

Defining Significant Events for Neonatal and Pediatric Transport: Results of a Combined Delphi and Consensus Meeting Process

A. C. Gunz¹ J. D. McNally² H. Whyte³ K. O'Hearn⁴ J. R. Foster^{1,5} M. J. Parker^{6,7} S. Dhanani²

¹Department of Paediatrics, Schulich School of Medicine & Dentistry, Western University, London, Ontario, Canada

²Division of Critical Care, Department of Pediatrics, University of Ottawa, Children's Hospital of Eastern Ontario, Ottawa, Canada

³Division of Neonatology, Department of Paediatrics, University of Toronto, Hospital for Sick Children, Toronto, Canada

⁴Children's Hospital of Eastern Ontario Research Institute, Ottawa, Canada

⁵Department of Pediatrics, Dalhousie University, Halifax, Canada

⁶Division of Critical Care, Department of Pediatrics, McMaster University, Hamilton, Ontario, Canada

⁷Division of Emergency Medicine, Department of Pediatrics, University of Toronto, Hospital for Sick Children, Toronto, Canada

Address for correspondence A. C. Gunz, MD, FRCPC, FAAP, Division of Pediatric Critical Care Medicine, C2-847, London Health Sciences Center, 800 Commissioners Road East, London, ON N6A 5W9, Canada (e-mail: anna.gunz@lhsc.on.ca).

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Abstract

Objective To develop standardized definitions for a list of indicators that represent significant events during pediatric transport, which were previously identified by a national Delphi study.

Methods We designed a three-phase consensus process that applied Delphi methodology to a combination of electronic questionnaires and a live consensus meeting.

Results Thirty-one pediatric transport experts evaluated a total of 59 indicators. Twenty-four indicators represented events or interventions that did not require definition. One indicator was removed from the list. Definitions for the remaining 34 indicators were developed.

Conclusion This standardized indicator list is intended for application to quality improvement and clinical research initiatives.

Keywords

- ▶ transportation of patients
- ▶ outcome assessment (health care)
- ▶ intensive care units
- ▶ pediatrics

Introduction

The transport of critically ill children from initial stabilizing hospitals to specialized pediatric facilities for ongoing medical and surgical management is a high-risk procedure. Transport distances can be extensive and may require transition between various modes of transportation. With exposure to environmental hazards, in combination with the potential for worsening of the underlying disease state, these children are at risk of experiencing adverse events (AE).^{1,2} In addition, this risk of AE increases due to the unique challenges of providing patient care during transport, including awkward physical access to the patient, difficulties with physiologic monitoring, and limited resources.

AE rates in the literature vary widely, from 1.5 to 91% of pediatric transports.^{1–7} While some of the disparity in AE rates is due to differences in the structure and degree of pediatric specialization of transport teams, it is likely that the variation in the choice and definition of AE between studies also contributes. Discrepant definitions of AE create challenges for the design of quality improvement and research initiatives in pediatric transport medicine, and indeed make it difficult for individual teams to benchmark and assess their own performance. Adoption of a well-defined, standardized list of indicators will enhance the consistency of event reporting and enable comparisons between different

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transport services. To facilitate this, we previously used Delphi methodology to identify an inclusive list of indicators relevant to pediatric transport medicine and represent significant events if they occur while the transport team is in direct contact with a patient during patient retrieval.⁸ This paper reports on the second stage of the consensus process whereby we used a systematic, consensus-based methodology to establish definitions for each of these indicators.

Materials and Methods

Study Design

We conducted a Delphi-questionnaire process and consensus meeting to review and establish definitions for the indicators identified by the initial study.⁸ In the absence of a standardized methodology, our protocol was developed after a literature review of consensus meetings that applied a Delphi methodology^{9–19} and consultation with local researchers who had experience with the design and coordination of consensus meetings.^{20,21} Approval for this consensus process was obtained from the Institutional Review Board at the Children's Hospital of Eastern Ontario.

Participant Selection

We sought a panel of physician and nonphysician health care providers with expertise in neonatal and pediatric transport medicine and with representation from different regions and transport services from across the country. Panelists were obtained from two sources: (1) participants from the initial Delphi study,⁸ and (2) other health care providers and stakeholders who became aware of the program of research after the completion of the initial study. The process by which the initial Delphi panel was selected has been previously described.⁸ Briefly, panelists were identified through contact with the medical directors of the 16 pediatric intensive care units in Canada, as well as senior members of two independent transport organizations. The latter two organizations are respectively responsible for (1) patient transport in the most populated Canadian province, Ontario, and include service to 4 pediatric intensive care units, and (2) transport of children from a large region of one of Canada's arctic territories, Nunavut. All participation was voluntary.

The panel included experts from transport teams that provide care for patients aged from birth to 18 years across a broad range of transport environments. A variety of patient volumes and acuity, geographies (including mountainous, coastal, forested, and arctic desert), distances (up to thousands of miles), population densities, modes of transport (including land, helicopter, plane, and boat), and team structures (provider type, level of pediatric specialization, and physician presence on transport) were represented.

Consensus Process

Preliminary definitions for indicators were developed from two sources: (1) suggestions from participants in the initial study,⁸ and (2) from recognized sources that were modified when necessary to suit the transport population/environments.^{22–41} The consensus process had three phases: a premeeting

electronic questionnaire, a consensus meeting, and a postmeeting electronic-based Delphi process. In the premeeting questionnaire, participants first indicated whether an indicator required a definition. Where a definition was required, they indicated which definition they preferred, any they would consider acceptable, and had the opportunity to propose an alternate definition. Responses were collated and anonymized and presented at a consensus meeting hosted in Toronto, Ontario, Canada, May 2, 2013. The definition with the highest rate of preference was reviewed for modification through a two-iteration process of discussion and voting. Definitions without 100% consensus were moved to the phase 3 postmeeting process, wherein a refined literature search and expert deliberation generated a modified definition that was then evaluated by the full expert panel using Delphi methodology, as previously described.⁸ Data for the post meeting Delphi were collected and managed using REDCap electronic data capture tools hosted at the CHEO Research Institute.⁴² The minimum level of agreement was set at 80% for the postmeeting process. Given the multiple consensus-building techniques that we applied to this study, including a face-to-face meeting, and that this definition-building process was separate from initial indicator selection, we refer to this study as a consensus process rather than a Delphi study. Principles of Delphi methodology were applied where possible, including using multiple iterations to establish consensus, a priori defined consensus, and preserving anonymity in the pre- and postmeeting phases.

Statistical Analysis

Microsoft Office Excel 2007 software (Microsoft Canada Inc., Mississauga, Ontario, Canada) was used to tabulate survey responses in the pre- and postmeeting processes and perform descriptive statistical analyses.

Results

A total of 29 experts from 10 institutions participated in one or more stages of the definition consensus process, 18 of whom (from 8 institutions) joined the consensus meeting. **Table 1** displays the demographic characteristics of the expert panel. Of note, the panel included physicians (pediatric intensivists, pediatric emergency physicians, and neonatologists) as well as nonphysician health care providers (including, nurses, nurse practitioners, paramedics, and respiratory therapists). Our panel included some participants with < 5 years of experience but who had relevant methodologic expertise, experience working specifically with transport metrics, and/or ensured regional representation.

Of the 52 indicators that were identified during our original Delphi process,⁸ the panel subdivided 2 indicators for clarity and identified the need for separate neonatal and pediatric definitions for 5 indicators, resulting in the discussion of 59 definitions (**Table 2**). Overall, 24 indicators did not require further definition as they represented clear clinical events (e.g., seizure, death) or interventions (vagal stimulation, endotracheal intubation). One indicator (cyanosis) was removed as it was felt to be redundant when the indicators apnea, respiratory arrest, and respiratory deterioration were all included.

Table 1 Consensus study expert panel profession and experience

Characteristics	No. (%)
<i>Health care profession</i>	29
Physician	18
Neonatologist	4 (22)
Pediatric emergency physician	3 (17)
Pediatric intensivist ^a	11 (61)
<i>Nonphysician health care provider</i>	13
Registered nurse ^b	6 (46)
Nurse practitioner	2 (11)
Registered respiratory therapist	2 (11)
Critical care paramedic	3 (23)
<i>Experience (y)</i>	
< 5	5 (17)
5–10	5 (17)
10–15	7 (24)
> 15	12 (41)
<i>Patient population of transport^c</i>	
Neonatal	21 (72)
Pediatric	26 (90)
Adult	2 (7)
<i>Role in pediatric transport medicine^c</i>	
Administrative/supervisor	6 (21)
Telephone advice/consultation	20 (69)
Bedside patient care ^d	22 (76)

^aOne pediatric intensivist is also an emergency physician.

^bOne nurse practitioner and one registered nurse are certified paramedics.

^cPercentages may add up to > 100% as survey participants could indicate more than one category.

^dBedside patient care includes care at the peripheral hospital and/or during transport between facilities.

Of the 34 remaining indicators, there was 100% acceptance without modification of 12 definitions that were initially proposed in the premeeting questionnaire. Of the other 22 definitions discussed at the consensus meeting, 18 were modified and accepted at the consensus meeting and 4 were moved to the postmeeting process, which included a full Delphi process. After further definition development, three of these indicators were accepted by the panel after one Delphi iteration, and the remaining indicator was accepted after two Delphi iterations. The phase at which consensus was reached for each indicator is listed with their respective definitions in **Table 2**.

Discussion

Considerable variability has been noted in the AE rates reported in the pediatric transport literature.^{1–7} This

variability is in part likely due to inconsistency in the indicators selected as outcome measures, as well as differences in how these indicators are defined. This consensus process is the first to provide a comprehensive list of significant and relevant event indicators and accompanying definitions for use within pediatric transport medicine.

Standardized definitions to enhance the comparability of different event rates for the purpose of benchmarking and research is explicitly stated as a best practice for surveillance of health care–associated infection (HAI).⁴³ This prompted the standardization of definitions for many conditions, including pediatric acute respiratory distress syndrome,⁴⁴ nosocomial infection,⁴⁵ and pediatric sepsis.²² Adoption of this indicator list and definitions by pediatric transport services may enhance the consistency of event reporting and, in so doing, enable comparisons between different transport services and environments. In addition, the list and definitions may be used to provide cutoff values for concern and allow individual agencies to benchmark team performance against a standard.

Bigam and colleagues introduced a consensus-based list of pediatric transport quality metrics^{18,19} with the aim to provide a truncated list of metrics to measure and track quality of care. While there is some overlap with our event indicators, our goals differed. While the goal of the aforementioned list was to develop a truncated list of metrics to measure and track quality of care, our aim was to develop an inclusive list of significant event indicators to identify *all* AE on transport. Given that our consensus process identified 21 novel indicators not previously measured in the literature, we are concerned that adverse event rates are still underreported. To effectively benchmark transport team performance and launch effective quality assurance strategies, we must first ensure we accurately understand the risks of transport. While the long indicator list may appear burdensome, when applied to a transport database, multiple indicators should signal different aspects of the same event, thus hopefully improving the sensitivity of event detection. Transport teams should then review each identified event to note whether it represented an adverse event and for any modifiable contributing factors. For example, if a patient developed hypotension en route, this may be signaled in the database by low blood pressure, administration of fluids, or initiation/escalation of inotropes. When this event is reviewed, it should be determined whether this was caused by the transport process (e.g., medication administration), inadequate pre-transport resuscitation, or whether this was inevitable given their severity of illness. Quality assurance initiatives should target any concerns.

Within the adult literature, Papson et al⁴⁶ developed a checklist of unexpected events for intrahospital transport of adult patients. This checklist focused largely on indicators that represent equipment-related issues and physiologic deterioration. By incorporating trigger tools (e.g., procedural interventions) and team process issues (e.g., communication and medication error), our pediatric list is more extensive and inclusive, which may improve event detection during transport for the purpose of quality assurance initiatives and the improvement of patient safety.

Table 2 Final agreed indicator definitions

Indicator	Definition	Stage at which agreement reached
Physiologic deterioration		
Respiratory failure, as indicated by		
Apnea	Cessation of respiratory airflow for ≥ 20 s; or shorter if associated with cyanosis, marked pallor, hypotonia or bradycardia	Consensus meeting (unmodified from premeeting questionnaire)
Disordered breathing	Pattern of breathing, including periods of apnea and hypopnea, which does not allow for adequate oxygenation or ventilation	Consensus meeting (unmodified from premeeting questionnaire)
Hypercapnia	CO ₂ > 55 mm Hg (end tidal, arterial, venous, transcutaneous, capillary) ²⁷	Consensus meeting
Provided Asherman chest seal or chest tube placement	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Provided bag-mask ventilation	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Provided endotracheal intubation	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Provided laryngeal mask insertion	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Provided needle or surgical cricothyrotomy	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Provided needle thoracostomy	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Provided noninvasive ventilatory support	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Pulmonary aspiration	Observed event of aspiration of foreign substance (e.g., vomitus) with associated change in oxygenation needs or respiratory status	Consensus meeting (unmodified from premeeting questionnaire)
Respiratory arrest	No definition required	Premeeting questionnaire
Respiratory deterioration	Defined by at least one of the following: <ul style="list-style-type: none"> • Increased work of breathing • Increased oxygen requirements • Increased carbon dioxide retention • Increased ventilator parameters from baseline 	<i>Neonatal definition:</i> Consensus meeting (modified from premeeting questionnaire despite 100% acceptance in this stage) <i>Pediatric definition:</i> Consensus meeting
Cardiac instability, as indicated by		
Cardiac arrest	No definition required	Consensus meeting
Cardiac bradycardia	Mean heart rate < 10th percentile. ¹¹ By age: <ul style="list-style-type: none"> • 0 d to 2 y: < 100 beats/min • > 2 y old: < 60 beats/min 	Consensus meeting
Cardiac tachycardia	A mean heart rate that is > 2 SD (standard deviation) above age-defined norms. ¹¹ By age: <ul style="list-style-type: none"> • 0 d to 1 y: > 180 beats/min • 2–5 y: > 140 beats/min 	Consensus meeting

Table 2 (Continued)

Indicator	Definition	Stage at which agreement reached
	<ul style="list-style-type: none"> • 6–12 y: > 130 beats/min • 13–18 y: > 110 beats/min 	
Death during transport	No definition required	Premeeting questionnaire
Hypothermia	<p><i>Neonates</i>: Core body temperature¹²:</p> <ul style="list-style-type: none"> • Mild: 36–36.4°C • Moderate: 32–35.9°C • Severe: < 32°C <p><i>Pediatric</i>: Body temperature < 36°C, excluding therapeutic hypothermia¹¹</p>	<p><i>Neonatal definition</i>: Consensus meeting (unmodified from premeeting questionnaire)</p> <p><i>Pediatric definition</i>: Consensus meeting</p>
Initiation or escalation of vasoactive/inotropic medication	Increased requirement for vasoactive/inotropic support, indicated by introduction of new inotropic/vasoactive medication or increase in dose administered	Consensus meeting (unmodified from premeeting questionnaire)
Provided cardiopulmonary resuscitation or chest compressions	No definition required	Premeeting questionnaire: The prefix “Received” was changed to “Provided” during meeting discussion
Provided cardioversion or defibrillation	No definition required	Premeeting questionnaire: The prefix “Received” was changed to “Provided” during meeting discussion
Provided transcutaneous pacing	No definition required	Premeeting questionnaire: The prefix “Received” was changed to “Provided” during meeting discussion
Provided vagal stimulation	No definition required	Premeeting questionnaire: The prefix “Received” was changed to “Provided” during meeting discussion
Systemic hypotension	<p><i>Neonates</i>^a: Mean arterial pressure (MAP) less than gestational age</p> <p><i>Pediatric</i>^a: Systolic blood pressure < 5th percentile for age-defined norms.¹³ By age¹¹:</p> <ul style="list-style-type: none"> • 1 mo to 1 y: < 70 mm Hg • 1–10 y: < 70 mm Hg + 2 × age • > 10 y: < 90 mm Hg or <p>Mean blood pressure < 5th percentile for males at the 95th percentile for height, by age (selecting the highest MAP available)¹⁴:</p> <ul style="list-style-type: none"> • 1 mo to 1 y: < 40 mm Hg • 1–5 y: < 50 mm Hg • 5–10 y: < 60 mm Hg • > 10 y: < 65 mm Hg 	Pediatric definition of hypotension by systolic blood pressure and neonatal definitions were accepted at the consensus meeting. Pediatric definition of hypotension by mean blood pressure was accepted during postmeeting Delphi after one iteration (92% agreement)
Neurologic deterioration, as indicated by		
Acute loss of spinal cord function	Flaccidity, areflexia, and loss of sensation of extremities below level of presumed injury	Consensus meeting (unmodified from premeeting questionnaire)
Change in mental status	An acute change in mental status with a decrease in the Glasgow coma score (GCS) of ≥ 3 points from abnormal baseline, with neurologic dysfunction defined as GCS ≤ 11 ¹¹	Consensus meeting
Change in pupillary response	<p>A deviation from patient’s baseline pupillary response, including</p> <ul style="list-style-type: none"> • Pupils become slow to respond • Pupils are no longer equal in size or response to light • Pupils are fixed and dilated 	Consensus meeting (unmodified from premeeting questionnaire)

(Continued)

Table 2 (Continued)

Indicator	Definition	Stage at which agreement reached
Clinical seizure	No definition required	Premeeting questionnaire
Loss of brainstem reflexes	No definition required	Consensus meeting
Significant increase in urine output	Urine output ≥ 4 mL/kg/h <i>not</i> related to medications	Consensus meeting
Signs of increased intracranial pressure	Decrease from baseline in level of consciousness, and two of the following: <ul style="list-style-type: none"> • Hypertension • Bradycardia • Pupillary changes (As defined above) • Respiratory pattern changes on a nonventilated patient 	Consensus meeting
Renal and electrolyte abnormalities, as indicated by		
Absolute or relative hyponatremia	Serum sodium < 135 mmol/L or a decrease of > 5 mmol/L ¹⁵⁻¹⁷	Consensus meeting
Provided administration of dextrose or glucagon	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Hyperkalemia	Neonates: Serum potassium > 6.0 mmol/L ²⁰ Pediatric: Serum potassium > 5.5 mmol/L ^{15,18-20}	Consensus meeting
Hypoglycemia	Serum glucose < 3 mmol/L ²¹⁻²⁶	<i>Neonatal definition:</i> Consensus meeting (modified from premeeting questionnaire despite 100% acceptance in this stage) <i>Pediatric definition:</i> Consensus meeting
Equipment failure and other urgent interventions		
Accidental extubation	No definition required	Premeeting questionnaire
Equipment or vehicle failure	No definition required	Consensus meeting: Description modified from "equipment failure (e.g., IV pump failure, ventilator failure)"
Failure to provide oxygenation from exhaustion of supply or unintentional disconnection	No definition required	Premeeting questionnaire
Intravenous (IV) extravasation of caustic medication	No definition required	Premeeting questionnaire
Loss of peripheral IV access	No definition required	Premeeting questionnaire
Need for intraosseous needle insertion	No definition required	Premeeting questionnaire
Obstructed endotracheal tube	Inability to provide airflow through the endotracheal tube due to intra- or extraluminal obstruction	Consensus meeting
Provided removal of foreign object from airway	No definition required	Premeeting questionnaire: The prefix "Received" was changed to "Provided" during meeting discussion
Specific medication/intervention triggers for acute patient deterioration	Administration of medications for resuscitation (epinephrine, atropine, sodium bicarbonate, amiodarone, adenosine, lidocaine), any fluid bolus administration > 60 mL/kg, hypertonic saline or mannitol bolus, inhaled nitric	Consensus meeting (modified from premeeting questionnaire despite 100% acceptance in this stage)

Table 2 (Continued)

Indicator	Definition	Stage at which agreement reached
	oxide, prostaglandins, flumazenil, naloxone, or blood products	
Process errors and transport team safety issue		
Communication error	Error that occurs due to failure to accurately receive or transmit information between two parties ²⁸	Consensus meeting (unmodified from premeeting questionnaire)
Inability to properly and safely access and secure patient during transport	Inadequate infrastructure in transport vehicle to secure patient according to governmental safety standards, and inability for transport crew to adequately access the patient for an emergent reason without compromising the safety of themselves or the patient	Consensus meeting (unmodified from premeeting questionnaire)
Lack of appropriate equipment or supplies in patient transport environment	Inability to provide appropriate level of care to patient due to transport environment	Consensus meeting (modified from premeeting questionnaire despite 100% acceptance in this stage)
Lack of neck immobilization in a patient for whom a neck injury cannot be excluded	Cervical spine precautions for the following patients: high-speed motor vehicle collision (> 100 km/h), rollover, ejection; axial load to head; fall from > 3 ft/5 stairs; bicycle crash; paresthesias in extremities or focal neurologic deficits; cervical spine tenderness; distracting injury or decreased loss of consciousness where suspicious mechanism of injury cannot be excluded	Consensus meeting (unmodified from premeeting questionnaire)
Medication error	<p>a) A deviation from the weight-appropriate dose (ordered or given) by > 20%, or drug-related serious adverse event (SAE, defined by Health Canada^a) or</p> <p>b) May include any of the following: incorrect drug; documented allergy to medication; incorrect IV rate; incorrect time for medication; incorrect patient; incorrect method of administration; medication omission</p> <p>^aHealth Canada definition of SAE: A serious adverse event (experience) or reaction is any untoward medical occurrence that at any dose: results in death; is life-threatening^b; requires inpatient hospitalization or prolongation of existing hospitalization; results in significant disability/incapacity; or is a congenital anomaly/birth defect</p> <p>^bNote: The term “life-threatening” in the definition of “serious” refers to an event in which the patient was at risk of death at the time of the event; it does not refer to an event that hypothetically might have caused death if it were more severe²⁹</p>	Consensus meeting
Delays in transport (e.g., weather-related, access to flight/land crews)	<p>Delay in the urgent transport of a pediatric patient from a sending to receiving facility at any point during transport, including a delay in 1 or more of the of the following³⁰:</p> <p>A) <i>Dispatch time</i>: time from receipt of transport call to transport team dispatch in excess of 15 min</p> <p>B) <i>Mobilization time</i>: time from</p>	Postmeeting Delphi after two iterations (88% agreement)

(Continued)

Table 2 (Continued)

Indicator	Definition	Stage at which agreement reached
	<p>transport team dispatch to departure from home hospital/base in excess of:</p> <p>For land transport:</p> <ul style="list-style-type: none"> i) > 15 min for transport teams with dedicated staffing (24 h/d, 7 d/wk) ii) > 30 min for transport teams with nondedicated staffing <p>For air transport (<i>Note: this only includes time from team dispatch to departure from home base/hospital and does not include transport time to airport</i>):</p> <ul style="list-style-type: none"> i) > 30 min for transport teams with dedicated staffing 24 h/d, 7 d/wk ii) > 60 min for transport teams with nondedicated staffing <p>C) <i>For air transport</i>: Delay for any reason that occurs between the departure from home base/hospital to aircraft engines on considering what is reasonable for the distance covered/type of aircraft used.</p> <p>D) <i>Time en route</i>: Delay that occurs for any reason between transport team departure to arrival at receiving facility, considering what is reasonable given the geographic distance covered and mode(s) of transportation used.</p> <p>E) <i>Stabilization and preparation time</i>: The time taken by the transport team to stabilize patient and prepare them for transport. All transports should be reviewed if this time is in excess of:</p> <ul style="list-style-type: none"> i) 60 min for pediatric transports ii) 120 min for neonatal transports <p>F) <i>Out-of-hospital time</i>: The total amount of time spent by the patient between facilities in the transport environment, considering what is reasonable given the geographic distance covered and mode(s) of transportation used.</p>	
Unsafe environment for transport crew due to personal crew factors	Includes, but is not limited to, safety policies pertaining to impairment from exhaustion, drugs, alcohol, illness, or injury; appropriate clothing for environmental conditions (both expected and potential); crew members fit the personal physical requirements specified by the transport team; additional crew stressors (e.g., challenges to adequate nutrition and hydration); adequate transport crew education/training given patient demands and transport environment; appropriate orientation of team members to transport vehicles.	Postmeeting Delphi after one iteration, although wording slightly modified in second iteration after consistent written feedback (85% agreement)
Unsatisfactory safety environmental for transport crew	Includes, but is not limited to, access to government-mandated safety items (e.g., seatbelts); exposure to external environmental conditions (strict adherence to vehicle-specific minimal weather requirements); appropriate medical configuration of vehicle (e.g., adequate lighting, reduced vibration and noise, adequate supplies); adequate and	Postmeeting Delphi after one iteration, although wording slightly modified in second iteration after consistent written feedback (85% agreement)

Table 2 (Continued)

Indicator	Definition	Stage at which agreement reached
	functioning communication equipment for crew members, including when appropriate, hands-free technology for driver/pilot; adequate environment/vehicle configuration to facilitate adherence to team-specific safety policies (e.g., guidelines regarding when to provide unrestrained care to the patient, standard precautions, transport of family members); adequate pressurization capabilities of transport vehicle; access to appropriate personal protective equipment.	

Note: Definitions with citations were adopted or modified from specified references.

^aThese values may not correlate with a clinical diagnosis of hypotension if other signs of end organ perfusion are adequate, but provide a diagnostic cutoff for further evaluation.

Given that defining entities within health care is not an objective straightforward science this consensus process had several strengths. The initial definitions for discussion were grounded in the literature and the integrated, multi-level Delphi process was rigorous with high levels of consensus (> 85%) at each stage. The pre- and post-meeting processes provided the necessary time and means for input of all participants (esp. for any controversial definitions at the meeting) and prevented forced consensus at the meeting due to time constraints. Of particular note is the diverse panelist representation of experience, profession, geographic scope, transport mode, and team composition.

There are limitations of this consensus process and the definitions generated. First and foremost, although the definitions were grounded in the literature where possible, they are based on expert consensus interpretation and judgment. While the indicators have good face validity, the content validity and reliability of the indicators to identify all AE and adverse outcomes are unknown and require examination. Although the panelist representation was diverse, the generalizability of these findings to jurisdictions outside Canada is unknown. Transport teams will differ in their ability to measure some indicators (particularly laboratory values) based on differences in resources and access to technology, which may limit applicability of the indicators and definitions. However, the importance of providing definitions for the indicators relevant to each team (as a minimum set) will still improve standardization between studies.

Application and Future Directions

This inclusive list of indicators and their definitions is intended for application to neonatal and pediatric transport services and associated databases for prospective data capture. Efforts to create a national pediatric transport database in Canada that incorporates these indicators are currently underway, and will be used to assess the validity of indicators with the definitions provided, including their relation to

patient outcome. Broad application of this list may facilitate benchmarking of different transport teams, quality assurance programs, and clinical research initiatives.

Conclusion

We completed an interdisciplinary, national consensus process using Delphi methodology to verify the importance of, and establish definitions for, indicators that represent significant events during pediatric transport. We believe application of these indicators to the pediatric transport environment could improve the sensitivity of event detection that we hope will facilitate enhanced patient safety and quality improvement initiatives.

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Medical Director of Neonatal Transport Team, Department of Pediatrics, University of Ottawa, Children's Hospital of Eastern Ontario, Ottawa, Canada; N. Jackson, RN BScN, Neonatal Transport Team, Children's Hospital of Eastern Ontario, Ottawa, Canada; Trevor Lang, Critical Care Flight Paramedic, Ornge; Angelo Mikrogianakis, Chief, Section of Pediatric Emergency Medicine, Co-Director of Critical Care Transport Program, Associate Professor of Pediatrics, University of Calgary, Alberta Children's Hospital, Calgary, Alberta, Canada; Hadi Mohseni-Bod, MD, MRCPCH (U.K.), Pediatric Intensivist, Hospital for Sick Children, Toronto, Canada; Lisa Ramnarine, BSc, RRT, Neonatal Transport Team, Pediatric CCRT, Children's Hospital of Eastern Ontario, Ottawa, Canada; Stephanie Redpath, MBChB, FRCPC (U.K.), Medical Director CHEO Transport Team, Neonatologist, Division of Neonatology, Department of Pediatrics, University of Ottawa, Children's Hospital of Eastern Ontario, Ottawa, Canada; Janlyn Rozdisky, RN(NP), MN CNCCP(C), Clinical Nurse Educator, Pediatric Intensive Care Unit, Royal University Hospital, Saskatoon, Saskatchewan, Canada; Gabriela Speck, RRT, Neonatal Transport Team, Children's Hospital of Eastern Ontario, Ottawa, Canada; Tanya Spence, RN MN, Clinical Nurse Specialist ECLS Program, Pediatric Critical Care Transport Program, Pediatric Intensive Care Unit, Alberta Children's Hospital, Alberta, Canada; Jeremiah Soucie, BHSc, MBA CCP(f) Critical Care Flight Paramedic, Ornge; Ronald K. Tam, MD, FRCPC, Assistant Professor of Departments of Pediatrics and Emergency Medicine, University of Ottawa, Staff Pediatric Emergency Medicine Physician, Children's Hospital of Eastern Ontario, Ottawa, Canada; Janice A. Tijssen, MD, FRCPC, FAAP, Pediatric Intensivist, Department of Pediatrics, Schulich School of Medicine & Dentistry, Western University, London, Ontario, Canada; Penny Triggs, VP Air Medical Operations, Keewatin Air; Mary Wagner, AEMCA, Pediatric Critical Care Paramedic, Ornge; David Wensley, MD FRCPC, Division Head, Critical Care, Department of Pediatrics, University of British Columbia, Vancouver, Canada; Hilary Writer, MD, FRCPC, Assistant Professor, Division of Critical Care, Department of Pediatrics, University of Ottawa, Children's Hospital of Eastern Ontario, Ottawa, Canada.

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