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Triage and resuscitation tools for low and middle income countries: how to catch the killer?

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ABSTRACT

Under-5 mortality rates in low and middle-income countries (LMIC) remain high. One major contributing factor is the failure to recognise critically unwell children when they first present to hospital. This leads to delayed or inadequate resuscitation and an increased risk of death. Triage is a key skill in this setting to sort the queue and prioritise patients, even when staff and equipment are scarce. In LMIC, children generally present late in their illness and often have progressed to some degree of multiorgan dysfunction.

Following triage, a structured systematic primary survey is critical to ensure the detection of subtle signs of multiorgan dysfunction. Repeated physiological assessments of the child guide subsequent resuscitation management decisions, which depend somewhat on the resources available. It is possible to achieve significant improvements in survival of critically unwell children presenting for emergency care in the resource-limited setting. The three key steps in the patient's journey that we can influence in emergency care are triage, primary survey and initial stabilisation. Resources that address these steps have been developed for all settings. However, these resources were developed in a specific clinical context, and must therefore be adapted to local structures and processes. A systematic approach to triage and resuscitation saves lives.

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INTRODUCTION

Under-5 mortality rates in low and middle-income countries (LMIC) still remain high, with many children dying from diarrhoeal disease and lower respiratory tract infections.[1 2] Over 30% of deaths occur in the first 24 hours of hospital admission.[3] Preventable illness and failure to recognise critically unwell children when they first present have been highlighted as major contributing factors.[4 5]

Acutely unwell children can develop life-threatening organ dysfunction, which can go unrecognised by their caregiver and medical staff. Early recognition at the time of presentation to health services is key to initiate the appropriate emergency treatment and may lead to reduced mortality. Internationally endorsed standards for paediatric emergency care have been developed and are a vital tool to improve the quality of care.[6]

Emergency care in LMIC is unpredictable, fast paced and demanding, yet has the potential to make a significant impacts on health outcomes of critically ill children.[4 5] Access to healthcare facilities is limited. Patients and families will often have to travel long distances, which results in delayed presentations. For example, in status epilepticus, the median time of seizure duration prior to hospital arrival was 45 min with virtually no deaths in Australia and New Zealand,[7] whereas in India the median time of seizure duration prior to hospital arrival was 172 min and the mortality rate was 4.6%.[8] The limited number of healthcare facilities in low-resource settings also results in long queues of patients waiting to be seen. It is therefore critical to have a way of rapidly recognising children who require urgent resuscitation.

Case introduction

> You have decided to take time out of your current position and volunteer in an LMIC. You ask yourself: Why do children not respond in the same way to medical intervention as in HICs? What can be done to ensure better outcomes for unwell and critically ill children in resource-limited settings?

The basic principles of management of airway, breathing and circulation management, the ABCDE approach remains the

same in all settings. However, 'standard' treatment extrapolated from high-income settings may sometimes have unexpectedly negative results. For example, a study of over 3000 children in Uganda, Tanzania and Kenya with severe febrile illness and impaired perfusion found that fluid bolus therapy was associated with significantly *higher* mortality,[9] challenging the accepted wisdom from high-income countries (HIC) of repeated fluid boluses in sepsis.

The ABCDE approach is not a 'one-size-fits-all' solution. It must be adapted to the clinical context and the practice environment. For example, in trauma, this requires early attention to major haemorrhage. The 'zero-point survey' in trauma includes preparation prior to the patient's arrival and emphasises the need for team preparation and leadership, and anticipation and management of complications.[10] In LMICs, adapting the primary survey to not only recognise and treat obvious life threats, but also to identify *subtle signs of organ dysfunction,* is critical. As these findings will influence ongoing management decisions and aid rapid recognition of children with pre-terminal 'normalisation' of previously abnormal vital signs.

In the LMIC setting, the standard ABCDE approach needs to be further adapted to reflect local disease patterns and available resources.[11]

A team approach to these critically unwell patients may be challenging in resource-poor settings. Triage, followed by a structured primary survey (designed to detect subtle signs of multisystem organ dysfunction) and a structured summary of these findings to formulate a holistic management plan, based on the available resources, may be key to improved survival (box 1).[12]

TRIAGE

Effective triage is key to identifying the critically unwell child on arrival, and has been shown to save lives.[4 13] However, recognising a sick child can be challenging in any setting. Those working in LMIC face a number of difficulties: overcrowding, late presentation, absence of equipment, understaffing and patient risk factors including dehydration, malnutrition, malaria and/or severe developmental problems due to neonatal complications.[4] There is often a lack of senior support, such as paediatricians, anaesthetists and intensivists, on-site.

Box 1 Patient journey adapted from zero-point survey in trauma (adapted from Reid *et al*[10])

1. Pre-arrival—prepare staff and appropriate resources.
2. Arrival—triage (emergency, priority, wait).
3. Initial assessment (primary survey)—to rule in life threats and subtle signs of organ dysfunction.
4. Summarise findings and formulate resuscitation plan.
5. Emergency treatment—resuscitation with the available resources.
6. Reassessment and monitoring for complications.
7. Disposition and convalescence—home or inpatient ward.

Case 1

Bonginkosi is a 2-year-old boy. He has had diarrhoea for the last couple of days and is lethargic with sunken eyes. He arrives with his grandmother at the clinic and joins the queue.

The WHO developed Emergency Triage Assessment and Treatment (ETAT), a triage system designed for LMIC settings, which takes these difficulties into account.[14] ETAT can be taught to anybody, from frontline medical to lay staff, to help identify critically unwell children.[15] It triages children into three categories (emergency, priority and wait). It is the current standard of care in Africa and other LMIC settings.[14–16] In 1995, the WHO and UNICEF launched the Integrated Management of Childhood Illness (IMCI), which provides nurse practitioners comprehensive evidence-based management guidelines for children in LMIC. The IMCI guidelines have been integrated with ETAT in some settings.[17]

Case 1 continued

Bonginkosi is showing signs of dehydration (sunken eyes, lethargy). Using ETAT, he is triaged as an emergency.

The ETAT triage tool has been further developed in East Africa to the ETAT+, where the plus stands for *plus treatments* and includes management algorithms for common paediatric emergency presentations and advice on specific interventions such as oxygen, fluids and glucose control.[13] These have been adopted to local disease patterns and prevalence in different countries and integrate both local and WHO guidance.[16]

Case 1 continued

As ETAT+ is used at the healthcare facility that Bonginkosi attends, oral rehydration solution is commenced according to the local protocol, which he tolerates.

Triage systems validated in the paediatric population in HIC settings include the Australasian Triage Scale, the Canadian Triage and Acuity Scale, the Manchester Triage System and the Emergency Severity Index.[18] They allocate patients to one of five levels. A common limitation of these aggregated triage systems is that they were not designed for the LMIC setting, and their failure to recognise inherent risk factors specific to these settings as previously outlined.

An example of an aggregated triage systems developed for these settings is the South African Triage Scale for children, however the practical application can be challenging in the busy resource-limited settings.[9 16 18]

In Tamil Nadu, India a stepwise approach designated as Pediatric Resuscitation and Emergency Medicine (PREM) is used. The word 'PREM' means 'affection' in Sanskrit. PREM was initially developed to screen febrile children for life-threatening organ dysfunction (online supplemental appendix 1).[12]

Step 1 of the PREM approach comprises a series of focused questions to screen children waiting in the

queue for early subtle signs of hypoxia, shock, cardiovascular dysfunction or non-convulsive status epilepticus (NCSE).[12] See table 1 for a comparison of the ETAT and PREM triage approach.

PREM triage questions with rationale

Primary complaint: Fever **with or without a clear focus**

Ask if there has been any altered level of consciousness or breathlessness during this illness:

Altered level of consciousness?

- Infant: incessant cry? Lethargy? Not his usual self? More sleepy than usual?
- Child: agitation? combativeness?

Fever + altered level of consciousness = septic shock

Breathlessness?

- Episodic? Or since birth? (to rule out asthma, recurrent aspiration and congestive heart failure or chronic lung disease).

Fever + altered level of consciousness + first acute episode of breathlessness

= **septic shock** with possible **pulmonary oedema** due to **acute lung injury** or **cardiac dysfunction**

Adapted from the National Health Mission-Strengthening of Pediatric Emergency Care System in Tamil Nadu-Establishment of Pediatric Resuscitation and emergency Units under Tamil Nadu Accidents and Emergency Care Initiative under the name of PREM G.O(D)No. 539, Department of Health and Family Welfare, dated 30 November 2019.

Case 2

Ram is 12 months old. His mum says that Ram has had **fever** for the past 2 days and has been **crying inconsolably** since the previous night. This morning he became **sleepier than usual** and has developed **fast breathing**. He is normally well, with no major comorbid conditions.

Triage of case 2 (table 1)

ETAT triage	PREM triage
Lethargy (sleepier than usual) **Respiratory Distress** (fast breathing)	**Fever** (with cough, diarrhoea or any other focus?) 1. fever for the last 2 days **Altered level of consciousness?** 1. Inconsolable cry 2. Sleepy 3. Lethargy First acute episode of **Breathlessness** (not episodic, not chronic?) 1. fast breathing
Emergency	Fever + altered level of consciousness + first acute episode of breathlessness = **septic shock** with possible **pulmonary oedema** due to acute lung injury or cardiac dysfunction

ETAT, emergency triage assessment and treatment; PREM, pediatric resuscitation and emergency medicine.

PRIMARY SURVEY

Even in HIC, the assessment of the unwell child can be challenging. This has led to initiatives such as 'Spotting the Sick Child' (https://spottingthesickchild.com).[19] This initiative arose out of the realisation that the assessment of sick children is different to adults and many health professionals are anxious about assessing sick children.

The Paediatric Assessment Triangle (PAT) is a hands-off evaluation to assess the physiological status of a child in less than 30 seconds, endorsed by the American Academy of Paediatrics. It has been validated as a powerful tool for quickly identifying the severity of illness in children in emergency care and prehospital settings. The PAT's three sides stand for general appearance, breathing and cardiovascular status.[20]

Advanced Life Support Courses teach a primary survey to rule in life threats using a team approach.[11 21] This is followed by a more detailed secondary survey once these have been addressed.[22] This approach may lead to subtle signs of organ dysfunction being missed on the inital primary survey with the potential to lead to detrimental resuscitation decision being made. This is especially relevant in settings where children present late and or already have developed subtle multiorgan dysfunction at presentation. An example would be a child presenting with seizures secondary to hypoxia and sepsis (as opposed to seizures caused by sudden abnormal electrical discharges in the brain or a primary brain pathology). Standard status epilepticus management, with failure to recognise the subtle signs of multiorgan dysfunction and sepsis at initial presentation and failure to concurrently optimise all organ systems could be fatal in this presentation.[12] Examination to detect subtle signs of NCSE (non-convulsive status epilepticus) is part of the PREM assessment.[12 23] Detrimental outcomes can also be seen with overzealous fluid bolus therapy.[9 12 13]

Case 2 continued (modified Rapid Cardio-Pulmonary Cerebral Assessment)

Ram's airway is **unstable** as he is **not vocalising**, and you can hear **grunting** when you count his respirations (60/min). You note **retractions** and an abdominal pattern of respiration. Auscultation reveals **crepitations**. His heart rate is 120 beats per minute (BPM), heart sounds are not clearly heard. There is no gallop. His **peripheries are warm**, femoral and dorsalis pedis pulses are of equal strength. The sole of his **foot is bright pink**, and **capillary return** (CRT) **is rapid**. His liver is firm with a **liver** span of 8 cm (**enlarged**). Ram is **responsive to pain**, but his tone and posture is **floppy**. His eyes have **conjugate gaze with nystagmus**. Pupils are responding equally to light. His **systolic blood pressure (SBP)** was **90 mm Hg** and his **diastolic blood pressure** was **0mm Hg** (Korotkoff sounds were heard until the end).

Step 2 of PREM advocates a primary survey that employs a 60-second modified Rapid Cardio-Pulmonary Cerebral Assessment (online supplemental appendix 2: mRCPCA).[8] The modifications include evaluation for gallop; quality of heart sounds; liver span; comprehensive non-invasive blood pressure assessment (ie, systolic and diastolic pressures, pulse pressure and mean arterial pressure (MAP)), and eye signs of NCSE (online supplemental appendix 3: PREM chart)). These clinical findings were incorporated around the PAT and renamed as the PREM triangle (online supplemental appendix 4: PREM triangle).[12]

In the PREM system, vital signs are interpreted as follows: increased, normal, relatively low or low. This approach was developed since the standard primary survey failed to detect the subtle signs of multiorgan dysfunction, which are frequently seen in LMIC settings, from causes such as pulmonary oedema, cardiovascular dysfunction and NCSE.

Among the most difficult cases to identify are those where there is a subtle discrepancy between what would be expected and that which is seen. Often with vital sign parameters appearing to be better than expected. For example, in an infant with a history of severe gastroenteritis presenting with hypovolaemic shock, a heart rate within the normal range should be interpreted as relative bradycardia. This is an ominous sign that compensatory mechanisms have been exhausted. Similarly, in a child with severe pneumonia, a normal or low-normal respiratory rate for age should raise the suspicion of imminent respiratory failure.

In the resource-limited setting, the ability to detect subtle signs of organ dysfunctions during primary survey allows the resuscitation plan to be modified accordingly. This, combined with knowledge of local disease patterns, complications of management protocols and side effects from treatments, facilitates rapid optimisation of the critically unwell child prior to admission. This strategy can potentially improve child survival.[12 24]

SUMMARY AND PLAN

Case 2 continued

You wonder what the best way to summarise Ram's assessment findings to formulate a holistic management plan with the resources available to you.

Different tools have been developed to summarise clinical findings during resuscitation. A well-run emergency response ensures that all information is taken into account. In many tools, following the completion of the primary survey, the team leader asks for an update from the team to rule in all immediate life threats detected. This creates a shared mental model with all team members and allows team members to voice any concerns that may have.[10 11] The immediate life threats are then addressed, and a secondary survey is performed.

Step 3 in the PREM approach summarises the findings from the focused history and the mRCPCA (performed instead of the primary survey). The individual variables are recorded on a structured template and then collated around the PREM triangle, to understand the physiological status holistically (online supplemental appendix 3, table 2). The advantage of this approach is the ability to detect subtle signs of organ dysfunction prior to the start of resuscitation and guide subsequent management decisions depending on the resources available. In Tamil Nadu, the implementation of the PREM approach has contributed to reduce post-neonatal under-5 mortality in children presenting for emergency care.[24]

Case 2 continued: Table 2 Ram's PREM triangle

Disability: Responsive to pain
Tone and posture: abnormal
Eyes: conjugate deviation+nystagmus+, no lid twitch, pupils equal and reactive to light

Airway: unstable
Breathing: RR 60 BPM, grunt+, no stridor, retractions+, abdomino-thoracic respiration+, bilateral air-entry+, crepitation+

Circulation: heart rate 120 BPM
Heart sounds: muffling+, no gallop, warm peripheries
Pulses: +++/+++, flushed, CRT<2 s
Liver span: 8 cm firm
SBP: 90 mm Hg
DBP: 0 mm Hg
Pulse Pressure: > 40 mmHg
MAP: 30 mm Hg

Summary: physiological status using the PREM triangle
Airway: unstable
Breathing: impending respiratory failure
Circulation: relative bradycardia, vasodilatory shock, cardiac dysfunction, SBP high, wide pulse pressure, low MAP
Disability: altered level of consciousness, non-convulsive status epilepticus

Adapted from the National Health Mission-Strengthening of Pediatric Emergency Care System in Tamil Nadu-Establishment of Pediatric Resuscitation and emergency Units under Tamil Nadu Accidents and Emergency Care Initiative under the name of PREM G.O(D)No. 539, Department of Health and Family Welfare, dated 30 November 2019.

BPM, beats per minute; CRT, capillary refill time; DBP, diastolic blood pressure; MAP, mean arterial pressure; PREM, Pediatric Resuscitation and Emergency Medicine; RR, respiratory rate; SBP, systolic blood pressure.

Case 2 continued: consideration for Ram's further management

Ram has sepsis resulting in impending respiratory failure, *relative bradycardia*, vasodilatory cardiogenic shock with low MAP and NCSE. Your resuscitation and management plan needs to reflect local resources available to resolve hypoxia, shock, cardiac dysfunction and NCSE, anticipating any side effects of therapy.

Despite vasodilatory shock, he was not tachycardic. Tachycardia, tachypnoea, and high SBP are noted in early hypoxia or shock. As compensatory mechanisms fail, the respiratory rate, heart rate and SBP fall to the normal range for age, before the child collapses with apnoea, bradycardia and low BP.

It is crucial to differentiate the 'real' normal versus 'relative normal'. Vital signs that are within the normal range but associated with profound alerted level of consciousness, respiratory failure and shock are ominous. This combination of findings is indicative of exhausted compensatory mechanisms with a grave risk for abrupt deterioration.

Systems considerations for the management of acutely unwell children

All approaches, ranging from IMCI, ETAT+, PREM triangle to advanced paediatric life support (APLS) and paediatric advanced life support (PALS) recommend further general management strategies. These depend on local disease patterns and prevalence, availability and access to medication and equipment. It is important to realise that it is the overall systematic and structured approach encompassing triage, primary survey, and a holistic resuscitation and management plan that results in improved outcomes.[17]

The difference in prehospital median seizure duration times and associated mortality in status epilepticus is one example that highlights system difference between LMIC and HIC.[7 8] Understanding the capacity, resources and organisational gaps with respect to healthcare provision is key. The Donebedian model highlights the need to address structure, processes and outcome, in order to better understand the local context.[25] For example, outcomes for emergency care for children may be impacted by structures (lack of a functioning prehospital ambulance service and/or no universal health insurance) and processes (use of clinical algorithms developed in HIC with different patterns of disease). In a high-income setting, mortality is a very rare outcome, leading to an emphasis on readily accessible and broadly applicable measures (such as patient satisfaction), while in the LMIC setting, survival to hospital discharge remains a very relevant target for children seeking emergency care.[26]

The resuscitation of a paediatric patient is a stressful event and prone to errors, which have been found to occur during all aspects of paediatric resuscitation stages.[27] Cognitive offloading has been recognised to decrease errors, therefore APLS UK and others recommend the use of various aide memoires at the bedside to guide resuscitation.[21 27 28] This may be especially important for LMIC, when working in a high-acuity setting with overcrowding. Examples include various smartphone apps and books which reduce the need to calculate doses at the bedside.[21 28 29]

CONCLUSION

It is possible to achieve significant improvements in survival of critically unwell children presenting for emergency care in the resource-limited setting. The three key steps in the patient's journey that we can influence in emergency care are triage, primary survey and initial stabilisation. Resources that address these steps have been developed for all settings. However, these resources were developed in specific clinical contexts, and must therefore be adapted to local structures and processes. A systematic approach to triage and resuscitation saves lives.

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Contributors IS: original idea, manuscript. PM: triage, African experience. BJ: images. AY-C: triage, Latin American experience; review of the manuscript. BC: triage, African experience; review of the manuscript. SC: review of the manuscript. HKJ: manuscript, case scenario.

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PREM Triage questions with rationale

Primary complaint: **Fever** with or without a clear focus

Ask if there has been any altered level of consciousness or breathlessness during this illness:

Altered level of consciousness?

- Infant: Iincessant cry? Lethargy? Not his usual self? More sleepy than usual?
- Child: Aagitation? Ccombativeness?

Fever + altered level of consciousness = Septic shock

Breathlessness?

- Episodic? Or since birth? (to rule out asthma, recurrent aspiration and congestive heart failure or chronic lung disease).

Fever + altered level of consciousness + first acute episode of breathlessness

= Septic shock with possible **pulmonary oedema** due to **acute lung injury** or **cardiac dysfunction**

Adapted from the National Health Mission-Strengthening of Pediatric Emergency Care System in Tamil Nadu-Establishment of Pediatric Resuscitation and emergency Units under Tamil Nadu Accidents and Emergency Care Initiative under the name of PREM G.O(D)No. 539, Department of Health and Family Welfare, dated 30.11. November 2019.

Modified rapid cardio-pulmonary cerebral assessment (mRCPCA)

Airway & Breathing

The assessment is started by placing both hands palm down (one on the chest and the other on the abdomen) with an eye on ones watch. Respiratory rate (RR) is counted for 6 seconds and multiplied by 10.

Figure 1: Assess RR and feel /listen for grunt and stridor.

If RR is low normal for age and mental status is "unresponsive", relative bradypnea must be considered and bag valve mask ventilation is initiated.

As the RR is being counted, the responder, listens for grunt and stridor (anticipating an obstructed airway in the unresponsive child) and looks for retractions and pattern of respirations; whether thoracic or abdominal. Grunt or abdominal respiration are suggestive of impending respiratory failure.

The infra-axillary area is auscultated for air-entry and adventitious sounds.

Figure 2: Auscultate infra-axillary region on both sides.

Circulation:

The heart is auscultated, and the heart rate is counted for 6 seconds and multiplied by 10. While counting quality of heart sounds is noted. Are the sounds difficult to hear (muffled) or can you hear a gallop?

Figure 3: Assessment of HR.

The responder proceeds to assess the core peripheral temperature gap by placing one hand on the abdomen and sliding the other hand down the leg to the ankle. She notes whether, it is warm throughout or cool below ankle, knee, or thigh.

Figure 4: Core-peripheral temperature gap.

Comparison of the central and peripheral pulse is performed by placing the index finger of one hand on the femoral and the other on the dorsalis pedis, comparing the strength.

Figure 5: Comparison of pulses.

Table 1: Interpretation of concurrently palpated pulses

Femoral pulse	Dorsalis Pedis	Inference
+++	++	Normal
+++	+++	Vasodilation (suggestive of warm shock)
+++	+	Narrow pulse pressure (suggestive of cold shock)
+++	0	Hypotensive shock
+ or 0	0	Cardiac arrest

Color is assessed by comparing the physician's palm with the color of the patient's sole. If found to be relatively pale, dusky, ashen, or flushed, it is documented as "abnormal".
Capillary refill time (CRT) is assessed by elevating the limb above the level of the heart and blanching the skin. Normally, CRT is immediate. Both a delay or rapid CRT may be interpreted as signs of poor perfusion when associated with altered level of consciousness, respiratory impairment and altered heart rate.

Figure 6: Compare color and CRT

Assessment of liver-span is performed by placing the palm of their right hand on the abdomen, parallel to the right costal margin, starting near the inguinal region and progressing upwards. Using a pen, the border of the liver is marked along the medial aspect of their right index finger, parallel to the right costal margin. The upper border is identified by percussing for liver dullness in the mid-clavicular line from the intercostal space. Wherever, dullness is felt, a horizontal line is drawn. The liver span measured in the mid-clavicular line using a measuring tape. The consistency of the liver edge (firm or normal) is also noted.
(see table 2: Assessment of liver span)

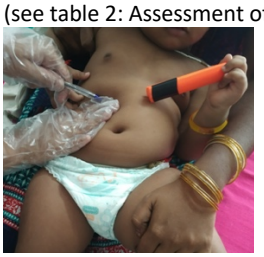

Figure 7: Palpate lower border along the right costal margin and mark.

Figure 8: Percuss for the upper border of liver dullness.

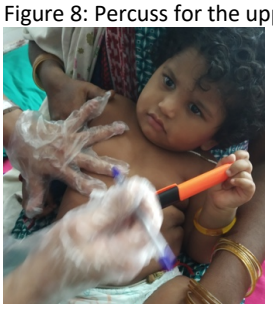

Figure 9: Mark upper border.

Figure 10: Measure span in the mid-clavicular line.

Table 2: Approximate normal liver span of infants and children

Age	Liver span (cm)
Birth	5.6-5.9
2 months	5
1 year	6
2 years	6.5
3 years	7
4 years	7.5
5 years	8
12 years	9

Adapted from: Naveh Y, Berant M. Assessment of liver size in normal infants and children. J Pediatr Gastroenterol Nutr. 1984;3(3):346-8.

Disability

The level of consciousness is scored using the AVPU scale. Tone and posture are documented as abnormal if the child is floppy, not able to sit or stand by himself.

The eyes are examined for eye position and abnormal movements (conjugate deviation, nystagmus, or lid twitch). Pupils are checked for pupillary response to light and equality.

Abnormal eye signs are seen not only in primary status epilepticus but also in patients who are profoundly hypoxic and shocked (i.e. non-convulsive-status-epilepticus (NCSE)). It is crucial to differentiate between seizures due to a primary epileptogenic activity and “seizure like movements” associated with severe cerebral hypoxia or ischemia, since administration of anticonvulsants without managing the underlying cause in the latter could be fatal.

Figure 11: As you examine for pupillary response to light, make note of the eye position and movements.

Blood Pressure (BP)

BP is measured manually using an age-appropriate cuff. Measurement of diastolic BP (DBP) (disappearance of Korotkoff sounds) is as important as systolic BP (SBP). Pulse pressure is the difference between SBP and DBP. A DBP less than 50% of SBP is diagnostic of vasodilation. Monitoring mean arterial pressure (MAP) is an essential component of the PREM process. Even if SBP is high, MAP maybe low for age indicating the need for an inotrope. Hence it is crucial to monitor DBP, MAP and pulse pressure – and not just SBP.

Figure 12: Measuring BP.

Adapted from National Health Mission-Strengthening of Pediatric Emergency Care System in Tamil Nadu-Establishment of Pediatric Resuscitation and emergency Units under Tamil Nadu Accidents and Emergency Care Initiative under the name of PREM G.O(D)No. 539, Department of Health and Family Welfare, dated 30.11.19.

PREM Chart

Individual variables	Airway	Breathing	Circulation	Disability
	Stable: Voice or cry	RR for age: 1. Increased 2. Normal 3. Decreased 4. Apnea	HR for age: 1. Increased 2. Normal 3. Decreased (relative bradycardia) 4. Bradycardia Heart sounds: Muffled: Yes/ No Gallop: Yes/ No	A: Alert (Carer confirms) V: Responsive to voice Carer reports incessant cry, lethargy, more-sleepy, not as usual (but you feel child is "conscious" although not fully alert) P: Responsive to pain. Include here children unable to sit or stand/normally ambulant child carried into hospital/ posturing/floppy U: Unresponsive
	Unstable: No voice (un-responsive victim, not breathing)	Retractions: 1. Yes 2. No	Femoral pulse vs dorsalis pedis: (Table 1: Pulses) 1. +++/+ 2. +++/+++ 3. +++/0 4. ++/0	Eye position/ movements: Mid-position/Conjugate deviation 1. Nystagmus: Yes/No 2. Lid twitch: Yes/No 3. Looks around (EOM-Normal): Yes/No 4. Dolls eye movement: Yes/No
	Obstructed: (Stridor) (Noise during every breath)	Grunt: 1. Yes 2. No	Core peripheral temperature gap 1. Warm throughout 2. Cool below ankle 3. Cool below knee 4. Cool below thigh	Pupils 1. Equal/ unequal 2. Response to light: brisk/ sluggish
	Stable obstructed: (Voice with added noise)	Type of respiration: 1. Thoracic 2. Abdominal	Color: 1. Flushed 2. Abnormal 3. Normal	GTC (Generalized Tonic Convulsions) 1. Yes 2. No
	Endotracheal Tube (ET)	Bilateral air-entry: 1. Yes 2. No	CRT (capillary refill time): < 2 seconds < 1 second > 2 seconds	Tone and posture 1. Normal 2. Abnormal
	Tracheostomy	Crept/wheeze: Yes/ No	Hepatomegaly (Table 2: Liver span): 1. Yes 2. No	
			Systolic BP (SBP) for age: Normal High Low	
			Diastolic BP (DBP): 1. < 50% of SBP 2. > 50% of SBP	
			Pulse pressure: 40 < 40 >40	
			MAP Mean Arterial Pressure): Normal High Low	
INFERENCE	**Airway**	**Breathing**	**Circulation**	**Disability**
	1. Stable 2. Unstable 3. Obstructed 4. Stable obstructed 5. Unstable obstructed 6. ET/Trach	1. Normal 2. Effortless tachypnea 3. Respiratory distress 4. Impending Respiratory failure 5. Bradypnea 6. Apnea	1. HR: Normal/tachycardia/ Relative bradycardia/ Absolute bradycardia 2. Perfusion: shock/ no shock 3. Hepatomegaly: Yes/ No 4. Cardiogenic shock: Yes/No 5. SBP: High/normal/ low 6. Pulse pressure: Normal/ wide/ narrow 7. MAP: Normal/ high/ low	1. Alert 2. ALC (altered level of consciousness) 3. Non-convulsive status epilepticus/ Subtle status epilepticus 4. ICP (intracranial pressure)

HR, Heart Rate; RR, Respiratory Rate; BP, Blood Pressure; EOM, Extra-ocular Movements

Adapted from National Health Mission-Strengthening of Pediatric Emergency Care System in Tamil Nadu-Establishment of Pediatric Resuscitation and emergency Units under Tamil Nadu Accidents and Emergency Care Initiative under the name of PREM G.O(D)No. 539, Department of Health and Family Welfare, dated 30.11.19.

Table 1: Interpretation of concurrently palpated pulses

Femoral pulse	Dorsalis Pedis	Inference
+++	++	Normal
+++	+++	Vasodilation (suggestive of warm shock)
+++	+	Narrow pulse pressure (suggestive of cold shock)
+++	0	Hypotensive shock
+ or 0	0	Cardiac arrest

Table 2: Approximate normal liver span of infants and children

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Adapted from: Naveh Y, Berant M. Assessment of liver size in normal infants and children. J Pediatr Gastroenterol Nutr. 1984;3(3):346-8.

PREM Protocol: Triage & resuscitate using Pediatric Resuscitation and Emergency Medicine (PREM) Triangles

NORMAL PHYSIOLOGICAL STATUS

DISABILITY
LOC: Alert;
T&P: N;
Eyes: EOM N; PERL

AIRWAY Stable (vocalizes)

BREATHING RR N; No grunt, stridor, retractions, thoracic respiration; bilateral air-entry+, no added sounds; SaO_2 > 94%

CIRCULATION HR: N (for age); no muffling or gallop; P&C: Warm, pink sole of foot; *Pulses +++/++; CRT< 2 secs; Liver span: N; Blood Pressure: SBP N, Diastolic BP > 50% SBP, Pulse Pressure 30-40 mm Hg, MAP N

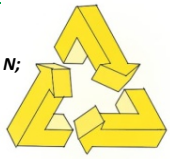
*Pulses: Femoral (F) & Dorsalis Pedis (DP) +++/++ means both normal volume
Note: +++/+++ F = DP ; ++/+ both weak; ++/0 or +/0 weak Femoral palpable but no DP

PREM Terminology & Definitions:

- **Breathing Normal** = Normal RR + normal work of breathing
- **Respiratory distress** = Increased RR + retractions
- **Impending respiratory failure** = Grunt+ respiratory distress
- **Relative bradycardia** = Heart rate within normal range for age - whilst other sides of the triangle are abnormal
- **Wide Pulse pressure** = SBP-DBP > 40 mm Hg
- **Vasodilatory shock** = DBP <50% SBP + wide PP with or without low MAP
- **Mean Arterial Pressure** = Normal MAP is DBP +1/3rd pulse pressure
- **Liver span** = Mark lower border along right costal margin, percuss & mark upper border for liver dullness. Measure span (cms) in the mid-clavicular line. Check lower border & remeasure span after every intervention.
- **Non-Convulsive Status Epilepticus** = LOC: Responsive to pain or unresponsive + 1 or more abn EOM: Conjugate deviation, nystagmus, lid twitch

RESPIRATORY DISTRESS

DISABILITY
LOC: Alert;
T&P: N;
Eyes: EOM N;
PERL

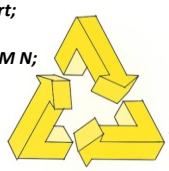


AIRWAY Stable
BREATHING ↑RR; no grunt, stridor±, retractions+, thoracic respiration; bilateral air-entry +, added sounds ±; SaO_2 > 94%

CIRCULATION
HR: ↑/ N; HS: N; P&C: Warm, pink; Pulses +++/++; CRT< 2 secs; No shock; No hepatomegaly; BP: SBP N, DBP N, PP N, MAP N

CARDIAC FAILURE

DISABILITY
LOC: Alert;
T&P: N;
Eyes: EOM N;
PERL

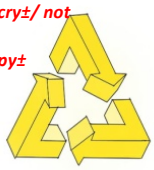


AIRWAY Stable
BREATHING ↑RR; No grunt, stridor± retractions+, thoracic respiration; bilateral air-entry+, added sounds±; SaO_2 > 94%
Exception: CCHD

CIRCULATION
HR: Tachycardia; HS: N; P&C: warm, pink or dusky; Pulses +++/++; CRT< 2 secs; No shock; Hepatomegaly+; BP: SBP N, DBP low, wide PP (shunt lesion), MAP N

VASODILATORY CARDIOGENIC SHOCK (MAP N)

DISABILITY
LOC: Incessant cry±/ not usual self±/ lethargic±/sleepy±
T&P: N;
Eyes: EOM N;
PERL



AIRWAY Stable
BREATHING ↑RR, grunt±, stridor ± retractions+, abdom. respiration±; bilateral air-entry+, added sounds±; SaO_2 ±< 94%

CIRCULATION
HR: Tachycardia; HS: Muffling±, gallop ±; P&C: Very warm, very pink; Pulses: +++/+++; CRT instant; Shock; Hepatomegaly±; BP: SBP↑, DBP ↓, wide PP, MAP N

RESPIRATORY FAILURE (RESPIRATORY EMERGENCIES)

DISABILITY LOC: Responds to pain; T&P abnormal: Agitated, combative, fighting mask or floppy, ± posturing; EOM ± abN, PERL; NCSE±

AIRWAY Stable/unstable
BREATHING RR↑↓, grunt+, stridor±, retractions+, abdominal respiration; bilateral air-entry±, added sound ±; SaO_2 < 94%

CIRCULATION
HR: Tachycardia; HS: N; P&C: Warm, pink; Pulses: +++/+++; CRT <2sec; Shock+; Liver span N; BP: SBP N, DBP ↓, wide PP, MAP N

VASODILATORY CARDIOGENIC LOW MAP SHOCK

DISABILITY LOC: Responds to pain; T&P abnormal: Thirsty, agitated, combative, fighting mask or floppy, ± posturing; EOM ± abN , PERL; NCSE±

AIRWAY Stable/ unstable
BREATHING RR↑↓, grunt+, stridor± , retractions+, abdominal respiration; bilateral air-entry+, added sounds±; SaO_2 <94%

CIRCULATION
HR: Tachycardia/relative bradycardia; HS: Muffling±, gallop±; P&C: Very warm, very pink; Pulses: +++/+++; CRT instant; Shock; Hepatomegaly±; BP: SBP N, DBP ↓, wide PP, MAP N

LOW SBP SHOCK

DISABILITY LOC: Responds to pain; T&P abnormal: Thirsty, agitated, combative, fighting mask or floppy, ± posturing; EOM ± abN, PERL; NCSE±

AIRWAY Stable/ unstable
BREATHING RR↑↓, grunt+, stridor± , retractions+, abdominal respiration; bilateral air-entry+, added sounds±; SaO_2 <94%

CIRCULATION
HR: Tachycardia/relative bradycardia; HS: Muffling±, gallop±; P&C: Cool, dusky; Pulses: ++/+, ++/0 or +/0; CRT >2sec; Shock; Hepatomegaly±; BP: SBP ↓, DBP ↓, PP N, wide or narrow, MAP↓

IMMINENT ARREST

DISABILITY
LOC: Unresponsive; T&P abnormal: Posturing, GTCS±; EOM abn, pupils sluggish; NCSE±

AIRWAY Unstable
BREATHING Bradypnea or apnea; Little/no respiratory effort; Reduced or absent breath sounds; SaO_2 <<94%

CIRCULATION
HR: Bradycardia; HS: Muffled, gallop; P&C: Cool, dusky; Pulses: ++/0 or +/0; CRT >>2sec; Shock; Hepatomegaly; BP: SBP ↓, DBP ↓, PP N, wide or narrow, MAP↓

Note: All Normal (N), Increased (↑), relative (N) or Decreased (↓) values – are interpreted with respect to normal ranges for age and the other parts of the PREM triangle.

RR: Respiratory Rate
HR: Heart Rate
HS: Heart Sounds
P&C: Peripheries (warmth) & Colour (foot-sole)
LOC: Level of Consciousness
T&P: Tone & Posture
EOM: Extra Ocular Movements
PERL: Pupils Equal, Reacting to Light
SBP: Systolic Blood Pressure
DBP: Diastolic Blood Pressure
PP: Pulse Pressure
MAP: Mean Arterial Pressure
NCSE: Non-Convulsive Status Epilepticus
GTCS: Generalised Tonic Clonic Seizures
CCHD: Cyanotic Congenital Heart Disease

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