The Aetiology of Oro-Pharyngeal Dysphagia and its Effects in Stroke

David G Smithard

Dysphagia following stroke is common and its effects may last for many years. Swallowing frequently improves in the first few weeks. The cause of the dysphagia may be related to the stroke, by the medication used, or by concurrent illness. Assessment and intervention needs to be undertaken promptly to ensure that calories are provided; without energy, recovery cannot occur and rehabilitation cannot be undertaken. Treatment has progressed from nihilism to the present exciting times where more potential treatments and interventions in the rehabilitation are being developed.

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Key words: Dysphagia; Stroke; Rehabilitation; complications; Outcome


INTRODUCTION

A safe swallow is important for independent living and to maintain ones place in society. Anecdotally, being able to swallow safely will result in the ability to enjoy food such that it is not a chore to keep body and soul together but also a convivial social past time.

THE NORMAL SWALLOW

The process of swallowing has been described as the most complete all or non- reflex, however, although the pharyngeal swallow is a reflex it can be modified by the cortex depending on feedback regarding bolus size and viscosity.

A normal is swallow is difficult to define, but essentially it is a series of sequential coordinated events that ensures a safe passage of food or liquid from the mouth to the stomach via the pharynx and oesophagus.

Swallow Timings

The reflex swallow lasts less than one second, and although events are sequential there has been a debate as to when the swallow triggers and the actual sequencing of each of the various events of the swallow.

Original research on single swallows, had suggested that the swallow would trigger once a bolus passed the base of the anterior faucial arches. Subsequent to this, evidence suggests that this is true in some cases but for others the swallow does not trigger until the bolus is in the pharynx itself.
The coordination of swallowing in the anterior insula cortex are two areas that appear to be critical for the onset of upper oesophageal sphincter opening. Cortical control is complex and is detailed elsewhere. Within these areas are numerous transmitters including substance P, Dopamine and norepinephrine.

**Airway Protection**

The pharynx is an anatomical structure that is shared by both respiration and swallowing. To swallow safely, there needs to be an interruption to the respiratory cycle. The respiratory centre and the swallowing centres within the brainstem are connected via interneurons with a feedback loop. This interconnection drives the suspension of respiration during swallowing resulting in a period of apnoea, followed by, but not invariably, expiration. However, in some clinical scenarios, inhalation rather than expiration may occur (e.g. after sequential swallowing). Where it is not possible to interrupt the respiratory cycle, e.g. lung fibrosis, chronic obstructive pulmonary disease, heart failure, it may not be possible to swallow safely and consequently dysphagia results.

Protection of the airways commences at the beginning of the swallow, with the upward and forward movement of the larynx. As this is happening the false vocal cords begin to come together, followed closely by the true vocal cords and lastly the epiglottis. The vocal cords are the mainstay of laryngeal protection, not the epiglottis. Studies have shown that it is possible to swallow safely without the presence of an epiglottis and in sequential swallowing the epiglottis is upright.

As the bolus moves to the back of the oral cavity, the soft palate elevates to close off the nasal passages, aided by the forward movement of the posterior pharyngeal wall (Passavant’s cushion).

**Swallowing following stroke**

Fifteen million people suffer a stroke annually and stroke is the third largest cause of death in the world.

Stroke has two essential aetiological pathologies, ischaemic and haemorrhagic. Ischaemic strokes can be subsequently divided further by aetiology or stroke syndromes depending on stroke severity and location.

The presence of dysphagia following an acute stroke may not be directly related to the incident cerebral insult. The ability to swallow safely may have many different aetiologies/premorbid comorbidities that interplay; compounded by the fact that some older people will have presbyphagia and a new physiological insult has led to a decompensation of their swallow. Many people with stroke will have neurological co morbidities all of which could result in dysphagia. Apnoea or the ability to breath hold is a central feature of a safe swallow, consequently if this is not possible (heart failure, COPD, Lung Fibrosis) or there is an erratic respiratory cycle then dysphagia will result.

Musculo skeletal disease, Rheumatoid arthritis affecting the arthryenoid joint or osteoarthritis resulting in a mechanical impediment, lack of teeth and dentures can all result in an unsafe swallow resulting in a fear of swallowing or eating particular foods.

The occurrence and recovery of dysphagia frequently depends on the relative dominance between the affected and unaffected hemisphere for swallowing, there has been much research investigating the lesion location, but there has been no conclusive single cortical location identified as the most relevant. Stroke within the subcortical structures, cerebellum and brainstem may be more likely to result in dysphagia, particularly because of the close

**Motor cortex, amygdala, frontal cortex and cerebellum are also involved.** Within these areas are numerous transmitters including substance P, Dopamine and norepinephrine.
proximity of many important pathways\cite{33,34}.

Abnormalities within the swallowing system are common following stroke. Some authors have suggested that the occurrence may be as high as 100%, how ever clinically relevant problems with swallowing or dysphagia, are present in 28-65% of people during the acute phase of stroke, reducing significantly during the early times of stroke, such that by 14 days after the stroke 90% of people will be swallowing safely\cite{35,46-48}. However a small proportion of people will have on going problems for some time\cite{60,61}. Some of those that appear to have returned to a safe swallow after 3 months are found to have difficulties at 6 months\cite{50,51}. If the swallow does not show any signs of recovery in the first ten days, it is probable that the return of a safe swallow may take between 2 and 3 months.

**Swallowing Recovery**

Swallowing recovery is dependent on neural plasticity\cite{52-54}, with on either the non-affected hemisphere enlarging\cite{52} or other cortical areas taking over or both. Failure of the non-affected hemisphere to enlarge will result in dysphagia persisting\cite{52,54}. Hamdy and colleagues have undertaken many eloquent studies to show this using both fMRI and TCMS\cite{35,36}.

**Outcome**

The presence of dysphagia following a stroke is an independent marker of both short and long-term outcomes.

**Early/Acute complications**

There are many complications of dysphagia following stroke, if the swallowing abnormality is mild there may be no clinical effects but for others they are quite serious. The majority of the complications of dysphagia are related to the aspiration (Table 1) of saliva and oral pathogens rather than food or liquids. The main consideration must be, is there a clinical problem or not, and if there is, aspiration may or not be present\cite{49}. However, all readily available investigations (Fibreoptic Endoscopic Evaluation of Swallowing - FEES, Videofluoroscopy) only assess the swallow for short periods of time\cite{57-59}.

<table>
<thead>
<tr>
<th>Table 1 Complications of Aspiration.</th>
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<tbody>
<tr>
<td>Complications of Aspiration</td>
</tr>
<tr>
<td>No obvious ill effects</td>
</tr>
<tr>
<td>Recurrent cough</td>
</tr>
<tr>
<td>Grumbling Pyrexia</td>
</tr>
<tr>
<td>Chest Infection</td>
</tr>
<tr>
<td>Asthma / COPD</td>
</tr>
<tr>
<td>Food avoidance</td>
</tr>
<tr>
<td>Weight loss</td>
</tr>
<tr>
<td>Dehydration</td>
</tr>
<tr>
<td>Cyanosis/ hypoxia</td>
</tr>
<tr>
<td>Hypoxic fit</td>
</tr>
<tr>
<td>Airway obstruction</td>
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<tr>
<td>Death</td>
</tr>
</tbody>
</table>

All people aspirate, usually at night when the swallow either ceases or the number of swallows is greatly reduced\cite{60,61}. In many there is no ensuing complication. Following stroke, up to half of those examined by videofluoroscopy will have silent aspiration; the question is “is this relevant clinically?” The literature is unclear, partly because, in many studies the cohorts are selected from those that have have been referred for assessment, whereas those following consecutive stroke patients have found different results\cite{36,52-54}. Smithard et al and Ramsey et al only detected small numbers of people with silent aspiration, and did not note any difference in outcome\cite{33,34}. Schmidt, however, in a cohort of patients referred for videofluoroscopy noted that the risk of pneumonia was greatly increased\cite{65}. This is an important debate as it could have a major implication for the management of dysphagia in stroke patients.

**Late Effects**

The presence of dysphagia or aspiration in the acute phase is associated with an increased mortality (Figures 1 and 2), the majority in the first year. Smithard et al noted not only a worse outcome in the presence of dysphagia, but that there was a deterioration up to five years later\cite{36}. Smithard et al reviewing the South London Stroke Register noted that mortality after stroke was increased in those people with dysphagia, but this was mainly in the first year\cite{66} (similar results have been seen by Handy –personal communication). Further work is required to find out why this is happening, is it general frailty, carer fatigue, recurrent stroke or increased morbidity.

![Figure 1 Survival after stroke in the presence or absence of dysphagia (Handy et al).](image)

**Figure 2 Survival after stroke with (failed assessment) and without (passed) dysphagia**\cite{65}.

**Medication**

Many people suffering a stroke also have many other medical problems and as a consequence are taking a multitude of medications. Many of these may affect the ability to swallow (Table 2) either by affecting the production of saliva, alteration of taste or conscious level\cite{33}. Medication with an anticholinergic action (Major antipsychotics – Chlorpromazine, Haloperidol) and some medications
DYSPHAGIA MANAGEMENT

The management of dysphagia needs to be a proactive process, beginning from the moment a stroke occurs, or at least at the time of assessment in hospital. There are many guidelines, both local and national, regarding the management of dysphagia[67-71], and the evidence suggests that the presence of such guidelines reduced the incidence of aspiration and chest infection[66-71]. Despite the evidence base as many as 50% of people are not having their swallow assessed on admission to hospital[71]. There is wide variation between therapists and countries as the way dysphagia management occurs[72,74].

Swallow Screens

There are numerous different swallowing screens available with different sensitivities and specificities (Table 3); they all have similar core elements, some have weighted different elements to provide a score[70,75-79]. Many swallowing screens have been assessed following stroke, and some do not involve testing the person’s ability to swallow (e.g. MASA), whilst others are an extension of a previously validated screen, with the FAST added to it (ASDS)[70,80].

### Table 3

<table>
<thead>
<tr>
<th>Reference</th>
<th>Screen</th>
<th>N</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smithard et al</td>
<td>BSA</td>
<td>83</td>
<td>47</td>
<td>86</td>
<td>50</td>
<td>85</td>
</tr>
<tr>
<td>De Pippo et al</td>
<td>3oz</td>
<td>44</td>
<td>76</td>
<td>59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith</td>
<td>8</td>
<td>53</td>
<td>80</td>
<td>68</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Splaingard (b)</td>
<td>3oz</td>
<td>107</td>
<td>42</td>
<td>91</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>Daniels (a)</td>
<td>59</td>
<td>92</td>
<td>67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clavel[90]</td>
<td>85</td>
<td>100</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martino[91]</td>
<td>TOR-BBST</td>
<td>50</td>
<td>100</td>
<td>81</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>59</td>
<td>96.3</td>
<td>63.6</td>
<td>76.5</td>
<td>93.3</td>
<td></td>
</tr>
<tr>
<td>Rehab</td>
<td>35</td>
<td>80</td>
<td>68</td>
<td>50</td>
<td>89.5</td>
<td></td>
</tr>
<tr>
<td>Trap[92]</td>
<td>Gugging</td>
<td>21</td>
<td>100</td>
<td>50</td>
<td>81</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>69</td>
<td>74</td>
<td>100</td>
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</table>


The sensitivities of many of these screens is poor, but in some cases the negative and positive predictive values[77,81] are helpful in the short term. Despite this many services use their own local, unvalidated swallowing screen[77,78]. One common medical myth that needs to be dispelled is that an absent gag does not mean that the swallow is compromised[74,88].

Pulse oximetry has been suggested as a possible adjunct to the swallowing screen. At present the jury is out[80-82] as there is an inconsistency in the results reported. As an isolated assessment, pulse oximetry is unhelpful, but in conjunction with a full assessment it may add some useful information.

Similar controversy surrounds the use of laryngeal auscultation. Some practitioners find it useful, others find it to be inaccurate to be of any use at all as the interpretation is subjective[83-85]. The issue may be a difference between clinical use and interpretation of sound and laboratory usefulness (in the hand of the researcher).

Ramsey et al investigated the feasibility of undertaking a modified swallowing screen; this was the Bedside Swallowing Assessment[71], using radio opaque liquid, although this showed promise, not enough people with significant stroke deficit were recruited and no positive conclusion could be drawn.

It is clear that no one method, on its own, has the sufficient sensitivity and specificity to provide complete confidence in its use. An assessment that can be used with confidence, in clinical settings without access to VF or FEES is required. It is likely that in the future a combination of clinical swallow screen/assessment with pulse oximetry and plain radiology will provide the requisite specificity and sensitivity, to permit someone to eat and drink with the confidence that the swallow is safe.

**Cough Reflex**

The ability to cough is important in minimizing the occurrence of aspiration as it is a protective reflex. A good cough prevents penetration becoming aspiration. This will be impaired if there is a weakness in the intercostal muscles or the diaphragm[96,100]. There have been studies using either citric acid or air puffs to trigger the cough reflex[101,102].

**Instrumental Assessment**

Following on from a screening assessment, which may have been conducted by a doctor, nurse, physiotherapist, or dentist[77,78,103], a more in depth assessment of swallowing needs to be undertaken. This will be a further clinical assessment and possibly instrumental investigation[103].

This will include an assessment of the oral anatomy, cognition, timing of the swallow, head positioning, breathing and the use of different consistencies. The examination of the oral anatomy would have included reviewing tongue control, dentition and the general state of mouth and dental plate hygiene[104].

In many institutions, instrumental investigation/assessment will be limited to videofluoroscopy (VF)[105-109]. VF is considered the “gold” standard investigation, though inter rater concordance is less than ideal[113]. Palmos[106] suggested a modified form of videofluoroscopy to improve assessment and Rosenbeck developed the penetration/aspiration scale[111]. Guidelines and consensus statements advise and encourage the use of VF however pragmatically many clinicians employ VF when there is diagnostic uncertainty. This is often driven by availability and accessibility, but also the evidence base[109].

FEES has been available for at least 20 years, despite this, it is not being routinely used in the UK and other north European countries. This is frequently driven by resource allocation, and availability of trained staff rather than clinical decision-making. Where FEES is used it has good inter and intra rater scores[108].

FEES provides a lot of information regarding the swallow, but...
is not able to provide conclusive evidence of aspiration, nor image the whole of bolus transport at the same time\textsuperscript{[125]}. One main advantage is the lack of exposure to radiation and the procedure can be undertaken at the bedside. FEES should be seen as complementary to VF rather than a replacement for it.

FEES and VF only provide limited information regarding the swallow, other investigative techniques such as manometry, ultrasonography,\textsuperscript{[126-127]} EMG,\textsuperscript{[128]} pH monitoring\textsuperscript{[129]} and scintigraphy\textsuperscript{[130]} are available and although used in clinical practice, in many areas of practice they are often research tools rather than being used in routine clinical practice.

**Oral Care**

Mouth care is a significant issue in many hospitals and nursing homes, either because the patient will not permit mouth care, or mouth care has been neglected\textsuperscript{[120-125]}. Anecdotal monitoring and undertaking mouth care is reduced when a patient is nil by mouth or has a nasogastric tube in situ.

Gosney et al\textsuperscript{[125]} showed that the use of oral metronidazole gel reduced the incidence of aspiration pneumonia and a meta-analysis has suggested that antibiotics may reduce aspiration pneumonia prophylactically by 24%.

**MANAGEMENT OF NUTRITION AND HYDRATION**

During the first week of stroke swallowing assessment (MASA score) eating assessment (FOIS- Functional Oral Intake Scale) and severity of stroke are associated with poor nutritional intake and dehydration\textsuperscript{[127]}

The question raised, is the deterioration in nutritional markers following a stroke due to the consequences of stroke such as dysphagia, infection etc. Davalos et al\textsuperscript{[128]} found that there was evidence of a negative energy balance Spanish data though this was not supported by Elia and Weekes who noted that there was no increase in energy use following stroke in the resting state\textsuperscript{[129]}

Davalos et al\textsuperscript{[129]} suggested that this negative energy state could not be reversed by enteral feeding. More recent work by Nascimento and colleagues\textsuperscript{[130]} suggests that the loss of albumen during the acute phase could be reversed or halted depending on the type of feed used with whey protein being more beneficial in reducing IL6 and increasing glutamathione peroxidase than casein based products\textsuperscript{[130]}

Smithard et al\textsuperscript{[131]} measured various anthropometric markers several times over 6 months and found a decrease in some anthropometric markers (mid arm circumference) only. This reduction in mid arm circumference was apparent whether there was aspiration present on videofluoroscopy or not and had not returned to base line by six months. Similar results had been found in a Chinese population with pneumonia\textsuperscript{[131]}

Nutrition (Calories) is essential for survival. From a stroke point of view there are essentially two methods of providing nutrition, orally or enterally (Table 4). Parenteral nutrition should only be used as a last resort where it is not possible to enterally provide nutrition.

Before feeding via the nasogastric tube can commence, it needs to be positioned correctly. Misplacement of a nasogastric tube is a constant concern and, if feeding commences when the tube is in the right main bronchus, it may prove fatal. Guidance suggests that prior to use there should be an attempt to aspirate gastric contents and check the pH. If that fails, a chest radiograph should be requested\textsuperscript{[131,132,133]}. Devices are being developed to assist with the placement of nasogastric tubes (eg Cortrack) and if these are reliable then it will be possible to avoid using chest films. Their role in the community is potentially exciting\textsuperscript{[134]}

There are three big questions associated with nasogastric tubes: when to feed, are they appropriate and will the regimen work? The timing of feeding remains uncertain despite the results of the FOOD Trial\textsuperscript{[135]}. The FOOD trial, a randomized control study of a family of nested studies. One of these studies investigated the timing of

<table>
<thead>
<tr>
<th>Table 4 Reasons for the “Falling Out” of Nasogastric Tubes</th>
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<tbody>
<tr>
<td>Reasons why Nasogastric Tubes “Fall Out”</td>
</tr>
<tr>
<td>Pullled due to pain/ discomfort</td>
</tr>
<tr>
<td>Agitation Movement</td>
</tr>
<tr>
<td>Poor fixation</td>
</tr>
<tr>
<td>Confusion</td>
</tr>
<tr>
<td>Pediatric Fluids</td>
</tr>
</tbody>
</table>

Delivering nutrition often resulted in protein energy malnutrition and then a risk of re-feeding syndrome once nutrition started\textsuperscript{[136]}

**Oral Feeding**

The use of oral supplements as an addition to normal in stroke, as yet does not have a good evidence base\textsuperscript{[131,133,134]}. However, when a person is not supporting their nutritional needs and they are able to swallow; they are useful when they are the only energy source.

**Hydration**

Hydration is as equally important, though it is often managed poorly on rehabilitation units. During the acute phase of stroke parenteral fluids are frequently provided\textsuperscript{[135]}. During the first week of recovery phase, where the swallow is compromised, the use of agents to thicken fluids, inhibits fluid intake with a consequent dehydration\textsuperscript{[127,127]}

**Enteral Feeding**

Enteral feeding is the provision of nutrition directly into the gastrointestinal tract. Over the years trends have changed such that rectal feeding is no longer practiced. In the western world, tubes passed nasally or percutaneously are most widely used.

**Nasogastric Tubes**

Nasogastric tube feeding is the usual first stage of enteral feeding, and are frequently placed early, predominantly for the administration of medication. They are not without problems (Table 5).

<table>
<thead>
<tr>
<th>Table 5 Restraints used to prevent Nasogastric Tubes “falling out.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Boxig Gloves (hands wrapped in bandages)</td>
</tr>
<tr>
<td>American Football helmet</td>
</tr>
<tr>
<td>Web-Spacings device</td>
</tr>
<tr>
<td>Sedation</td>
</tr>
<tr>
<td>Nasal loop/ Bridle</td>
</tr>
<tr>
<td>Tying to the bed side</td>
</tr>
</tbody>
</table>

Before feeding via the nasogastric tube can commence, it needs to be positioned correctly. Misplacement of a nasogastric tube is a constant concern and, if feeding commences when the tube is in the right main bronchus, it may prove fatal. Guidance suggests that prior to use there should be an attempt to aspirate gastric contents and check the pH. If that fails, a chest radiograph should be requested\textsuperscript{[131,132,133]}. Devices are being developed to assist with the placement of nasogastric tubes (eg Cortrack) and if these are reliable then it will be possible to avoid using chest films. Their role in the community is potentially exciting\textsuperscript{[134]}

There are three big questions associated with nasogastric tubes: when to feed, are they appropriate and will the regimen work? The timing of feeding remains uncertain despite the results of the FOOD Trial\textsuperscript{[135]}. The FOOD trial, a randomized control study of a family of nested studies. One of these studies investigated the timing of
the use of early enteral feeding, i.e. commencing in the first week vs no enteral feeding. Despite randomizing 859 patients, there was no statistical difference between the two groups\cite{133}. Do nasogastric tubes deliver nutrition, i.e. do they work? Studies have suggested that the tubes often fall out, need replacing such that feed regimes often fail\cite{140,141} and there is a negative body image\cite{142}. Concern has been raised that the use of nasogastric tubes may affect the swallow adversely, but this has not been born out in studies\cite{143,144}, provided that it has been positioned correctly\cite{145}. In a small study, it was found that placing a nasogastric tube early (in the first four days) increased the risk of a chest infection (RR 3.73, CI: 2.6-5.32), therefore it may be sensible, where possible to delay feeding by this route for a few days\cite{146}.

Nasogastric tubes have a habit of falling out, and the reason for this needs to be sought (Table 4). If it is considered that the need for enteral feeding is short term, then restraints have been used (Table 5), the most common and least intrusive would be the use of the bridle and nasal loop\cite{143,146,147}. Although Nasogastric Tubes are frequently used with impundy, they are not without complications (Table 6) and as a consequence care is required not only with placement but also with the ongoing care.

### Table 6 Complications of Nasogastric Tube placement.

<table>
<thead>
<tr>
<th>Complications of Nasogastric tube placement</th>
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</thead>
<tbody>
<tr>
<td>Recurrent placement</td>
</tr>
<tr>
<td>Nasal Ulceration</td>
</tr>
<tr>
<td>Poor tube placement / wrong placement</td>
</tr>
<tr>
<td>Food sticking to the nasogastric tube</td>
</tr>
<tr>
<td>Increased pharyngeal secretions</td>
</tr>
<tr>
<td>Feed failure</td>
</tr>
<tr>
<td>Oesophageal reflux</td>
</tr>
<tr>
<td>Aspiration</td>
</tr>
<tr>
<td>Poor body image</td>
</tr>
</tbody>
</table>

### Enterostomy

Enterostomy tubes are used to provide long-term nutrition. The most common approach is that positioned percutaneously (PEG), via endoscopy by the gastroenterologist or the radiologically (RIG) by the radiologist. Studies suggest that these are more reliable at ensuring nutrition is provided as they are less likely to fall out. Park et al has also suggested that they are preferred to nasogastric tubes (Table 7) due to positive body image and reliability and completion of treatment\cite{136,145,148-153,155}. Complications are listed in table 8.

The timing of enterostomy tubes remains uncertain despite the results of the FOOD trial\cite{157}. The Cochrane database suggests that no benefit was sought in early PEG feeding. The final conclusion being that PEG feeding was not necessary prior to week four after stroke, which was a move away from clinical practice of early intervention.

### Table 7 Complications of Percutaneous gastrostomy Placement.

<table>
<thead>
<tr>
<th>Major complications (Reported incidence 3-19%)</th>
<th>Minor complications (Reported incidence 13-62%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastric haemorrhage</td>
<td>Tube displacement</td>
</tr>
<tr>
<td>Gastricolic fistula</td>
<td>Tube obstruction</td>
</tr>
<tr>
<td>Gastric perforation</td>
<td>Tube leakage</td>
</tr>
<tr>
<td>gastro-oesophageal reflux</td>
<td>Pneumoperitoneum</td>
</tr>
<tr>
<td>Aspiration pneumonia</td>
<td>Skin excoriation/ infection</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>Cellulitis</td>
</tr>
<tr>
<td>Serious abdominal wall infection</td>
<td>Pain at tube site</td>
</tr>
<tr>
<td>Bowel obstruction</td>
<td>Buried bumper syndrome</td>
</tr>
<tr>
<td>Intussusception</td>
<td>Over granulation of entry site</td>
</tr>
<tr>
<td>Oesophageal perforation</td>
<td>Diabetes control may be affected</td>
</tr>
</tbody>
</table>

### Dietary Modification

Dietaries with swallowing may be consistency specific depending on which phase(s) of swallowing is affected. An oral phase would result in difficulties predominantly with liquids exceeding that with solids and perhaps thick fluids, whereas pharyngeal phase problems may be better with thinner liquids. There are problems with the descriptors of different consistency with terms such as “custard thick”, “nectar” and “thin” being terms used. There has been an attempt to use a standard terminology\cite{125,137} but this has not got wide spread uptake. There is ongoing work to try to resolve this problem. Concerns have been raised concerning the use of different textures and thickeners, in that the number of calories\cite{139} or volume of fluid consumed\cite{150} may be inadequate, partially due to presentation and taste.

Thickeners may be starch or gum based, which have properties of their own. Starch based thickeners are less stable if mixed with saliva, but this is also Ph dependent\cite{129,131}. Thickeners will also change the characteristic (including taste) of the bolus, which may not provide the wetness in the mouth and as a consequence not provide some of the feedback required around thirst\cite{149}.

### Respiratory Modifications

Maintaining a patent pharynx is complex and achieved by support of the palatal, hyoid and external tongue muscles\cite{15}. The period of apnoea during swallow is highly variable for both liquids and solids\cite{150}, however the longer the period of apnoea, absence of breathing and the faster the pharyngeal transit, the less laryngeal penetration/ aspiration there is\cite{152}. The apnoea may end before the larynx has fully descended, which may lend itself to increasing an aspiration risk where there is pooling.

Consequent to this, swallowing professionals have sought to harness the normal physiology, with breath holding during, and expiration after swallowing.

### Postural Changes

Mechanical changes to bolus flow are achieved by changing head position to encourage bolus flow in a certain direction. Turning the
head to the side of the weak pyriform sinus, in effect closing it off, encourages bolus flow down the strong side of the pharynx. Double swallows encourage clearance of residue; Mendelsohn maneuver may assist in maintaining laryngeal elevation and closure\[162-164\]. The most common benefit from swallowing manoeuvres, except head turning, is to increase UES opening\[166,167\]. Although studies report a reduction in aspiration, the changes in physiological parameters frequently sought are often not present.

**SWALLOWING REHABILITATION**

Swallowing rehabilitation comes in two different formats. There are training programs and external neuromuscular stimulation.

**Clinical training programs**

Clinical training programs are akin to physiotherapy. The majority involve muscle strengthening exercises such as the Shaker\[180,181\], forced chin tuck\[188\] or the McNeil\[170\] exercise program which utilises a series of exercises and techniques. Tongue strengthening, where indicated is also employed and there are devices on the market with proven results\[171\].

**External neuromuscular stimulation**

These include transcutaneous muscular stimulation, electromagnetic stimulation and pharyngeal stimulation. Older clinical methods such as icing and faucal stimulation are have not been shown to work\[55,172,173\].

Transcutaneous electrical muscular stimulation is undertaken by stimulating the external laryngeal muscles to result in laryngeal elevation. This methodology has been approved by the FDA, and is marketed as Vital Stim\[5\] by (Chattanooga). Freed et al have published data claiming an almost 100% improvement in swallows using 3.5 sessions per week\[166\]. However, the best results are found in those that can eat something prior to treatment\[179\]. A meta analysis has shown a 20% improvement\[180\], the confidence limits are large. Despite some objective and subjective improvements, no cortical change has been demonstrated\[171\].

Ludlow et al found conflicting results depending on the stimulation used, stimulation at a sensory threshold showed some improvement of the swallow using the NIH Swallow Severity Scale, but not with motor level stimulation, with a suggestion that there was a depression of the pyriform rather than an elevation putting patients at risk of aspiration\[177-179\]. It is unclear how this works, but sensory afferents must be part of the answer.

Electro-magnetic stimulation, via transcranial magnetic stimulation and/or electrical pharyngeal stimulation (EPS) can induce brain plasticity and improve swallowing\[191\]. The brain is stimulated using a figure of eight coil situated over a predefined area of the brain to drive the pharyngeal swallow. Research has shown that using PET studies that there is an increase in the signal detected at the skin is a summation of different muscles and repeatability. The lack of specificity is as a consequence of the signal detected at the skin is a summation of different muscles and back ground noise. There is also a risk regarding a lack of reproducibility secondary from the placement of the electrode which may not always be in exactly the same place.

The basis is that when the patient is swallowing, an EMG wave form is produced that the patient can see. With work the patient is able to modify the wave form. Huckerbee and Steele have had some positive results but more work is needed\[166,167\].

**Biofeedback**

Biofeedback is a useful way of involving the patient in their rehabilitation. It works by providing the patient with a visual representation of progress, but not a representation of the swallow itself.

With swallowing, surface EMG has been used to provide this feedback. There is potential, but, as yet, has not reached routine clinical use. EMG can be measured in one of two ways, by surface recording or by an intramuscular needle. The use of needles is invasive, but provides feedback on a particular muscle; surface EMG, is easier and less invasive, but suffers from lack of specificity and repeatability. The lack of specificity is as a consequence of the signal detected at the skin is a summation of different muscles and back ground noise. There is also a risk regarding a lack of reproducibility secondary from the placement of the electrode which may not always be in exactly the same place.

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**Medication**

As already stated, medication can have a negative impact on the ability to swallow. However, a few medications may be beneficial. These include Nifedipine MR\[182\], ACE Inhibitors\[184-186\], Banxia Houpo Tang\[196-197\] and capsacian\[193,194\]. It is possible that they all work by enhancing the synaptic levels of Substance P either in the nigral striatal system or the pharyngeal plexus\[198\].

More recent work with novel compounds (TRV-1) have shown beneficial results\[199\].

**ETHICAL ISSUES**

There are many difficult and contentious issues around the provision of nutrition. The main question is “whether to provide nutrition is appropriate or not?” Generally enteral nutrition is seen as a medical treatment. Consequently it can be stopped and started along the lines of any medical treatment\[199\]. Consequently it has been suggested that, if there was doubt, a two week trial of enteral feeding should be attempted with outcomes monitored. The question that needs to be asked is this long enough and what improvements are expected in this time. What is clear is that no food equates, eventually, to no life. The decision to provide nutrition or not, must not be taken lightly, must be done and on individual case by case basis after full discussion with all parties involved including the patient if they are competent.

There are two further issues that frequently tax clinicians, firstly that of the person who wants to eat and drink, but whose swallow is unsafe and they are at high risk of aspiration. The compliance with instructions/ advice may depend on the food consistency, with less compliance being demonstrated with thickened fluids\[197\]. Providing...
the patient cognitively intact and is deemed to have mental capacity, and after explaining all the risks that eating and drinking entails, they should be allowed to eat and drink. If capacity is an issue, a similar discussion should be had with their representative/advocate.

The second scenario is of some one who is capable of swallowing and is able to meet their own needs but refuses to swallow. This case scenario is difficult and very burdensome on all formal and informal carers. Restraint and forced provision of nutrition will only work whilst it is being administered, with the original position rapidly returning. In a patient with mental capacity this is not an option in some countries (UK Mental Capacity Act)[198].

The use of restraints is not encouraged, as frequently they do not influence the long-term outcome or prognosis of the patient. Where restraint is being used, it should be used for the minimum period of time after seeking legal advice.

Where possible, the person with swallowing difficulties should make the decision regarding swallowing and compliance. As part of the informed consent process and capacity is autonomy[199]. In short a competent patient has the right of self-determination, so long as no one else is harmed[200].

Who makes the decision and the appropriateness of a decision is always difficult. Although a proxy may have been appointed to make a medical decision, research has shown that there decision and that of the person they are acting for are, in the majority of cases, not congruent[201].

What ever decisions are taken, it is essential that communication is paramount, to ensure that all carers (formal and informal) are aware of the plan of care; a framework may need to be implemented where the person and professionals do not agree on the best treatment.

SUMMARY

Swallowing problems following stroke are common and may be a direct result of the stroke or secondary to or exacerbated by medication or comorbid disease. Recovery is good in many but is persistent in a few. Rehabilitation techniques are improving and the future looks exciting. Complications are frequent but the most common are related to nutrition. More work is required here.

CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

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**Peer reviewer:** Heather Shaw Bonilha Ph.D., CCC-SLP, Associate Professor, Dept of Health Sciences & Research, College of Health Professions, Medical University of South Carolina, 77 President St. MSC 700, the United States; Gary H. McCullough, Ph.D., CCC-SLP, Interim Dean, The Graduate School, Professor, Communication Sciences & Disorders, University of Central Arkansas, 201 Donaghey Avenue, Torreyson West 328, Conway, AR 72035-0001, the United States; Ebru Karaca Umay, MD, Associate Professor, Ankara Diskapi Yildirim Beyazit Education and Research Hospital, Ankara, Turkey.