# IMPACT OF DYSPHAGIA ON NUTRITIONAL STATUS IN AMYOTROPHIC LATERAL SCLEROSIS

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BY

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To Associate Vice President for Research and Dean of Graduate Studies:

I am submitting herewith a thesis written by Sandra Calvin entitled "Impact of Dysphagia On Nutritional Status In Amyotrophic Lateral Sclerosis." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

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The Impact of Dysphagia on
Nutritional Status in Amyotrophic
Lateral Sclerosis

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## ABSTRACT

Patients diagnosed as having amyotrophic lateral sclerosis (ALS) can suffer from a combined form of protein calorie malnutrition, marasmic kwashiorkor, resulting in atrophy and wasting of skeletal muscles along with dysfunction of voluntary muscles and components of the central nervous system. The bulbar musculature is eventually affected resulting in varying degrees of dysphagia, dysphonia, and dysarthria. The direct impact of dysphagia on oral intake and nutritional status in this patient population has yet to be clearly defined. Intake records, lab data, and weight records were collected on thirty-six patients diagnosed with ALS who were part of a concurrent study at Baylor College of Medicine. No differences were found between the dysphagic and the non-dysphagic group in terms of gender, age, serum albumin, serum cholesterol, initial weight, ending weight, percent ideal body weight, or percent of weight change. However, significant weight loss was found within the dysphagic

subjects. Mean intake of calories, protein, and fat were significantly greater in the dysphagic group compared to the non-dysphagic group. The possibility of errors in data collection and analysis of food records may partially explain what appear to be inconsistent results.

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# CHAPTER I

## Introduction

Skeletal muscle wasting can be a result of malnutrition, with a reduction in intake leading ultimately to a reduction in muscle mass. Malnutrition and its relationship to muscle wasting in neuromuscular diseases such as Amyotrophic Lateral Sclerosis (ALS) is particularly difficult to identify.

A combined form of protein calorie malnutrition, marasmic kwashiorkor, occurs when the stress of disease is superimposed upon chronic malnutrition. Such nutrient deprivation has previously been shown to cause alterations in both muscle and nerve function (Veldee & Peth, 1992).

Non-nutritional factors may impact muscle function such as age, gender, medication, surgery, sepsis, and certain diseases. Neuromuscular dysfunction as a result of protein calorie malnutrition manifests as muscle wasting, hypotonia, muscle weakness, and attenuation or loss of stretch reflexes (Chopra, 1991).

ALS, a particularly devastating, progressive neuromuscular disease combines atrophy and muscle wasting as a result of the disease with malnutrition which is often a direct result of dysphagia. Calorie deprivation occurs

secondary to individuals altering their food intake out of fear of choking, aspiration, or frustration from the length of time required to eat (Caroscio, 1986).

Malnutrition is a disease affecting over forty percent of all hospitalized patients in which diagnosis and aggressive treatment are always stressed. In few conditions is this more important than in the patient with dysphagia. Of patients admitted over a one year period to the hospital with the primary diagnosis of dysphagia, ninety percent were malnourished (Sitzmann, 1990).

Degenerative neurologic diseases such as Parkinson's Disease, ALS, Multiple Sclerosis, Myasthenia Gravis, dystonia, and dermatomyositis are characterized by swallowing problems that gradually worsen over the course of the disease. Clinical manifestations of a swallowing problem include drooling, retention of food in the mouth, feeling a lump in the throat, coughing or choking on attempts to swallow, and a gurgly voice (Zeman, 1991). Loss of bolus control, improper timing or sequencing, inadequate propulsion or peristalsis, faulty valuing, and luminal compromise can all cause bolus misdirection (Feinberg, Knebl, Tully & Segall, 1990). The result is varying degrees of dysphagia and resultant aspiration.

Typical manifestations of oropharyngeal dysphagia include inefficient oral control and mastication of liquid

and food boluses; delayed initiation of the swallowing reflex; residue in the pharynx after swallowing; and aspiration into the trachea before, during, and after swallowing (Horner, 1991). As the ability to swallow is progressively compromised, patients begin to eat less, take progressively longer to eat, and begin to change the food consistency that they incorporate into their diet.

Muscular diseases are a well identified cause of dysphagia, and any muscle disease is likely to create a swallowing disorder. Consequences of dysphagia have been reported to include weight loss, pulmonary infections, episodes of asphyxia due to a laryngeal foreign body, need for modified food consistency, or non-oral feeding (St. Guilly et al., 1994).

Most patients will have diminished nutrient stores because of a failure to take in enough food along with deficits secondary to their underlying disease. The purest example of malnutrition results from oropharyngeal or esophageal dysphagia in which the patient is unable to bring adequate nutrition and hydration to the stomach (Ganger & Craig, 1990).

Assessing both the degree of malnutrition and the degree of dysphagia will have an effect on the kind of nutritional therapy that will be used. More important, however, in choosing the appropriate therapy are the

expected duration of the dysphagia, some estimate of future energy needs, and the cause of dysphagia (Sitzmann, 1988).

## Problem Statement

Research confirms that adequate nutritional status positively impacts muscle mass as well as the strength and function of muscles. It is generally believed that the strength and functioning of muscles involved in swallowing impact oral intake and therefore nutritional status.

A review of the literature however provides little evidence of the effect that dysphagia has on the intake of not only calories and protein, but of other nutrients. If dysphagia is predictive of decreased oral intake and decreased nutritional status, the parameters and specific nutrients which are affected and possibly diminished are yet to be identified.

The purpose of this study was to determine the impact that dysphagia makes on the nutritional status of patients diagnosed with ALS. Intake, body weight, and biochemical parameters were examined. The possibility that patients who exhibited dysphagia were deficient in one or more nutrients was explored.

Studies have been done which link decreased oral intake and dysphagia, however little information exists in the literature which relate specific nutritional deficiencies to difficulty swallowing. The information that this study

includes will hopefully prove useful to other clinicians in the assessment and management of the nutritional status of patients diagnosed with dysphagia.

## Null Hypothesis

To evaluate the impact that dysphagia has on nutrient status in patients diagnosed with ALS the following null hypotheses were tested:

1. There will be no significant difference in nutritional status as determined by serum albumin in patients diagnosed with ALS who demonstrate dysphagia by the need for a mechanical soft diet as compared to those ALS patients without dysphagia who tolerate a general diet.

2. There will be no significant difference in nutritional status as determined by percent ideal body weight in patients diagnosed with ALS who demonstrate dysphagia by the need for a mechanical soft diet as compared to those ALS patients without dysphagia who tolerate a general diet.

3. There will be no significant difference in nutritional status as determined by serum cholesterol in patients diagnosed with ALS who demonstrate dysphagia by the need for a mechanical soft diet as compared to those ALS patients without dysphagia who tolerate a general diet.

4. There will be no significant difference in nutritional status as determined by the intake of calories

in patients diagnosed with ALS who demonstrate dysphagia by the need for a mechanical soft diet as compared to those ALS patients without dysphagia who tolerate a general diet.

## Definitions

Bolus - A mass of food ready to be swallowed or a mass passing along the intestines.

Dysphagia - Difficulty swallowing.

Dysphonia - Impairment of voice, difficulty in speaking.

Dysarthria - Imperfect articulation in speech.

Dyspnea - Difficult or labored breathing.

Incidence Rate - The number of cases that developed over a specific period of time.

Larynx - The musculocartilaginous structure lined with mucous membrane, situated at the top of the trachea and below the root of the tongue.

Pharyngeal - Pertaining to the pharynx.

Pharynx - The musculo-membranous sac located between the mouth, nares and esophagus.

Prevalence Rate - The number of cases in existence at a certain time in a designated area.

## CHAPTER II

## Review of Literature

### Amyotrophic Lateral Sclerosis

ALS is a degenerative disease of the nervous system which was first described by Bell in 1830 and named by Charcot in 1874 (Caroscio, 1986). Despite intensive research, the cause of ALS remains unknown and no known therapy can slow its course. It is a progressively fatal neurological disease.

Today this devastating disease also carries the name of one of the most famous major league first basemen - Lou Gehrig. After setting a record for the greatest number of consecutive games played by a baseball professional, Gehrig averaged 36.2 home runs annually from 1932 to 1935.

In 1938 Lou Gehrig began the season at a noticeably lower level of performance than his previous seasons. Gehrig maintained a stable but subpar performance for the first ten weeks of the season after which he experienced a precipitous decline in his hitting percentage (Kasarskis, 1989). Gehrig's home run percentage did not decline until halfway through the 1938 season. It is now believed that the devastation of his disease began initially in his lower extremities reducing his ability to run bases leaving the

strength in his upper extremities intact until mid-season. Lou Gehrig finally succumbed to ALS. While in the midst of the disease he saw himself as not a mere victim of a form of paralysis but a symbol of hope for thousands of sufferers of the same disorder (Kasarskis, 1989).

ALS begins with focal weakness and progresses to disability of the limbs and the bulbar musculature. In a study of fifty eight patients at Baylor College of Medicine, compromised speech was the initial manifestation of ALS in 12 (21%) patients, and weakness of the extremities was the initial manifestation in 38 (66%) patients (Appel, Stockton-Appel, Stewart, & Kerman, 1986). Of the thirty eight patients presenting with extremity weakness, 44% presented with weakness or fatigability in the right extremity, 36% in the left extremity, and 20% in both extremities simultaneously. Twelve percent had additional sensory complaints of either pain or parathesias.

Regardless of presentation, the neurological deterioration follows a characteristic course. If weakness begins in the right lower extremity, the next area of involvement is the left lower extremity. If onset is in one upper extremity, the next area of involvement is the remaining upper extremity. In patients whose onset is of the bulbar musculature, the next area of involvement is usually an upper extremity.

Clinical experience indicates that there is a great deal of variability in the musculature that is initially involved and in the rate of progression of the disease. Specific signs and symptoms of upper motor neuron degeneration are muscle weakness, spascity, and hyperreflexia; those of lower motor neuron degeneration are muscle weakness, atrophy, fasiculations, hypotonia, and areflexia (Caroscio, 1986). Most people who are diagnosed with ALS have bulbar and spinal muscle involvement but not all people experience bulbar involvement.

The principle symptom in ALS is weakness which can occur in any voluntary muscle in the body. Weakness begins insidiously and progresses at various rates however there is a pattern of asymmetry in the progression. The rate of progression, once begun, remains unchanged throughout the course of the disease with fast, moderate, and slow progressive cases. Only occasionally will a patient's progressive weakness plateau or reach a point where the disease stabilizes and progression stops.

Characteristic of the disease is the selective degeneration of motor nerve cells of the central nervous system. Cranial nerve damage also occurs and is responsible for progressive bulbar dysfunction that results in weakness or paralysis of the muscles controlling swallowing. Table 1 lists the specific cranial nerves involved and the

TABLE 1

CRANIAL NERVES INVOLVED IN EATING MECHANICS

| Nerve | Dysfunction |
|---|---|
| Trigeminal Cranial Nerve V | Muscles of mastication |
| Facial cranial nerve VII | Sensory muscles for taste to front of tongue; sensory to submaxillary and sublingual glands. |
| Glossopharyngeal nerve IX | Swallowing; sensory for taste to cranial posterior on-third of tongue; sensation from soft palate |
| Vagus cranial nerve X | Soft palate and pharyngeal muscles |
| Accessory cranial nerve XI | Muscles of soft palate |
| Hypoglossal cranial nerve XII | Muscles of tongue |

NOTE: From Amyotrophic Lateral Sclerosis - A Guide To Patient Care (p. 139) by J. T. Caroscio, 1986, New York: Thieme Medical Publishers, Copyright 1986. Reprinted by permission.

dysfunction that results.

Clinical manifestations of upper motor neuron involvement of the cranial nerves is an increase in jaw jerk and in the gag reflex. Corticobulbar tract degeneration results in a kind of pseudobulbar palsy that contributes further to the difficulties seen with both speech and swallowing. Two thirds of all patients diagnosed with ALS will have tongue fasiculations, weakness of both facial and palatal muscles, and dysphagia or difficulty swallowing.

The diagnosis of ALS is based on the clinical presentation of progressive weakness, atrophy, fasiculations, and hyperreflexia with, ordinarily, an absence of sensory and sphincter disturbance. If only motor bulbar signs are present, the diagnosis of ALS is almost certain.

Mentation is generally spared with only 4.7% of 272 patients diagnosed with ALS being reported to exhibit organic mental syndromes (Caroscio, 1986). These rare mental changes are variable but represent a subset of ALS patients who exhibit an Alzeheimers type dementia.

The incidence of ALS is one to two per 100,000. The prevalence is five to seven per 100,000. The disease affects twice as many men as women and the mean age of onset is 57 years of age (Appel et al., 1986).

In sporadic ALS pathologic changes in the corticospinal

tracts and the corticobulbar tracts are seen in approximately 95% of all cases. Five percent of diagnosed patients have the familial form of the disease. Although many etiologies have been proposed for sporadic ALS including viral, toxic, endocrine, and genetic, the cause remains unknown. Ultimately most patients become quadriplegic, dysarthric, and dysphagic with death occurring from respiratory insufficiency (Jablecki, 1989).

The duration of sporadic ALS has a wide range from a few months to years with an average duration of three years. A small percentage of patients will survive longer than five years; however, the quality of life is greatly altered by bulbar and respiratory involvement.

Due to the variable presentation and progression of the disease, controlled trials have been difficult to conduct. Patients may present with rapid deterioration in speech and swallowing function and have minimal change in extremity strength thus rendering extremity strength testing useless in evaluating the disease progression. Likewise measuring pulmonary function in a patient whose bulbar function is normal and who possesses only compromise of extremity strength is a less than accurate gauge of disease progression.

Published ALS rating scales many times do not take into account the variability in presentation and progression of

the disease. "A Rating Scale For Use With ALS" was developed at Baylor College of Medicines Department of Neurology which allows for the quantitative estimate of the clinical status of the patient as well as of the disease progress.

This scale includes assessments of swallowing, speech function, respiratory function, muscle strength in upper and lower extremities, and function of upper and lower extremities (Appel, Stewart, Smith, & Appel, 1987). The assessments are completed by members of the ALS team including a neurologist, occupational therapist, respiratory therapist, nurse-clinician, dietitian, and speech pathologist.

A total ALS score can range from 30 points for normal function to 164 points for maximal dysfunction. It consists of five group scores that are divided into sub-groups providing from 6 to 36 points each. This total score is the cumulative score from the 5 groups including swallowing, speech, respiratory function, physical therapy, occupational therapy, muscle strength, and muscle function. See Figure 1 for the scoring of the bulbar group.

The ALS score and each of the group scores permits a reproducible and reliable assessment of the patient's condition over time. The total ALS score is a more accurate reflection of overall progression than any single group

Bulbar (6-30 pts)

Swallowing

| | |
|---|---|
| General diet | 3 |
| Soft diet (soft, cooked; eliminates popcorn, nuts, cornbread, etc.) | 6 |
| Mechanical soft diet (finely chopped or ground + thick liquids) | 9 |
| Pudding consistency diet (strained, pureed, blended, + thick liquid) | 12 |
| Tube feedings | 15 |

Speecn

| | |
|---|---|
| Clear | 3 |
| Slightly slurred on enunciation of | 6 |
| Slurred | 9 |
| Unintelligible | 12 |
| None | 15 |

Figure 1. Bulbar Rating Scale

NOTE: From "A Rating Scale for Amyotrophic Lateral Sclerosis" by V. Appel, S.S. Stewart, G. Smith and S. H. Appel, 1987. Annals of Neurology, 22.

score (Appel et al., 1987).

Progression of ALS differs markedly from patient to patient, with a greater than twenty fold difference in the rate of progression from the slowest to the most rapid course (Appel et al., 1987). Appel et al. (1987) reported that of their 51 ALS patients all had an initial score below 80. At the end of one year, 19% showed minimal progression, 47% intermediate progression, and 34% rapid to severe progression (terminal stage).

Data from an ALS score can also be used to estimate the number of years required before the patient reaches the terminal stage and to predict the likely course of the disease. In a longitudinal study of 194 patients diagnosed with sporadic ALS, Jablecki (1989) demonstrated that it is possible to predict survival time when provided with the patient's age, duration of weakness, and ALS score. Such data is helpful in clinical management and in the construct of clinical trials.

Malnutrition In Neuromuscular Disease

Malnutrition in individuals with neuromuscular disease is especially difficult to identify. The degree of malnutrition that is contributing to muscle atrophy in this patient population is frequently unknown. Recent observations suggest a more significant role of malnutrition than was previously suspected.

A combined form of protein calorie malnutrition, marasmic kwashiorkor, occurs when the stress of disease is superimposed upon chronic malnutrition. This is the case in neuromuscular diseases such as ALS. Such nutrient deprivation has previously been shown to cause alterations in both muscle and nerve function (Veldee & Peth, 1992).

In marasmic kwashiorkor the metabolic rate increases and tissue catabolism supersedes anabolism producing overall destruction of tissue with skeletal muscle making the greatest contribution. In most cases, adequate intake and appropriate nutritional therapy permits intracellular energy substrates to become repleted.

In ALS, weight loss and anorexia can occur in patients who are not experiencing dysphagia or bulbar symptoms. Muscle atrophy is the result of increased catabolism, but the mechanism is unclear (Asbeck, 1988).

Normalization of muscle function due to repletion is generally followed by the regeneration of muscle tissue. The cellular biochemical changes noted to occur in muscles with nutrient deprivation may prove to be more clinically relevant than the morphological changes that are observed (Veldee & Peth, 1992).

Skeletal muscle wasting is an obvious result of malnutrition with a reduction in intake ultimately leading to a reduction in muscle mass. Nutrition appears to be one

of the major factors which contributes to the changes that are observed in muscle function as well.

Non-nutritional factors may impact muscle function such as age, gender, medication, surgery, sepsis, and disease. However, the most significant correlation with the reversal of abnormal muscle function appears to be the duration of adequate nutritional support (Jeejeebhoy, 1988). A reduction in macro-nutrients leads to a reduction in muscle mass along with a concomitant decrease in muscle fiber diameter, a reduction in maximal isometric contractile force, and an increase in the percent of force generated (Veldee & Peth, 1992).

Malnutrition causes changes in all three primary muscle functions-contraction force frequency, relaxation rate, and fatigability. The possible ways in which a malnourished muscle may not be able to utilize energy at the same rate as a normally nourished muscle are:

1. Availability of substrate
2. Activity of enzymatic pathways
3. Changes in ph
4. Changes in ATP hydrolysis
5. Changes in calcium kinetics (Jeejeebhoy, 1988).

Skeletal muscle is the largest tissue in the body constituting forty percent of total body weight and seventy-five percent of lean body mass (Chopra, 1991). Dissipation

in body weight which is observed as part of a disease process may be attributed to the co-existing state of protein-energy deprivation which is the cause of wide spread muscle wasting.

Neuromuscular dysfunction as a result of protein calorie malnutrition clinically manifests itself as muscle wasting, hypotonia, muscle weakness, and attenuation or loss of stretch reflexes (Chopra, 1991). Skeletal muscle also exhibits a variety of pathological alterations including muscle fiber atrophy, myopathic motor unit potentials, fibrillations on electro-myography, and alterations in the activity of various enzymes.

The skeletal muscle changes observed appear to reflect a combination of the direct effect of protein calorie malnutrition on muscle tissue as well as secondary involvement of the peripheral nerve (Chopra, 1991). Recent studies have assessed the effect of protein calorie malnutrition on nerve function after myelination was completed and suggests that a functional decline in central nervous system performance in adults does occur. There are altered autonomic reflexes associated with malnutrition as well as reduced sympathetic activity, degeneration of the myelin sheath, and slowing of conduction velocities with nutrient deprivation (Veldee & Peth, 1992).

Although the data is limited, a negative effect of

protein calorie malnutrition on mature neuronal tissue is probable (Veldee & Peth, 1992). However, the effect appears to be less apparent than the alterations in muscle size and contractile properties that are directly caused by protein calorie malnutrition.

Dysphagia

Malnutrition is a disease affecting over forty percent of all hospitalized patients; early diagnosis and aggressive treatment are always stressed in these patients. In few disease states is diagnosis and treatment more important than in the dysphagia patient.

Nutrient deprivation causes changes in the neuro-musculature of the swallowing function but the exact effect is unknown. It is reasonable to assume that dysphagia supersedes the development of malnutrition. The possibility that malnutrition predisposes dysphagia also exists.

Deglutitive muscles may be some of the first muscles to be affected by reduced food intake (Veldee & Peth, 1992). The coordinated muscular events of swallowing depend on the proper functioning of the central nervous system. Cranial nerves signal the swallowing center in the brain stem which triggers the swallowing response by efferent cranial nerves. Protein calorie malnutrition can potentially interfere with the execution of the swallowing response. This could be done by altering the action potential generation,

propagation, and transmission in the component neuron (Veldee & Peth, 1992). The integrity of the swallow could be compromised by malnutrition.

Dysphagia or the inability to swallow food and liquid, is ordinarily due to an underlying neurologic or mechanical dysfunction. Dysphagia can pose a major diagnostic problem as well. Aside from the difficulties in diagnosis and treatment associated with dysphagia, the basic repercussion of the failure to swallow effectively is starvation (Sitzmann, 1988). Table 2 indicates the pathophysiology of dysphagia.

Individuals with swallowing impairment secondary to disease are placed at risk for aspiration as well as for the development of malnutrition. If dysphagia is severe, intake can become progressively inadequate, and a catabolic state can result. The amount of weight lost by individuals with esophageal cancer was found to be predictive of their degree of dysphagia (Veldee & Peth, 1992).

Generally, repletion of intracellular energy substrates occurs quickly with the appropriate nutritional therapy, permitting the normalization of muscle function that is associated with swallowing. In most cases, adequate nutritional support can reverse most of the effects that mild protein calorie malnutrition has on swallowing.

TABLE 2

GENERAL PATHOPHYSIOLOGY OF DYSPHAGIA

| SWALLOWING PHASE | DYSFUNCTION | SYMPTOM |
|---|---|---|
| Oral | Difficulty opening and closing mouth; difficulty maintaining lip closure and tongue mobility | Movement of food within oral cavity, drooling, oral retention and leakage of liquids |
| Pharyngeal | Decreased sensitivity or reflex behavior, absence of swallow reflex, premature swallow, poor laryngeal elevation or poor vocal fold closure, hypertonicity of the cricopharyngeal sphincter | Choking, coughing, loss of liquids through the nose or inability to suck through a straw, food lodging in pathway |
| Esophageal | Insufficient tone and decreased pressure or pressure of the esophageal sphincter and esophagogastric junction | Regurgitation of esophageal contents into pharynx, regurgitation of gastric contents of stomach into esophagus |

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Prevalence of Dysphagia

It is estimated that twelve to thirteen percent of all hospitalized patients are dysphagic. Forty percent of patients in chronic care facilities are dysphagic as well (Sitzmann, 1988). Dysphagia, causing admission to the hospital, can clearly be viewed as a systemic disease associated with severe malnutrition, carrying a 13% risk of mortality regardless of etiology (Sitzmann, 1988).

At the Johns Hopkins Swallowing Center, approximately thirty percent of all patients have neurological disease. Of these thirty percent, ten percent exhibited dysphagia as the predominant symptom overshadowing other symptoms and signs (Jones & Ponner, 1991).

In patients with stroke, dysphagia is a complex disorder that can contribute to increased length of stay and malnutrition. Dysphagia in patients with stroke has an incidence reported to be from twenty-five to forty-five percent depending on the methodology of data collection (Young & Jones, 1990). Using a chart review of two hundred and twenty-five stroke patients, Young and Jones (1990) reported that twenty-eight percent had documented evidence of dysphagia. When dysphagia co-occurred with stroke there were significantly more functional problems and complications. Among those reported were an increased need for diet modification and alternative feeding methods. At

discharge, half of the aforementioned patients continued to need feeding modifications.

Barer (1989) reported, from data obtained from three hundred fifty-seven stroke patients within forty-eight hours of symptoms, that nearly thirty-five percent of patients with single hemisphere stroke had initial difficulty swallowing. Swallowing impairment had a significant inverse correlation with functional ability at follow-up one to six months later. This implies that dysphagia may well lead to complications which later hamper functional recovery.

In the chronic care setting, one third to one half of residents are liable to experience dysphagic symptoms. Groher (1990) found that if the patients who had only disorders of feeding transport were added to those with symptoms of oral stage dysphagia, the incidence of disorders relating to feeding could be as high as seventy-nine percent.

Groher and Bukatman (1986) reported that the percentages of patients with dysphagia by service at two teaching hospitals (Veterans Administration Medical Center [VAMC] and New York Hospital [NYH]) was medicine, VAMC - 11%, NYH - 10%; surgery, VAMC - 9%, NYH - 12%; neurology-neurosurgery, VAMC - 33%, NYH - 34%, respectively. Cherney (1994) reported that 307 (31.55%) patients presented with dysphagia in a retrospective study of 973 referrals of

adults with neurologic impairment . Thirty-one point six percent of these were ranked at the severe range and 29.32% at the mild to moderate range, based on a functional oral intake scale.

Dysphagia and Malnutrition

Sitzmann (1990) reported that of ninety patients admitted with the primary complaint of dysphagia, all exhibited marked malnutrition with an average weight loss of 12± 9.8% body weight, serum transferrin of 165± 60.1 mg/dl., and serum albumin of 3.2± 0.85 mg/dl. Other authors have reported an association between the kind of dysphagia or its severity and the degree of nutritional depletion.

In patients with underlying dysphagia due to disease or disability, the compromise in swallowing caused by protein calorie malnutrition can further hinder an individuals ability to consume adequate nutrition. Sheppard (1988) was able to achieve a predictability of dysphagia severity by using body mass index in a study of one hundred and eight mentally retarded adults.

Protein calorie malnutrition can negatively affect dysphagia morbidity and mortality by either increasing the incidence of aspiration episodes, and therefore the risk of pneumonia, or by interfering with an individual's ability to recover from pneumonia (Veldee & Peth, 1992). Thus, hospitalized dysphagic patients frequently manifest varying

degrees of nutritional compromise and present the physician with the task of treating not only the cause of dysphagia, but also malnutrition (Sitzmann, 1990).

Normal Swallowing

Normal swallowing involves three separate stages: the voluntary transfer of material from mouth to pharynx, the involuntary transport of material away from the mouth into the upper esophagus, and the transport of material along the esophagus into the stomach. In neurologic disorders of swallowing, the smooth and striated musculature is affected as are the central nervous system centers including the spinal cord and peripheral nerves. The act of swallowing is complex and involves approximately fifty, paired muscles and virtually all levels of the central nervous system.

The first phase or oral stage is primarily preparatory and is the period in which food is chewed and mixed with saliva to provide the proper texture and consistency for smooth transit through the pharynx and esophagus. The second or pharyngeal stage begins when the bolus passes into the upper pharynx and ends when it crosses the pharyngoesophageal sphincter. The third or esophageal stage includes the period during which the bolus is transported from the pharynx to the stomach via the esophagus.

The oral stage is almost entirely voluntary and involves the facial muscles, the muscles of mastication, and

the intrinsic and extrinsic muscles of the tongue. Neural control of mastication is located in the lower brain stem with motor neurons in the fifth, seventh, and twelfth cranial nerves eliciting mastication. The somatosensory information that is conveyed by the fifth cranial nerve seems to be the most important for the coordination of mastication (Jones & Ponner, 1991).

The pharyngeal phase has a complex anatomical structure with the activation of more than two dozen muscles that function together to transmit the bolus from mouth to esophagus. The muscles involved in the pharyngeal stage are controlled by neural connections in the medulla. This stage is the involuntary, reflex dependent, transport of material away from the mouth by the pharyngeal constrictor muscles into the upper esophagus (Groher, 1984).

The esophageal stage transports the bolus of food from the pharynx to the stomach. The most effective stimulus for eliciting esophageal peristalsis appears to be distention, negative interthoracic pressure, and the physical distention caused by the bolus acting in concert to elicit reflex peristalsis. In the upper third of the esophagus, where striated muscle predominates, esophageal peristalsis is largely dependent on the vagus nerve and intact medullary reflux (Jones & Ponner, 1991). In the lower esophagus, or smooth muscle portion, the vagus nerve has a more modulatory

TABLE 3

PHASES OF DEGLUTITION

| PHASE | CHARACTERISTICS |
|---|---|
| Oral Phase | Jaws close and lips come to together. Mastication requires jaw and teeth contact and rotation; tongue lateralization and elevation. Initiation of a swallow requires elevation of tongue tip to alveolar ridge, followed by entire elevation of tongue to hard palate with a slight elevation of larynx. |
| Pharyngeal Phase | A reflex act propels the bolus from the oral cavity into the pharynx. The soft palate moves posteriorly and upwardly to posterior pharyngeal wall. the lateral pharyngeal walls constrict and elevation of tongue effects a tilting of the epiglottis posteriorly toward the laryngeal opening. Simultaneous elevation and forward movement of larynx protects the airway. Laryngeal elevation results in the epiglottis being drawn downward. As a consequence, laryngeal opening closes and food is directed properly. To prevent aspiration, vocal folds close. The cricopharyngeal sphincter relaxes, and the bolus of food is plunged into the esophagus. |
| Esophageal Phase | Contractions of cricopharyngus initiates esophageal peristalsis. The bolus of food is carried to the gastroesophageal junction and the lower esophageal sphincter relaxes. |

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role. Table 3 lists the phases of deglutition.

In neurologic disorders of swallowing, the smooth and striated musculature is affected. Also affected are the central nervous system centers, including the spinal cord and peripheral nerves (Groher, 1984).

Pathophysiology of Dysphagia in ALS

In ALS there is degeneration of motor units as a result of the involvement of both upper and lower motor neurons with spastic atrophic symptoms in the cranial, spinal, and peripheral musculature. It often affects the motor neurons of the brain stem resulting in bulbar palsy with prominent slurred speech, hoarseness, breathiness, dysphagia, and dyspnea (Groher & Bukatman, 1986).

Degenerative neurologic diseases are characterized by swallowing problems that gradually worsen over the course of the disease. In ALS specifically, problems begin with a reduction in tongue mobility so that patients are initially less able to chew their food and less able to control material in the oral cavity. Loss of bolus control, improper timing or sequencing, inadequate propulsion or peristalsis, faulty valuing, and luminal compromise can all cause bolus misdirection (Feinberg et al., 1990).

Logeman (1984) reported that the progression of deterioration in neuromuscular control of deglutition begins with a reduction in lingual control and pharyngeal

peristalsis followed by a delay in the swallowing reflex. If laryngeal function is severely affected early in the progression of the disease, complete vocal cord adduction during the swallow may not be attained, and material may be aspirated during the swallow. It is more likely that pharyngeal peristalsis will be reduced so that material remains in the pharynx after the swallow has been initiated, and the entire swallowing reflex is delayed. This material can then be aspirated when the patient inhales.

Neurogenic oropharyngeal dysphagia refers specifically to oropharyngeal dysfunction as distinguished from primary esophageal disorders. Typical manifestations of oropharyngeal dysphagia include inefficient oral control and mastication of liquid and food boluses; delayed initiation of the swallowing reflex; residue in the pharynx after swallowing; and aspiration into the trachea before, during, or after swallowing (Horner, Buoyer, Alberts, & Helms, 1991).

Degrees of Dysphagia and Nutrition Therapy

Martens, Cameron, and Simonsen (1990) demonstrated the effect of a multi-disciplinary treatment team in a prospective study of thirty one patients, most of whom were referred from a neurology/neurosurgery unit of a thirteen hundred bed university hospital. At the end of the study, the control group exhibited a mean weight loss of 2.82 kg

while the treated group had a mean weight gain of 1.41 kg to indicate a statistically significant difference. The mean calorie difference (i.e. the average daily calorie intake compared to the minimum desired calorie intake) for each patient was measured. Both weight and intake were found to be improved through the use of a multi-disciplinary dysphagia program. A significant correlation between weight difference and caloric intake existed.

Because of the progressive nature of neurogenic dysphagia, various levels of impairment exist. Low grade dysphagia for solid food only, in the absence of advanced malnutrition or increased energy needs, could be managed by supplementing the diet. Patients with moderate to severe dysphagia with concurrent evidence of malnutrition could be repleted solely with oral supplements (Sitzmann, 1988). Dysphagia that is severe and not reversible requires long term enteric intubation using either pharyngotomy, gastrostomy, or jejunostomy feedings.

In addition to degrees of dysphagia, the type of dysphagia defined according to the swallowing phase involved and the type of aspiration experienced is important. Neumann (1993) reported that of sixty-six patients suffering from neurologic disorders including dysphagia, eighty-four percent improved with either direct or indirect therapy based on individual clinical and radiographic assessment.

Appropriate therapy for dysphagia patients suffering from neurologic disorders appears to correlate with improvement in the type of feeding used. Assessing both the degree of malnutrition and the degree of dysphagia will have an effect on the kind of nutritional therapy used. More important, however, in choosing the appropriate therapy are the expected duration of dysphagia, some estimate of future energy needs, and the cause of dysphagia (Sitzmann, 1988).

As the ability to swallow gets progressively compromised, patients begin to take progressively longer to eat and then begin to change the food consistency that they incorporate into their diet. Data from patients with surgically induced lesions suggest that if a given food consistency can not be swallowed within ten seconds, the patient will either discontinue eating that consistency of food or will reduce their intake to the extent of being unable to maintain their weight (Gelfard & Richter, 1989). Using the Fleming Index of Dysphagia, Layne (1989) revealed that following a modified diet was the limitation most frequently noted by patients followed by dentition status, continuous weight loss, need for positioning when eating, and complaints of dysphagia. Table 4 lists the recommended dietary alterations for dysphagia.

Incidence of Aspiration

Dysphagia is a sign of cranial nerve dysfunction,

TABLE 4

RECOMMENDED DIETARY ALTERATIONS FOR DYSPHAGIA

| Dysfunction/Symptoms | Texture/Consistency |
|---|---|
| ↓ Jaw Movement | ↓ Tolerance for raw fruits and vegetables; meat cooked tender |
| ↓ Tongue mobility | Soft, cooked, moist foods; small particle size |
| ↓ Mouth and lip closure | Moist foods; mixed and held together; liquids taken separately; placement of food to middle or back of tongue |
| ↓ Sensitivity or ↓ reflex behavior ↓ Laryngeal elevation | Pureed and strained foods; ↓ tolerance for liquids Ground meat and stewed vegetables well tolerated; head positioned forward and downward to protect airway |
| ↑ Cricopharyngeal tonicity | Small-particle foods avoided; food in bolus form better tolerated |
| ↓ Saliva | ↑ Foods of high water content (ice cream, gelatin desserts, puddings); ↑ sour or tart foods and concentrated forms of carbohydrates that will stimulate saliva production; moist food better tolerated, use sauces and gravies |
| ↑ Phlegm/ ↑ mucous | Milk and milk beverages avoided; warm and hot beverages better tolerated; lemon or lime juice concentrated or mixed with water helps break up phlegm |

(TABLE CONTINUES)

TABLE 4

RECOMMENDED DIETARY ALTERATIONS FOR DYSPHAGIA

| Dysfunction/Symptoms | Texture/Consistency |
|---|---|
| ↓ Esophageal sphincter control | ↑ Protein, ↓ fat; alcohol and caffeine avoided; ↓ tolerance for citrus fruits |
| Absence of gag reflex | Alternate feeding route |

NOTE: From Amyotrophic Lateral Sclerosis - A Guide To Patient Care (p. 139) by J. T. Caroscio, 1986, New York: Thieme Medical Publisher, Copyright 1926. Reprinted by permission.

disorders of the muscles involved in swallowing, lesions of the cerebral cortex or brain stem, or dysfunction at the myoneural junction. In ALS, weakness and paralysis of the muscles involved in swallowing is the result as it is instrokes, aneurysms, head injury, and brain tumors. Horner et al. (1991) studied twenty-three individuals who had had brain stem strokes confirmed by computed tomography of the head or MRI; fifteen of the twenty-three patients examined showed aspiration. Statistical analysis revealed a significant association between aspiration and pharyngeal residue which is characteristic of neurogenic oropharyngeal dysphagia seen in ALS and other degenerative neurologic diseases.

Persons with single, unilateral ischemic cardiovascular accident experience delays in pharyngeal transit time. In a study of twenty-four patients, Robbins and Levine (1988) showed that there was a significant difference in the duration of oral stage response time for both liquid consistency and paste consistency boluses. The prepharyngeal response time for paste consistency boluses was longer and more variable than for liquids while the pharyngeal response time for the paste consistency and liquid consistency was similar. This indicates that, at least in unilateral stroke patients with neurogenic dysphagia, there is significant delay in pharyngeal response to both liquids and paste consistency.

Aspiration in these patients occurred most frequently just prior to the initiation of the pharyngeal stage at which time material was allowed to fall into the open airway. This occurred in thirty-seven percent and zero percent of the right CVA and left CVA subjects respectively (Robbins & Levine, 1988).

The frequency of aspiration in bilateral stroke patients selected for video fluoroscopic examination was between forty percent and seventy percent (Barer, 1989). A modified barium swallow done under video fluoroscopy was used to identify delays in the swallowing reflex and pharyngeal weakness that contributed to the aspiration. The most common reasons for aspiration in this group of bilateral stroke patients with neurogenic dysphagia was incomplete laryngeal elevation and closure and weak pharyngeal peristalsis.

Neurogenic dysphagia is common in neuromuscular disease and stroke. Because pneumonia is a common sequela and contributes to both morbidity and mortality, detection of both audible and silent aspiration is essential (Horner & Massey, 1988). Among hospitalized elderly patients the development of pneumonia is associated with a forty-three percent mortality rate (Langmore, 1991).

Identification of clinical features associated with aspiration can lead to preventative medical and nutritional therapy. Horner & Massey (1988) reported that of twenty-one

stroke patients, only fifty-four percent of those who aspirated had subjective complaints; an absent or diminished gag reflex was found in half of all patients regardless of whether there was aspiration; and a weak cough reflex was found to more likely occur in aspirating patients. All stroke patients exhibited dysarthria and were dysphonic with dysphonia occurring more among patients who aspirated.

The phenomenon of silent aspiration is seldom emphasized but can occur in neurologically impaired adults. Concurrent findings associated with silent aspiration were an absence of subjective complaint, bilateral neurologic signs, weak cough, and dysphonia (Horner, 1988). Specific factors that contribute to the morbidity in this group of subjects requires further research.

Assessment Of Malnutrition In Neuromuscular Disease

The techniques used in nutrition monitoring in neuromuscular disease are of significant importance. Objective parameters such as diet history, weight-in light of muscle atrophy, and appropriate biochemical parameters are still effective indicators of malnutrition (Veldee & Peth, 1992).

Weight

Assessment of intake through food or formula records and the weight changes that are observed can identify patients who are at risk of nutritional compromise. Measures used to assess nutritional status include

anthropometric measurements such as height, weight, and subjective data such as history of weight loss, usual weight, and deviation from usual weight (Coats, Morgan, Bartolucci, & Weinsier, 1993).

Weight for height measures can be an indication of malnutrition or an increased risk of its development. Weight for height data can be interpreted as being within normal range, at risk of malnutrition, or malnourished. Weight change and the direction of the change can be a more useful parameter than absolute weight in some instances. A weight loss of five to ten percent of usual body weight over a six month period can indicate a micronutrient deficiency and a loss of lean body mass (Veldee & Peth, 1992).

When more than 20% of body weight has been lost, moderate to severe protein energy malnutrition with accompanying physiologic impairments is invariably present (Hill, 1992). There is also an increased risk of mortality (Zeman, 1991).

Weight Loss

Dysphagia causes rapid weight loss in ALS, however, weight loss and anorexia occur in ALS patients who are not experiencing dysphagia or bulbar symptoms. Muscle atrophy in ALS is the result of increased catabolism, but the mechanism is unclear (Asbeck & Burns, 1988). The term ALS cachexia, although used in the literature, is not well defined or explained.

Most patients will have diminished nutrient stores because of failure to take in enough food; some may also have deficits secondary to their underlying disease process. For instance, a patient with multiple sclerosis who is unable to walk will have obligate muscle atrophy and nitrogen loss from the lower extremities (Ganger & Craig, 1990). Atrophy of this kind that is seen in many neuromuscular diseases presents as progressive loss of body weight.

Formulas used for the calculation of ideal body weight based on height can provide a reasonable estimate of adequacy. A loss of ten percent of total body weight over six months or a weight below ninety percent of the ideal is associated with malnutrition (Kamel, 1990). Weight is also an important clinical parameter to evaluate in the process of nutritional repletion.

Hill (1992) reported on a consecutive group of patients awaiting major gastrointestinal resection. Forty-three percent had less than ten percent weight loss and no physiologic impairment; seventeen percent had sustained more than ten percent weight loss and also had demonstrable functional impairment. The remaining forty percent who had lost more than ten percent of body weight also had marked impairment in liver function, skeletal muscle function, respiratory function, and some aspects of altered psychologic function.

Decreased Oral Intake

Oropharyngeal dysphagia can severely limit nutrient intake. Restricted dietary intake of protein and calories engenders variable morphologic and physiologic alterations in body tissues. These changes are either a direct result of dietary deficiency or indirect evidence of the body's adaptation to this and other accompanying stress conditions (Chopra, 1991).

Following hypocaloric feeding, the ultrastructure of muscle has been observed to change including the appearance of fiber atrophy at a time when total body composition is still normal (Jeejeebhoy, 1988). The abnormalities observed appear to be in the area of muscle function, ultrastructure, and biochemistry.

The changes observed are positively influenced by refeeding and can sometimes be distinguished from other causative factors such as illness or injury. In most cases adequate intake and appropriate nutritional therapy permits intracellular energy substrates to become repleted. Normalization of muscle function is generally followed by the regeneration of muscle tissue.

Loss of Body Protein

In a study of patients who had both measurements of weight loss and total body protein loss, Hill (1992) reported that there was a significant correlation between weight loss and protein loss. Patients with a ten percent

weight loss have not usually lost sufficient protein to produce physiologic impairment. Protein loss is usually clinically significant when more than fifteen percent of body weight has been lost. When more than twenty percent of body weight has been lost significant protein loss is invariable (Hill, 1992).

The physiologic impairments seen in moderate to severe protein energy malnutrition are clearly associated with a loss of total body protein. Serum proteins including serum albumin provide an estimate of visceral protein stores. When more than twenty percent of body protein has been lost most physiologic functions are significantly impaired (Hill, 1992).

Acute illness with rapid protein loss may not be reflected in reduced serum albumin levels. In chronic, stable patients serum albumin is reflective of overall nutritional status, although it does not reflect acute alterations in nutrition. Serum albumin levels are dependent on the rate of the protein's production and destruction as well as distribution between intra and extravascular space (Kamel, 1990).

Hypoalbuminemia occurs in some disease processes and is unrelated to nutrient supply. This hypoalbuminemia will not resolve despite intense nutritional support until the patient begins to experience resolution of multiple medical and surgical insults (Ganger & Craig, 1990).

Visceral protein is measured by biochemical assay on serum and serum albumin concentration in most cases is a reflection of the adequacy of amino acids in the diet. Other measures of protein status include pre-albumin, retinol binding protein, fibronectin, and somatomedin C.

Another biochemical indicator of nutritional status is serum cholesterol. Spiekerman, Rudolph, and Bernstein (1993) found serum cholesterol levels to be indicators of nutritional status. They studied malnourished individuals and found serum cholesterol concentrations below 3.38 mmol/L. (130 mg/dl.) indicative of nutritional depletion. For all malnourished individuals the following valves were found: pre-albumin, 73 mg/L.; total protein, 55 mg/L.; albumin, 21 gm/L; cholesterol, 3.02 mmol/L. (116 mg/dl) and AST (aspartate amino transferase) .68 U/L (Spiekerman et al., 1993).

Over the years, attempts have been made to quantitate nutritional status in malnutrition through the use of a single measurement or a combination of biochemical, clinical, subjective, and anthropometric evaluations. The use of such nutritional assessment scores or indexes of these values has been found to be predictive of outcomes in some cases.

Nutritional Evaluation

In ALS the initial evaluation of nutritional status is essential in obtaining baseline data and to identify

nutritional problems early. The nutritional evaluation should include:

1. Determination of actual weight versus ideal and usual weight.
2. History of recent weight changes.
3. Diet history to determine adequacy of current diet and recent changes in intake.
4. Laboratory indices (albumin or transferrin) to evaluate visceral protein status (Asbeck & Burns, 1988).

Sitzmann (1990) reported that to evaluate the nutritional status of patients diagnosed with dysphagia at the Johns Hopkins Hospital, patients were evaluated by the Nutrition Support Service by use of information from the physical examination, history, anthropometric exam, and serum evaluations of albumin, transferrin, and total lymphocyte count. The diagnosis of nutritional deficit was established by the presence of two or more of the following:

1. Body weight loss of ten percent or more within the proceeding two months.
2. Anthropometric exam (triceps skin fold and mid-arm muscle circumference) below eighty percent of normal.
3. Serum transferrin (by direct measure) below two hundred mg/dl.
4. Serum albumin below 3.5 ml/d.

5. Total lymphocyte count below 1500 (Sitzmann, 1990).

From the five measurements listed a malnutrition score was derived through summation of the abnormal parameters obtained for any given patient.

Spiekerman et al. (1993) reported an incidence of protein calorie malnutrition of forty-four percent of their study population of 245 patients admitted for gastrointestinal surgery over a period of eighteen months. The diagnosis of protein calorie malnutrition was made based on:

1. Weight loss exceeding ten percent of usual body weight.
2. Serum albumin concentration of less than 30 gm/L.
3. Inability to meet sixty-five percent of estimated needs for more than seven days.
4. Hypercatabolism or major stress increasing metabolic requirements.

The practice of classifying patients into levels of nutritional status or using decision points to separate the malnourished from the well nourished patient seems inadequate in some instances. A more rigorous definition of malnutrition is needed occasionally which encompasses appropriate measures of nutritional status.

Coats et al. (1993) reported on the use of a likelihood of malnutrition (LOM) score to assess 228 consecutive

patients at admission and at the fourteenth day of hospitalization. The findings indicated that the identification of malnutrition has improved since 1976 but that improvement in assessment and intervention is still needed.

Because non-nutritional factors can affect the anthropometric status of an individual such as the loss of muscle mass in bed ridden patients or diseases which result in protein loss from the gut and influence plasma protein levels, traditional markers of malnutrition lose their specificity. Only by recognizing the different facets of malnutrition can we define its various manifestations in relation to our clinical objectives (Jeejeebhoy, 1990).

The use of subjective global assessment (SGA) to identify patients likely to develop nutritionally mediated complications is more appropriate than to base the definition of malnutrition on changes in any one parameter. It should be recognized that clinical judgment is based on a composite of criteria based on an estimate of:

1. Past nutritional intake.
2. Disease process affecting future intake of nutrients.
3. Catabolic effect of the disease.
4. Current physical state in relation to weight loss, wasting, functional status, body fat loss, and other signs of malnutrition (Jeejeebhoy, 1990).

Perhaps a combination of clinical judgement and subjective evaluation of nutritional status is the best approach to the identification of malnutrition. This is especially true if we see it as a continuum that begins when a patient fails to eat enough to meet needs and progresses through a series of changes which may or may not change body composition. The assessment of nutritional status in neuromuscular diseases such as ALS appears to be one in which this approach would be appropriate.

# CHAPTER III

## METHODS

Subjects for this study were individuals diagnosed with ALS who were involved in a study conducted at Baylor College of Medicine using Insulin Like Growth Factor 1. The study was double blind and placebo controlled by design. It was being conducted to determine the safety and effectiveness of the use of IGF-1 in the ALS patient population. The study was in compliance with and was previously approved by the Human Subjects Review Committee of Baylor College of Medicine.

Subjects were seen monthly on an out-patient basis. Data collected with each visit included body weight, percent ideal body weight, and percent usual body weight. Twenty-four hour recall food intake records were obtained, and assessment of swallowing function was done.

Subjects were asked to record food intake for three days each month. These intake records were collected and reviewed at monthly clinic visits. The 24 hour intake record that was felt to be most representative of that subject's actual intake was selected for analysis.

A swallowing score was determined by a registered dietitian who graded the swallowing function into five degrees of severity. Normal swallowing function denoted

consumption of a regular diet. The most severely diminished swallowing function indicated the need for non-oral feeding.

Subjects for this study were assigned to either the non-dysphagic or dysphagic group. The non-dysphagic group were those subjects who tolerated a general diet. The dysphagic group was those individuals who required alteration in diet consistency that reached the dysphagia mechanical soft level.

Data for assessing nutritional status was recorded at the most distant time point in the IGF study (3 mos., 6 mos., or 9 mos.) when the subject demonstrated a swallowing score requiring a dysphagia mechanical soft diet or general diet. This data included serum albumin, percent ideal body weight, serum cholesterol, and the twenty-four hour recall intake records. All information collected for this study was existing data that was already an integral part of the subject's medical record. The intake records were analyzed for calories, protein, carbohydrate, fat, fiber, iron, calcium, phosphorous, zinc, vitamin A, vitamin D, vitamin E, vitamin C, folate, $B_{12}$, and vitamin K using the Nutritionist IV on an IBM personal computer.

Statistical analysis was completed using the Statistical Package for the Social Sciences (SPSS) at Texas Woman's University. Hypotheses were evaluated using t-test analysis. Significance level was established at $p < .05$.

# CHAPTER IV

## RESULTS

Fifty two subjects diagnosed with ALS were screened for inclusion in the Baylor Study. Thirty six subjects met criteria and were entered into the study (See Appendix C for inclusion and exclusion criteria).

Bulbar scores, as an assessment of dysphagia, were assigned to all thirty six subjects with thirty five attaining a score that designated either a regular diet (18 subjects) or a dysphagia mechanical soft diet (17 subjects). One subject attained a score designating a dysphagia soft diet and therefore was excluded from statistical analysis for this research.

Table 5 reports characteristics of the 36 study subjects. Twenty-eight (78%) were males, and eight (22%) were females. Subjects ages ranged from 31 years to 77 years. Mean age was 54.94 ± 15.11 SD for the dysphagic subjects and 54.72 ± 12.18 SD for the non-dysphagic subjects. No significant difference in age or gender was found between the dysphagic and non-dysphagic group.

To further evaluate the differences in characteristics between the means of the two groups of subjects, t-tests were used. No significant differences were found between the two groups in initial body weight, ending body weight,

TABLE 5

CHARACTERISTICS FOR DYSPHAGIC AND NON-DYSPHAGIC SUBJECTS*

| VARIABLE | DYSPHAGIC N=17 | NONDYSPHAGIC N=18 | t | DF |
|---|---|---|---|---|
| Gender | | | | |
| Male | 13 | 14 | - | - |
| Female | 4 | 4 | | |
| Age (years) | 54.94 ± 15.11 | 54.72 ± 12.18 | -.05 | 33 |
| Initial Wt. (lb.) | 171.00 ± 40.29 | 182.66 ± 33.04 | .94 | 33 |
| Ending Wt. (lb.) | 164.77 ± 43.85 | 182.00 ± 38.55 | 1.24 | 33 |
| % IBW | 104.11 ± 19.58 | 118.22 ± 23.28 | 1.93 | 33 |
| Wt. Loss (lb.) | 6.23 ± 9.76 | .66 ± 11.37 | -1.55 | 33 |
| % Wt. Change | .0395 ± .55 | .0076 ± .071 | -1.56 | 33 |
| Chol. (mg./dl.) | 226.00 ± 39.01 | 220.83 ± 37.78 | - .40 | 33 |
| Albumin (mg./dl.) | 4.65 ± .644 | 4.47 ± .234 | -1.06 | 19.94 |

NOTE:
IBW - Ideal body weight; Wt. - weight; Chol. - cholesterol
t - t value; DF - degrees of freedom

* No differences between groups at $p < .05$

% ideal body weight, % weight change, serum cholesterol, or serum albumin. Therefore, null hypotheses 1, 2, and 3 could not be rejected.

There were no significant differences in weight between groups, however the results obtained within the dysphagic group indicated a significant difference existed between initial weight and ending weight. Table 6 indicates the amount of weight loss that occurred within each group. No significant change in weight occurred within the non-dysphagic group.

The difference in mean caloric intake between groups did prove to be statistically significant allowing the rejection of the null hypothesis #4. The dysphagic group took in significantly more calories than the non-dysphagic group.

Evaluation of the carbohydrate content of the diet of the two groups resulted in no significant difference being found. However, when the protein and fat content of the diets were evaluated, significant differences were found. The protein and fat intake were significantly higher in the diets of the dysphagic group.

Mean intakes of other nutrients are reported in Table 7. Mean intake for fiber, iron, calcium, phosphorous, zinc, folate, and vitamins A, C, and $B_{12}$ was higher in the dysphagic group. Intakes of vitamins D, E, and K were not

TABLE 6

WEIGHT CHANGE WITHIN GROUPS

| GROUP | INITIAL WEIGHT | ENDING WEIGHT | t | DF |
|---|---|---|---|---|
| Dysphagic N=17 | 171.0* (± 40.30) | 164.76* (± 43.85) | 2.63 | 16 |
| Non-Dysphagic N=18 | 182.67 (± 33.05) | 182.00 (± 38.55) | .25 | 17 |

NOTE: Weights in pounds ± standard deviation; t - t-value; DF - degrees of freedom.

* Significant difference at $p < .05$.

TABLE 7

MEAN INTAKE OF NUTRIENTS BY GROUP

| NUTRIENT | DYSPHAGIC (N=17) Mean ± SD | NON-DYSPHAGIC (N=18) Mean ± SD |
|---|---|---|
| Calories | 2246.24 ± 744.81* | 1705.83 ± 471.21* |
| Protein (gm) | 93.059 ± 36.302* | 68.27 ± 23.09* |
| Fat (gm) | 98.765 ± 45.37* | 68.00 ± 26.58* |
| CHO (gm) | 253.53 ± 89.00 | 202.50 ± 65.00 |
| Fiber (gm) | 11.941 ± 7.902 | 9.55 ± 5.18 |
| Fe (mg) | 13.882 ± 3.58 | 13.16 ± 8.17 |
| Calcium (mg) | 912.467 ± 542.04 | 612.68 ± 265.44 |
| Phosphorous (mg) | 1393.05 ± 503.75 | 1042.05 ± 361.27 |
| Zinc (mg) | 11.70 ± 6.39 | 9.05 ± 4.58 |
| A (RE) | 1568.00 ± 1078.33 | 505.33 ± 191.85 |
| D (mcg) | - | - |
| E (mg) | - | - |
| C (mg) | 123.77 ± 74.32 | 106.66 ± 66.72 |
| Folate (mcg) | 272.29 ± 90.58 | 251.88 ± 121.49 |
| $B^{12}$ (mcg) | 4.53 ± 2.09 | 3.44 ± 1.97 |
| K (mg) | - | - |

NOTE: Vit. D, E, and K values are not reported due to incomplete data. Calories, protein, fat, and carbohydrate between groups was evaluated by t-test.
* Differences are statistically significant at $p < .05$.

reported due to incomplete data on the Nutritionist IV software. The statistical significance of the intake of these nutrients between groups was not assessed.

# CHAPTER V

## DISCUSSION

Distribution of males and females was similar between the dysphagic and non-dysphagic groups. The prevalence of ALS in males is consistent with that reported in the literature. Of the thirty-five subjects studied, thirteen male and four female subjects were found to be dysphagic while fourteen male and four female subjects were non-dysphagic. This provided a similar gender distribution between groups.

The mean age for the dysphagic group was 54.94 years ± 15.11, and for the non-dysphagic group it was 54.72 years ± 12.18. No significant difference was found in mean age between the groups, thus both groups were considered to be representative of the age and gender distribution reflected in the ALS population.

In spite of increased intake in the dysphagic subjects, no significant differences were found in initial weight, ending weight, weight loss, or percent ideal body weight between dysphagic and non-dysphagic subject. Significant weight loss was found between the initial and ending weight within the dysphagic group.

Mean serum cholesterol level for the dysphagic group was 226 mg/dl. ± 39.01 and for the non-dysphagic group

220.83 mg/dl. ± 37.78. No statistically significant difference in these levels was found between the groups. The mean serum albumin level for the dysphagic group was 4.65 mg/dl. ± .644 and for the non-dysphagic group 4.47 mg/dl. ± .234 to reveal no statistically significant differences between the two groups. Mean levels for both serum albumin and serum cholesterol were within normal ranges.

The dysphagic subjects consumed more calories, fat, and protein than did the non-dysphagic subjects. Mean caloric intake of the dysphagic group was 2246.24 calories ± 744.81 per day while the mean intake of the non-dysphagic group was 1705.83 calories ± 471.21 per day. The dysphagic subjects' mean protein intake was 93.059 gm ± 36.30 and the non-dysphagic subjects' mean intake was 68.27 gm. ± 23.09 per day. Dysphagic subjects obtained adequate protein in their diets even with the possible increased difficulty associated with swallowing various meats and the increased incidence of mucous formation associated with consuming dairy products.

The intake of fat was also statistically different between the two groups. Dysphagic subjects' mean level of fat intake was 98.76 gm. ± 45.37 while non-dysphagic subjects' mean level of fat intake was 68 gm. ± 26.58 per day. Dysphagic subjects were able to obtain adequate fat or fat containing foods in their diet despite their difficulty

with swallowing various consistencies and textures.

No statistically significant differences were indicated in the intake of carbohydrate between the two groups. The mean level of carbohydrate in the dysphagic group was 253.53 gm. ± 89 while the mean level for the non-dysphagic group was 202.50 ± 65. Thus the dysphagic group obtained their increased caloric intake primarily from their increased intake of fat and protein.

Mean levels of all other analyzed nutrients were higher in the dysphagic group, although statistical differences were not evaluated. Iron, calcium, phosphorus, vitamin C, folate, and vitamin $B_{12}$ intakes were adequate in both groups when compared to 2/3 of the RDA. Zinc intake was adequate in the dysphagic group but may have been inadequate in the non-dysphagic group for some individuals. This is consistent with the lower protein intake of this group. Similarly, vitamin A intake was adequate in the dysphagic group but mean intake fell below 2/3 RDA for the non-dysphagic group. This may indicate an inadequate intake in some subjects and is consistent with the lower fat intake of this group. Mean levels for the intake of fiber were below suggested levels in both groups; modification of diet consistency for dysphagia reduces the fiber content. Fiber must therefore be added pharmacologically.

This study dealt with patients who were experiencing

mild to moderate dysphagia rather than the more severe dysphagia sometimes seen in the latter stages of the disease. Axelsson, Asplund, and Norberg (1989) state that severe dysphagia could very easily be associated with undernutrition while mild dysphagia may not be. Sitzmann et al. (1988) reported that if a patient has low grade dysphagia, oral supplements would suffice (as partial support, in addition to oral intake) provided there is no evidence of a major increase in energy needs.

A limitation to this study was the method of data collection which was used to obtain food records. Limited by the amount of time which could be spent with each patient in the clinic setting, it was decided that a 24 hour intake was the only feasible method of obtaining records of foods eaten.

The 24 hour intake record was selected and recorded by the researcher from the 3 day food records provided by the patient. Entry of food record data into the computer was done by a research assistant. Printout data was checked for accuracy by an auditor. Although reasonable means were taken to assure data accuracy, selection bias and input errors remain a possible limitation to this study.

The potential limitations of the 24 hour food record analysis may explain the contradictory results of higher caloric intake but a significant weight loss in the

dysphagic group. In view of this, further research is needed.

Another limitation to the study may have been the size of the study itself. There were 36 subjects in the original study, 35 of whom were classified as being either dysphagic or non-dysphagic. One subject did not fit either category. A larger sample size would have improved statistical results; the smaller sample size tended to decrease the statistical significance of the results obtained.

The length of time involved in the study may also have impacted the validity of the data obtained. This amount of time spent in the study protocol increased the chances of errors in recordkeeping such as with intake records and with the recording of weight data. Weights were recorded at each clinic visit by various clinic personnel using one of two different scales.

Last, an additional limitation to the study may have been the random occurrence of catabolism in this patient population. Asbeck & Burns (1988) refer to ALS cachexia which is not well defined or explained in the literature. They state that weight loss and anorexia occur at times in ALS patients who are not experiencing dysphagia or bulbar symptoms and that muscle atrophy is a result of a type of catabolism, specific to ALS, whose mechanism remains unclear.

Mitsumoto, Hanson, & Chad (1988) reported that the muscle atrophy noticed in ALS is a result of increased catabolism. They report an increase in acetylcholinesterase activity in the plasma of ALS patients due to alterations in neuron-muscle interaction and increases in protease and collagenase activity.

Corbett, Griggs, & Moxley (1982) cited an underlying defect in muscle metabolism (in ALS) that accounts for the wasting which could be either accelerated catabolism or defective anabolism or both. They describe a wasting of skeletal muscle suggestive of an accelerated catabolism or reduced synthesis of muscle protein.

All of the aforementioned limitations need to be considered in light of the statistical results obtained. Patients were encouraged to eat frequently - six meals per day - with emphasis on high protein, high calorie foods which are calorically dense. Subjects with dysphagia or those losing weight were also encouraged to take a multi-vitamin preparation containing adequate iron and B complex vitamins to help in stimulating the appetite and promoting weight maintenance.

If appetite diminished all medications being taken were reviewed for their impact on appetite, taste alteration, taste sensation, and their possible contribution to a feeling of fullness. Conferences were held with the

physician if necessary to try to arrange for alternative medication choices or for alternative dosing arrangements (i.e. split dosing).

These measures were routinely taken with subjects experiencing a gradual weight loss and especially with subjects who had dysphagia to any degree. Counseling specific to the type of dysphagia being experienced with written guidelines for the diet consistency appropriate to the current dysphagia level was provided. Ways of supplementing the diet with oral supplements were given.

Patients with dysphagia were given all the necessary tools for increasing their intake, and every effort was made to maintain weight or at least halt any additional weight loss in this group of individuals. It was felt that stopping weight loss or maintaining current weight if acceptable, were preferable goals rather than trying to attain repletion in this patient population.

Clinical experience had led this researcher to suspect that dysphagic subjects would have diminished intakes of meats and dairy products due to dysphagia and increased mucous formation. However, patients received counseling in this regard not only from the dietitian but from the nurse clinician and all of the physicians associated with the care of these patients. These aggressive counseling and support

techniques may in part be responsible for the results obtained.

# CHAPTER VI

## IMPLICATIONS FOR FURTHER RESEARCH

Research in the area of malnutrition and dysphagia is greatly needed (Veldee & Peth, 1992). Assessment of the degree of dysphagia, followed by appropriate care plans and therapy is needed for effective and safe management. Perhaps with effective use of electromyographic measures of swallowing performance coupled with appropriate nutritional assessment parameters more effective nutritional support can be obtained and its effect observed.

Young and Jones (1990) reported that in their study of 225 patients with documented evidence of dysphagia the most common procedure for diagnosing dysphagia was a bedside assessment conducted by the physician who assessed the presence or absence of the gag reflex. Further referrals for the evaluation and management of dysphagia were made most often to the dietary department. They reported that in 79% of all cases of dysphagia the dietitian was consulted for nutritional support of the patient compared to 46% for speech and language pathology assessment and 48% for radiographic studies of swallowing performance. Further research into appropriate assessment and management of dysphagia by dietitians is needed as is clear delineation of the dietitian's role on the dysphagia team approach to care.

This is clearly an appropriate area of involvement for the dietitian especially with regard to the modification of food and liquid textures and consistencies as well as counseling in diet modification. With regard to ALS specifically more research is needed in the area of changes in metabolic rate, perhaps through the use of techniques such as indirect calorimetry. Also, additional work in controlled settings such as Clinical Research Centers is needed to clarify the obvious changes which occur in anabolism and catabolism during the course of ALS and other neuro-muscular diseases.

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# APPENDIX A

# DATA COLLECTION LOG

# DATA COLLECTION FORM

| | | | | SERUM | | | | |
|---|---|---|---|---|---|---|---|---|
| NAME | SUB# | WT. | HT. | BUL-BAR SCORE | ALB. | CHOL. | % IBW | CAL. |

# APPENDIX B

## AGENCY PERMISSION

TEXAS WOMAN'S UNIVERSITY
HOUSTON CENTER
DEPARTMENT OF NUTRITION AND FOOD SCIENCES
1130 M.D. Anderson Blvd., Houston, Texas 77030 (713) 794-2371

# AGENCY PERMISSION FOR CONDUCTING STUDY

The Baylor College of Medicine.
grants to Sandra Calvin
a student enrolled in the Department of Nutrition and Food Science at Texas Woman's University, the privilege of its facilities in order to study the following problem:

The Impact of Dysphagia On Nutritional Status In Amyotrophic Lateral Sclerosis

The conditions mutually agreed upon are as follows: (to be completed by the Agency Representative)

1. The agency *may* / ~~*may not*~~ be identified in the final report.
2. The names of consultative or administrative personnel in the agency ~~*may*~~ / *may not* be identified in the final report.
3. The agency ~~*wants*~~ / *does not* want a conference with the student when the report is completed.
4. Other _____

Date: 9/24/94

Signature of Agency Representative

Signature of Research Committee Chair

Signature of Student

Distribution: One copy each to student (original - to be included in the final paper), Agency, Dean of Graduate School (to accompany prospectus); Department of NFS, TWU-Houston Center.

# APPENDIX C

## INCLUSION/EXCLUSION CRITERIA

## INCLUSION CRITERIA

To be considered eligible to participate in this study, patients must meet all of the following requirements:

1. Patient is 20 years of age or older.
2. Patient has a clinical diagnosis of classical, sporadic, non-familial ALS.
3. If female, patient is surgically sterile or post-menopausal.
4. Duration of illness is less than 36 months.
5. AALS score is $\geq$ 40 and $\leq$ 80 at screening.
6. As evidence of disease progression, patient's total AALS score is at least 5 points higher at baseline than at the initial screening visit. The 5-point or greater change must occur within the 2-3 month run-in period.
7. Patient is willing and able to comply with protocol and has signed an Institutional Review Board (IRB) approved consent form.

## EXCLUSION CRITERIA

Patients will not be eligible to participate in this study if they have any of the following characteristics:

1. Patient is diagnosed as having any of the following:
   - Familial ALS
   - Progressive bulbar palsy
   - Progressive muscular atrophy
   - Primary lateral sclerosis
   - Monoclonal/polyclonal gammopathy
   - Hyperparathyroidism
   - Hyperthyroidism
   - Insulin-dependent diabetes mellitus
   - Post-polio syndrome
   - Dementia
   - Multifocal conduction block (electrodiagnosis)
2. Patient has a systemic illness which, in the judgment of the investigator and medical monitor, is significant or poorly controlled (e.g., cardiovascular, pulmonary, hepatic, renal, autoimmune, metabolic).
3. Patient is HIV seropositive.
4. Patient has a history of substance abuse, including prescription drugs, street drugs, and/or alcohol within the past 6 months.
5. At screening, patient has received an investigational drug which the past 8 weeks.

6. At screening, patient has received a marketed drug of purported value in ALS treatment, such as steroids or immunosuppressants, within the past 8 weeks.
7. Patient has a forced vital capacity <50% of the predicted mean value at screening or baseline.
8. Patient has a history of malignancy within 3 years of screening.
9. Patient is a pregnant or lactating woman.
10. Screening laboratory results are judged to be clinically abnormal. They may be repeated once and, if normal, the patient may enter the study with the agreement of the investigator and medical monitor.