# ENLS Version 3.0

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# ENLS Version 3.0

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# Emergency Neurological Life Support: Third Edition, Updates in the Approach to Early Management of a Neurological Emergency

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**Abstract** Emergency Neurologic Life Support (ENLS) is an educational program designed to provide users advisory instructions regarding management for the first few hours of a neurologic emergency. The content of the course is divided into 14 modules, each addressing a distinct category of neurological injury. The course is appropriate for practitioners and providers from various backgrounds who work in environments of variable medical complexity. The focus of ENLS is centered on a standardized treatment algorithm, checklists, to guide early patient care, and a structured format for communication of findings and concerns to other healthcare professionals. Certification and training in ENLS is hosted by the Neurocritical Care Society. This document introduces the concept of ENLS and describes revisions that constitute the third version.

**Keywords** Emergency · Algorithm · Neurocritical care · Resuscitation · Critical care

## Background

The purpose of the Emergency Neurological Life Support (ENLS) course remains focused on improving care during the first hours of contact for patients with acute neurological emergencies. The structure of the ENLS course is based on the concept that a standardized approach to diagnosis, stabilization and early work up and management will improve functional outcomes for these patients. Special attention is placed on timely collection of relevant data which can be communicated effectively to consultants from the emergency department setting.

The 14 ENLS modules span a broad range of neurologic emergencies and include modules detailing aspects of general emergency medicine and critical care that need to be specifically tailored to the patient with acute nervous system illness or injury. An example of this is the "Airway, Ventilation and Sedation" module. Furthermore, the modules are meant to be applicable for clinicians from diverse training backgrounds. The basic structure of ENLS education was created by its inaugural chairs, Dr. Wade Smith and Dr. Scott Weingart. The original ENLS algorithms and supporting manuscripts were published in *Neurocritical Care* in July of 2012 and presented at the Neurocritical Care Society Annual Meeting the following fall. Currently, the ENLS curriculum has been taken by over 6000 trainees. The ENLS training can be taken either as a live course given by accredited trainers or by on-line self-study on the ENLS training website (http://www.neurocriticalcare.org). Currently 201 courses have been held in over 30 states and 22 countries. ENLS content will soon be available in three languages including English, Spanish and Japanese. This represents an unprecedented growth and considerable progress towards improving clinical care for patients with acute neurological emergencies.

The ENLS modules present a step wise approach to early clinical care and each module contains an initial algorithm, a checklist of important clinical points and a list of information needed for communication to improve transitions across care settings. Furthermore, ENLS can be a tool for longitudinal learning as participants have access

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to the modules, manuscripts and references throughout their certification.

## Changes in ENLS Version 3.0

The ENLS program was designed to be updated to reflect best practice. Accordingly, trainee feedback is highly valued. This feedback has been incorporated to help shape the changes seen in ENLS Version 3.0. The ENLS content has been updated with three emphasis areas in mind.

- More directive algorithms and specific information in checklists.
- Incorporation of aspects essential to providing nursing care for patients with acute neurological emergencies.
- Attention to consistency with published guidelines from the Neurocritical Care Society as well as our sister societies involved in emergency and critical care of these patients.

ENLS Version 3.0 includes updates related to the recent guidelines for the management of traumatic brain injury from the Brain Trauma Foundation [1]. Attention has also been given to changes in the care of patients with acute ischemic stroke after recent trials emphasizing the importance of rapidly identifying and treating large vessel occlusions with endovascular therapies [2, 3]. The use of targeted temperature management has continued to evolve in this setting, and recent changes have been incorporated into the resuscitation after cardiac arrest module.

**Table 1** List of ENLS protocols and their authors

| Module | Author(s) |
|---|---|
| Airway, ventilation, and sedation | Venkatakrishna Rajajee, MD |
| | Becky Riggs, MD |
| | David B. Seder, MD |
| Acute non-traumatic weakness | Anna Finley Caulfield, MD |
| | Oliver Flower, MD |
| | Jose A. Pineda, MD |
| | Shahana Uddin, MBBS, MD |
| Pharmacotherapy | Gretchen M. Brophy, PharmD, BCPS, FCCP, FCCM, FNCS |
| | Theresa Human, PharmD, PhD, BCPS, FNCS |
| Approach to the patient with coma | Rhonda S. Cadena, MD |
| | Aarti Sarwal, MD |
| Intracranial hypertension and herniation | Rhonda Cadena, MD |
| | Michael Shoykhet, MD, PhD |
| | Jonathan J. Ratcliff, MD, MPH |
| Intracerebral hemorrhage | J. Claude Hemphill III, MD, MAS |
| | Arthur Lam, MD |
| Acute ischemic stroke | Hartmut Gross, MD |
| | Noah Grose, BSN, MSN, ACNP-BC |
| Subarachnoid hemorrhage | Brian L. Edlow, MD |
| | Owen Samuels, MD |
| Meningitis and encephalitis | David F. Gaieski, MD |
| | Nicole F. O'Brien, MD |
| | Ricardo Hernandez, MD |
| Resuscitation following cardiac arrest | Jonathan Elmer, MD, MS |
| | Kees H. Polderman, MD, PhD |
| Spinal cord compression | Kristine H. O'Phelan MD |
| Status epilepticus | Jan Claassen, MD, PhD |
| | Joshua N. Goldstein, MD, PhD |
| Traumatic brain injury | Rachel Garvin, MD |
| | Halinder S. Mangat, MD |
| Traumatic spine injury | Deborah M. Stein, MD, MPH, FACS, FCCM |
| | William A. Knight IV, MD, FACEP, FNCS |

**Table 2** Manuscript reviewers

| |
|---|
| Kimberly Alva, ACNP |
| Cynthia Bautista, PhD, APRN, FNCS |
| Megan Corry, EdD, EMTP |
| Jeff Fong, PharmD |
| Jimmy Huh, MD |
| Jeffrey Mucksavage, PharmD |
| Jose Pineda MD |
| Aaron Raleigh |
| Eljim Tesoro, PharmD, BCPS |

ENLS is indebted to the authors and reviewers who worked to assure the revisions met expectations for quality and content. The authors and reviewers are listed in Tables 1 and 2. Special gratitude is given to Becca Stickney and Connie Hayden, who provided guidance, management and administrative support during the revision process.

In conclusion, this revised version of ENLS continues to provide an algorithmic approach to the early stages of clinical care for patients with acute neurological emergencies. It also will serve as a springboard for ongoing education and improvements in the quality of clinical care for these patients.

## References

1. Carney N, et al. Guidelines for the management of severe traumatic brain injury, fourth edition. Neurosurgery. 2017;80(1):6–15.
2. Saver JL, et al. Stent-retriever thrombectomy after intravenous t-PA vs. T-PA alone in stroke [SWIFT PRIME]. N Engl J Med. 2015;372:2285–95.
3. Powers WJ, et al. 2015 AHA/ASA focused update of the 2013 guidelines for the early management of patients with acute ischemic stroke regarding endovascular treatment. Stroke. 2015;46:3020–35.

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# Emergency Neurological Life Support: Airway, Ventilation, and Sedation

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**Abstract** Airway management and ventilation are central to the resuscitation of the neurologically ill. These patients often have evolving processes that threaten the airway and adequate ventilation. Furthermore, intubation, ventilation, and sedative choices directly affect brain perfusion. Therefore, Airway, Ventilation, and Sedation was chosen as an Emergency Neurological Life Support protocol. Topics include airway management, when and how to intubate with special attention to hemodynamics and preservation of cerebral blood flow, mechanical ventilation settings and the use of sedative agents based on the patient's neurological status.

**Keywords** Airway · Ventilation · Sedation · Neurocritical care · Emergency

## Introduction

Intubation of the acutely brain injured patient can be a matter of life or death. Failure to intubate a patient with rapidly progressive neurological decline may result in respiratory arrest, secondary brain injury from hypoxia, acidosis, elevated intracranial pressure, or severe aspiration pneumonitis and acute respiratory distress syndrome. Conversely, the process of induction and intubation can elevate intracranial hypertension when a mass lesion is present, complete a massive infarction when brain tissue is marginally perfused, and result in temporary loss of the neurological examination at a time when neurological and neurosurgical decision-making is required.

The goals of airway management in neurological patients are to maintain adequate (but not excessive) oxygenation and ventilation, preserve cerebral perfusion, and prevent aspiration. A neurological assessment prior to the administration of sedating and paralyzing medications should be performed to provide a functional baseline, whereby neurological and neurosurgical decision making may ensue.

The ENLS suggested algorithm for the initial management of airway, ventilation, and sedation is shown in Fig. 1. Suggested items to complete within the first hour of evaluating a patient are shown in Table 1.

## Assessing the Need for Intubation

Patients in severe respiratory distress or impending arrest should be intubated without delay. Additionally, a patient who cannot "protect his airway" because of depressed mental status or vomiting with aspiration may need tracheal intubation. Intubation has the potential for complications, creates significant hemodynamic disturbances, and should not be undertaken without a risk benefit assessment. However, it should not be delayed when necessary. The decision to intubate is influenced by factors specific to patient physiology, clinical environment, and the anticipated course of care.

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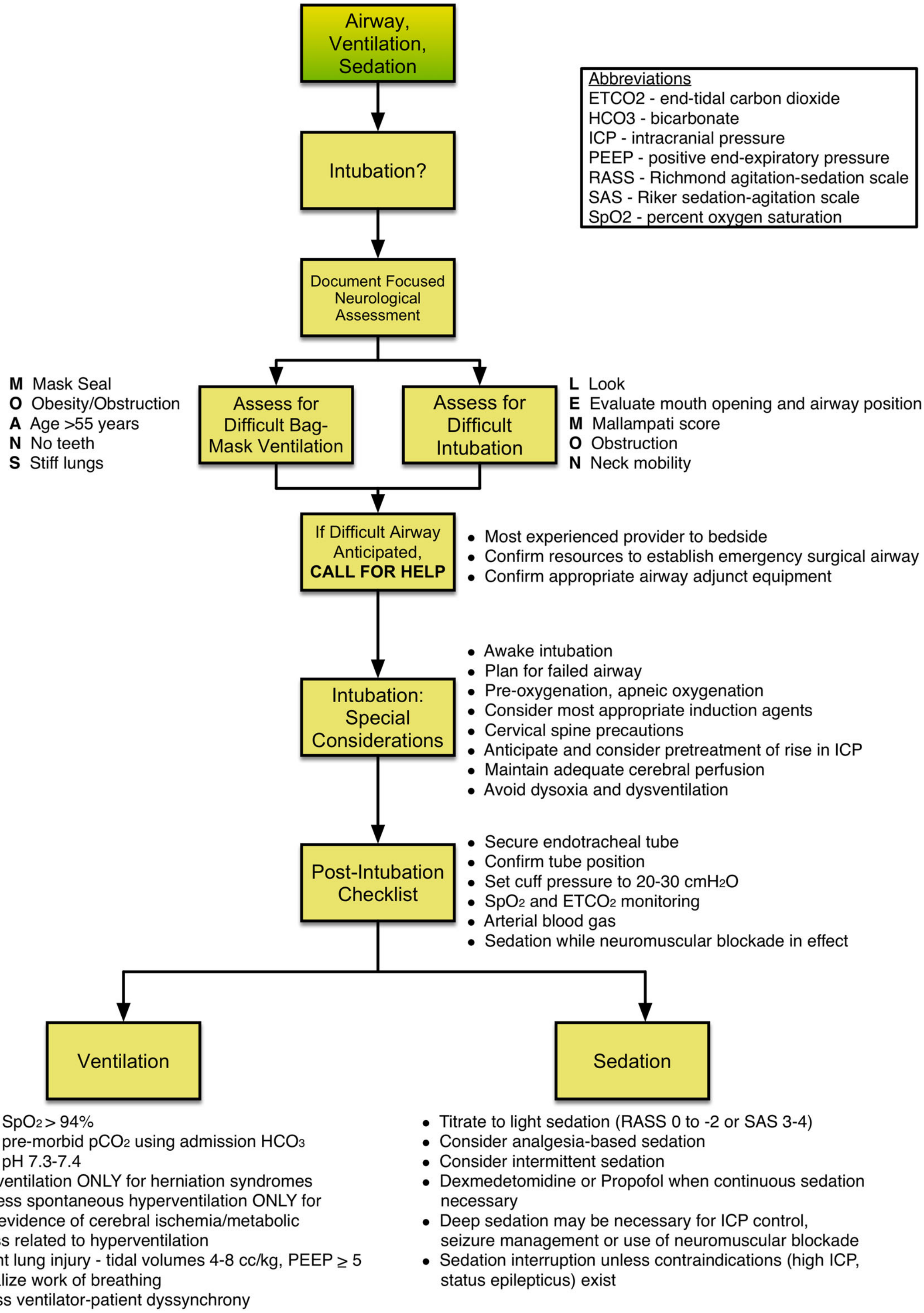


**Fig. 1** ENLS airway, ventilation, and sedation protocol

In the emergency department (ED) or prehospital environment, a stuporous or comatose patient with an unknown diagnosis requiring extended transport, transfer, imaging, or invasive procedures may be most appropriately managed with a secure endotracheal airway. The same patient with a known condition, an anticipated stable or improving course, and no planned transportation may not require intubation and might be managed by a more conservative approach.

Table 1 Airway, ventilation, and sedation checklist within the first hour

| Checklist |
|---|
| ☐ Assess the need for intubation or non-invasive positive pressure ventilation |
| ☐ Perform and document a focused neurological assessment prior to intubation |
| ☐ Verify the endotracheal tube position |
| ☐ Determine ventilation and oxygenation targets, and verify with ABG/$SpO_2$/$ETCO_2$ |
| ☐ Assess the need for analgesia and/or sedation in mechanically ventilated patients |

With these considerations in mind, there are four commonly accepted indications to intubate:

### Failure to Oxygenate

This finding may be determined by pulse oximetry (limitations include regional or systemic hypoperfusion, severe anemia, and opaque nail polish), arterial blood gas analysis, or the patient's visual appearance (cyanosis).

### Failure to Ventilate

Ventilation is assessed by capnometry through nasal cannula or transcutaneous monitoring [1], arterial blood gas analysis, or gross visual appearance (excessive or inadequate work of breathing).

### Failure to Protect the Airway

Airway protection is the result of numerous variables including bulbar function, airway anatomy, quantity and quality of secretions, strength of cough reflex, and ability to swallow after suctioning [2]. The presence of a gag reflex is an inadequate method of assessing airway protection [3].

### Anticipated Neurological or Cardiopulmonary Decline Requiring Transport or Immediate Treatment

Anticipation of the trajectory of the patient's condition can avoid rushed or emergent intubations and allow for appropriate preparation for the procedure.

## Decision Made to Intubate: Perform Neurological Assessment

Whenever possible, urgent management of the airway should coincide with a focused neurological assessment. The examination can typically be conducted in 2 min or less. The pre-sedation/pre-intubation neurologic exam establishes a baseline that is used to assess therapeutic interventions (e.g., patients with stroke, seizures, hydrocephalus or other disorders) or may identify injuries that are at risk of progressing (e.g., unstable cervical spine fractures). The assessment identifies the type of testing required and may help to limit unnecessary interventions, such as radiological cervical spine clearance. In general, the pre-intubation neurological assessment is the responsibility of the team leader who is coordinating the resuscitation. Findings should be documented and communicated directly to the team that assumes care of the patient. The pre-intubation neurological examination includes an assessment of:

- Level of arousal, interaction, and orientation, as well as an assessment of simple cortical functions such as vision, attention, and speech comprehension and fluency.
- Cranial nerve function.
- Motor function of each individual extremity.
- Tone and reflexes.
- Recognition of involuntary movement consistent with tremor or epileptic activity.
- Cervical tenderness or gross spinal abnormality.
- Sensory level in patients with suspected spinal cord injury.

## Airway Assessment

A difficult airway may be broadly defined as an endotracheal intubation attempt in which a provider who is appropriately trained in airway management experiences difficulty with bag-mask ventilation, tracheal intubation or both [4]. Using this broad definition, up to 30% of ED intubations may involve "difficult airways" [5]. Patients with acute neurological injury may be particularly likely to have a difficult airway, because of the need to immobilize the cervical spine in patients who suffer trauma or are "found down" following neurological emergencies such as strokes and seizures. It is essential that all healthcare providers who manage critically ill neurological patients be able to identify common factors that may increase the complexity of airway management. Identification of the difficult airway is essential for selection of the appropriate technique (awake fiberoptic vs rapid sequence induction), tools (video vs direct laryngoscopy) and operator (anesthesiologist vs other provider, attending vs trainee). Failure to identify a difficult airway prior to induction is one of the most important factors predicting a subsequent failed airway during the intubation attempt [6, 7].

The "LEMON" pneumonic has been shown to successfully predict difficult tracheal intubation in the emergency department [3, 8]:

**L** = Look externally, for features such as abnormal facies, oro-maxillo-facial trauma and abnormal body habitus.
**E** = Evaluate with the **3-2-2 rule**.

- Will 3 of the patient's fingers fit between the incisors of the open mouth? If not, mouth opening may be too limited to permit adequate laryngoscopic visualization or manipulation of the endotracheal tube.
- Will 3 of the patient's fingers fit between the chin (mentum) and the hyoid bone? If not, the airway may be too anterior for easy visualization with direct laryngoscopy (DL).
- Will 2 of the patient's fingers fit between the hyoid bone and the superior thyroid notch? If not, the airway may be too high in the neck to permit easy visualization.

**M** = Mallampati score assesses the extent of mouth opening in relation to tongue size [9, 10].

Grade I: Soft palate, entire uvula, faucial pillars visible.
Grade II: Soft palate, entire uvula visible.
Grade III: Soft palate, base of uvula visible.
Grade IV: Only hard palate visible.

Grades 1 and 2 predict easy visualization, 3 predicts difficulty and 4 extreme difficulty. Mallampati grading ideally requires some patient co-operation and may be difficult to assess in patients with acute brain injury.

**O** = Obstruction/obesity. The presence of redundant soft tissue (obesity), a supraglottic mass or trauma/hematoma within the oropharynx may obscure the view of the glottis.
**N** = Neck mobility. Inability to attain the sniffing position because of immobilization of the cervical spine in the trauma patient, ankylosing spondylitis, rheumatoid arthritis or age related degenerative disease.

The "MOANS" pneumonic predicts difficulty of bag mask ventilation [3]:

**M** = Mask seal, may be compromised by abnormal facies, facial hair and body fluids.
**O** = Obesity/obstruction.
**A** = Age >55.
**N** = No teeth.
**S** = Stiff lungs.

When a difficult airway is identified, the most important next step is to call for help, as appropriate. The provider with the most experience in airway management should be present at the bedside, as well as a provider capable of rapidly establishing a surgical (or percutaneous) airway in the event of a failed intubation. Availability of all necessary tools at the bedside, such as a supraglottic airway, endotracheal tube introducer (bougie), cricothyroidotomy tray, and a video laryngoscope should be confirmed. Finally, it is important to remember that prediction of a difficult airway is imperfect and that an *unanticipated* difficult airway may be encountered [11]. Ready availability of the necessary expertise and equipment in the form of an institutional airway team may increase survival to hospital discharge and decrease the need for a surgical airway [12, 13].

## Endotracheal Intubation in the Critically Ill Neurological Patient

Several societies have published guidelines for the management of the difficult airway, particularly in the setting of anesthesia for elective procedures [4, 14–16]. Intubation of the critically ill patient is a fundamentally different clinical situation than intubation in the relatively stable environment of the operating room [16]. While over 90% will be technically successful, about 20–25% of critically ill patients will develop severe hypoxemia during intubation, 10–25% will develop severe hypotension and about 2% will suffer cardiac arrest [7, 17–19]. More so than other critically ill patients, the patient with acute brain injury is unlikely to tolerate significant periods of hypoxia or hypotension, which may result in secondary injury to the vulnerable brain [20–26]. The ENLS intubation algorithm, therefore, emphasizes evidence-based best practice for maintenance of adequate oxygenation and perfusion during intubation, as well as the most direct and dependable pathway to a definitive airway for providers with varied experience and backgrounds.

As a first step, at least 2 providers, including at least one provider experienced in airway management, should be present at the bedside. Two-provider presence may decrease complications associated with intubation of the critically ill [17, 27] (Fig. 2).

## Awake Intubation

The provider may be "forced to act" in the patient with acute neurological illness who has a compromised airway and rapid progression to cardiovascular or respiratory collapse, necessitating an urgent attempt at laryngoscopy