessments: blood glucose, blood work, urinalysis, lumbar puncture and head CT.
Adherence to evidence-based guidelines for seizures	Process	Assessment	Percentage of paediatric patients with a neurologic reassessment.
		Intervention	Percentage of paediatric patients that received at least one additional class of antiepileptics (for patients requiring ≥2 doses of benzodiazepines).
		Intervention	Percentage of paediatric patients that received hypotonic saline.
		Diagnostics	Percentage of paediatric patients that received an antibiotic.
Adherence to evidence-based guidelines for respiratory reports	Process	Intervention	Percentage of paediatric patients with asthma or croup that received a steroid. Median time to steroids in patients diagnosed with asthma or croup. Percentage of paediatric patients ≥2 years with a diagnosis of asthma that received beta agonist. Median time to beta agonist administration in patients ≥2 years with a diagnosis of asthma (ED arrival to beta agonist administration). Percentage of patients that received an antibiotic.
		Diagnostics	Percentage of patients that underwent a chest X-ray.
		Intervention	Percentage of paediatric patients that received an antiemetic. Time to first antiemetic (ED arrival to antiemetic administration). Percentage of patients that received oral rehydration.
		Assessment	Percentage of patients who had a structured suicide screen. Percentage of patients with a positive suicide screen who had a structured suicide assessment.
Assess the timeliness and variability of interventions for vomiting	Process	Intervention	Percentage of patients with a positive suicide screen who had a consultation with a licenced mental health professional. Percentage of patients with a positive suicide screen that received a discharge safety plan.
		Assessment	Percentage of patients with a positive suicide screen who had a structured suicide assessment.
		Intervention	Percentage of patients with a positive suicide screen who had a consultation with a licenced mental health professional. Percentage of patients with a positive suicide screen that received a discharge safety plan.

\*For purposes of standardisation, discharge is defined to be the moment of physical departure from the ED.

†Evidence-based guidelines.

‡Includes temperature, heart rate, respiratory rate, blood pressure, pulse oximetry, mental status and pain assessment.

§Paediatric Emergency Care Applied Research Network.

ED, emergency department; PECARN, Paediatric Emergency Care Applied Research Network.



Children-funded Paediatric Emergency Care Applied Research Network (PECARN), which has published over 150 articles on a diverse range of paediatric emergency medicine topics.<sup>17</sup> While much of the research from multicentre trials focuses on high risk, low-frequency events such as sepsis, some of the most prominent guidelines generated from PECARN relate to common clinical conditions encountered at virtually every ED in the USA: management of closed head injury in children, bronchiolitis management, pain management, suicidality and paediatric patient safety considerations.<sup>17 31 34–36</sup>

The NPRQI measures individually may overlap with the development of paediatric measures by others.<sup>12–14</sup> What differs is the context in which they are implemented which focuses on clinical presentation rather than a specific diagnosis, and that they are imbedded in a set of measures that capture all ED phases of care for managing the patient, not the diagnosis. This approach can be applied across low-volume EDs where specific diagnoses are infrequent, but the phases of ED care are universal. The large proportion of NPRQI measures (28.6%) that fall within cross-cutting care processes further supports engagement by very-low volume EDs (fewer than five paediatric patients per day). These measures set the foundation for measuring the quality of ED care provided for most children in the USA. In the absence of pay-for-performance incentives, the adoption of paediatric-specific quality measures in low-volume EDs (where most children seek care) will depend on the ease of data collection, relevance to a large proportion of the paediatric population and linkage to patient-centred outcomes. These measures strive to be feasible at the local level and actionable for the ED care team.

Families rely on EDs of close proximity to meet the needs of critically ill and injured children, most of which see fewer than 15 children per day.<sup>1 37</sup> The potential impact of quality measures on care delivery is dependent on relevance to the population served, and uptake by those who can implement change. Engagement of frontline practitioners in QI efforts is essential to ensuring the success of improvement strategies. The measures proposed herein are a first step to recognising variability in care within a single ED as the focus is optimisation of processes of care that are central to the delivery of high-quality care for all paediatric patients. The potential impact of the 28 NPRQI quality measures is that any ED can immediately improve processes of care that are linked to improved health outcomes in children.

The NPRQI measures provide a foundation for any ED care team to measure adoption of evidence-based guidelines for paediatric care using a patient-centred, provider-driven approach to QI. Unlike many quality measures that rely on administrative data or a diagnosis-based retrospective review, the NPRQI measures were designed for any ED to assess performance and improve delivery of care to the undifferentiated paediatric patient. The NPRQI paediatric quality measures may be biased from using a consensus model. It was critical to engage a diverse group

to participate in the modified Delphi process as well as create an environment for sharing differing perspectives. The subset of research panellists engaged in measures proposal and final review were chosen for their clinical, research and implementation expertise to ensure feasibility. The consensus panel was composed of multidisciplinary organisational representatives that intersect with low-volume EDs. With significant input from consensus panellists and national organisations, the NPRQI measures are relevant, feasible and linked to improved outcomes for paediatric patients with common clinical presentations.

## CONCLUSION

The majority of paediatric emergency care is sought in diverse, low-volume ED settings with variable capacity and capabilities and where the majority of patients are adults. We worked to identify relevant, feasible, patient-centred and process-focused paediatric quality measures for adoption in any ED, especially low-volume settings. The quality measures proposed herein were developed as part of the NPRQI, the operational arm of the National Paediatric Readiness Project.<sup>4</sup>

The NPRQI is an effort to optimise emergency care delivery for children regardless of site-specific resources or infrastructure. The development of relevant and applicable paediatric quality measures is the first step in implementation of paediatric QI processes. The presence of QI processes that includes paediatric-specific measures is associated with improved paediatric readiness and increased survival from critical illness and injury. The NPRQI framework differs from previous efforts in the following ways: (1) diversity and national representation of the selected consensus panel, (2) focus on the undifferentiated patient, (3) adherence to the perspective of healthcare providers in rural and community settings and (4) prioritisation of easily accessible data points. This is the first set of paediatric emergency care quality measures that supports implementation in low volume, low-resourced EDs; provider-driven improvement strategies; and encompasses all four phases of care in the ED setting. The NPRQI measures will be used to create a national open access, electronic paediatric emergency care QI data platform and registry to facilitate engagement in QI efforts, support ED providers to assess the current state of paediatric emergency care delivery and benchmark performance across similar ED settings. Future efforts will focus on establishing performance benchmarks across variably resourced EDs, geographical regions and patient demographic groups to begin to identify and address disparities in the ability of our nation's emergency care system to meet the needs of all children.

**Acknowledgements** The authors wish to acknowledge the NPRQI Quality Improvement and Analytics Advisory Board for their time and effort participating in the consensus process.

**Contributors** KER, KAB and EAE conceived and designed the study. KER, KAB, LG, KSM and EAE provided study supervision. KER and EAE obtained funding. KER, KAB,

LG, KSM and EAE drafted the manuscript and all authors contributed substantially to its revision. KER, KAB, LG, KSM and EAE take responsibility for the paper as a whole.

**Funding** The NPRQI is supported by the Health Resources and Services Administration (HRSA) of the US Department of Health and Human Services (HHS) as part of an award (H34MC33244) totaling US\$1.2 million with 0% financed with non-governmental sources. The contents are those of the author(s) and do not necessarily represent the official views of, nor an endorsement, by HRSA, HHS or the US Government.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** The NPRQI was reviewed by the University of Texas at Austin Institutional Review Board and deemed exempt as defined under 45 CFR 46.102(d).

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iDs

Katherine E Remick <http://orcid.org/0000-0002-1423-919X>

Louis Gonzales <http://orcid.org/0000-0001-9300-1069>

## REFERENCES

- Whitfill T, Auerbach M, Scherzer DJ, *et al.* Emergency care for children in the United States: epidemiology and trends over time. *J Emerg Med* 2018;55:423–34.
- Gausche-Hill M, Ely M, Schmuhl P, *et al.* A national assessment of pediatric readiness of emergency departments. *JAMA Pediatr* 2015;169:527–34.
- Centers for Medicare and Medicaid Services. Measures inventory tool. Available: [https://cmit.cms.gov/CMIT\\_public/ListMeasures](https://cmit.cms.gov/CMIT_public/ListMeasures) [Accessed 14 Nov 2021].
- National Pediatric Readiness Project. Emergency medical services for children innovation and improvement center. Available: <https://emscimprovement.center/domains/pediatric-readiness-project/> [Accessed 14 Nov 2021].
- National EMS for Children Data Analysis Resource Center. National pediatric readiness assessment, 2021. Available: <https://www.pedsready.org> [Accessed 14 Nov 2021].
- Remick K, Gausche-Hill M, Joseph MM, *et al.* Pediatric readiness in the emergency department. *Ann Emerg Med* 2018;72:e123–36.
- Remick K, Gausche-Hill M, Joseph MM, *et al.* Pediatric readiness in the emergency department. *J Emerg Nurs* 2019;45:e3–18.
- Remick K, Gausche-Hill M, Joseph MM, *et al.* Pediatric readiness in the emergency department. *Pediatrics* 2018;142.
- Ames SG, Davis BS, Marin JR, *et al.* Emergency department pediatric readiness and mortality in critically ill children. *Pediatrics* 2019;144:e20190568.
- Newgard CD, Lin A, Olson LM, *et al.* Evaluation of emergency department pediatric readiness and outcomes among US trauma centers. *JAMA Pediatr* 2021;175:947.
- Remick K, Kaji AH, Olson L, *et al.* Pediatric readiness and facility verification. *Ann Emerg Med* 2016;67:320–8.
- Michelson KA, Lyons TW, Hudgins JD, *et al.* Use of a national database to assess pediatric emergency care across United States emergency departments. *Acad Emerg Med* 2018;25:1355–64.
- Alessandrini E, Varadarajan K, Alpern ER, *et al.* Emergency department quality: an analysis of existing pediatric measures. *Acad Emerg Med* 2011;18:519–26.
- Alessandrini E. Using performance measures to drive improvement in pediatric emergency care. HRSA-EMC Webinar. 11/2/2010. Available: [https://media.emscimprovement.center/documents/Webinar\\_20101102\\_EMSC\\_PMstoDriveImprovementinPedEmergencyCare\\_slides2125.pdf](https://media.emscimprovement.center/documents/Webinar_20101102_EMSC_PMstoDriveImprovementinPedEmergencyCare_slides2125.pdf) [Accessed 14 Nov 2021].
- Dalkey NC. *The Delphi method: an experimental study of group opinion.* Rand Corp public RM-58888-PR. Santa Monica: Rand Corp, 1969.
- McDermott KW, Stocks C, Freeman WJ. Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project. In: *Overview of pediatric emergency department visits, 2015 SB#242*, 2018.
- Pediatric Emergency Care Applied Research Network. Available: <https://pecarn.org/publications-studies/> [Accessed 14 Nov 2021].
- Kyeremanteng K, D'Egidio G. Why process quality measures may be more valuable than outcome measures in critical care patients. *J Biostat Biodef* 2015;07:1–3.
- Donabedian A. Evaluating the quality of medical care. 1966. *Milbank Q* 2005;83:691–729.
- Institute of Medicine (IOM). *Crossing the quality chasm: a new health system for the 21st century.* Washington, D.C: National Academy Press, 2001.
- National Quality Forum. Measure evaluation criteria and guidance for evaluating measures for endorsement. Available: <https://www.qualityforum.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=88439> [Accessed 14 Nov 2021].
- Whittington JW, Nolan K, Lewis N, *et al.* Pursuing the triple aim: the first 7 years. *Milbank Q* 2015;93:263–300.
- Green NA, Durani Y, Brecher D, *et al.* Emergency severity index version 4: a valid and reliable tool in pediatric emergency department triage. *Pediatr Emerg Care* 2012;28:753–7.
- Mora MC, Veras L, Burke RV, *et al.* Pediatric trauma triage: a pediatric trauma Society research Committee systematic review. *J Trauma Acute Care Surg* 2020;89:623–30.
- Griffin ES, Lippmann SJ, Travers DA, *et al.* A matched-cohort study of pediatric head injuries: collecting data to inform an evidence-based triage assessment. *J Emerg Nurs* 2014;40:98–104.
- Lane RD, Funai T, Reeder R, *et al.* High reliability pediatric septic shock quality improvement initiative and decreasing mortality. *Pediatrics* 2016;138:e20154153.
- Bhogal SK, McGillivray D, Bourbeau J, *et al.* Early administration of systemic corticosteroids reduces hospital admission rates for children with moderate and severe asthma exacerbation. *Ann Emerg Med* 2012;60:84–91.
- Eriksson K, Metsäranta P, Huhtala H, *et al.* Treatment delay and the risk of prolonged status epilepticus. *Neurology* 2005;65:1316–8.
- Emerson BL, Setzer E, Bechtel K, *et al.* Improving patient experience scores in a pediatric emergency department. *Pediatr Qual Saf* 2021;6:e417.
- Miglioretti DL, Johnson E, Williams A, *et al.* The use of computed tomography in pediatrics and the associated radiation exposure and estimated cancer risk. *JAMA Pediatr* 2013;167:700–7.
- Kuppermann N, Holmes JF, Dayan PS, *et al.* Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. *Lancet* 2009;374:1160–70.
- Hiscock H, Neely RJ, Warren H, *et al.* Reducing unnecessary imaging and pathology tests: a systematic review. *Pediatrics* 2018;141:e20172862.
- Genovesi AL, Olson LM, Telford R, *et al.* Transitions of care: the presence of written Interfacility transfer guidelines and agreements for pediatric patients. *Pediatr Emerg Care* 2019;35:840–5.
- Corneli HM, Zorc JJ, Mahajan P, *et al.* A multicenter, randomized, controlled trial of dexamethasone for bronchiolitis. *N Engl J Med* 2007;357:331–9.
- Shaw KN, Lillis KA, Ruddy RM. Pediatric emergency care applied research network. reported medication events in a paediatric emergency research network: sharing to improve patient safety. *Emerg Med J* 2013;30:815–9.
- King CA, Brent D, Grupp-Phelan J. Pediatric emergency care applied research network (PECARN). five profiles of adolescents at elevated risk for suicide attempts: differences in mental health service use. *J Am Acad Child Adolesc Psychiatry* 2020;59:e5:1058–68.
- Ray KN, Olson LM, Edgerton EA. Access to pediatric-ready emergency care. *J Pediatr* 2018;194:225–32.

**Appendix A: Consensus Panel, National Pediatric Readiness Quality Initiative Measures Development**

Name	Credentials	Affiliation(s)
Aaron Jensen	MD, MEd	American College of Surgeons Committee on Trauma; University of California San Francisco School of Medicine
Amber Viitanen	MPH	National Association of State EMS Officials; Colorado Department of Public Health
Annie Relph*	RN	Moab Regional Hospital
Ashley Yount	MSN, RN, CPN	HCA Healthcare, Medical City-Dallas
Belinda Waters	RN, CEN, CCRN-K	Nurse Expertise
Bonnie Zima	MD, MPH	UCLA Center for Health Services and Society; Jane and Terry Semel Institute for Neuroscience and Human Behavior
Bryan McNally	MD, MPH	Cardiac Arrest Registry to Enhance Survival (CARES); Emory University School of Medicine
Charles Macias	MD, MPH	Emergency Medical Services of Children Innovation and Improvement Center; University Hospitals Rainbow Babies and Children's Hospitals
Christi Thornhill	DNP, APRN, ENP, ACNP-BC, CPNP-AC, CP-SANE	Cook Children's Medical Center
Craig Newgard	MD, MPH	Oregon Health Sciences University, Emergency Medical Services for Children Program, Targeted Issues Grant
Crissie Richardson	MS, BSN, RN, CEN, CPEN	Premier Care
David Fairbanks	MD	American Academy of Family Physicians; Big Horn County Public Health Department
Deanna Gillespie	BSN, RN, CEN, CPEN	Physicians Premier ER
Eileen Klein	MD, MPH	Pediatric Emergency Care Applied Research Network
Elizabeth Alpern	MD, MSCE	Northwestern University Feinberg School of Medicine
Eric Chaney	MS	National Highway Traffic Safety Administration
Evelyn Lyons	MPH, RN	Emergency Medical Services for Children State Partnership Program, Illinois Department of Health
Hilary Hewes	MD	National EMS for Children Data Analysis Resource Center; University of Utah, Primary Children's Medical Center
Isabel Barata	MD	American College of Emergency Physicians; Donald and Barbara Zucker School of Medicine at Hofstra/Northwell
James Augustine	MD	American College of Emergency Physicians; Wright State University
Jennifer Hoffmann	MD	Northwestern University Feinberg School of Medicine
Jason Larson*	MD	Uintah Basin Medical Center
Kathleen Donise	MD	Lifespan Child Emergency Psych Services, Rhode Island Hospital
Kenneth Gramyk	MD	American College of Emergency Physicians; Lake Pend Oreille Emergency Medicine
Kirk Stiffler*	MD	University Hospitals Ahuja Medical Center
Lisa Gray	MHA, BSN, RN, CPN	Pediatric Trauma Society; Ascension St. Vincent - Evansville
Lorah Ludwig	MPH	Health Resources and Services Administration
Marianne Gausche-Hill	MD	David Geffen School of Medicine at UCLA, National Pediatric Readiness Project
Neil Uspal	MD	Seattle Children's Hospital
Rachel Stanley	MD, MHSA	Pediatric Emergency Care Applied Research Network, Nationwide Children's Hospital
Raina Paul	MD	American Academy of Pediatrics, Ann and Robert H. Lurie Children's Hospital of Chicago
Rebecca Kovack	MSN, MBA, RN, TNS, CEN, CPEN	Emergency Nurses Association; Rush Copley Medical Center
Sally Snow	BSN, RN, CPEN	National Pediatric Readiness Project



Shilpa Patel	MD, MPH	Children's National Medical Center
Stephen Janofsky	MD	American Academy of Pediatrics; University of Pittsburgh Medical Center, Children's Hospital of Pittsburgh
Steven Rogers	MD	Connecticut Children's Hospital
Sujit Iyer	MD	US Acute Care Solutions; Dell Children's Medical Center
Susan Duffy	MD, MPH	Alpert Medical School, Brown University
Thomas Chun	MD, MPH	Alpert Medical School, Brown University
Tricia Elliot	MBA, CPHQ	The Joint Commission
Vera Feuer	MD	Pediatric Emergency Psychiatry and Behavioral Health Urgent Care, Cohen Children's Hospital

Appendix B: Proposed Behavioral Health Structural Measures<sup>^</sup>

Pediatric Readiness Domain	Behavioral Health Quality Measure
Policies and Procedures	Policy for basic triage and mental health assessment
	Policy for pediatric safety assessment
	Policy for pediatric mental health observation
	Policy and procedure for pediatric suicide screening
	Policy for medical screening exam for pediatric patients with mental health complaints
	Clinical pathways guideline for management of children with mental health problems, including special populations
	Pediatric de-escalation policy and procedure
	Policy and procedure for pediatric restraint
	Arrangements/Transfer agreements with community agencies for children's mental health (and substance use) <u>referral/follow up</u>
	Arrangements/Transfer agreements with community mental health crisis services to provide community-based mental health <u>crisis interventions</u>
Pediatric Competencies	Mandatory mental health de-escalation training for all staff
	Mandatory trauma-informed care training for all staff
Support Services	Mental health professional consultation available 24/7
Infrastructure*	Dedicated location and space for pediatric patients with mental health complaints
<sup>^</sup> These measures were proposed by the Emergency Mental Health Quality Improvement Collaborative for Kids (EMQUICK) composed of 22 national experts in children's mental health Co-Chaired by Drs. Susan Duffy and Tom Chun. EMQUICK works collaboratively to assist in the development and implementation of rigorous, evidence-based quality improvement measures for pediatric mental health care in emergency departments (ED).	
* Not considered a pediatric readiness domain.	

## Appendix C: Evaluation of NPRQI Measures

(3-point Likert scale)

		National Quality Forum Criteria							
		Importance		Scientific Acceptability		Usability		Feasibility	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
<b>Timely Recognition</b>									
1	Percentage of patients with weight documented in kilograms only	3.00	0.00	2.93	0.26	3.00	0.00	3.00	0.00
2	Percentage of medication dosing errors for target medications	3.00	0.00	2.93	0.26	2.79	0.56	2.64	0.61
3	Percentage of patients with a full set of vital signs	2.86	0.52	2.79	0.41	2.71	0.59	2.71	0.59
4	Percentage of patients with pain assessed	2.71	0.45	2.57	0.49	2.46	0.63	2.69	0.46
5	Percentage of patients with abnormal vital signs included in notification process	3.00	0.00	2.79	0.41	2.57	0.62	2.57	0.62
6	Median time from first set of vitals to first intervention	2.50	0.63	2.36	0.72	2.21	0.56	2.36	0.48
7	Percentage of patients with vital signs re-assessed	2.57	0.49	2.71	0.45	2.50	0.63	2.57	0.49
8	ED Length of Stay	2.14	0.64	2.07	0.70	2.29	0.70	2.57	0.62
<b>Interfacility Transfers</b>									
1	Median time from arrival to transport	2.64	0.48	2.57	0.62	2.71	0.45	2.57	0.62
2	Percentage of families who received transfer packet	2.21	0.67	1.93	0.70	2.14	0.64	2.00	0.65
3	Percentage of transferred patients who were discharged from the receiving center ED within less than 24 hours from arrival	2.29	0.59	2.21	0.56	2.29	0.59	2.23	0.58
4	Percentage of transfers that met minimum site-specific criteria	2.43	0.62	2.14	0.64	2.36	0.61	2.29	0.59
<b>Blunt Head Trauma</b>									
1	Percentage of patients with full set of vital signs (must include GCS and pain)	3.00	0.00	3.00	0.00	2.93	0.26	2.93	0.26
2	Percentage of patients with head CT	3.00	0.00	3.00	0.00	2.93	0.26	2.86	0.35
3	Percentage of CTs that used appropriate dose for weight	2.43	0.62	2.36	0.72	2.29	0.80	2.36	0.72
4	Median time to CT scan	2.57	0.62	2.36	0.72	2.36	0.72	2.29	0.80
5	Percentage of patients with GCS re-assessment	2.57	0.62	2.50	0.63	2.29	0.70	2.29	0.70
6	Patients that received telemedicine assessment	1.93	0.59	1.79	0.67	1.93	0.59	1.86	0.74
7	Percentage of patients intubated (last GCS to be included)	2.64	0.61	2.50	0.63	2.71	0.59	2.71	0.59
8	Percentage who received hypotonic fluid (D10W, 1/2NS, 1/4NS)	2.29	0.59	2.43	0.62	2.36	0.61	2.36	0.72
9	Median time to transfer	2.71	0.45	2.64	0.48	2.79	0.41	2.86	0.35
10	Percentage of patients with return precautions on discharge summary	2.36	0.72	2.36	0.61	2.43	0.62	2.36	0.72
<b>Seizures</b>									
1	Percentage of patients with full set of vital signs (must include mental status (GCS, AVPU) and pain)	2.79	0.41	2.79	0.41	2.64	0.61	2.71	0.59
2	Percentage of patients with neurologic re-assessment	2.86	0.35	2.79	0.41	2.64	0.61	2.57	0.62

3	Percentage of patients who received diagnostic assessment (1 or more elements from target list: blood work, UA, lumbar puncture, head CT)	2.29	0.80	2.21	0.77	2.29	0.80	2.36	0.72
4	Percentage of patients with blood glucose level assessed or documented (pre-hospital or ED setting)	2.93	0.26	2.86	0.35	2.86	0.35	2.92	0.27
5	Percentage of patients that utilize telemedicine (percentage of patient consults with other facility prior to transfer)	1.86	0.52	1.79	0.56	1.93	0.59	2.00	0.53
6	Percent of CTs that used appropriate dose for weight	2.29	0.70	2.21	0.77	2.21	0.77	2.29	0.70
7	Median time to first medication in the emergency department	2.71	0.45	2.57	0.49	2.43	0.49	2.43	0.62
8	Percentage of patients with medication dosing errors (outside 20%)	2.71	0.59	2.79	0.41	2.50	0.63	2.50	0.50
9	Percentage of patients whose treatment aligns with medication component of guidelines	2.79	0.41	2.71	0.59	2.43	0.62	2.43	0.73
10	Time to first respiratory intervention	2.79	0.56	2.64	0.72	2.43	0.73	2.36	0.81
11	Percentage of children discharged from receiving ED	1.79	0.56	1.64	0.48	1.57	0.49	1.64	0.61
<b>Respiratory Distress</b>									
1	Percentage of patients with full set of vital signs	2.93	0.26	2.92	0.27	2.79	0.56	2.93	0.26
2	Percentage of patients with vital signs re-assessed	2.86	0.35	2.86	0.35	2.86	0.35	2.86	0.35
3	Percentage of steroids administered	2.71	0.45	2.71	0.45	2.57	0.62	2.50	0.63
4	Median time to steroids	2.57	0.49	2.57	0.49	2.57	0.62	2.50	0.63
5	Percentage of patients that receive antibiotics	2.29	0.70	2.29	0.70	2.21	0.67	2.00	0.70
6	Median time to albuterol administration in asthma exacerbation	3.0	0.00	3.00	0.00	2.93	0.26	2.93	0.26
7	Percentage of patients with labs collected	2.07	0.46	2.00	0.38	1.86	0.52	1.86	0.52
8	Percentage of patients that received albuterol	2.36	0.61	2.36	0.48	2.14	0.64	2.21	0.67
9	Percentage of patients with chest x-ray	2.43	0.62	2.50	0.50	2.21	0.77	2.14	0.74
10	Percentage of patients with suctioning used	2.36	0.72	2.36	0.61	2.07	0.80	2.00	0.76
11	Percentage of patients with oral fluid challenge	1.93	0.59	1.93	0.59	1.79	0.67	1.93	0.70
12	Percentage of patients less than 18 months of age with a diagnosis of asthma	1.64	0.61	1.64	0.61	1.57	0.62	1.57	0.62
<b>Vomiting/Diarrhea</b>									
1	Percentage of patients with full set of vital signs (must include GCS and pain)	2.92	0.27	2.92	0.27	2.85	0.36	2.92	0.27
2	Percentage of patients with vital signs re-assessed	2.85	0.36	2.77	0.42	2.77	0.42	2.77	0.42
3	Percentage of patients with abnormal CT scan	2.23	0.80	2.23	0.80	2.15	0.66	2.23	0.58
4	Percentage of patients that received ultrasound before CT (time stamps both u/s and CT)	2.54	0.63	2.46	0.75	2.46	0.75	2.46	0.75
5	Percentage of CTS that used appropriate dose for weight	2.62	0.62	2.62	0.62	2.38	0.62	2.42	0.64
6	Time to first antiemetic and route administration	1.92	0.73	2.0	0.68	2.00	0.68	2.00	0.68

7	Percentage of patients that received IV/SC/IO fluids	2.31	0.82	2.15	0.77	2.15	0.77	2.08	0.73
8	Percentage of patients that received oral rehydration therapy	2.46	0.75	2.38	0.74	1.92	0.92	2.00	0.88
<b>Behavioral Health</b>									
1	Percentage of patients who had a structured suicide screening	1.96	0.19	1.67	0.62	1.81	0.48	1.81	0.48
2	Percentage of patients with a positive suicide screen who had a structured suicide assessment	1.89	0.32	1.59	0.69	1.74	0.45	1.59	0.64
3	Percentage of patients who received a standardized substance abuse screen	1.44	0.70	1.56	0.64	1.41	0.64	1.48	0.64
4	Percentage of patients screened for intimate partner violence	1.33	0.78	1.22	0.58	1.26	0.66	1.3	0.67
5	Percentage of patients screened for other family/domestic violence	1.48	0.75	1.26	0.71	1.37	0.63	1.41	0.64
6	Percentage of patients screened for human trafficking	1.63	0.49	1.04	0.71	1.3	0.61	1.15	0.72
7	Percentage of patients screened for child abuse	1.89	0.32	1.48	0.75	1.7	0.47	1.56	0.58
8	Percentage of pediatric patients that received consultation with a licensed mental health professional	1.85	0.36	1.48	0.70	1.33	0.62	1.41	0.64
9	Percentage of pediatric patients that received a discharge safety plan	1.93	0.27	1.63	0.63	1.78	0.42	1.56	0.70
10	Percentage of pediatric patients that underwent blood work/drug screening	0.96	0.76	0.96	0.85	1.07	0.78	1.11	0.75
11	Percentage of patients that received behavioral health follow-up	1.89	0.32	1.48	0.70	1.52	0.70	1.33	0.78
12	ED Length of Stay (arrival to disposition)	1.33	0.68	0.96	0.76	1.11	0.85	1.26	0.76