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Concept proposal for IRCF national CPR Registry and update on resuscitation guidelines for infants and children

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Abstract

There is a lack of scientific data to use as local evidence on resuscitation science from the Indian subcontinent and other developing countries, making it difficult to develop regional guidelines and updates on practice of resuscitation based on the context, resources, infrastructure, geographical variabilities, values, and preferences. In this report, we try to identify key problem statements and plan to expand the list related to resuscitation practices primarily for in-hospital cardiac arrest (CA) in infants and children in India. To stimulate local research and data collection on resuscitation science and practices, Indian Resuscitation Council Federation proposes the concept of National CPR Registry and post-CA care bundle in the form of a checklist targeted for Indian settings.

Keywords: Cardiopulmonary resuscitation, child, CPR Registry, infant, resuscitation

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INTRODUCTION

The International Liaison Committee on Resuscitation (ILCOR) was formed in 1992 to provide a forum for liaison between principal resuscitation organizations worldwide. At present, ILCOR comprises representatives of American Heart Association (AHA), European Resuscitation Council (ERC), Heart and Stroke Foundation of Canada,

Australian and New Zealand Committee on Resuscitation, Resuscitation Councils of Southern Africa, Inter American Heart Foundation, and Resuscitation Council of Asia.^[1] Indian Resuscitation Council Federation (IRCF), a joint body of professional bodies active in the field of resuscitation in India, is working toward Indian membership in ILCOR and contributes to the global science in resuscitation. An important mandate of all resuscitation bodies is to lead

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the international resuscitation research to address gaps in knowledge and develop regional database on incidence, process of care, and outcomes to improve patient care.

ILCOR follows a continuous process of bringing out evidence-based consensus summary of scientific data on resuscitation and first aid in the form of Consensus on Science and Treatment Recommendation (CoSTR) publications.^[1] The AHA updates pediatric advance life support (ALS) guidelines every 5 years, and the latest update was published in 2020.^[2] ERC guidelines were produced every 5 years from 2005 to 2015. From 2017, the ERC has been publishing annual updates linked to the CoSTR publications of ILCOR.^[3] In India, periodic updates on existing resuscitation guidelines for infants, children, and adults have been published by individual researchers, Advance Life Support (ALS) Basic Life Support (BLS) group of Indian Academy of Pediatrics (IAP) and Indian Resuscitation Council.^[4-8]

Although periodic updates on resuscitation science and practice fill the knowledge gap for individuals, there is a lack of scientific data to use as local evidence on resuscitation science from the Indian subcontinent and other developing countries that pose a major challenge in developing regional guidelines and updates on practice of resuscitation based on the context, resources, infrastructure, geographical variabilities, values, and preferences. The aim of this IRCF consensus report is to identify key problem statements related to resuscitation practices primarily for in-hospital cardiac arrest (IHCA) in infants and children with update summary. To stimulate local research and data collection on resuscitation science and practices, we propose the concept of National CPR Registry using code blue form based on IAP cardiac arrest (CA) algorithm and post-CA care bundle in the form of a checklist targeted for Indian settings that may be used as standard of care in different units to collect research data on cardiopulmonary resuscitation (CPR) and postresuscitation care.^[6] The purpose of framing these problem statements is to provide a framework to prioritize the taskforce recommendations in the field of resuscitation in India.^[9,10]

METHODOLOGY

In view of continuously evolving updates and need of local research and data collection on resuscitation science, the IRCF had constituted a guideline update team comprising of experts in the field of pediatric resuscitation to provide an update and suggest simplified tool for CPR Registry in India. The update team drafted a list of questions and circulated among experts. For identifying key questions,

the task force experts reviewed the existing CPR guidelines from various professional bodies and framed problem statement related to CPR in infants and children. Based on exchange of drafts of problem statements requiring update via e-mails and video-based conference meetings, a list of questions were identified and finalized. Subsequently, literature search was carried out in PubMed, Scopus, and websites of the relevant professional organizations for the identified key questions with appropriate key words. Guidelines, systematic reviews, studies, narrative reviews, and other descriptive reports were reviewed by two independent authors for each question. The context, resources required, feasibility of implementation, values, and preferences were considered for contents of the CPR registry tool and postresuscitation care checklist. Final recommendations were made on consensus among all experts through exchange of drafts via e-mails and video-based conference meetings. IRCF endorsed the whole process.

Shortlisted questions for update

1. How to recognize cardiac arrest in infants and children?
2. What should be the sequence of CPR in infants and children?
3. What should be the respiratory rate for infants and children who need only rescue breaths or those who have advance airway in place?
4. What should be the compression to ventilation ratio for infants and children?
5. What should be the volume of each aliquot of fluid bolus for children with septic shock?
6. What is the first-line vasoactive drug for infants and children with septic shock in emergency?
7. What is target timeline for the first-dose epinephrine for infants and children in nonshockable rhythm?
8. What is proposed Indian CPR Registry documentation tool for capturing minimum data on in-hospital CA in infants and children?
9. What is proposed checklist for post-CA management bundle in infants and children?

Commonly practiced, pediatric BLS approach includes the critical steps of verifying scene safety, unresponsiveness, and checking breath and pulse. One should give rescue breath to those who have pulse but absent or inadequate respiratory efforts. High-quality chest compression with ventilation should be started if pulse is also not palpable in universal 30:2 ratio if single rescuer is available and converted to 15:2 ratio as soon as more than one rescuers are available using C-A-B sequence.^[4-6] Understanding the pathophysiology of CA in children, there are enough evidence and consensus that CA is primarily due to hypoxic

insult in children rather than of primary cardiac origin as seen in adults. Some common concepts and updates based on the available evidence and as modified by task force experts for its suitability in Indian context are summarized below.

Problem statement 1: How to recognize cardiac arrest?

As per the 2021 update of ERC, the practical, operational definition of CA is when a person is unresponsive with absent or abnormal breathing. Earlier guidelines included the absence of a palpable pulse as a criterion.^[3] As per the 2020 AHA update, palpation for the presence or absence of a pulse is not reliable as the sole determinant of CA and the need for chest compressions and stresses that lay rescuers should not delay starting CPR in a child with no “signs of life.” such as movement and coughing. Healthcare providers may consider assessing the presence of a pulse as long as the initiation of CPR is not delayed more than 10 sec.^[2] Reliably detecting peripheral pulses in stressful medical emergencies proved difficult for professionals and lay people alike.^[11,12] Using the criteria of unresponsiveness and abnormal breathing would over triage for CA, but this risk is believed to be far outweighed by the increased mortality associated with delayed CPR for CA victims.^[13]

Problem statement 2: What should be the sequence of cardiopulmonary resuscitation in children?

In infants and children, asphyxial CA is more common than CA from a primary cardiac event; therefore, effective ventilation is important during resuscitation of children. One pediatric study demonstrated only a 5.74 s delay in the commencement of rescue breathing with compressions-airway-breathing compared with airway-breathing-compressions.^[14] The AHA continues to recommend compressions-airway-breathing sequence as it causes only minimal delays in rescue breathing and allows for a consistent approach to CA treatment in adults and children.^[2] However, the ERC 2021 guideline recommends that in an unresponsive child, if breathing is absent or abnormal, give five initial rescue breaths and immediately proceed with 15 chest compressions, unless there are clear signs of circulation (such as movement and coughing). After 15 compressions, 2 rescue breaths should follow and then alternating (15:2 duty cycle). Do not interrupt CPR at any moment unless there are clear signs of circulation or when exhausted.^[3]

Problem statement 3: What should be the respiratory rate for infants and children, who need only rescue breaths or those who have advanced airway in place?

Asphyxia related CA being more common in children

newer guidelines recommend a respiratory rate of 20–30 breaths per minute (1 breath every 2–3 s) for infants and children who are receiving CPR with an advanced airway in place or receiving rescue breathing and have a pulse.^[2] Rates exceeding these recommendations may compromise hemodynamics. The optimum ventilation rate during continuous chest compressions in children with an advanced airway is based on limited data and requires further study.^[15] For above scenarios, the ERC 2021 guideline recommends that ventilations should approximate to the lower limit of normal rate (breaths/min) for age, e.g., 25 for infants, 20 for 1–8 years, 15 for 8–12 years, and 10 for >12 years.^[3]

Problem statement 4: What should be the compression-to-ventilation ratio for infants and children?

The optimum compression-to-ventilation ratio in children is uncertain. Better outcomes were demonstrated with compression-ventilation ratios of either 15:2 or 30:2 compared with compression-only CPR in children in out-of-hospital CA setting.^[16] Thus, the 2020 AHA guideline reiterates 30:2 ratio for single rescuer and 15:2 for two rescuers when performing CPR without an advanced airway in place.^[2] However, the ERC 2021 does not differentiate on single-rescuer versus two-rescuer scenario and suggests 15:2 as standard compression-to-ventilation ratio for infants and children up to 18 years of age during CPR without an advanced airway. It also suggests that BLS providers who are untrained in pediatric BLS should follow the adult CPR algorithm with ventilations, as they were trained, adapting the techniques to the size of the child.^[3]

Problem statement 5: What should be the volume of each aliquot of fluid bolus for children with septic shock?

Although fluids remain the mainstay initial therapy for infants and children in hypovolemic and septic shock, fluid overload characterized by increased rates of mechanical ventilation and worsening oxygenation was more likely to develop.^[17,18] A recent study limited by small sample size reported no significant differences in outcomes with the use of 20 mL/kg versus 10 mL/kg as the initial fluid bolus volume.^[19] Thus, the AHA 2020 guideline recommends that it is reasonable to administer balanced or unbalanced isotonic crystalloid fluid in 10 mL/kg or 20 mL/kg aliquots with frequent reassessment.^[2] The ERC 2021 guideline recommends smaller volume (10 mL/kg) aliquots as it enables faster reassessment without limiting the total amount of fluid to be given in the 1st h of treatment. Although the evidence base for balanced crystalloids (e.g., lactated Ringer’s) is limited, normal saline (NS) induces

hyperchloremic acidosis and might be associated with a worse outcome. The ERC 2021 considered balanced crystalloids the first choice (and NS an acceptable alternative). Albumin should be second line due to the higher cost though specific diseases (e.g., dengue, cerebral malaria) might benefit from earlier use of albumin 4.5% as a resuscitation fluid. In case of repeated fluid boluses, early consideration of vasoactive or inotropic drugs and respiratory support is crucial in case repeated fluid boluses (i.e., 40 mL/kg) are needed. In settings where advance monitoring and treatment options are not readily available, it seems prudent to be even more restrictive.^[3]

Problem statement 6: What is the first-line vasoactive drug for infants and children with septic shock in emergency?

The AHA 2020 guideline recommends to use either epinephrine or norepinephrine as an initial vasoactive infusion in fluid-refractory septic shock. If epinephrine or norepinephrine are unavailable, dopamine may be considered.^[20] Two well-designed randomized controlled trials (RCTs) demonstrated benefit of epinephrine above dopamine as vasoactive infusion.^[21,22] A 2020 ILCOR scoping review included above two RCTs but did not find sufficient evidence to suggest a change in recommendation.^[23]

The ERC 2021 writing group suggests starting with either noradrenaline or adrenaline, depending on local practices and infusing via either a central or a peripheral line. Dopamine should only be considered in settings where neither adrenaline nor noradrenaline is available. If there is any evidence of cardiac dysfunction, an inodilator might be added.^[3]

Problem statement 7: What is target timeline for first-dose epinephrine for infants and children in nonshockable rhythm?

Epinephrine is given to increase the coronary and cerebral perfusion through its vasoconstrictive and inotropic effect during active CPR. For pediatric patients in any setting, the initial dose of epinephrine within 5 min from the start of chest compressions is recommended by the AHA 2020.^[2,20,24] The benefit of early administration of epinephrine has been documented in another study involving out of hospital cardiac arrest (OHCA) patients, both children and adults, receiving CPR.^[25]

In line with the PLS COSTR, the ERC 2021 recommends administering the first dose of adrenaline for nonshockable rhythms as early as possible after collapse, if possible, within 3 min. Although there is lack of evidence to

recommend duration of time interval between subsequent doses of adrenaline, it is advised to follow 3-5 minute interval in subsequent doses. One should avoid next dose of adrenaline before 3 minute interval. In case of trauma, less emphasis is put on early adrenaline and rescuers should first consider treatment for reversible causes. In shockable rhythms, in line with the 2015 pediatric guidelines, it is recommended to give a first dose of adrenaline after the third shock (about 4-5 min after start of CPR). It should be avoided in catecholaminergic polymorphic ventricular tachycardia (VT) as this may aggravate the arrhythmia and worsen outcome.^[3]

Problem statement 8: What is proposed cardiopulmonary resuscitation registry documentation tool for capturing minimum data on in-hospital cardiac arrest in infants and children?

We propose that all the hospitals should document each event of CA in infants and children and a National CPR Registry is developed. Experience was also sought from the ongoing regional CPR registry for CA s in infants and children. This registry has a dedicated code blue form [Figure 1] which is based on IAP CA algorithm.^[6] Based on task force expert's opinion, existing local registry, and available evidence for the CPR registry, a framework was prepared and shared with the ILCOR for their opinion with regard to context and content. The registry may be developed in a phased manner by expanding the regional registry to multiple, voluntarily participating centers in the country for initial data collection on a dedicated online portal comprising of data set summarized in Figure 1. After analysis of initial data and experience, broader participation may be requested through the hospitals or the governments to develop a national data base.

Problem statement 9: What is proposed checklist for postcardiac arrest management bundle in infants and children?

Once return of spontaneous circulation (ROSC) is achieved, these patients are at the risk of developing a post CA syndrome over next few days that includes brain injury, myocardial dysfunction, systemic ischemia, and reperfusion response, particularly in brain having has limited tolerance of ischemia, hyperemia, or edema.^[26] The AHA 2020 update focuses on anticipating, identifying, and treating this complex physiology to improve survival and neurological outcomes suggesting a check list for post-CA care in children.^[2] The ERC 2021 also stresses upon good post CA care.^[3] We suggest similar checklist but more practical and suitable to Indian settings based on the ABCDE of resuscitation [Figure 2]. Such checklist may be activated for all infants and children immediately surviving a CA.

Patient Name:	Age/Sex:	Date of admission
CR No:	CA was detected by: Nurse / doctor / patient attendant	
Date:	Time:	Day of hospital stay:
Time lapse since recognition of cardiac arrest to starting of high-quality CPR: (<1 min) / (1-2 min) / (2-3 min) / (3-5 min) / (>5 min)		
Please mention the event number of CA and CPR support for this patient during current hospital stay: 1 st CPR / 2 nd CPR / 3 rd CPR / 4 th CPR...		
Working Diagnosis:		
Co-morbidity if any:		

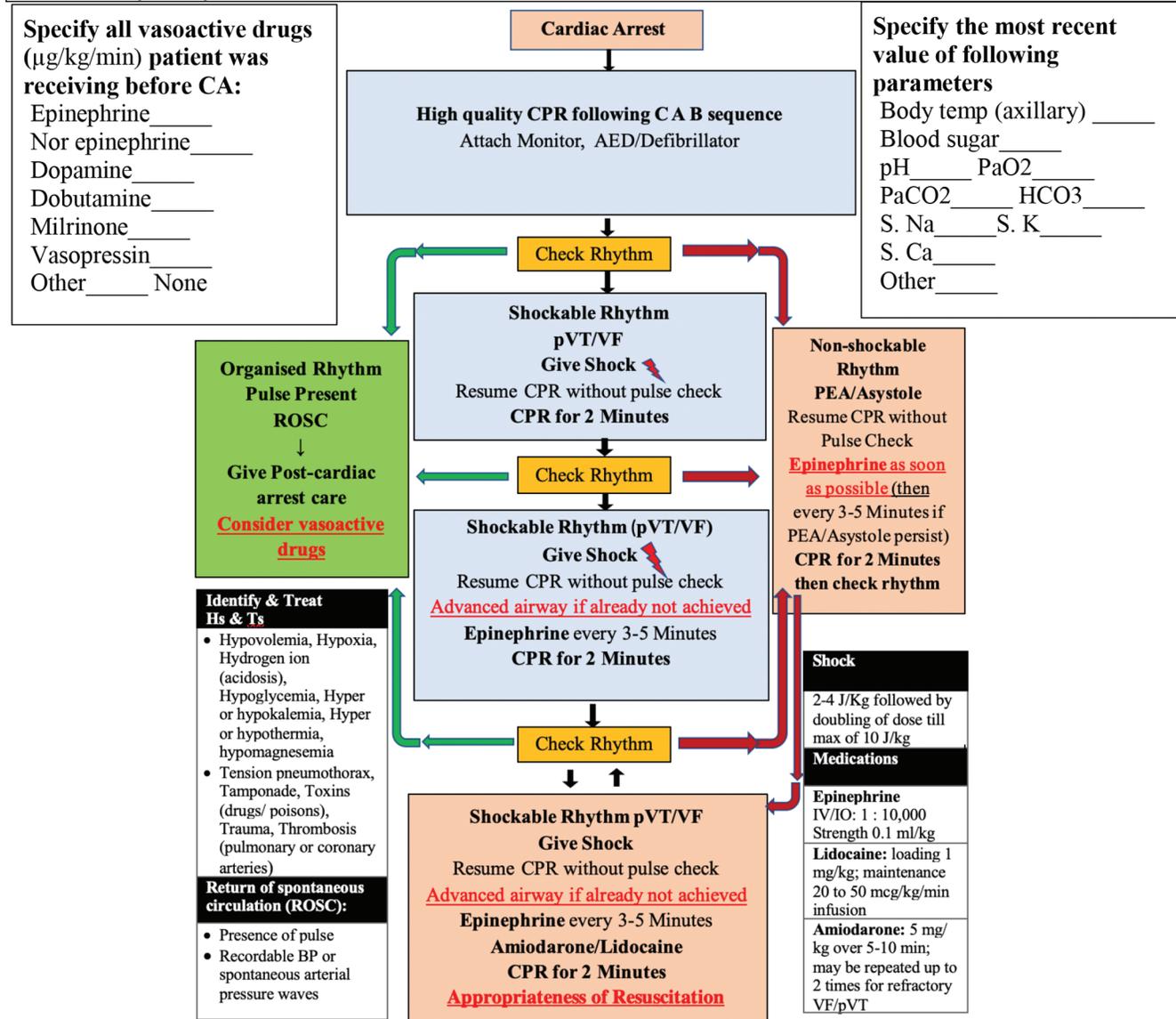


Figure 1: Code blue form for CPR registry of infants and children at AIIMS Patna

ΔTime epinephrine- Time in minutes from identification of cardiac arrest to 1 st dose of epinephrine given:	No. of doses of Epinephrine given:
No. of shocks given:	Total duration of CPR (min):
Type of rhythm: Asystole/VF/VT/Other (specify):	24 h outcome (Live and neurologically intact/Live with mild/mod/severe neurological disability/Dead)
ROSC Achieved (Yes/No):	Date of Discharge/death...../...../.....
Final Outcome (Live and neurologically intact/Live with mild/mod/severe neurological disability/Dead)	Name & sign of CPR Nurse:
Name and sign of team leader:	

Figure 2: Post cardiac arrest management bundle for infants and children

Evaluate	Identify and Intervene	Tick box
A and B: Oxygenation and ventilation	Measure oxygenation: Target SpO ₂ 94%-99% Measure target PaCO ₂ ; Avoid hyper or hypocarbia	
C: Circulation	Set specific hemodynamic goals and review daily Use fluid bolus with or without inotropes to maintain systolic BP >5 th percentile for age Monitor urine output, s. lactate, ScVO ₂ , and arterial blood pressure to guide therapy Maintain electrolytes within the normal range to avoid arrhythmias	
D: Neuromonitoring	Measure blood glucose and avoid hypo/hyperglycemia Treat seizures and nonconvulsive status epilepticus Continuous EEG monitoring if feasible Early neuroimaging (CT scan or MRI) Use sedatives and/or anxiolytics	
E: Targeted temperature management	Measure core temperature and continuously monitor it Prevent and treat fever and shivering If patient is comatose, TTM (32°C-34°C followed by 36°C-37.5°C) or only TTM (36°C-37.5°C)	
Prognosis	Consider multiple modalities (clinical, laboratory, and other) to prognosticate	

BP: Blood pressure, EEG: electroencephalogram, CT: Computed tomography, MRI: Magnetic resonance imaging, TTM: Targeted temperature management

CONCLUSIONS

There is a lack of scientific data to use as local evidence on resuscitation science from the Indian subcontinent and other developing countries that poses a major challenge for developing regional guidelines and updates on practice of resuscitation based on the context, resources, infrastructure, geographical variabilities, values, and preferences. This IRCF consensus report identifies key problem statements related to resuscitation practices for in-hospital CA in infants and children with update summary of available evidences. Proposed National CPR Registry and post-CA care bundle for infants and children in the form of a checklist targeted for Indian settings is expected to stimulate local research and data collection on resuscitation science and practices useful for developing India-specific guidelines on resuscitation.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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