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Amyotrophic lateral sclerosis:

Nursing care and considerations

BY VINCENT M. VACCA, JR., MSN, RN

Abstract: Amyotrophic lateral sclerosis (ALS) is a rapidly progressive neurodegenerative disease that is always fatal, although treatment can help slow disease progression. This article discusses the etiology and pathophysiology, signs and symptoms, diagnosis, and clinical management of ALS, with special nursing considerations to help patients at the end of life.

Keywords: ALS, amyotrophic lateral sclerosis, corticospinal tract, LMN, Lou Gehrig disease, lower motor neurons, motor neuron disease, muscle atrophy, neurodegenerative disorder, UMN, upper motor neurons

AMYOTROPHIC LATERAL SCLEROSIS (ALS), also known as motor neuron disease, was first described in the 19th century by French neurologist Jean-Martin Charcot. In the 20th century, ALS became known as Lou Gehrig disease after the famous New York Yankees baseball player. Gehrig died from ALS in 1941 at age 37.[1]

ALS is the most common form of motor neuron disease and the third most common neurodegenerative disorder behind Alzheimer disease and Parkinson disease.[2] An estimated 300,000 individuals are living with ALS in the US currently.[3] The median age of onset is 55, and disease incidence peaks between ages 70 and 75.[1,4] More males are affected than females. Approximately 90% of ALS cases are determined to be sporadic, or acquired, while the remainder are considered familial, or hereditary. The known risk factors of ALS include age and family history, but there is now evidence that cigarette smoking may also be a risk factor.[1]

This article provides information on the etiology, pathophysiology, and signs and symptoms of ALS, as well as nursing considerations to help patients

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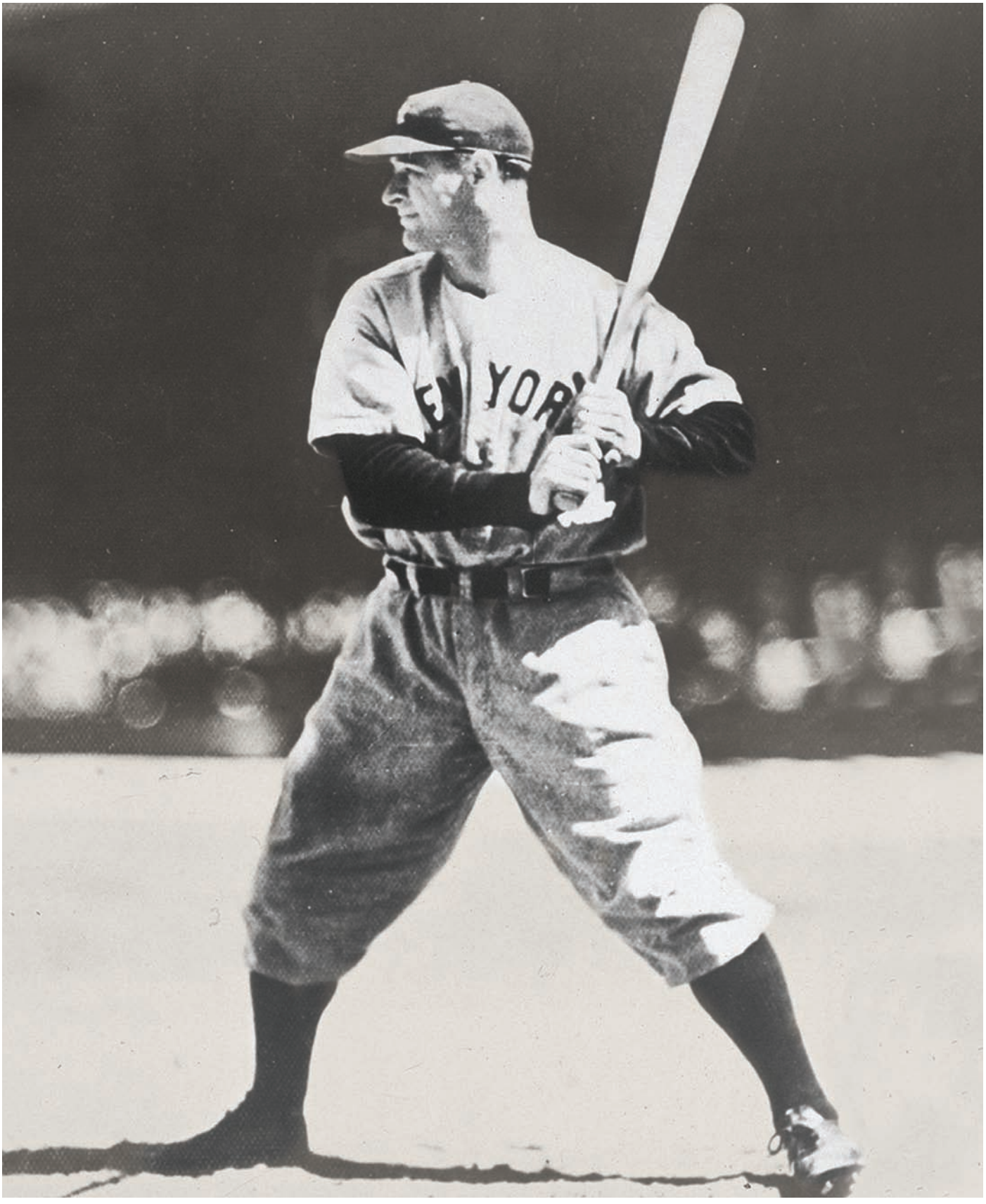

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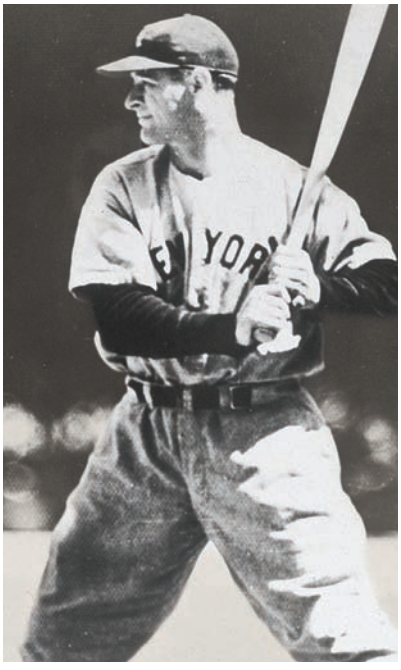
at the end of life. Although treatment can slow disease progression, it is not curative.

Anatomy and physiology

The motor cortex of the brain processes incoming signals and creates the electrical impulses for voluntary muscle movements. Upper motor neurons (UMNs) are the myelinated nerve fibers that descend from the motor cortex to the brainstem and spinal cord; lower motor neurons (LMNs) are the nerves exiting from the spinal cord that connect to skeletal muscles.[5,6]

Myelin is a fatty substance produced in both the central and peripheral nervous systems. It forms a sheath that wraps around axons, provides vital supporting functions, and increases the rate of nerve conduction to target muscles and organs. The myelin sheath acts as an insulator that protects and facilitates the integrity, speed, and intensity of nerve impulses to the target muscle or muscle group.[3,7]

Beginning at the motor cortex of the brain, UMNs descend through the brain and decussate, or cross over, in the medulla to form the lateral corticospinal tract. The lateral corticospinal tract contains more than 90% of nerve fibers present in the entire corticospinal tract and runs the length of the spinal cord. (See *Following the corticospinal tract*.) It is primarily responsible for voluntary movements in the contralateral limbs. UMNs form synapses with LMNs in the anterior horn of the spinal cord, and the LMNs exit the spinal cord and form synapses with skeletal muscle.



In the 20th century, ALS became known as Lou Gehrig disease after the famous New York Yankees baseball player who died from the disease in 1941.

Pathophysiology

In ALS, dysfunction of the UMNs in the lateral corticospinal tract leads to slower and weaker nerve impulses arriving at the synapse to the LMNs. This leads to the motor signs and symptoms seen in ALS, which are a combination of hyperreflexia, spasticity, and weakness of specific muscles or muscle groups.[5,6] Disruptions of the myelin sheath occur in ALS and contribute to the associated muscle dysfunction.[3,7]

Although the underlying cause of ALS is not completely understood, various damaging cellular events have been identified as suspected contributors to the pathology. These include:[1,4]

- oxidative stress
- mitochondrial dysfunction
- excitotoxicity
- protein aggregation
- impaired axonal transport
- neuroinflammation
- dysregulated RNA signaling.

The excitotoxicity hypothesis suggests that glutamate, a naturally occurring neurotransmitter, may initiate a cascade that results in the death of motor neurons. It is thought that excessive activation of glutamate receptors leads to increased intracellular calcium, which then triggers neuronal cell death.[8,9]

Dysfunction and failure of the UMNs in the corticospinal tract, which includes the brain, brainstem, and spinal cord, may lead to LMN involvement and cause atrophy or wasting of the corresponding muscle fibers. Muscle atrophy is the basis for the term *amyotrophic* in ALS.[3,8] (See *Motor neuron changes*.)

Clinical signs and symptoms

ALS makes up approximately 70% of the total number of cases within the motor neuron disease class. Its pathology involves a mix of both UMN and LMN signs and symptoms.[4] (See *UMN and LMN signs and symptoms*.) Any muscle or muscle group may be the first to show signs of ALS, resulting in a unilateral or asymmetric impairment. As time passes, more and more muscles become involved until

UMN and LMN signs and symptoms[10]

UMN	LMN
• increased muscle tone, spasticity	• hypotonia, muscle flaccidity
• brisk reflexes, hyperreflexia	• hyporeflexia or areflexia
• primitive reflex, Babinski reflex	• fasciculations
• minimal muscle wasting	• muscle wasting, atrophy

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the disease takes on a symmetric distribution in all regions, including the muscles of respiration.[3,8]

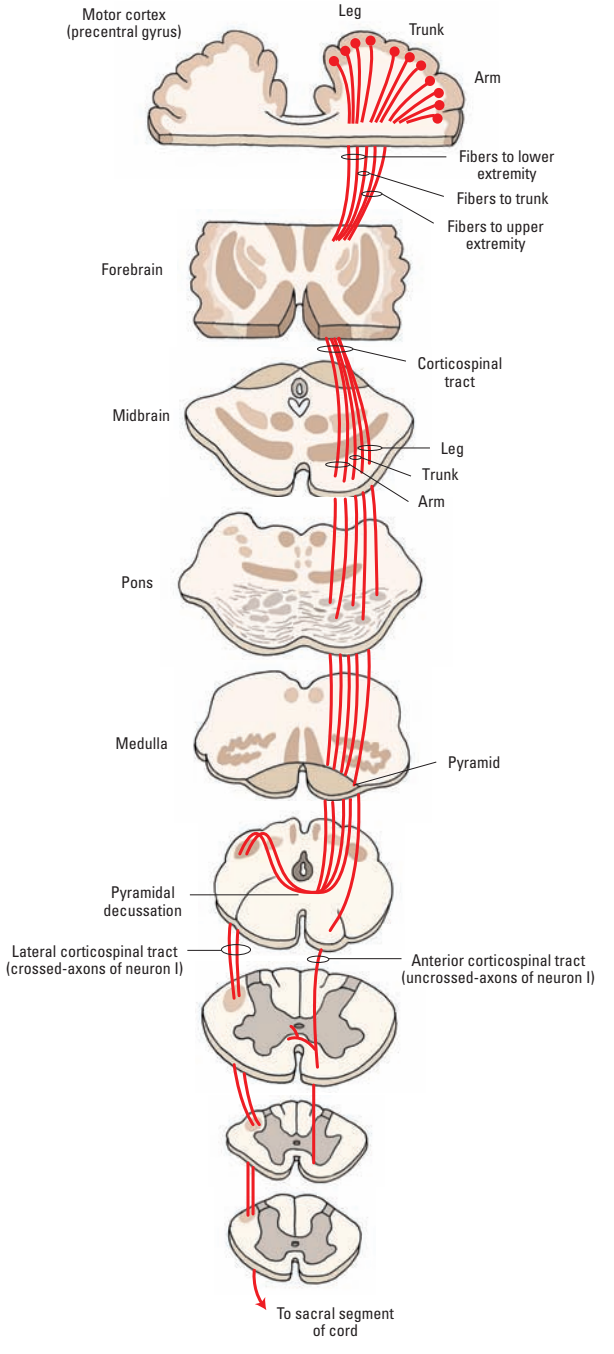
The signs and symptoms of ALS depend on the corresponding somatosensory motor cortex area and affected UMN nerve fibers. Approximately 70% of patients present with upper or lower limb-onset ALS, approximately 25% have bulbar-onset ALS, and the remaining 5% have truncal muscle-onset that may involve the respiratory muscles.

UMN signs and symptoms can be designated as negative and positive. Negative signs and symptoms include weakness, loss of dexterity, fatigue, and impairment or loss of motor planning and control. Positive signs and symptoms include increased and spastic muscle activity and exaggerated spinal reflexes. Other examples include hyperreflexia, spasticity, spasms, and clonus or involuntary rhythmic muscular contractions and relaxations. LMN signs and symptoms typically present with muscle weakness, muscle atrophy, paralysis, fasciculation, hypotonia, and hyporeflexia.[10]

Cervical level-onset ALS can affect both the UMNs and LMNs and may be associated with upper-limb signs of weakness or spasticity either unilaterally or bilaterally. For example, weakness of upper limbs affects daily activities such as hair washing and teeth brushing and causes difficulties with fine motor movements such as grasping or manipulating small objects. ***Lumbar-onset ALS*** is associated with signs and symptoms such as muscle fasciculation, muscle wasting, and weakness of the lower extremities.[6,8] ***Bulbar involvement*** is associated with weakness in both palatal and tongue muscles, resulting in dysphagia and dysarthria.[6,8]

Following the corticospinal tract

This tract arises from the motor cortex (precentral gyrus), passes through the medullary pyramids, and terminates in the spinal cord. Note that most corticospinal fibers cross to the contralateral side in the caudal medulla (pyramidal decussation) and descend as the lateral corticospinal tract. The remaining fibers descend ipsilaterally as the anterior corticospinal tract.



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Eventually, ALS will affect both UMNs and LMNs, but the sensory, bowel, bladder, and cognitive functions are preserved throughout the disease. Ocular motility is also typically preserved until the latter disease stages.[3,8]

As ALS progresses, it eventually causes severe dysphagia and dyspnea, rendering patients unable to speak above a whisper, swallow, or breathe. Death is usually due to respiratory failure and typically occurs 3 to 5 years following disease onset.[11]

Diagnosis

Currently, no specific biomarkers are used to diagnose ALS. Diagnosis remains clinical, based on the detection of UMN and LMN signs and symptoms and the exclusion of ALS mimics such as isolated bulbar palsy, progressive muscular atrophy, and primary lateral sclerosis.[12]

Besides clinical evaluations, nerve conduction studies and electromyography are used to diagnose ALS. Nerve conduction studies measure the ability of the nerves to send impulses to the muscles; electromyography measures the presence and strength of electrical activity during muscle contraction and relaxation. Electrical impedance myography, another diagnostic study, measures stimulation changes in the muscles using weak, high-frequency electrical currents and can predict the spread of ALS to other muscles.[13] Brain and spinal cord imaging with computed tomography or MRI and serum lab studies may also be used to rule out differential diagnoses that manifest with muscle weakness but are not ALS.[4,10]

A committee of the World Federation of Neurology has established diagnostic guidelines for ALS.[4] Simultaneous UMN and LMN involvement with progressive weakness and the exclusion of alternative diagnoses is essential. An ALS diagnosis is considered definite when at least three of the following sites of UMNs and/or LMNs are involved:

- bulbar
- cervical
- thoracic
- lumbosacral.

When only two sites are involved, the diagnosis is probable ALS; when only one site is involved, the diagnosis is possible ALS.[1]

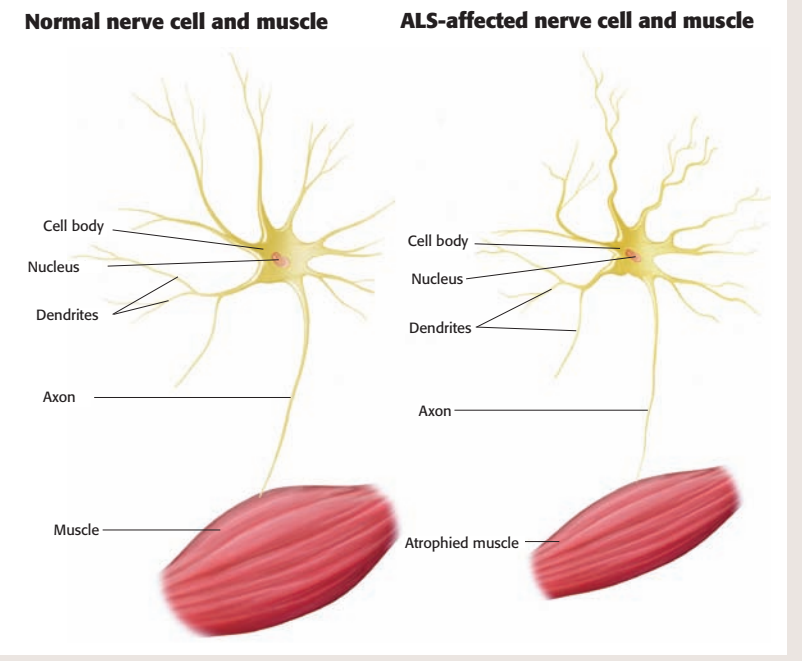
The Amyotrophic Lateral Sclerosis Functional Rating Scale–Revised (ALSFRS-R) evaluates the functional status of patients with ALS. The scale shows close agreement with objective measurements of muscle strength and pulmonary function. It is reliable and consistent as a testing and retesting tool, as well as sensitive to changes in a patient's clinical status due to disease progression.[14]

The ALSFRS-R score is calculated using a patient survey that assesses activities of daily living and respiratory function. It ranges from 0 to 48 points and monitors functional change over time. Each category has several point-associated conditions, with lower point totals correlating to increased impairment. The ALSFRS-R is currently considered the primary metric for assessing overall ALS disease progression. A decline in a patient's score signifies disease progression.[14] (See *Resources*.)

Management

Two FDA-approved drugs are considered disease-modifying treatments for ALS: riluzole and edaravone.

Motor neuron changes



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However, the precise mechanism of action for either drug is unknown.

- Riluzole reduces damage to motor neurons through an inhibitory effect on the excitatory neurotransmitter glutamate release. In clinical trials, it extended the median time to tracheostomy or death of patients with ALS by 2 to 3 months.[15]
- Edaravone acts as a neuroprotective agent, preventing oxidative stress damage to nerve cells. It is an antioxidant and free radical scavenger that was initially developed as an I.V. treatment for acute ischemic stroke. It was approved by the FDA for use in patients with ALS in May 2017. Although edaravone is an option that may benefit patients with ALS, it is not curative and raises significant drug-related concerns that must be addressed. For example, it is available only as an I.V. medication and has a high cost—approximately $145,000 annually.[15]

Supportive pharmacologic therapies include muscle relaxants for muscle cramps, which are common in patients with ALS. Fatigue is another common symptom, and modafinil has demonstrated improved endurance, with one study showing that 76% of patients responded favorably. Muscle fasciculations and spasticity typically occur early in the disease process due to muscle wasting or atrophy and may be managed with baclofen or tizanidine.[15]

Many patients with ALS experience excessive drooling, or sialorrhea, for which anticholinergic drugs can be beneficial. In addition, patients may experience involuntary and excessive emotional manifestations due to the pseudobulbar effect. Antidepressants or other mood-altering drugs may be beneficial for these patients.[3,15]

Resources

ALS Association: www.alsa.org
ALS Finding a Cure: www.alsfindingacure.org
ALS ONE: www.alsone.org
ALS Therapy Development Institute: www.als.net
ALSFRS-R tool: https://n.neurology.org/content/suppl/2006/10/07/67.7.1294.DC1/E3.pdf
Family Caregiver Alliance: www.caregiver.org
Les Turner ALS Foundation: www.lesturnerals.org
Muscular Dystrophy Association: www.mda.org
National Alliance for Caregiving: www.caregiving.org
National Family Caregiver Action Network: www.caregiveraction.org
Project ALS: www.projectals.org

Many rehabilitative aids can substantially assist patients with ALS. For example, foot-drop splints facilitate ambulation by preventing tripping; finger extension splints can potentiate gripping ability; and respiratory support via artificial airways and mechanical ventilation may be life-sustaining. For some, noninvasive positive pressure ventilation provides transient relief (weeks to months) from respiratory insufficiency and can prevent or manage hypercarbia and hypoxemia.

Additionally, cough augmentation with a mechanical insufflation-exsufflation device may be beneficial for airway protection and maintenance. This is highly effective in preventing aspiration pneumonia.

When bulbar disease prevents normal chewing and swallowing, a gastrostomy tube may be inserted to restore normal nutrition and hydration. Various speech synthesizers are available to augment speech, especially when deficits are related to advanced bulbar involvement. These devices facilitate oral communication.[3]

End-of-life care

Patients with ALS may live up to 5 years after symptom onset.[11] Shortly after onset, they should discuss advanced planning with their families and caregivers and begin to make decisions regarding end-of-life care. Nurses are well situated to provide holistic, individualized end-of-life care to patients with ALS and their families.[16]

Patients with ALS often retain the mental capacity to make decisions even when close to death. However, the disease can impair their communication abilities, so patients and families must plan for end-of-life care before these abilities deteriorate. Patients should be offered the option to create a living will and/or advance directives to detail their end-of-life preferences while still in the early stages of ALS. For example, they should consider whether they would want mechanical ventilation via an artificial airway such as a tracheostomy, or if they would be unhappy with this quality of life.[16] Encourage patients to remain involved in decision-making regarding the pursuit or rejection of life-sustaining treatments.

Patients may struggle emotionally with facing death and require emotional support from their family, friends, and caregivers as they cope with and process their fears of the

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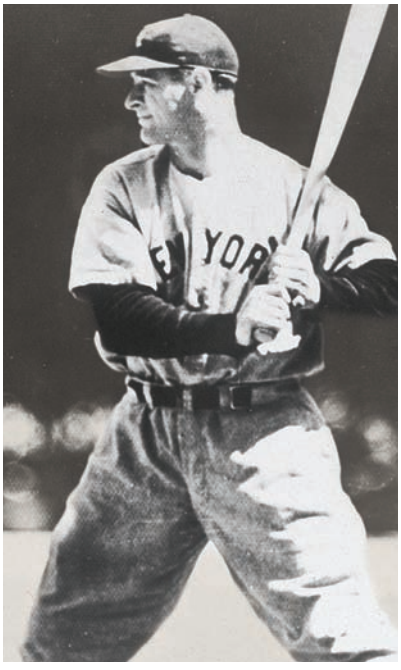
future. Nurses and other healthcare professionals should anticipate these needs. Discovering and understanding how individuals cope allows healthcare providers to collaborate with patients to form an acceptable plan for the end-of-life phase.

The coping process during any degenerative disease varies among patients. Keeping communication channels open between clinicians, the patient, and family is critical to delivering optimal patient care at the end-of-life phase of ALS.[16]

Because the presentation and progression of ALS may vary, nurses should discuss the comprehensive aspects of ALS to learn how each patient wants treatment to proceed.[16] Patients may resent relinquishing control of various facets of their lives to their families or caregivers. Timing is vital when planning discussions about life-sustaining measures.

Clinicians should remain alert to all aspects of each patient's ALS journey. For example, some patients prefer to die at home in the presence of family rather than in a healthcare facility. Healthcare providers should explore and facilitate this option and help coordinate it when possible. Encouraging patients to participate in the decision-making process early gives them a sense of control over their end-of-life process.[16]

Patient decisions about life-sustaining support are essential and should include a complete disclosure of their options and the corresponding risks and benefits by a healthcare provider, which will help them make the best decisions according to their preferences.[16] Healthcare professionals must take care to communicate with the patient and/or family or caregivers in an objective way that does not pressure them to make life-sustaining decisions that may not be acceptable to them. A consultation with a palliative care specialist could improve communication and interactions for patients, families, and caregivers.[16]



Shortly after ALS onset, patients should discuss advanced planning with their families and caregivers and begin to make decisions regarding end-of-life care.

Most patients with ALS lived independently before their diagnosis, and some may be resistant to advice or assistance from healthcare providers. The reality of their physical deterioration means they cannot continue living the same way, and this is a significant emotional hurdle that healthcare providers must recognize and respond to in a sensitive and patient-centered manner. The challenges associated with a loss of independence can be exacerbated if their healthcare providers are not giving clear information in a sensitive and respectful manner.

Comprehensive nursing care along with holistic elements (focusing on mind, body, spirit, and emotional well-being) can help nurses positively impact patients with ALS at the end of life.[16] Holistic care can assist patients and generate satisfaction and an overall sense of peace in daily functioning for these individuals and their families. This approach can provide comfort during disease progression, especially during the end-of-life phase.[16]

Looking forward

Over 600 global clinical trials are underway to study all aspects of ALS.[17] In the US, the CDC and other collaborators maintain a national ALS registry, the purpose of which is to:[17]

- describe the incidence and prevalence of ALS in the US.
- examine appropriate factors, both environmental and occupational, that may be associated with the disease.
- outline key demographic factors (such as age, gender, race or ethnicity, and family history) associated with the disease.
- examine the connection between ALS and other motor neuron disorders that can be confused with, misdiagnosed as, or progress to ALS.

ALS is a relentless disease process that progresses without remissions or exacerbations. The rate of progression varies among affected patients, but the signs and symptoms, which typically appear unilaterally or asymmetrically, will spread in a predictable manner and cause disability and life-threatening neuromuscular respiratory failure. Nurses are in a key position to provide holistic care and support to

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patients and families throughout their ALS journey. ■

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Vincent M. Vacca, Jr., is an associate lecturer at the University of Massachusetts in Boston, Mass., and a member of the *Nursing2020* editorial board.

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