I, Amy Harmon, hereby submit this as part of the requirements for the degree of:
Master of Arts

in:
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It is entitled:

Pediatric Dysphagia: A Retrospective Study of Patients Receiving Flexible Endoscopic Evaluation of Swallowing (FEES)

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ABSTRACT

PEDIATRIC DYSPHAGIA: A RETROSPECTIVE STUDY OF PATIENTS RECEIVING FLEXIBLE ENDOSCOPIC EVALUATION OF SWALLOWING (FEES)

By: Amy L. Harmon

The demographic and diagnostic trends of patients receiving FEES exams at a pediatric facility were examined. Relationships between diagnosis type, findings, recommendations, and other dysphagia evaluations were investigated. Data were collected from 99 pediatric FEES reports performed from April through December of 2001. The average age of a patient receiving the FEES exam was 49.47 months (approximately 4 years). A greater percentage of the patients in the study were males (59.6%) than females (40.4%). Males were also more prevalent in every diagnostic category, except those with a cardiovascular diagnosis where females dominated. The most frequent diagnoses were neurologic, structural, and other (congenital, acquired, and miscellaneous). Variations among findings and recommendations were found between diagnostic categories. Premature spillage was the most frequent finding across all diagnostic categories.
PEDIATRIC DYSPHAGIA: A RETROSPECTIVE STUDY OF PATIENTS RECEIVING FLEXIBLE ENDOSCOPIC EVALUATION OF SWALLOWING (FEES)

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I would like to acknowledge the cooperation of Dr. Paul Willging for allowing me access to the most recent FEES reports at Cincinnati Children’s Hospital. His administrative assistant Tricia Davis was also helpful in my data collection by organizing the reports for me and facilitating communication between myself and the Otolaryngology Department at Children’s.

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CHAPTER I

Introduction

The increasing prevalence of pediatric dysphagia is secondary to improved survival rates of premature infants and children with life-threatening illnesses (Newman, 2000; Abraham & Wolf, 2000). Medical complications often accompany the birth of premature infants. For example, the respiratory systems of premature infants are often not fully developed. The infants surviving difficult births often present with oral motor feeding delays or deficits and/or swallow dysfunction secondary to complications associated with prematurity. These infants may become medically fragile children who persist with swallow dysfunction as well. Speech-language pathologists have become more involved in diagnosing and treating swallowing disorders in the pediatric population (Newman, 2000). The role of the speech-language pathologist includes identifying infants and children at risk for dysphagia, assisting other professionals in diagnosing dysphagia through clinical examinations and aiding in management decisions regarding the disorder (www.professional.asha.org).

The pediatric population presents unique diagnostic differences in feeding and swallowing disorders compared to adults (Rudolph, 1994). As in the adult dysphagia population, the etiology of pediatric dysphagia can be congenital or acquired (Willging, Miller, Link, & Rudolph, 2001). However, a major difference between pediatric and adult dysphagia exists in that oral motor and feeding skills are already learned in the adult population. Christensen (1989) stated that relearning skills is fundamentally different than learning new skills when they are related to the impairment of feeding and swallowing development. In the pediatric population, skills are being acquired. Constant
changes in the developing respiratory, neurologic, and gastrointestinal systems compound the identification, diagnosis, and management of pediatric dysphagia (Newman, 2000; Willging et al., 2001).

Etiologic Factors

Pediatric feeding and swallowing disorders are the result of a variety of etiologic factors (Hartnick, Hartley, Miller, and Willging, 2000; Newman, 2000; Willging et al., 2001). They may be structural abnormalities such as cleft lip or palate or airway obstructions. However, the predominant cause of pediatric dysphagia is the presence of some type of neurological condition (Willging et al., 2001). Neuromotor and neurosensory impairment can impede the safety of airway protection and swallowing. Children with neurological impairments demonstrate decreased postural control and imprecise timing that may lend to swallow dysfunction. Examples may include cerebral palsy, seizure disorders, or Chiari malformations.

Other etiologic factors associated with pediatric dysphagia include prematurity, cardiorespiratory problems, behavioral issues, and metabolic disorders. Premature infants often present with oral motor feeding delays or deficits due to their medically fragile status, lack of oral stimulation or respiratory problems. Cardiorespiratory problems often affect an infant’s ability to maintain a coordinated suck-swallow-breathe sequence. Children with respiratory compromise also have airway protection deficits that may result in pneumonia (Willging et al., 2001) Behavioral issues that stem from psychosocial problems can also cause feeding and swallowing problems in children. Finally, inflammatory processes such as esophagitis or metabolic abnormalities such as
allergies or endocrine problems can be causal factors of pediatric dysphagia (Willging et al., 2001).

**Evaluation of Dysphagia**

The pediatric dysphagia evaluation is best accomplished using a multidisciplinary team and approach (Rudolph, 1994). This team can include the disciplines of gastroenterology, nutrition, occupational therapy, otolaryngology, pulmonary medicine, psychology, nursing, and speech pathology. At Cincinnati Children’s Hospital Medical Center (CHMCC), the "Interdisciplinary Feeding Team" uses an approach that coordinates care to address the multiple interacting factors of complex feeding problems. The use of the interdisciplinary model allows development of a management plan that reflects the input and collaboration of multiple disciplines (C. Miller, personal communication, 2002).

A thorough dysphagia evaluation begins with obtaining a case history, performing a clinical exam, and choosing the appropriate instrumental dysphagia exam (Newman, 2000). The instrumental exam will allow evaluation of the physiology of the patient’s current swallowing (Arvedson, 1998). Possible instrumental examinations include videofluoroscopic swallow study (VFSS) or videofluoroscopy and the flexible endoscopic evaluation of swallowing (FEES) (Arvedson, 1998; Newman, 2000; Langmore, 2001).

In 1983, VFSS became the first instrumental exam used to routinely assess oropharyngeal dysphagia (Logemann, 1983; Langmore, 2001). The effectiveness of the procedure was immediately recognized and it was soon implemented as an independent instrumental exam. In 1988, FEES was introduced as an adjunct to VFSS to evaluate
pharyngeal dysphagia. However, in recent years it has gained more widespread use as an independent instrumental exam and it is becoming a standard tool for diagnosing and managing dysphagia (Langmore, et al, 1988; Langmore, 2001).

While its use is more common in the adult population, application of FEES for children is not as prevalent. Few pediatric facilities in the nation are performing FEES. At Children’s Hospital in Cincinnati, FEES has been performed on patients with pediatric dysphagia since 1995. There are a limited number of facilities in the nation using the evaluation for children. St. Louis Children's, San Diego Children's, and Rush University Hospital in Chicago are a few of the known facilities currently using the procedure to evaluate pediatric dysphagia (C. Miller, personal communication, April 30, 2002).

**General Statement of the Problem**

Although there are documented advantages and disadvantages in utilizing FEES to help assess pediatric dysphagia, research is still somewhat new and limited for this particular instrumental examination (Newman, 2000). Further research in the area of applying FEES to the pediatric population is needed. Demographic data such as the most common diagnoses of FEES patients and diagnostic results such as primary findings and recommendations are areas of research to be further explored.

**Significance of the Problem**

Hartnick et al. (2000) aided in the identification of demographic variables (age, primary diagnoses, and baseline feeding recommendations) associated with pediatric patients receiving FEES exams. However, these results do not include findings obtained
during a FEES exam nor do the results from this study provide information regarding possible relationships between primary diagnoses and recommendations made from the exam. Additional research is needed to provide further demographic data as well as to investigate relationships between the demographics and diagnosis type, exam findings and exam recommendations. This data will lead to a more comprehensive profile of the pediatric FEES patient including current diagnostic trends.

**Purpose of the Study**

The purpose of the present study was to demonstrate a profile of patients receiving FEES exams at CHMCC and to examine relationships between diagnosis type and results obtained from the FEES exams. Identifying the demographic variables associated with pediatric dysphagia may lead to increased understanding of the applicability of FEES to the pediatric dysphagia population. The current study was designed to answer the following questions:

1) What are the demographic trends of pediatric patients selected to undergo FEES including age, gender, and primary diagnosis?

2) What are the diagnostic trends of pediatric patients selected to undergo FEES?

3) What are the principal findings of a pediatric FEES exam by diagnosis type?

4) What are common recommendations made from a FEES exam by diagnosis type?

5) What are the previous swallow evaluations performed on patients referred for a FEES exam?
CHAPTER II

Review of the Literature

This chapter was designed to inform the reader about two instrumental dysphagia evaluations. Background information regarding the evolution of each exam is given. The procedures and components of each exam are described. Advantages and disadvantages to each method of evaluation are provided. Finally, the chapter will demonstrate that FEES is becoming more widely used and is considered reliable and safe for the pediatric dysphagia population.

The nature of a pediatric dysphagia evaluation has become more comprehensive secondary to advances in research and technology. The information obtained from a traditional clinical examination regarding feeding abilities and the oral phase of swallowing has always been essential to the diagnosis and management of pediatric dysphagia. However, over time the need to evaluate the pharyngeal and esophageal phases necessitated the development and implementation of instrumental exams. The traditional clinical evaluation has been enhanced by the use of two instrumental examinations: VFSS and FEES. These instrumental exams can allow the examiner to visualize parameters of swallowing that cannot be assessed adequately by a clinical examination (Willging et al., 2001).

Videofluoroscopic Swallow Study (VFSS)

Between the years of 1968 and 1970, Dr. Jeri Logemann developed techniques to study the oropharyngeal phase of swallowing at Northwestern University (Miller & Groher, 1993). These radiographic techniques were developed because Logemann stated that a bedside evaluation did not allow her to adequately discover or define swallowing
problems. These techniques have evolved into what is known today as the “modified barium swallow” (MBS) or “videofluoroscopic swallow study” (VFSS).

VFSS is a radiologic exam performed to assess the oral, pharyngeal, and esophageal phases of swallowing. Considered the gold standard assessment of dysphagia, this procedure requires the patient to eat and drink food and liquids coated with barium contrast of different volumes and consistencies (Logemann, 1983). The contrast material is swallowed to allow for “visualization of the bolus as it travels through the alimentary tract” (Murray, 1999, p 113). Dynamic fluoroscopic images of the swallow are seen and videotaped for later analysis (Murray, 1999).

A VFSS is a unique exam in several ways. The views obtained from a VFSS are two-dimensional. That is, when using the VFSS, an examiner can view swallow function in two views: lateral and anterior-posterior projection. The lateral projection allows for an unobstructed examination of the aerodigestive tract. Movements of the tongue, velum, epiglottis, and arytenoids can be observed in this view. The anterior-posterior projection requires the patient to face the fluorescent screen. From this view, structures and functions may be viewed bilaterally for symmetry. It is possible to assess vocal fold mobility in this projection. (Murray, 1999; Logemann, 1983).

Advantages to using VFSS include the visualization of oral leakage, poor bolus formation, reduced tongue movement, nasal regurgitation, laryngeal penetration, tracheal aspiration, esophageal dysfunction and reflux (Groher, 1997). The VFSS also allows the examiner to view the timing and coordination of all phases of the swallow. A study by Logemann (1983) reported that through the use of VFSS, 40% of the patients examined were identified as silently aspirating. These same patients were not identified as
aspirating at a bedside exam because of a lack of cough or any other outward sign of aspiration (Logemann, 1983). Finally, therapeutic and compensatory techniques can also be introduced during a VFSS to aid in making the safest and most efficient management decisions (Palmer, DuChane & Donner, 1991).

There are disadvantages that accompany the VFSS. During the exam, both the patient and the examiner are exposed to radiation. Completion of a VFSS also requires the use of a radiologic facility and a wide number of professionals including the radiologist, radiology technician, nursing and transfer staff. Behaviorally, children often are unwilling to eat or drink substances with barium added to them. Finally, it is difficult for children who ingest only very small amounts of food or liquid because the barium contrast may not be visible during these swallows (Willging et al., 2001).

Flexible Endoscopic Evaluation of Swallowing (FEES)

FEES was first described in 1988 as an alternative or adjunct exam to the VFSS. It uses a flexible endoscope, camera, light source, monitor, and video recorder to assess the pharyngeal phase of the swallow (Langmore, 2001). The flexible laryngoscope is passed through a nasal passage to the level of the oropharynx. From there it is possible to view food and liquid during the pharyngeal stage of a swallow. The examiner observes the images on a monitor. A flexible tip allows the examiner to control the angle of viewing upward and downward during the examination (Langmore, 1988; Murray, 1999; Langmore, 2001).

There are five basic parameters evaluated during a pediatric FEES exam. They include pooling of secretions, premature spillage, laryngeal penetration, aspiration, and residue. Pooling of secretions occurs when secretions fall over the tongue base and
collect in the hypopharynx without a swallow initiation. A significant amount of pooling of secretions can be an aspiration risk (Murray, 1999). Premature spillage is defined as the fall of material over the tongue base without oral transfer and before swallow initiation. Significant amounts of premature spillage with the presence of a swallow delay can lead to accumulation of material in the valleculae, pyriform sinuses, and even to the laryngeal vestibule. Penetration occurs when the bolus enters the laryngeal vestibule to the level of the true vocal cords. Aspiration is entry of the bolus below the level of the true vocal cords. Finally, residue is defined as material that remains in the hypopharynx or valleculae after the swallow (Willging et al., 2001).

There are a number of advantages to using FEES in the pediatric population. The FEES equipment is portable and compact which allows for the evaluation of patients who are not physically able to leave the ICU because of their medically fragile status. The pediatric FEES exam can be performed by an otolaryngologist and/or a trained speech-language pathologist (Palacio, 2001). Patients with severe disabilities who are unable to sit for a lengthy period can be evaluated with FEES during their normal mealtime. Muscle fatigue can accompany developmental disorders such as cerebral palsy, muscular dystrophy, and other childhood syndromes. “Due to the problems with coordination, individuals begin to fatigue toward the end of a meal, increasing the risk of aspiration” (Palacio, 2001, p 6). FEES makes it possible to evaluate patients for a longer period of time and thus receive more accurate results in detecting problems such as aspiration (Palacio, 2001).

Speech-language pathologists have reported that they have had no difficulty leaving the scope in place for 15-30 minutes as compared to the maximum of 5 minutes
of evaluation time for these same types of patients using a VFSS (Palacio, 2001). Unlike the use of barium in the VFSS, there is no change in the taste of the food since it is only stained with the addition of food coloring (Aviv et al., 1998). Finally, FEES allows viewing of the swallow from a third dimension, from above. This added scope of vision allows for the inspection of the management of a patient’s own secretions and the possibility of reflux (Palacio, 2001). The endoscopic view is more sensitive to the presence of abnormal pooling of secretions and persistent residue after the completion of a swallow (Willging, 1995). This image can also be used to assess the pre-feeding behaviors of infants by observing the spontaneous swallowing of secretions or dyed formulas (Leder & Karas, 2000).

FEES has also been reported to be more cost-effective than a VFSS (Palacio, 2001; Aviv et al., 1998). An additional benefit to FEES is that the exam does not require the use of radiation. If necessary, a caregiver or assistant can hold a child in his/her lap during a FEES evaluation (Link, Willging, Miller, Cotton, & Rudolph, 2000). This is not an option with an VFSS due to the radiation emitted.

FEES is not intended to replace the standard VFSS, but rather aid in gathering additional diagnostic information. There are disadvantages to using FEES as well. The endoscopic evaluation is limited to the events immediately before and immediately after a swallow during the pharyngeal stage (Willging, 1995). This is due to the retraction of the tongue base, elevation of the velum, and deflection of the epiglottis at the moment of the swallow (Newman, 2000). FEES is also minimally invasive due to some discomfort or anxiety that may be perceived by pediatric patients (Willging, 1995). However, out of 40
children scoped during an investigational study, all of the children were able to cooperate with the test (Willging, 1995).

Clinically, FEES was first applied to the pediatric population at Cincinnati Children’s Hospital Medical Center in 1993. A protocol study of twenty children without known swallowing difficulties who were already receiving flexible laryngoscopy were given a FEES exam. Their ability to tolerate the procedure, their safety, and the overall feasibility of the procedure were evaluated. The results revealed a need for an oral motor feeding exam to be added to the pediatric FEES protocol (Willging et al., 2001).

In 1995, FEES was introduced to assess 40 cases of pediatric dysphagia at CHMCC (Willging, 1995). The median age of the test population was 3.5 years. The investigators found that the exam could be performed in 40 minutes. This included time to administer proper anesthesia, discuss information with the family, use play therapy to reduce child anxiety, and scope the patient. The investigators conducted FEES with a multidisciplinary approach. The expertise of a speech pathologist enhanced the quality of the exam by adding knowledge of oromotor development and swallowing function (Willging, 1995).

Increasingly, FEES is being considered a reliable technique to help diagnose and treat children with dysphagia (Leder & Karas, 2000; Willging et al., 2000; and Aviv et al., 1998). As pediatric FEES becomes more widespread, it may be used in a variety of places such as rehabilitation and outpatient settings (Leder & Karas, 2000). FEES has also been found to be a safe and effective means to evaluate dysphagia in both the adult and pediatric populations (Leder and Karas, 2000; Aviv, 2000).
CHAPTER III

Methods and Procedures

Subjects:

The reports of the last 99 pediatric patients to receive FEES evaluations at CCHMC were used. The only inclusion criteria were that the individual received a FEES exam at CCHMC. A patient record was excluded if the report was incomplete or if the patient was above 25 years of age.

Materials:

Data was obtained from 101 of pediatric FEES reports. A data sheet (Appendix A) was designed to record demographic and diagnostic information about each case. Data were tabulated using the Statistical Package for the Social Sciences (SPSS).

Procedures:

Permission was obtained from CCHMC’s IRB to view completed medical records stored in the Otolaryngology Department. These completed FEES reports were viewed during normal office hours. Each chart was reviewed and the pertinent information was recorded on an individual data sheet (Appendix A). Each patient was assigned a case number. At no time in reporting the results of the study were the patient names used. They were kept confidential throughout the study by the investigator.

In many situations the patients presented with more than one clinical diagnosis. A majority of the cases possessed compounding deficits. For recording purposes, the investigator used the primary diagnosis as stated in the FEES reports. Based on the review, the following diagnostic categories were used to classify the data: structural, neurologic, genetic, gastrointestinal, cardiovascular, metabolic, prematurity, psychiatric,
and other. The categories of structural, neurologic, gastrointestinal, and metabolic were previously described in the introduction including examples for each category. Examples of cases with genetic diagnoses are Down syndrome and Treacher Collins syndrome. Examples of cardiovascular cases included children with congenital heart defects and tetralogy of Fallot. The addition of an “other” category was necessary because there was insufficient reference to the specific symptoms of the diagnoses within the text of the reports to confidently place them in the predetermined diagnostic categories. These diagnoses included acquired, congenital, and other low incidence disorders. Some examples include congenital muscle weakness, Hirshsprung’s disease, and arthrogryposis. A classification key is included in Appendix B.
CHAPTER IV

Results

Data was obtained by the primary researcher from review of pediatric FEES reports at CCHMC. A total of 101 patient records were reviewed. These exams were performed from April through December of 2001. Two patient records did not meet the inclusion criteria and therefore 99 patient records were used for this study. The reports were analyzed using SPSS to compute descriptive statistics for the following categories: age, gender, and diagnoses. Frequency counts were obtained to describe the demographic data. Cross tabs were used to calculate the most frequent findings by diagnosis type. They were also utilized to tabulate the most common recommendations by diagnosis type.

The answers to the following research questions were sought in this study:

1) What are the demographic trends of pediatric patients selected to undergo FEES including age, gender, and primary diagnosis?
2) What are the diagnostic trends of pediatric patients selected to undergo FEES?
3) What are the principal findings of a pediatric FEES exam by diagnosis type?
4) What are common recommendations made from a FEES exam by diagnosis type?
5) What are the previous swallow evaluations performed on patients referred for a FEES exam?
Data Analyses

Results will be presented in the order of the research questions.

1) What are the demographic trends of pediatric patients selected to undergo FEES including age, gender, and primary diagnosis?

A description of age for the total sample (n=99) is as follows. The mean age for all subjects was 49.47 months or approximately 4 years old. The ages ranged from 2 months old to 25 years old. The 25 year old was included because he/she was being treated at Children’s Hospital. Subjects included 59 males (59.6%) and 40 females (40.4%). The frequency distribution of etiologies can be found in Table 1. The most prevalent diagnosis was a neurologic disorder. The following is a summary of the specific etiologic categories of all subjects: neurologic 32 (32.3%), structural 24 (24.2%), other 24 (24.2%), genetic 11 (11.1%), cardiovascular 5 (5.1%), and gastrointestinal 3 (3.0%). See Table 1.

Table 1: Frequency Count of Primary Diagnoses (n=99)

<table>
<thead>
<tr>
<th>Diagnosis Type</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td>24</td>
</tr>
<tr>
<td>Neurologic</td>
<td>32</td>
</tr>
<tr>
<td>Genetic</td>
<td>11</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>3</td>
</tr>
<tr>
<td>Cardiovascular/Cardiorespiratory</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
</tr>
</tbody>
</table>

2) What are the diagnostic trends of pediatric patients selected to undergo FEES?

A frequency count of gender by diagnosis type can be found in Table 2. A neurologic diagnosis was the most common diagnosis recorded and included the greatest number of males (19) and females (13). Only males presented with gastrointestinal
diagnoses (3). Males were more prevalent in every diagnostic category except cases with a cardiovascular diagnosis where females dominated.

**Table 2: Gender by Diagnosis Type (n=99)**

<table>
<thead>
<tr>
<th></th>
<th>Structural</th>
<th>Neurologic</th>
<th>Genetic</th>
<th>Gastrointestinal</th>
<th>Cardio</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>15</td>
<td>19</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>14</td>
<td>59</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>32</td>
<td>11</td>
<td>3</td>
<td>5</td>
<td>24</td>
<td>99</td>
</tr>
</tbody>
</table>

Table 3 lists each diagnosis type and the mean age of patients in each category. Patients with a neurologic diagnosis presented with the highest mean (5.8 years). The lowest mean was found in cases with cardiovascular diagnoses (2.1 years). The average age for every category except for the neurologic diagnosis fell below the average age for the total cases (4.1 years). The youngest case was two months old and had a structural diagnosis. The oldest case was 25 years old and had a neurologic diagnosis.

**Table 3: Mean Age in Years by Diagnosis Type (n=99)**

<table>
<thead>
<tr>
<th></th>
<th>Structural</th>
<th>Neurologic</th>
<th>Genetic</th>
<th>Gastrointestinal</th>
<th>Cardio</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>3.3</td>
<td>5.8</td>
<td>3.1</td>
<td>2.5</td>
<td>2.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Youngest Age</td>
<td>2 mos</td>
<td>3 mos</td>
<td>12 mos</td>
<td>18 mos</td>
<td>12 mos</td>
<td>6 mos</td>
</tr>
<tr>
<td>Oldest Age</td>
<td>16 years</td>
<td>25 years</td>
<td>7 years</td>
<td>4 years</td>
<td>3.9 years</td>
<td>23 yrs</td>
</tr>
</tbody>
</table>

3) What are the principal findings of a pediatric FEES exam by diagnosis type?

A summary of findings by diagnosis type can be found in Table 4. Overall, premature spillage was found to be the most common finding across all diagnostic categories (44% of cases). The most prevalent findings for cases with a structural diagnosis were premature spillage, pooling of secretions, and penetration. Neurologic diagnoses most commonly presented with premature spillage and residue. Cases with
genetic diagnoses presented with premature spillage and penetration most often. Gastrointestinal cases (3) presented with premature spillage only. All five cases with a cardiovascular diagnosis presented with penetration. Finally, the “other” category most commonly presented with premature spillage and penetration.

Table 4: Frequency Count of Findings by Diagnosis Type

<table>
<thead>
<tr>
<th>Diagnosis Type (# of cases)</th>
<th>Oral Secretion Mgmt</th>
<th>Premature Spillage</th>
<th>Pooling of Secretions</th>
<th>Penetration</th>
<th>Aspiration</th>
<th>Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td>24</td>
<td>0</td>
<td>12</td>
<td>10</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Neurologic</td>
<td>32</td>
<td>1</td>
<td>11</td>
<td>9</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Genetic</td>
<td>11</td>
<td>0</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>GI</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cardio</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
<td>0</td>
<td>10</td>
<td>7</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Totals n=99</td>
<td></td>
<td>1</td>
<td>44</td>
<td>32</td>
<td>39</td>
<td>22</td>
</tr>
</tbody>
</table>

4) What are common recommendations made from a FEES exam by diagnosis type?

The most common recommendation(s) for each diagnosis type are detailed in Table 5. They are as follows: surgeries including airway reconstructions for structural deviations (10/24), surgeries including decompressions and other medical evaluations such as CT scans for neurologic (8/32), surgeries including bilateral submandibular gland excision with parotid duct litigation for subjects with genetic diagnoses (4/11), reflux management and feeding team recommendations for gastrointestinal diagnoses, feeding therapy, aspiration risk, and pulmonary consult for cardiovascular (2/5) and diet specifications for other diagnoses (8/24). It should be noted again that few cases existed in the following diagnostic categories: gastrointestinal (3), and cardiovascular (5).

Many of the patients who receive FEES exams at CCHMC are possible candidates for airway reconstruction due to structural abnormalities. FEES is used to
evaluate the patient’s potential risk for aspiration following the surgery. The assessment of low aspiration risk indicates that the patient presents with no other swallowing contraindications. This recommendation is often accompanied by a surgery recommendation for airway reconstruction. Examiners were also able to make the recommendation of aspiration risk from the exam. This recommendation was usually accompanied by feeding therapy or other medical evaluations.

Table 5: Percentage of Most Common Recommendations by Diagnosis Type

<table>
<thead>
<tr>
<th>Diagnosis Type (# of cases)</th>
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<th>Feeding Therapy</th>
<th>Asp. Risk</th>
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<th>Feeding Team Recs</th>
<th>Pul. Consult</th>
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<td></td>
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<tr>
<td>Other 24</td>
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<td></td>
<td>33%</td>
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</table>

5) What are the previous swallow evaluations performed on patients referred for a FEES exam?

A description of previous swallow evaluations is included in Table 6. The patient records reviewed indicated the following: no other previous swallowing evaluations (70%), previous VFSS (23%), previous feeding team (6%), and previous FEES (2%). This data may not be reflective of typical results secondary to a lack of documentation of unknown evaluations. The results associated with this research question are subject to the limitations of a retrospective review. The anticipated information of previous swallow evaluations was not routinely documented in the FEES reports. It would require gathering information regarding previous swallow evaluations from patient charts to fully answer the proposed question.
Summary of Findings

Several conclusions can be made based on the results of the present study. Descriptive statistics such as mean age, gender, and diagnosis were found for the sample population. Frequent findings and common recommendations were deduced from the present study as well. Finally, previous swallow evaluations were tabulated based on the results. The present study lead to the following seventeen conclusions based on the results found:

1) The average age of patients receiving a FEES exam was 49.47 months or approximately 4 years old.
2) There were more males (59.6%) than females (40.4%) evaluated.
3) The most common diagnosis across all subjects was a neurologic disorder (32%).
4) Impaired secretion management was the most prevalent finding for subjects with structural diagnoses.
5) Pooling of secretions was the most prevalent finding for subjects with structural diagnoses.
6) Penetration was the most prevalent finding for subjects with cardiovascular diagnoses.
7) Aspiration was the most prevalent finding for subjects with cardiovascular diagnoses.
8) Residue was the most prevalent finding for subjects with neurologic diagnoses.
9) The most common recommendation for subjects with a structural diagnosis was for airway reconstruction surgery (e.g. laryngotracheal reconstruction).
10) The most common recommendations for subjects with a neurologic diagnosis were for surgery (e.g. decompressions, shunts) and other medical evaluations.

11) The most common recommendation for a genetic diagnosis was surgery (e.g. bilateral submandibular gland excision and parotid duct litigation) for treatment of impaired oral secretion management.

12) The most common recommendations for subjects with a gastrointestinal diagnosis were reflux management and feeding team recommendations.

13) The most common recommendations for subjects with a cardiovascular diagnosis were feeding therapy, aspiration risk (e.g. the patient was identified to be at higher risk for aspiration following an airway reconstruction), and a pulmonary consult.

14) The most common recommendation for the other category diagnosis was diet specification (e.g. consistency changes, supplemental feedings).
CHAPTER V

Discussion

This study involved an investigation of the application of FEES to the pediatric population. The purpose of this discussion is to give a more in depth description of pediatric patients receiving FEES and the results of their exams. Descriptions were obtained by recording, tabulating and analyzing demographic and diagnostic information from FEES reports generated by a facility (CCHMC) utilizing FEES to evaluate pediatric dysphagia. Demographic and diagnostic trends were assessed. Frequent findings and common recommendations were assessed by diagnosis type. Finally, the reports of the current study demonstrated that FEES was the primary swallow evaluation used. A discussion of each research question now follows.

1) What are the demographic trends of pediatric patients selected to undergo FEES including age, gender, and primary diagnosis?

Several studies also investigating pediatric FEES conducted at CHMCC will be used to make data comparisons. In 1995, the pediatric FEES protocol was used to examine 40 children with known swallowing disorders. The parameters of pooling of secretions, premature spillage, penetration, aspiration and residue were evaluated. With the use of FEES, the investigators reported that enhanced recommendations could be made, especially in the area of patients awaiting possible airway reconstructions. Reconstructions may be necessary for patients with neurological impairments, structural abnormalities such as subglottic stenosis, and those patients who present with chronic
aspiration. FEES allowed the investigators to assess the potential risk of aspiration after the surgery and suggest possible modifications of surgical techniques (Willging, 1995).

An additional study examined the demographic information of 568 patients undergoing FEES at CHMCC (Hartnick et al, 2000). This study reported patient ages, presenting diagnoses, and feeding recommendations such as normal feeding, feeding with supplements or restrictions, and no oral feeding. The investigators of this study also stated that FEES provided valuable information in making clinical decisions regarding patients with airway abnormalities (Hartnick et al., 2000).

The demographic data obtained from the current study can be compared to similar data obtained from the previous two aforementioned studies. The average age in this study from 2001 data was 4.1 years (range of 2 months to 25 years) compared to 2.5 years (range of 2 months to 17 years) from 1993 to 1999 (Hartnick et al, 2000) and 3.5 years in 1995 (Willging 1995). A variation in medians may be attributed to a discrepancy between age inclusion criteria between studies. Gender statistics were not reported in the other studies to allow for comparison.

Hartnick et al (2000) found the most common diagnosis was structural abnormalities (36%), neurologic (26%), gastrointestinal (12%), genetic (8%), pulmonary (7%), prematurity (5%), cardiovascular (3%), and metabolic (2%). This differs from the current study in that neurologic was the most prevalent diagnosis type. The current study also did not classify any cases as premature or metabolic. No cases were classified as premature because the cases with a history of prematurity also presented with compounding neurologic or structural deficits that were considered the primary cause of dysphagia as indicated by the FEES reports. In the Hartnick study (2000), a small
number of cases were metabolic. No metabolic abnormalities were reported to be the primary diagnosis in the current study which includes a smaller sample population. Both studies found neurologic and structural diagnosis to be the most common. This information is supported by Willging et al, (2001) who state that neurologic disorders are the most common etiology of pediatric dysphagia.

Current pediatric dysphagia literature also reported that children with neurologic impairments often present with dysphagia (Arvedson & Brodsky, 2002). In infancy, these children may have increased difficulty with the suck-swallow-breathe sequence. The need for a gastrostomy tube may be necessary as a nutritional supplement. Consequently, lack of stimulation may lead to oral motor feeding delays. All of these confounding deficits place children with neurologic impairments at risk for aspiration (Arvedson & Brodsky, 2002).

2) What are the diagnostic trends of pediatric patients selected to undergo FEES?

Research by other investigators regarding the diagnostic trends of pediatric FEES patients and their relationships to age and gender was unable to be located. Data comparisons were not possible for this question. The current research study revealed that males were more prevalent in every diagnostic category except cases with a cardiovascular diagnosis where females dominated. Only males presented with a gastrointestinal diagnosis (3). These results can be attributed to the fact that males were more prevalent in the study (59%). Current research does not suggest that pediatric dysphagia is more prevalent in either gender.
Cases with a neurologic diagnosis presented with the oldest mean (5.8 years). This information suggests that the feeding and swallowing deficits associated with neurologic impairments may continue to pose swallowing problems past infancy and the toddler years. Cardiovascular diagnoses represented the youngest mean (2.1 years). This mean may not be representative due to the small category size. The average ranges for every category except for the neurologic diagnosis fell below the average range for the total cases (4.1 years). Due to the fact that there were more neurologic cases in the study than any other type, the higher mean of 5.8 years in this category influenced the overall mean of 4.1 years. This may be a reason why the overall mean is higher than each of the other individual means.

3) What are the principal findings of a pediatric FEES exam by diagnosis type?

The most common finding across diagnostic groups was premature spillage. It was reported in 44% of all cases. However, the direct view of premature spillage that can be achieved through a pediatric FEES exam can allow for overestimation. Therefore, premature spillage should be assessed within the context of the clinical situation and not from the endoscopic view alone (Willging, et al., 2001). For example, if premature spillage noted to occur across consistencies or is it an artifact of the FEES exam.

Premature spillage may be indicative of decreased strength and control of the back of the tongue. It may also suggest that a patient presents with a delay of swallow initiation or reduced sensation. Premature spillage may become a great concern to swallow safety if a significant amount of spillage fills the pyriform sinuses. From the sinuses, the spillage may fall into the laryngeal vestibule if a swallow is not initiated. This delay increases a patients’ risk for aspiration (Swigert, 2000).
Structural

The principal findings of a structural diagnosis were premature spillage, pooling of secretions, and penetration. Patients with anatomical variations due to structural abnormalities often present with swallowing difficulties. Anatomical variations of any of the structures designed to protect the airway during a swallow may contribute to swallowing problems. Research has shown that swallowing problems are more likely to occur in individuals with laryngeal abnormalities (Langmore, 2001; Willging et al., 2001). For example, if the vocal folds do not close adequately during the swallow, aspiration could occur (Arvedson & Brodsky, 2002). Other structural variations such as tongue abnormalities may lead to reduced tongue strength and therefore reduced bolus control, placing a patient at risk for aspiration.

Neurologic

Premature spillage and residue were the most common findings with a neurologic diagnosis. Patients with this diagnosis can present with neurosensory impairments that hinder the ability to feel residue remaining in the hypopharynx (Willging, et al., 2000). Children with neurologic problems may also present with severe oral motor and feeding delays. Such delays may be caused by a lack of oral or pharyngeal stimulation from the child’s dependence on supplemental feedings. In such cases, the child may not yet have the ability to clear residue even if it is sensed. The presence of residue places a patient at risk for aspiration because the materials can fall into the airway by gravity or inhalation (Willging et al., 2000).
**Genetic**

Premature spillage and penetration were most prevalent in cases with genetic diagnoses. Penetration may be a sign of several swallow difficulties. It may be indicative of limited closure at the entrance to the larynx due to reduced arytenoids tipping. Penetration may also be caused by reduced laryngeal elevation which occurs when there is a weakness in the tongue or weakness of the laryngeal elevators. Finally, penetration may be attributed to a mistiming of the closure of the larynx or of the laryngeal elevation. If the patient is unable to expel the penetrated material and swallow it, the patient is at risk for aspiration (Langmore, 2001; Swigert, 2000).

**Gastrointestinal**

The only finding in cases with a gastrointestinal diagnosis was premature spillage. Interestingly, this case did not present with pooling of secretions, penetration, aspiration, or residue. The finding of no other impairments is consistent with current research that premature spillage is not always indicative of a pathological swallow (Willging et al., 2001). In fact, research has found that premature spillage can also be present in normal swallows (Murray, 1999).

**Cardiovascular**

Premature spillage and penetration were the most prevalent findings in cardiovascular cases. Although cardiac problems alone do not cause dysphagia, children with cardiac anomalies exhibit increased effort to breathe and may fatigue easily during feeding. Respiratory needs may influence the critical timing of airway protection and/or suck-swallow-breathe sequence. Children with breathing difficulties may not have the
strength or respiratory capacity to expel penetrated materials. This information supports the fact that respiration can influence swallowing (Arvedson & Brodsky, 2002).

Other

Premature spillage and penetration were the most prevalent findings in the “other” category. Cases with this diagnosis were often medically complex with additional structural abnormalities (Hirschsprung’s disease, arthrogryposis). Some causes of premature spillage are decreased strength and control of the tongue base, a swallow delay, and reduced sensation. Penetration may be caused by decreased laryngeal elevation or mistiming of the swallow. Previously mentioned causes of both premature spillage and penetration may be applicable to those in cases with an “other” diagnosis as well.

4) What are common recommendations made from a FEES exam by diagnosis type?

Multiple recommendations were made for many of the cases reviewed. For the purpose of this discussion the top two or three recommendations made by greatest percentage of occurrence for each diagnostic category will be addressed.

Structural

The three most common recommendations for cases with a structural diagnosis were surgery such as laryngotracheal reconstructions, feeding trials in therapy, and surgery precaution due to aspiration risk (precaution may indicate a hold on reconstructive surgery). FEES allows for direct observation of the structural abnormalities of the hypopharynx and larynx. From these observations, specific recommendations for surgery may be warranted to repair the anatomical variations interfering with normal swallow function. Even after the surgery, behavioral issues may
contribute to feeding difficulty. Due to this factor, feeding therapy was often recommended to develop sensorimotor skills to help ensure a safe swallow (Arvedson & Brodsky, 2002).

**Neurologic**

The three most common recommendations for cases with a neurologic diagnosis were surgery (e.g. decompressions, spinal surgeries, G-tube placements), other medical evaluations such as CT scans or other endoscopic procedures, and diet specifications. Again, the direct view of the structures seen during a FEES exam allows the otolaryngologist to make surgical recommendations. Children with neurological impairments may need alternative feeding methods such as a gastrostomy tube due to sensory and motor deficits leading to profound dysphagia and severe nutritional risk (Arvedson & Brodsky, 2002). Alternative feeding methods and diet recommendations were made for a majority of these patients based on the FEES exam. Results of the FEES exam also made it possible for the examiners to make recommendations for other referrals such as speech evaluations and additional endoscopic procedures.

**Genetic**

The most common recommendations made for the diagnostic category of genetic were surgery and feeding trials in therapy. Individuals with genetic disorders often present with structural abnormalities that require surgical repair (e.g. plastic surgery as indicated for craniofacial anomalies. Incorporating taste experiences into therapy will help these patients learn the oral motor and feeding skills necessary to swallow safely after surgery.
Gastrointestinal

The two recommendations made for cases with a gastrointestinal diagnosis were further reflux evaluations and the need for feeding team recommendations. Gastrointestinal disorders may be managed by medical, surgical, and/or behavioral methods (Arvedson & Brodsky, 2002). Medical management would include pharmacological treatment, surgical methods may include Nissen fundoplications and behavioral methods may require new dietary management. In other cases, they may be managed by diet specifications such as thickening of liquids or postural considerations such as elevating the head of the bed. Alternative management methods such as these are routinely discussed and recommended by the Interdisciplinary Feeding Team. Patients are typically referred to the feeding team when they present with multiple issues that span the scope of several disciplines. These are usually medically complex cases.

Cardiovascular

The three most common recommendations for cases with a cardiovascular diagnosis were feeding therapy, surgery precaution secondary to aspiration risk and pulmonary consults. Children with cardiovascular deficits often present with breathing difficulties secondary to coordination and endurance. This inability to coordinate breathing can perpetuate into swallowing dysfunction (Willging et al., 2000). Feeding therapy can help to coordinate the timing of the suck-swallow-breathe sequence and reduce the patient’s risk for aspiration. Finally, a pulmonologist may be needed to manage the asthma, chronic cough, and pneumonia often associated with breathing problems.
Other

The most common recommendations for cases with an “other” diagnosis were diet specifications, reflux evaluations, feeding therapy, and referral to the feeding team for further recommendations. Many of these cases consisted of complex acquired disorders that needed the expertise of several professionals to manage the swallowing difficulties. The feeding team recommendations were most often used in these cases to manage the oral, pharyngeal, and esophageal dysfunction exhibited by many of these patients.

5) What are the previous swallow evaluations performed on patients referred for a FEES exam?

The patient reports indicated that FEES was the primary instrumental exam used. However, this result may be misleading. Seventy percent of the reports did not reference any other swallow evaluations, but it is suspected that other evaluations such as the VFSS or Feeding Team were performed and that the information was not included. This information was not obtained from patient charts due to the limited scope of this investigation. From the data gathered, FEES was used in conjunction with the VFSS in 21% of the cases.

Clinical Implications

The findings of the current study may assist in efforts to identify the profile of a pediatric FEES patient. The results provide information regarding the current diagnostic trends of pediatric patients receiving FEES exams. This information may be valuable to other facilities planning to implement FEES as an adjunctive swallowing exam. In
addition, the results of this investigation can be used by the multidisciplinary team who performed the FEES exams to provide them with a profile of recent patients.

In general, the current study agreed with pediatric dysphagia literature. A neurologic diagnosis was the most common diagnostic category in the present study. This finding is supported in the literature. Although small discrepancies between mean age and most occurring diagnosis type were found, the descriptive statistics from the current study were similar to those reported by other researchers (Hartnick 2000; Willging 1995).

Several diagnostic trends were found in the present study. Diagnostic trends by age included neurologic cases which presented with the oldest mean of 5.8 years and cardiovascular cases which presented with the youngest mean of 2.1 years. By gender, more males were found to be receiving FEES exams than females. Males also dominated every diagnostic category, but cardiovascular cases where females dominated. Finally, only males presented with cardiovascular diagnoses.

Limitations

The majority of the FEES exams were conducted by a primary otolaryngologist and speech language pathologist. However, two other otolaryngologists and speech language pathologists performed a small portion of the exams. A difference in clinical interpretations by these professionals may have influenced findings and recommendations made during the exams. Also, the results of this study are representative of the CHMCC FEES patients only. However, these results could be extrapolated and used by other pediatric facilities as predictive information regarding typical patient profiles.
Another factor affecting the outcome of the study was the absence of some anticipated data. Initially, the investigator planned on documenting findings based on the stimulus used. However, the reports did not always specify the specific stimulus (secretions, puree, liquid, solid, etc) used. The findings in this study were recorded for each diagnosis type without specific reference to food material used.

An additional limitation was that only summary statistics and descriptive statistics were used to tabulate the data. No tests of significance were used for the analysis. This statistical information could have given further insight into the possible relationships between variables.

A final limitation to this study was that the data recorded was limited to the information present in the FEES reports. It is possible that information such as previous swallow evaluations was not included in the reports. This factor may explain why such a significant number of patients (70%) were reported to have had no previous swallow evaluations. Further information could have been obtained from patient charts, but was not possible within the scope of this investigation.

**Directions for Further Research**

Many avenues for future research are possible from the results of this study. Completion of similar studies in other pediatric facilities performing FEES exams would produce valuable information. Comparisons of patient profiles between facilities in various geographic locations could provide further information regarding what type of patients are being referred for FEES exams. It would also be beneficial to gather data regarding findings and recommendations to see if similar facilities are consistent with one another.
For the purpose of this study, only a primary diagnosis was used to classify each patient. Further research should investigate how patients with coexisting conditions differ from those with patients with one primary diagnosis. Compounding factors that exist with multiple conditions may influence the findings and recommendations made during a FEES exam.

Another beneficial area of further research would be to follow a patient’s progress after the FEES exam. For example, if it were recommended that a patient were at low risk for aspiration after laryngeal reconstruction, it would be useful to know if this information held true. A VFSS or repeated FEES exam after recovery from the airway surgery could confirm the otolaryngologist’s prediction that the patient was safe for reconstruction. It would also be beneficial to know if there was follow-through on the recommendations that were made for each patient were by the parents or caregiver to help manage their child’s pediatric dysphagia.
REFERENCES


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APPENDIX A

Patient #: _______________________

Date of FEES Exam: _______________  D.O.B.: _______________________

Age: ______

Gender: M or F

HISTORY:

Primary Dx: _____________________________________________________________

Birth Hx: Normal ____ wks gestation  Complications: __________________________

Current diet: PO  NPO  thickened liquids  puree  bottle feed ________

Supplemental: NG _____  G-tube _______  G-J _______  J tube _____________

Tracheostomy: Current  Past

Previous Surgeries: ___________________________________________________________________

Reason for Referral: __________________________________________________________________

Other swallow evaluations: VFSS  Date:__________

Clinical/Bedside Swallowing Exam  Date:__________

PRE FEES EXAM:

Intraoral exam: normal __________________________________________

Soft palate mobility: WNL  Decreased

Hypopharynx sensation: WNL  Decreased  Increased

Oral Motor/Feeding Skills: age appropriate ________ delayed__

Preparation needed: Afrin  Pontocaine Nasal Spray  Viscous Lidocaine

FINDINGS:

Stimulus used: secretions w/ dye; w/o dye  applesauce/pudding  liquid  solid

Anatomical variations: ____________________________________________________
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**Key:** present/p, absent/a, impaired/I, not applicable/NA

**RECOMMENDATIONS:**

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APPENDIX B

Primary Diagnosis
1. Structural
2. Neurologic
3. Genetic
4. Gastrointestinal
5. Cardiovascular
6. Metabolic
7. Prematurity
8. Psychiatric
9. Other

Birth History
1. Not known
2. Premature

Current diet
1. PO
2. NPO

Diet Specifications
1. Thickened liquids
2. Puree
3. Bottle fed/ breast fed
4. Gavage fed
5. None/other

Supplemental feedings
1. NG
2. G
3. J
4. GJ
5. None/ none specified
6. Nutritional supplements

Other Swallow Evaluations
1. VFSS
2. FEES
3. Feeding Team
4. None/ other

Intraoral Exam
1. Normal
2. Abnormal

Previous Surgeries
1. Airway reconstruction/surgery
2. Heart Repair
3. Eye Surgery
4. Decompression/shunt
5. Spinal surgery
6. Glandular excision
7. Ear surgery
8. Nasal reconstruction
9. Cleft palate/lip repair
10. Craniofacial reconstruction
11. Gastric surgery
12. Brain surgery
13. None

**Oral Motor/Feeding**
1. Age appropriate
2. Delayed

**Preparation Needed**
1. Afrin
2. Pontocaine Nasal Spray
3. Viscous Lidocaine
4. Other/not specified

**Stimulus Used**
1. Secretions w/o dye
2. Secretions w/ dye
3. Applesauce/pudding/puree
4. Liquid
5. Solids
6. Food materials
7. No specification

**Anatomical Variations**
1. None
2. Abnormal tonsils and/or adenoids
3. Arytenoid abnormality
4. Epiglottis abnormality
5. Edema/erythema
6. Laryngeal abnormality
7. Tongue abnormality
8. Pharyngeal/Lateral wall abnormality
9. Submucous cleft
10. Vocal cord abnormality
11. Esophageal abnormality
12. Other
Hypopharyngeal sensation
1. Normal
2. Decreased
3. Increased

Recommendations
1. None
2. FEES
3. MBS/VFSS
4. Reflux evaluations/mgmt
5. Feeding tx/oral motor therapy
6. Feeding in tx
7. Risk for aspiration
8. Low/no risk for aspiration
9. Supplemental feed/G-tube
10. Feeding Team evaluation
11. Feeding Team recommendations
12. Pulmonary consult
13. Neurology consult
14. Strategies
15. Surgery- airway reconstruction, glandular excision
16. Speech evaluation
17. Follow up
18. Diet specification
19. Other evaluations