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PAIN MANAGEMENT (S MACE, SECTION EDITOR)

Advocating For Pediatric Rapid Response Worldwide

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Abstract
Purpose of Review General pediatricians have been involved for decades in bringing health to the world's children with preventive and public health interventions. Building on this, this article seeks to explore the necessary concepts and components that would facilitate a rapid response for critically ill or injured pediatric patients to become a life-saving reality for all children.
Recent Findings It has been shown that emergency care can be done practically, cost-effectively, and is necessary to save the lives of children who will, just like children in the USA, suffer from critical illness and injury as a matter of living.
Summary There is a challenge to the pediatric emergency medicine community to facilitate the training and delivery of rapid pediatric response worldwide, with the recognition that emergency care is a specialty of rapid team formation to identify critically ill children, and rapid action to resuscitate them.

Keywords Global · Pediatric · Resuscitation · Resource-limited · Partnership · Education

The Case

I arrived in casualty to see a minimally responsive Kenyan boy with a body wasted from malnutrition. His parents had traveled for days to get to the hospital. My colleague told me his blood sugar was 10 mg/dL, and she had asked a nurse for an IV and some dextrose containing fluids. The nurse had left to gather supplies. As we both stepped to the bedside of this child, his shallow breathing stopped altogether. I looked around for a bag and mask and some oxygen to start positive pressure ventilation. The pediatric masks were not where the label on the box indicated, and the oxygen tubing did not fit the source. So my colleague stood, holding the airway open, while I searched for supplies and recruited help. The five minutes felt like an eternity. Unfortunately, Brian passed away in that time.

Two weeks later, back home and on shift in my own pediatric emergency department, I again was notified of a critically ill child. I stood in amazement at the team that assembled in seconds, the appropriate equipment in arms reach, and the complicated dance of resuscitation that was occurring with relative ease of step. Appreciation for my specialty of pediatric emergency medicine filled my heart that day, as a burning question entered my mind. How can we carry the concept of rapid pediatric response worldwide?

Introduction

Globally, 6.6 million children under the age of 5 died in the year 2012 [1]. While preventative care is often a focus, it is known that the specialty of pediatric emergency care needs more teachers. Pediatric emergency medicine physicians are passionate advocates for live-saving rapid response and resuscitation [2, 3••]. This article seeks to explore necessary concepts and components that enable a rapid response for critically ill or injured pediatric patients to become a life-saving reality for all hospitalized children.

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Personnel

Pediatric emergency care is, in essence, a training of a team. While equipment and skills are important, at the core, emergency medicine physicians are clinicians trained to recognize serious illness or injury early and trained to come together as a team to treat it quickly [4]. All emergency workers will acknowledge that resuscitation is a team effort [5].

In considering a team for rapid response, we acknowledge that too few hands make rapid response impossible and too many hands contribute to chaos. First, it is important to consider all of the stakeholders already in place, recognizing that personnel responsibilities in an LMIC (low-middle income country) may look different from a US hospital. For example, in a tertiary care US hospital there are multiple pharmacists and pharmacy technicians assigned to different areas of the hospital. Assigned emergency department pharmacists respond to pediatric emergency department resuscitations. In my partner hospital in Kijabe, Kenya, there is one degree holding pharmacist with a support staff of 10 supplying a 350-bed hospital, 10 ORs, and a 400 patient-per-day outpatient department. It would not be feasible for the pharmacist to leave the pharmacy to attend resuscitations. In this scenario, the pharmacist might be included in planning meetings and scheduled simulation trainings to increase awareness and education regarding emergency medications and preparation for those administering these medications during a rapid response. Or, as in the case in Kijabe, resuscitation medications might be under the stewardship of nursing.

Another critical human resource in LMIC settings is clinical officers (parallel to midlevel providers in the US). Unlike the rotating PGY-1 medical interns, and rare rotating residents, the clinical officers are often more permanent providers with a vested interest in providing good patient care. Involving the clinical officers as leading clinical stakeholders in planning and implementation of a rapid response would be a required element for success. In fact, Kijabe Hospital has become the first accredited ECCCCO (emergency and critical care clinical officer) training program in the country.

In general experience, in an emergency resuscitation, there are a minimum of four people needed. (Table 1) Broadly, these can be divided into two medical leaders/providers and two support/nursing staff. Provider leadership in the form of physicians, physician trainees, or clinical officers is needed in critical airway management and in general team leadership of the resuscitation. Nursing or support staff is needed for the detail work of locating and applying interventions. If available, there are important additional stakeholders to consider in the planning process, such as radiology, intensive care leaders, respiratory support staff, laboratory personnel, pharmacy as well as hospital leadership, and chaplain or spiritual support leaders.

Trained personnel will be the most valuable part of any rapid response team. It is for this reason that implementing a rapid response team should begin with gathering future team members and soliciting their thoughts regarding local priorities, obstacles, and solutions. Strong leadership and vision will be necessary, and including all stakeholders from the beginning will allow the best ultimate pathway toward successful rapid response care. It may be also worth considering and securing appropriate compensation, either in personal educational certificates, recognition, or financial compensation, for team members who become local experts in this area.

In considering personnel, training triage personnel will be of high importance [3••, 6••, 7, 8]. In Botswana, a child mortality audit revealed that 33% of in-hospital pediatric deaths occurred in the first 24 h [1]. My experience supports that children often arrive to the hospital in later stages of illness and more critically ill than in my US-based practice. A triage person should be charged with identifying the need for rapid response and activating the team formation. A developed activation tool should allow for any person to activate a rapid response team, but it is worth identifying a few people in the emergency department/casualty with the ability and who are assigned to identify the need for rapid response resuscitation. The activator of the rapid response can then become one of the four-member response team, or this can be a separate role.

Tools for use in a rapid response can be invaluable [7]. In Guatemala and Rwanda, having a triage tool in place in the emergency department for pediatric patients was shown to decrease length of stay and mortality rates [9, 10]. Other assessment tools, such as the PRESTO score for pediatric trauma, have been developed and validated for LMICs using easily obtainable low-tech predictor variables [11•] and Pediatric early warning scores (PEWS) have also been suggested as valid, a version of which has been adapted for use in the Kijabe emergency department setting to signal the need for escalated care. One of the first tools will be a trigger tool that triage personnel can use to decide when to activate the rapid response team. Tools ideally should be developed locally, keeping in mind local disease patterns and available data collecting devices. For example, a trigger tool should not include pulse oximetry if there are only a few available in the hospital.

Equipment

In considering pediatric rapid response implementation in an LMIC, barriers to equipment are often the topic of initial discussions. In actual practice, human ingenuity and creativity will provide ready solutions to equipment concerns [12]. It will be necessary, however, to think beyond the first step of initially obtaining the needed equipment, to questions of upkeep of inventory and stocking, and repair and replacement.

Table 1 Possible roles and responsibilities in a pediatric rapid response

Provider 1	Provider 2	Support 1	Support 2	Other stakeholders
Team leader	Airway cart	Triage activator/initial vital signs	Crash cart IV start	Pharmacy Respiratory
Orders	Assist ventilation	Attach monitors	Chest compressions	Administration
Results interpretation	Intubation	Chest compressions	IV medications	Laboratory Radiology
Family communicator		Chest compressions Assist intubation	Assist intubation	Chaplain

The supply chain will need to be secured in each LMIC hospital as well as methods to repair broken equipment. Regular replacement of used equipment will need to be maintained by a designated person who can assess inventory with regularity. Equipment needs can be thought of in the format of the ABCDE of any rapid resuscitation (Table 2).

It will be a challenge for the rapid response team to consider how to obtain equipment and devise creative substitutions when equipment cannot be reliably obtained. An example of creative substitution may include using endotracheal tubes as chest tubes, thereby eliminating the need to stock an additional piece of rarely used equipment. Large gauge needles may be used as intraosseous needles in small babies (Fig. 1), and large bore IV catheters may need to be substituted for central line catheters occasionally. Of prime importance will be obtaining appropriate sizes of airway equipment for ventilation, and stocking resuscitation drugs including epinephrine and sedation/pain medication. Other important considerations include age-appropriate-sized blood pressure cuffs, and methods of c-spine immobilization. Ventilator supply and allocation guidelines may need to be assessed and developed with hospital administration if the need for ventilator support becomes more than the supply of ventilators available. But again, creative solutions can be found. For example, soda bottle "spacers" have been used to deliver albuterol treatments (Fig. 2). And colleagues in Kijabe, Kenya, have decreased infant mortality by 80% by introducing simple bubble CPAP (Fig. 3). Consideration of a global bioengineering partner is another possibility. Engineers can easily help look at available local resources and engineer workable solutions.

Stocking of cost-effective equipment is something that should be assessed daily. Initially, it might be tempting to restock only after the rapid response is activated, but reality will dictate that organized equipment will tend to disappear for ad hoc needs, or become unorganized as time passes. Because equipment is often at a premium in a user-pays, low resource environment, efforts to keep pediatric resuscitation equipment available and organized may be not as simple as an informative keep-out sign. Each patient case review should include studying the role that equipment played in delaying or making impossible certain resuscitation efforts. These real-life scenarios can be used to illustrate and educate other hospital personnel on the importance of keeping needed equipment available and organized for rapid utilization. Beyond this reason, case-based illustration with local real-life examples can provide a powerful tool to institutional and humanitarian aid partners interested in supporting local efforts, or to hospital administration to advocate the need for pediatric patients.

Also of high priority along with equipment will be a medication sheet with doses of drugs by weight or age and simple dilution guidelines if needed. Medication errors are rampant in all of medicine and this is added to by the fact that pediatric medication doses need to be calculated individually by size [13]. To reduce the rate of errors, a tool that eliminates calculation in the moment will be helpful. Any rapid response member can give testament to the difficulty of doing math fractions in an emotionally charged atmosphere. It is important that international contributors to LMIC care consider the local applicability of donated/imported resources and equipment. For example, length-based estimations of weight in LMICs using HIC measuring tapes may fail to consider the impact of malnutrition—and a locally developed solution such as the PAWPER tape may be a safer local solution. Imported resuscitation drug books or resuscitation software may cite drugs that are not locally available (such as etomidate) or cost-prohibitive (such as sugammadex), or cite beside testing results such as blood glucose in non-international standard units. This highlights the importance of rapid response equipment lists being locally determined and sourced.

Leadership

Any rapid response will obviously need a leader during resuscitation efforts, but leadership will also be required in the form of a pediatric rapid response champion. Assigning a senior-level clinical support for pediatric emergency care has been shown to be an important intervention in itself [3••]. A local champion will be responsible for all actions that develop readiness. These responsibilities may include developing training and simulation programs for team education, participating in meetings with relevant stakeholders in evaluative and problem-solving efforts, assessing equipment inventory and

Table 2 Possible pediatric rapid response equipment

A—Airway	B—Breathing	C—Circulation	D—Disability	E—Environment
Bag and mask	Nasal cannula Non-rebreather face mask	IV cannulas Bandages for hemorrhage control	Cervical collar	Warming methods
Oral/nasopharyngeal airways	Oxygen/air source	Colloid infusions O neg blood	Splinting material	Sedation medications
Endotracheal tubes Laryngoscope blades	Chest tube Pulse oximetry	Blood infusion set IO needles	IV dextrose solution	Skin cleaning agents
Intubation adjuncts	Access to ventilator	Vasopressors		
		Cardiac monitor Defibrillator		Personal protective equipment (PPE)
		Staple or suture		

stocking, and working to develop tools to assist the team in the event of a rapid response activation. It cannot be stressed enough to include and prioritize local opinion, leadership, and expertise. Studies have shown that comparisons of local practice to a developed country practice, and language differences, have served as barriers to effective training [8, 14]. In conjunction with local leaders, however, partnerships with developed programs have been shown to be important in supportive roles for sustainability [3••, 15]. My personal favorite model is that of a multi-center collaborative between established US-based centers supporting an international partner spearheading training programs to meet locally identified priority needs. This model gives flexibility that a broad base of support allows, and has been shown to be feasible and useful in supporting partners in LMICs [16••].

Training and readiness of the team will be of paramount importance. Various educational tools can and have been used, and with appropriate local adaptations, resuscitation training has significantly reduced mortality [3••, 8]. PEARS (Pediatric Emergency Assessment, Recognition and Stabilization), through the American Heart Association, has been used to increase knowledge and recognition of respiratory distress and shock in children, as well as teaching indications for antibiotics, oxygen therapy, and intravenous fluid administration [1]. ETAT (Emergency Triage Assessment and Treatment) from the World Health Organization has been also been used successfully and is a standard training tool for clinicians and pediatricians across East Africa with local instructors acting as national champions [9]. Interestingly, having increased knowledge alone increased provider confidence in being able to care for a critically ill child. In some studies, resuscitation equipment was shown to be present in local hospitals, but was infrequently used secondary to lack of training and confidence, a very inefficient use of resources [1, 10].

With today's technological landscape, and our creativity, there is no shortage of ways to communicate, teach, and lead parts of a pediatric rapid response initiative. Telesimulation has been used successfully from Canada to Botswana to teach skills such as intraosseous needle insertion technique [17•]. In other locations, rapid resuscitation is included successfully in a more general pediatric emergency medicine curriculum, or taught via case-based software programs [14, 18].

Fig. 1 Eighteen-gauge needle used as intraosseous needle

Fig. 2 Plastic soda bottles used as asthma spacers

Fig. 3 Bubble CPAP used for respiratory support

Plan-Do-Study-Act (PDSA) cycles should be encouraged as a method of system improvement [19]. PDSA cycles can be used by the leader to assess each occurrence of rapid response team implementation. The "Planning" phase will include training and simulation with team personnel. Of course, "Doing" will occur with each rapid response activation. "Study" of each activation can occur with team members thoughts and solutions presented to the team [20]. Finally, "Action" can be taken to improve the response for the next patient. These evaluative efforts are not only helpful for the home institution but can also be disseminated through the medical literature to aid other locations develop a pediatric rapid response team. Evaluation that leads to discovery of equipment needs or personnel training can be used to guide hospital administration and grant funding agencies about needs.

Conclusion

General pediatric providers have an established presence in many LMICs, but the need exists to raise the profile of the tenets of pediatric resuscitation for the critically ill or injured child in these countries. It has been shown that emergency care can be done practically, cost-effectively, and is necessary to save the life of children who will, just like children in the USA, suffer from critical illness and injury as a matter of living. Support of and investment in international teams advocating for pediatric emergency care across all settings, such as the African Federation for Emergency Medicine (https://www.afem.info/) and the Pediatric Emergency Medicine Special Interest Group of the International Federation of Emergency Medicine (https://www.ifem.cc/paediatric-emergency-medicine-special-interest-group/), are a critical part of involving local LMIC advocates in the development of improved rapid response systems, with members from across every continent are growing into formal advocacy champions around the globe.

One idea that may need examination is the recognition that emergency care is more than equipment and skills, but is at its core, a specialty of rapid team formation and rapid action to identify critically ill and injured children and to resuscitate them. These critical minutes and hours for a child are important and often life-saving as the cardiovascular, respiratory, neurological, and immune systems are supported in a fight for life. This recognition and rapid team formation and response are not always available to children in LMICs. Therefore, a challenge exists to the pediatric emergency medicine community to advocate for rapid pediatric response worldwide.

Compliance with Ethical Standards

Conflict of Interest Alison Gardner and Mardi Steere declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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