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## **A Methodology for the Inclusion of Laboratory Assessment in the Evaluation of Dysphagia**

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### **Abstract**

*Detecting aspiration appears to be a major objective of any assessment for oropharyngeal dysphagia as a precursor to preventing pneumonia development. Convincing evidence supporting this clinical belief remains elusive. To the contrary, other variables of the patient's prevailing health status appear to be much better predictors. The purposes of this article are to discuss dysphagia as it relates to a specific health status model, to describe how specific blood tests are used to examine health status variables, and to provide discussion of the use of laboratory assessments to examine immune system status and infection and their potential relationship with pneumonia.*

### **Introduction**

When we, as clinicians, detect aberrations of the swallow, we are concerned about the co-morbidities that may accompany it, including malnutrition, dehydration, aspiration pneumonia, and decubitus ulcers (Smithard et al., 1996). Identification of per oral aspiration captures our attention because we believe that the development of pneumonia from aspiration has a strong relationship to it. We manage swallowing disorders in a way that demonstrates that belief. Much emphasis is placed on modifying diets, applying compensations and maneuvers and therapy to reduce aspiration risk (Logemann, 1998). While these considerations may have validity, it is important to recognize the Curtis and Langmore (1997) conclusion that the evidence linking per oral aspiration and pneumonia is not "uniformly strong" (p.116).

Data included in the Department of Veterans Affairs Directive 2006-032, "Management of Patients with Swallowing (Dysphagia) and Feeding Disorders" (Department of Veterans Affairs, 2006) summarizes findings across multiple studies. The summary indicates that in a given sample of 100 patients with acute CVA, between 43 and 54 will experience aspiration. Of the patients who do aspirate, an estimated 37% will develop pneumonia, while 63% will not. This raises an important question. Why will some patients who aspirate succumb to pneumonia while others

will escape its development? Importantly, can the differences be attributed solely to swallowing and bolus variables?

At the conclusion of a 4-year prospective study of pneumonia in the elderly, Langmore et al. (1998) reported that all factors that directly measured dysphagia were eliminated as significant predictors of pneumonia development. They concluded that, "This does not imply that dysphagia and aspiration are not important, but suggests that these factors were highly correlated with other risk factors that had better predictive value, and that dysphagia by itself is not sufficient to cause pneumonia" (p. 76). Among the significant predictors of pneumonia were feeding dependency, oral care dependency, number of decayed teeth, more than one medical diagnosis, number of medications, and the presence of smoking. These findings suggest that elements of the patient's health status may be powerful contributing factors to be considered as we manage dysphagia.

The purpose of this article is threefold. First, dysphagia will be discussed as it relates to the authors' health status model (Figure 1). Second, the authors will describe how specific blood tests can be used to shed light on health status variables. And, third, a brief and limited discussion is given of the use of laboratory assessments specific to immune system status and infection and their potential relationship with pneumonia.

### ***A Model of Health Status in Dysphagia***

Figure 1 illustrates the relationship between dysphagia and the organism. At the core of the model are the oral, pharyngeal, and esophageal components of the swallow. The band surrounding these swallowing stages represents the organism and six areas of health status. They are red blood cell (RBC) indices, hydration, renal function, nutrition, immune system status, and presence of infection. Note that arrows between the swallow components and the organism are pointed both outward and inward. The outward arrows indicate that the dysphagia can, as we all recognize, affect the organism through the production of co-morbidities (e.g., malnutrition, dehydration) or death. The inward arrows indicate that the six areas of health status of the organism may, in turn, impact on swallowing due to changes in muscle and nerve function through mechanisms such as protein-calorie malnutrition (Veldee & Peth, 1992; Hudson, Daubert, & Mills, 1995). The following description of the application of laboratory tests will demonstrate how each of these six health status areas can affect or be affected by the patient's dysphagia.

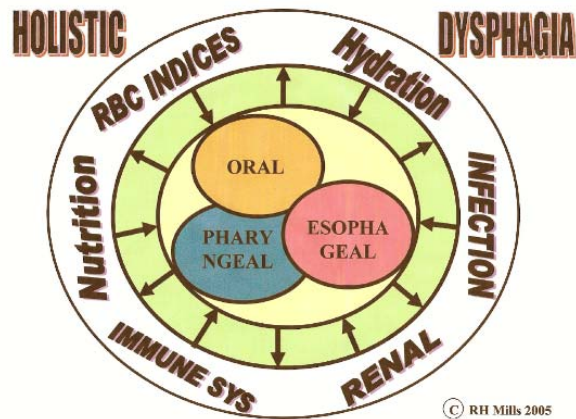


Figure 1. The relationship between dysphagia and the organism.

### Laboratory Values as an Indicator of Health Status

Laboratory assessment is surely one of the most important technologies in the evaluation of health status. Blood tests are often assembled into panels, grouping tests according to their diagnostic significance. Two panels, the Complete Blood Count (CBC) and a Complete Metabolic Panel (CMP), are often used in ambulatory screening when disease is suspected, at the time of hospital admission, or in monitoring the response to treatment (Shapiro & Greenfield, 1987). The authors make use of only selected tests from these panels: the ones that are most useful in shedding light on the six factors in the model. These tests can be found in Table 1.

When applying laboratory measures, it is important to recognize that using the finding from a single test to diagnosis a disease represents a gross oversimplification of medical practice. Many factors enter into diagnosing illnesses and the results from a single laboratory test, or even a full panel, are of limited utility without clinical symptoms and signs (Weitzman, 1975; Whitney, Cataldo, & Rolfes, 1998).

Table 1. Common Test Components of the CBC and CMP Panels.

Complete Blood Count (CBC)			
Test Name	Result	Units	Reference Range
WBC	6.30	K/cmm	4.80 to 10.80
RBC	4.47 L	M/cmm	4.7 to 6.1
HGB	13.1 L	g/dL	14 to 18
HCT	38.6 L	%	42 to 52
NEUT ABS	9.7 H	K/cmm	1.90 to 8.00
LYMPH ABS	0.4 L	K/cmm	0.90 to 5.20

MONO ABS	0.6	K/cmm	0.16 to 1.00
EOS ABS	0.2	K/cmm	0.00 to 0.80
BASO ABS	0.0	K/cmm	0.00 to 0.20
NEUT %	76.0 H	%	40 to 70
LYMPH %	11.6 L	%	25 to 33
MONO %	5.4	%	3 to 7
EOSINO %	2.6	%	1 to 3
BASO %	0.4	%	0 to 1

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Complete Metabolic Panel (CMP)

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Test Name	Results	Units	Reference Range
SODIUM	139	mmol/L	137 to 145
POTASSIUM	4.6	mmol/L	3.6 to 5.2
CHLORIDE	102	mmol/L	98 to 107
UREA NITROGEN	20	mg/dL	5 to 25
CREATININE	1.82 H	mg/dL	0.70 to 1.30
ALBUMIN	2.0 L	g/dl	3.5 to 5.0

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In Table 1, the name of each test is provided in the left-hand column. The next column gives an example of a value. If an “H” or an “L” follows the value, it is considered to be “high” or “low” relative to its reference range. In the next column are the units of measure. Finally, the right-hand column provides the reference range that is considered typical for that particular laboratory. Reference ranges may vary somewhat among laboratories depending on the nature of the population served.

The CBC provides values for the three red blood cell indices, (Red Blood Cell Count [RBC], hematocrit [HCT] and hemoglobin [Hgb]). Hemoglobin, which is attached to and transported by the red blood cells, is of particular importance as it is responsible for transporting oxygen molecules throughout all parts of the organism. Reduction in red blood cell populations and hemoglobin transport may occur due to reduced production or due to early death or loss of red blood cells, as is often seen in gastrointestinal (GI) bleeds. When oxygen transport is impaired, it affects all systems in the body. Depressed values may reflect the presence of any of several types of anemia, each with unique causes. Common symptoms of anemia are fatigue, loss of energy, shortness of breath, difficulty concentrating, and dizziness. Anemia is associated with an increased risk of cognitive decline (Peters et al., 2008) and increased mortality in the elderly (Dong et al., 2008).

The CBC also reports the total white blood cell count (WBC). The WBC represents the total number of leukocytes present in a measure of blood. There are five different types of leukocytes (lymphocytes, neutrophils, basophiles, eosinophils, and monocytes) all have differing functions as they relate to the immune system. In the normal state, the percentage of the total lymphocyte pool accounted for by each type can be predicted. Alterations in that expected distribution provide valuable information regarding the status of the immune system, the presence or absence of infection, and the ability of the individual with dysphagia to fight infection. These issues will be discussed in detail in the second portion of this article.

The CMP is a laboratory panel that includes the electrolytes—sodium, potassium and chloride. These values are most often looked to as indicators of hydration status. It is important to recognize that under-hydration and over-hydration can take several forms, not all of which are reflected in an “out of reference range” value for one or more electrolytes. A condition, termed hypernatremia, exists when there is greater water loss from the body than sodium. This condition often causes profuse sweating, severe diarrhea, or vomiting. Patients can also exhibit another form of dehydration called hypovolemia in which there are equal losses of fluid and electrolytes. These differing relationships can reflect different causes and require different interventions.

Blood Urea Nitrogen (BUN) and creatinine are waste products of metabolism. If these values elevate above their reference ranges, they may indicate the presence of renal impairment. The reader may wonder why renal factors are included in a health assessment for dysphagia. With renal impairment, there may be little urine output, a dry mouth, loss of appetite, nausea, vomiting and dehydration. All of these complications may affect outcomes in patients with dysphagia.

Also assessed in the CMP panel is albumin, a measure of protein stores that is often used as a measure of the patient's nutritional status. Low albumin levels may indicate that the body has been depleted of protein and that the patient is malnourished. Byrnes, Statton, and Wright (1998) pointed to the seriousness of this problem when they reported that, without intervention for low albumin levels, hospitalized elderly with dysphagia consumed only 14.5% of their estimated energy requirements.

It is important to recognize that the albumin measure has two particular weaknesses. First, it is hydration sensitive. In a dehydrated patient, albumin levels may be artificially elevated. Second, it has a half-life of 18-21 days (Zachary & Mills, 2000). That is, the value derived from today's blood sample reflects the patient's protein status over the last 18 to 21 days before the blood draw. However, if it is important to know whether a nutritional intervention is producing positive results, then a test of prealbumin should be ordered. Prealbumin has a half-life of 1-2 days and will allow more timely decisions to be made. Albumin value is considered important because nutritional status has been closely tied to the strength of the immune system. Thus, the detection of aspiration in a normally hydrated patient who exhibits an albumin level of 2.0 gm/dl, well below reference range, should indicate to the clinician that significant caution be exercised as the management plan is developed. This patient is likely to have an impaired immune response to the threats of bacterial invasion and be more likely to develop infection at any site.

### ***The Immune System and Dysphagia***

The body's ability to fight infection in patients with dysphagia is critical. The immune system, a very complex and multifaceted defense system, has two purposes: to recognize potential invading pathogens and to destroy and clear them from the host organism. Two subsystems—specialized immunoglobulins and complement proteins, and specialized white blood cells (WBC)—combine to seek out and destroy pathogenic microorganisms. White blood cells, or leukocytes, consisting of lymphocytes (B- & T-type), phagocytes, and granulocytes, play specific and unique roles in these defenses (Huffer, Kanapa, & Stevenson, 1986).

Of particular importance to clinicians assessing patients with dysphagia is the status of special WBC granulocytes called neutrophils. Neutrophils are nonspecific bacteria fighters comprising the largest number of white blood cells circulating in the blood system and are the first recruited to the sites of infection (Male, Brostoff, Roth, & Roitt, 2006). Neutrophil count may be expressed as the total percent present in a measured sample of blood or as the absolute neutrophil count (ANC) in a sample. A normal neutrophil count is 40% to 70% of white blood cell count and the ANC normal value is 1500/mm<sup>3</sup> or greater. Patients with values of 500 to 1500/mm<sup>3</sup> have a reduced number of neutrophils in the blood, or mild neutropenia, and usually are at minimum risk for developing infection. Patients with ANC values of less than 500/mm<sup>3</sup>, or moderate to severe neutropenia, are at increased to significant risk for developing infection. ANC values greater than 7500/mm<sup>3</sup>, or neutrophil counts above 70%, result in neutrophilia and this may also indicate acute bacterial infection. The physical and systemic stress of a serious illness, such as surgery or a cerebrovascular accident (CVA), may result in temporary neutropenia, which, if coupled with laryngeotracheal aspiration of over-colonized oropharyngeal bacteria, may result in pneumonia (Bartlett & Gorbach, 1975).

As a health status barometer, elevated WBC values indicate the presence of a peripheral inflammatory response and the body's localized immune response has been activated. For example, after the onset of a CVA, as part of a system-wide stress notification alert, the insulted area sends out chemical messengers alerting the immune system of injury. Circulating neutrophils leave blood vessels, enter the tissue, and begin protecting the injured site. Later, more long-lasting and specialized immune components arrive to support this initial response. Elevated neutrophil counts have been reported following transient ischemia attacks (Ross et al., 2007) and head injury (Rovlias & Kotsou, 2001). Thus, an elevated WBC count suggests the body is reacting to an inflammatory response, and, more specifically, an elevated ANC suggests the infection detected is bacterial, in nature.

The oropharyngeal environment is a constant incubator of many types of flora. Maintaining control of these pathogens falls to immune properties, including complement proteins, neutrophils, and monocytes. Neutrophils police the oral cavity by trapping and degrading bacteria and removing debris. Their efficient action reduces chronic oral inflammation and periodontal disease (Miyasaki, 1991). However, onset of stress from a severe illness, such as the surgery or CVA mentioned earlier, may alter the sympathetic nervous system's regulation of the body's immune system, including altering oral protection properties. As a result, secretion of saliva, the carrier of immunoglobulin, gingival crevicular fluid, complement proteins, and neutrophils, is reduced. This reduced protection then allows oral pathogens to quickly and significantly increase their populations, creating the potential for larger bacterial concentrations in oral secretions and food boluses. If aspirated into an immune-compromised lower respiratory system, these large bacteria concentrations could be responsible for pneumonia development (Langmore et al., 1998). For clinicians assessing dysphagia, knowledge of alterations in the immune system status, and particularly within the context of demonstrated aspiration and dysphagia, should influence our decisions regarding recommendations for continuing oral feeding, and, as such, blood assay values are an additional tool to use in assessing swallowing safety.

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