Resource-Limited ENLS
Approach to the Patient with Coma

Initial evaluation and stabilization: In resource-limited settings, the initial evaluation of the comatose patient may rely extensively or exclusively on the bedside physical exam. An assessment of the patient's circulation, airway, and breathing status should be performed. A full set of vital signs should be recorded. A brief neurologic examination to determine the Glasgow Coma Scale (GCS) score (best eye response, best verbal response, and best motor response) and Full Outline of UnResponsiveness (FOUR) score (best eye response, best motor response, brainstem reflexes, and respiration pattern), should be performed to establish the patient's baseline, symptom severity and immediate management priorities. If the presenting facility is equipped to provide safe intubation, patients with depressed consciousness and compromised airway protection should be intubated. IV access should be established for all patients. Cervical spine stabilization should be provided for all patients with witnessed or possible trauma.

Considerations for emergent transfer: Comatose patients require a wide range of diagnostic and therapeutic resources, and transfer to a referral hospital should be arranged as early as possible for patients presenting to peripheral health care facilities. The optimal setting for managing patients with coma is a tertiary care hospital equipped with a CT scanner, a clinical laboratory, an intensive care unit (ICU) capable of managing intubated patients, medications for managing intracranial pressure, seizures, and neurologic infections, and personnel trained in the management of neurologic emergencies. Patients should be transported between facilities in an ambulance if available. All feasible measures should be taken before and during transport to maintain the patient's airway, maintain normoxemia with supplemental oxygen as needed, maintain hemodynamic stability with IV fluid resuscitation as needed, and elevate the patient's head to 30 degrees to minimize intracranial pressure (ICP) unless there is concern for an unstable spine fracture. Oral medications should not be administered under any circumstances given the risk of aspiration. In the absence of a rigid cervical collar, the cervical spine may be stabilized manually or by placing sandbags on either side of the patient's head to maintain midline neck position.

Early diagnostic workup and management: Coma is the final common pathway of a multitude of potential etiologies, and successful management of coma depends on identifying and addressing the underlying disease process. Evaluation for readily reversible causes of coma should include blood pressure measurement to assess for shock or hypertensive emergency, finger stick blood glucose to assess for severe hypo- or hyperglycemia, and a urine drug screen should be performed to assess for illicit drug exposures. If an opiate overdose is possible or suspected, naloxone should be administered if available. Beyond these targeted assessments, a comprehensive laboratory evaluation should be performed to evaluate for potential metabolic, infectious, or hematologic etiologies.

The presence or absence of a CT scanner for emergent use constitutes a critical branch point in the acute evaluation of coma (and numerous other neurologic emergencies) in resource-limited settings. When CT is available on an emergent basis, imaging should be performed immediately to evaluate for a structural cause of coma. When a structural lesion is identified, therapeutic interventions targeting the likeliest etiologies should be implemented in accordance with the appropriate ENLS guidelines for the corresponding disease process(es). If emergent CT is unrevealing and no alternative metabolic or physiologic cause has been identified on physical or laboratory evaluation, further neurologic testing should be pursued as able with consideration of MRI brain, CT angiography, electroencephalography (EEG), and/or lumbar puncture as appropriate to the clinical context.

When early CT is unavailable for patients with coma of unknown cause, clinical assessment should focus on treatable causes of coma for which empiric treatment can be implemented safely in the absence of neuroimaging. Broadly, these diagnostic categories include structural and non-structural etiologies including: increased ICP, central nervous system (CNS) infection, status epilepticus, and metabolic derangements. The bedside assessment and empiric management of each of these categories of disease are outlined in Table 1 and are discussed in greater depth within their corresponding ENLS modules ("Intracranial Pressure and Herniation," "Meningitis and Encephalitis," and "Status Epilepticus").

***Triage and supportive care*:** Comatose patients should be cared for at the highest available level of care, ideally in an ICU. When an ICU is not available, patients should be located as close as possible to the ward nursing station and be given the highest feasible level of monitoring with regular vital signs and neurologic examinations to detect adverse changes in the patient's status. Interdisciplinary evaluation including neurology, neurosurgery, critical care, and nursing input, should be performed on an ongoing basis. Hospital-acquired complications are common in comatose patients, and supportive care should be aimed at preventing nosocomial infections, deep venous thromboses, and pressure ulcers.

Treatable cause of coma	Clinical indicators and bedside assessment	Empiric management
Increased intracranial pressure (see ENLS module for "Intracranial and Herniation")	• Asymmetric or non-reactive pupils • Papilledema • Sunset eyes (fixed downward gaze) • Cushing's physiology (bradycardia, hypertension, abnormal respiration) • Copious or projectile vomiting • History of severe headache and/or nausea/vomiting preceding progression to coma • Known history of brain neoplasm	• HOB elevation to 30 degrees • Maintain midline head position • Mannitol 0.25-1g/kg (assess for clinical improvement after administration, continue every 6 hours if positive clinical response) • Hyperventilation to pCO2 32-35mmHg if patient is intubated, not to exceed 12 hours • Avoid hypovolemia and hypotension • Avoid hypotonic fluids • Corticosteroids if known brain neoplasm
Central nervous system infection (see ENLS module for "Meningitis and Encephalitis")	• Fever • Meningismus, Kernig's sign, Brudzinski's sign • Immunocompromised host • Head/neck infectious source • Recent head trauma • Recent head/neck or neurosurgery	• Initiate early broad spectrum CNS antibiotics • Consider antiviral and/or anti-tuberculous therapy as indicated as available • If no clinical signs of increased ICP or lateralizing neurologic deficits, perform LP • Assess for abscess or space-occupying lesion when CT available
Status epilepticus (see ENLS module for "Status Epilepticus")	• Clinically evident seizures • History of epilepsy • History of poor adherence to antiseizure medication or acute trigger for provoked seizure	• Load with IV benzodiazepines • Load with IV anti-seizure medications • Connect to EEG if available • Consider workup for CNS infection • CT or MRI when available
Metabolic derangements	• Dysglycemia: hypo- or hyperglycemia on fingerstick or serum glucose test	• Dysglycemia: dextrose or insulin as indicated; follow institutional protocol for

	• Hepatic encephalopathy: jaundice, asterixis, hyperammonemia • Sepsis/systemic infection: fever, hypotension, abnormal WBC count, infectious source • Uremia: elevated BUN, typically co-occurring with renal failure • Extreme acid-base derangements: basic metabolic panel, anion gap, arterial blood gas if available • Extreme sodium derangements: basic metabolic panel • Ingestion of toxins or illicit drugs: clinical history from family/bystanders, toxicology screening if available	diabetic ketoacidosis management if applicable • Hepatic encephalopathy: laxatives as available to promote ammonia clearance, dialysis as available for extreme hyperammonemia • Sepsis/systemic infection: blood cultures, chest X-ray, urinalysis, empiric broad-spectrum antibiotics, hemodynamic support with fluids and vasopressors • Uremia: dialysis as available • Acid-base derangements: treat underlying cause • Sodium derangements: gradual correction with oral salt and free water restriction (hyponatremia), or with IV and enteral free water (hypernatremia); check serum sodium as frequently as possible to avoid rapid correction • Toxins/drugs: toxin-specific reversal agents as available, supportive care

Table 1

Empiric management for treatable causes of coma when CT is unavailable

Figure 1

Algorithm for coma management in resource-limited settings