Resource-Limited ENLS
Resuscitation Following Cardiac Arrest

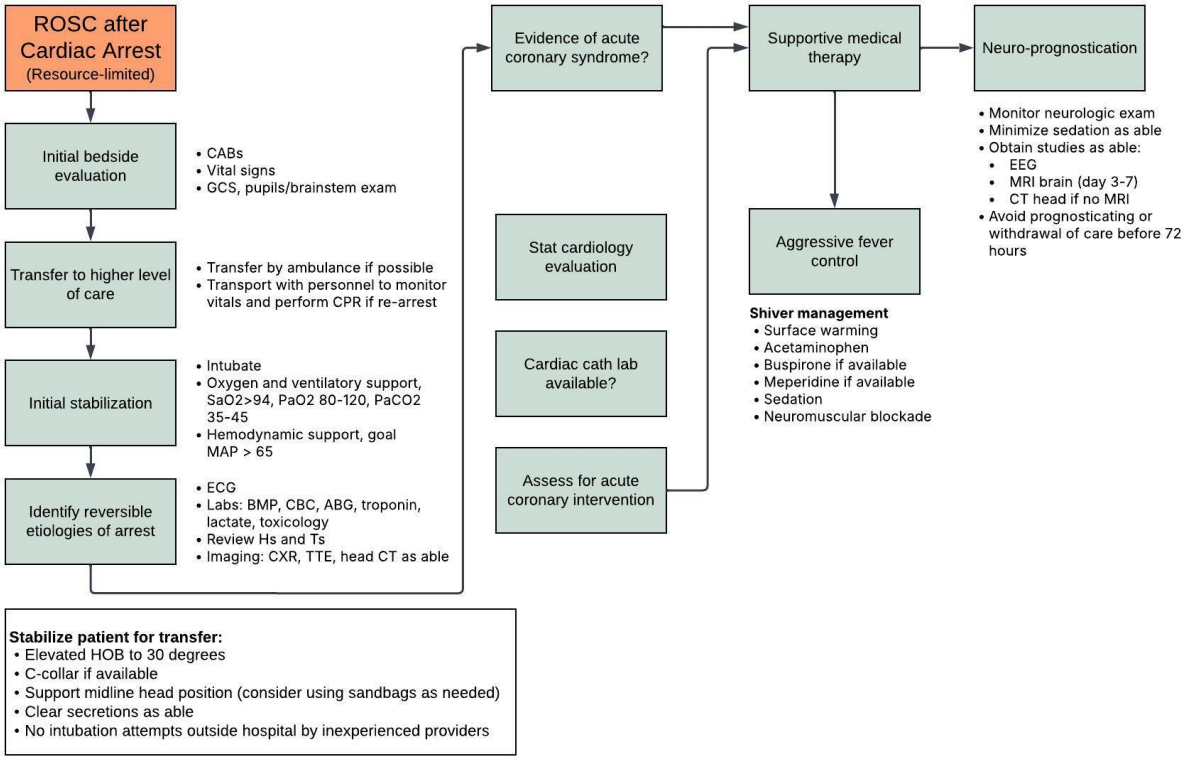
General considerations in resource-limited settings: Because of low rates of bystander CPR and defibrillation in low- and middle-income countries[1] and underdevelopment of pre-hospital care services to stabilize critically ill patients in the field[2], out-of-hospital cardiac arrest (OHCA) in resource-limited environments is associated with low rates of survival to hospital presentation. As a result, the recommendations discussed here are more likely to be pertinent to in-hospital cardiac arrest (IHCA), though the management principles may equally be applied to OHCA survivors. These recommendations emphasize the timely and safe transfer of patients to the highest available level of care, supportive care for neuroprotection, and prognostication of neurologic outcomes. Each of these domains of care is likely to be influenced by resource limitations that may require clinicians to deviate from management algorithms developed in high-income settings.

Initial evaluation, stabilization, and physiologic goals: The immediate priorities for survivors of cardiac arrest in resource-limited settings are stabilization of the circulation, airway, and breathing, and transport to a healthcare facility with capacity for intubation, mechanical ventilation, and interdisciplinary care from intensivists, cardiologists, and neurologists. Patients with OHCA who achieve ROSC in the field or in a community health facility should be stabilized to the extent possible with available resources, and emergent transfer to a higher level of care should be arranged. Please refer to figure 1 ("Stabilize patient for transfer") for pre-hospital recommendations. The patient should be transported by ambulance with staff trained in CPR when available, and for those transferring from community health centers, clinicians should contact staff at the receiving referral hospital to facilitate time-sensitive preparations for the patient's arrival. Patients who remain comatose after ROSC on evaluation by emergency department or critical care staff should be promptly intubated (see *ENLS Airway* module, section on "Resource-limited considerations"). Respiratory support with mechanical ventilation and supplemental oxygen should aim to maintain oxygen saturation above 94% and, when arterial blood gas measurement is available, PCO2 35-45mmHg. Hemodynamic support should be provided to maintain a mean arterial pressure above 65mmHg to maintain adequate cerebral perfusion. This may be achieved with vasopressors if available, or with IV fluid resuscitation (though the latter must be weighed against the suspicion for cardiogenic shock). A workup should be performed to determine the underlying etiology of the cardiac arrest (see figure 1, "Identify reversible etiologies of arrest"), and if available, point-of-care ultrasound should be performed to assess the patient's cardiac function and volume status.

Neuroprotection and supportive care: The overriding goal of post-cardiac arrest care is to limit secondary brain injury and minimize cerebral metabolic demand. Medical devices for therapeutic hypothermia are unavailable in most resource-limited settings, and in the absence of resources for targeted temperature management (TTM; see preceding sections of this module), all feasible efforts should be made to prevent maintain euthermia, as fevers are a known driver of secondary brain injury. Fever prevention and control may be achieved with antipyretics (acetaminophen, ibuprofen), ice packs applied to the axillary and inguinal regions, tepid sponging of the skin, and chilled intravenous saline (refrigerated to 4 degrees Celsius). The temperature should be monitored hourly, and interventions to treat fever should be tailored to avoid large fluctuations in body temperature. Shivering often occurs in febrile patients undergoing active cooling measures, and is an independent driver of secondary brain injury. Standard methods to treat shivering include surface counterwarming with forced air warming blankets and anti-shivering medications (acetaminophen, IV magnesium sulfate, buspirone, meperidine, opiates, and

dexmedetomidine), but may be unavailable in many resource-limited settings. Shivering that is refractory to available interventions may be treated with intermittent doses of IV paralytics as needed in patients who are intubated and adequately sedated. Patients with persistent fever should undergo a broad evaluation for infectious sources, including blood cultures, urinalysis, and chest radiography. If identified, infectious sources should be treated with antibiotics, though antibiotics should not be used in the absence of a clinically identified infection.

Neuroprognostication: Developing a neurologic prognosis and establishing goals of care after cardiac arrest in resource-limited settings is likely to depend on a variety of clinical and socio-cultural factors that may vary across contexts. Many countries worldwide do not recognize the concept of brain death[3] and do not allow for terminal extubation before cardiac death.[4] Clinicians should engage the patient's loved ones and surrogate decision-makers early in their hospital course to discuss goals of care, but refrain from prognostication in the first 72 hours and in the absence of key clinical data. In high-income settings, patients typically undergo neuroimaging with non-contrast head CT as part of the initial workup in the emergency department. Because CT imaging often entails significant out-of-pocket costs to patients, is insensitive to early signs of anoxic brain injury, and is unlikely to change early management, it may be reasonable to forgo imaging until 48-72 hours after cardiac arrest when the prognosis remains uncertain and when radiographic evidence of severe brain injury would change management or goals of care. MRI is the preferred imaging modality to assess for anoxic brain injury, but if MRI is unavailable or prohibitively costly, CT can be used. The patient's neurologic exam should be monitored closely, and sedation should be minimized for patients who do not require it for ventilator synchrony or pharmacologic paralysis.



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