Decisions about feeding are amongst the most difficult to face those managing stroke patients. About a fifth of patients with acute stroke are malnourished on admission to hospital. Moreover, patients' nutritional status often deteriorates thereafter because of increased metabolic demands which cannot be met due to feeding difficulties. Poor nutritional intake may result from: (i) reduced conscious level; (ii) an unsafe swallow (iii) arm or facial weakness; (iv) poor mobility; or (v) ill-fitting dentures. Malnutrition is associated with poorer survival and functional outcomes, although these associations may not be causal. Patients often receive support with oral supplements or enteral tube feeding via nasogastric or percutaneous endoscopic gastrostomy. Although these probably improve nutritional parameters, it is unclear whether they improve patients' outcomes. Also the optimal timing, type and method of enteral feeding is uncertain. Large randomised trials are now in progress to identify the optimum feeding policies for stroke patients.

The influence of nutrition on the risk of stroke has been the subject of much research. In contrast, few studies of nutrition after stroke, especially that during the first few days and weeks, have been reported. This is surprising because feeding problems are amongst the most common and difficult management issues which confront the clinician caring for stroke patients.

This review aims to define what is known, what is not known and areas where more research is needed. It will not address the issue of dietary modification in secondary prevention nor provide a detailed account of swallowing problems and their assessment in stroke patients which have been covered elsewhere. This review will focus on several clinically important questions including:

1 How can malnutrition be identified?
2 How common is malnutrition after a stroke?
3 Which patients are likely to have malnutrition?
4 Does malnutrition matter after a stroke?
5 Will nutritional support improve the patient's outcome?
How can malnutrition be identified?

In routine clinical practice there are practical difficulties in assessing stroke patients’ nutritional status. A dietary and weight history may not be available because of patients’ communication problems and an alternative source of this information may not be available if, as is common, the patient lives alone. Simple assessments of weight and height to estimate the body mass index (BMI) pose problems in immobile stroke patients. Specialised equipment, of limited availability, such as weighing beds or scales which accommodate wheelchairs, may be required and height may need to be estimated from the patient’s demi-span or heel-knee length. More complex anthropometric measures, e.g. mid-arm circumference (MAC) and triceps skin-fold thickness (TFT) which allow the mid-arm muscle circumference (MAMC) to be calculated, require not only a tape measure and skin-fold callipers but training for the assessor to obtain reproducible measures. Anthropometric measures may also change because of paralysis of the arm after stroke. Laboratory parameters such as haemoglobin, serum protein, albumen and transferrin, are readily available but low levels occur in many conditions and do not necessarily reflect nutritional status. Indeed, in any acute illness, the serum albumen tends to fall due to increased catabolism and preferential production of acute phase proteins. More specialised measures such as vitamin estimations, antigen skin testing and bioelectric impedance (the latter to estimate body fat mass, body lean mass, body cell mass and total body water) are used in research, but are not widely available and are not suited to routine clinical practice. An awareness of the possibility of malnutrition is a key factor in identifying malnourished patients. A simple end of the bed assessment reliably identifies most stroke patients with low BMI and abnormal anthropometry. Estimation of the BMI, serial weights to identify weight loss and monitoring of dietary intake could be used to screen patients on admission and monitor patients on stroke units although no specific assessment tool has been developed and tested for use in stroke patients. Some assessment of patients’ nutritional status should be routinely applied on admission to the stroke unit and periodically thereafter.
How common is malnutrition after a stroke?

Malnutrition is a common and often unrecognised problem in patients, especially the elderly, admitted to hospital. Those who remain in hospital for prolonged periods are also at risk. Inevitably, the reported frequency of malnutrition after stroke has varied depending on patient selection, the definitions of malnutrition and the method and timing of assessments. Table 1 shows the various estimates of the frequency of malnutrition on admission to hospital after an acute stroke. Studies have varied in the number of nutritional parameters measured, their reference ranges and the number of abnormal results required to categorise patients as malnourished. Most have focused on undernutrition, but overnutrition with obesity is probably more common in Western countries and poses practical difficulties for patients. Transfers, walking, continence and skin hygiene may all be compromised by obesity.

Several studies have shown that stroke patients’ nutritional status may worsen during hospital admission. However, these rely on grouped data where estimates of nutritional status later in the admission exclude those who have died or have already been discharged. Few studies have provided serial measurements in surviving patients, but those that have inevitably show that some patients improve, some deteriorate and some remain stable with respect to nutritional indices.

Which patients are likely to have malnutrition?

The factors which have been associated with malnutrition on admission are shown in Table 1, but few conclusions can be drawn.

Table 1  Estimates of the frequency of malnutrition in various studies

<table>
<thead>
<tr>
<th>Study</th>
<th>n at baseline</th>
<th>Type of patients</th>
<th>n (%) with low albumen</th>
<th>n (%) classified as malnourished and criteria</th>
<th>Factors associated with malnutrition on admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axelsson</td>
<td>100</td>
<td>Acute admissions</td>
<td>23 (23%)</td>
<td>16 (16%) &gt; 2 low values</td>
<td>Increased age*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Females*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prior peptic ulcer*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atrial fibrillation**</td>
</tr>
<tr>
<td>Unosson</td>
<td>50</td>
<td>Acute admissions</td>
<td>31 (62%) &lt; 36g/l</td>
<td>4 (8%) &gt; 2 low values</td>
<td>n/a</td>
</tr>
<tr>
<td>Davalos</td>
<td>104</td>
<td>Acute admissions</td>
<td>8 (8%)</td>
<td>17 (16%) either low albumen or TSF/MAMC</td>
<td>n/a</td>
</tr>
<tr>
<td>Gariballa</td>
<td>201</td>
<td>All acute admissions</td>
<td>38 (19%) &lt; 35g/l</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Choi-Kwon</td>
<td>88</td>
<td>Acute females only (highly selected)</td>
<td>n/a</td>
<td>30 (34%) &gt; 2 low</td>
<td>Haemorrhagic stroke</td>
</tr>
<tr>
<td>Finestone</td>
<td>49</td>
<td>Rehabilitation only</td>
<td>n/a</td>
<td>Mild 7 (14%)</td>
<td>Dysphagia*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Moderate 9 (19%)</td>
<td>Diabetes**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Severe 8 (16%)</td>
<td>Previous stroke**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 1 low level</td>
<td></td>
</tr>
</tbody>
</table>
Drawing on the non-stroke literature, one would expect malnutrition to be more frequent in older patients, those living in institutions and poor social circumstances, those with prior cognitive impairment, physical disability or gastrointestinal disease. Stroke, like any acute illness, may lead to a negative energy balance and greater nutritional demands, but stroke patients may be less able to meet these increased demands. Davalos et al. showed that patients with severe strokes have a greater stress response (based on cortisol levels) than those with milder strokes and that this was associated with a more marked deterioration in nutritional status. Complications such as infections which increase the patients’ metabolic demands are associated with deteriorating nutritional status. To compound the general problem of malnutrition, it has been estimated that up to 50% of hospitalised stroke patients are unable to swallow safely, although again the reported frequency depends on the selection of cases, the timing of assessments and the sensitivity of the method used to detect swallowing problems. In most studies, deterioration in nutrition occurred more often in dysphagic patients or in those who need help with feeding. Even patients who are capable of swallowing liquids and food may have a poor appetite because of the effects of intercurrent illness or medication and they may eat more slowly or be less keen to eat because of facial weakness, lack of dentures or poor arm function.

Does malnutrition matter after stroke?

Poor nutrition, although not specifically in stroke patients, has been associated with reduced muscle strength, reduced resistance to infection and impaired wound healing. Among patients with stroke, most of whom are elderly, muscle weakness, infections and pressure sores are common and account for significant mortality and morbidity. It is plausible that malnutrition could increase the frequency of these problems and result in poorer outcomes. Davalos et al. showed that malnutrition after the first week of admission was associated with an increased risk of a poor outcome (dead or Barthel index ≤50) at 1 month, death, a greater frequency of infections and pressure sores, and longer length of stay. However, these associations were not statistically significant after adequate adjustment for stroke severity, using the Canadian Stroke Scale. More recently, Gariballa et al. showed that serum albumen, which may reflect nutritional status, predicted post-stroke survival, but did not adequately adjust for baseline stroke severity in their Cox proportional hazards’ model. Although the Modified Rankin and Orpington Prognostic score at baseline was collected, the authors only included the former in their model, even though the latter
is the better validated prognostic indicator. Based on these studies, there appears to be an association between malnutrition and poor outcome, but this is not necessarily independent of other prognostic factors and may not be causal.

**Will nutritional support improve the patient's outcome?**

Evidence of a causal relationship between malnutrition and poor outcome could come from intervention studies if improving nutrition resulted in better outcomes. There have been a large number of randomised trials testing the effects of providing protein calorie supplementation to diverse groups of patients. These studies have been individually too small to reliably demonstrate an effect on their own, but a recent systematic review of all of the available trials suggested that oral or enteral (i.e. via a feeding tube) nutritional supplementation definitely improves nutritional parameters and may reduce the odds of death (odds ratio = 0.66; 95% CI 0.48–0.91)\(^{19}\). However, this review included trials of differing methodological quality and when only more rigorous studies were included in the analysis the effect was statistically non significant (odds ratio = 0.81; 95% CI 0.44–1.50). None of these studies were specifically for stroke patients and few stroke patients were included. One small randomised trial (n = 42) has suggested that oral supplementation after stroke improves nutritional parameters\(^{20}\) and a retrospective non-randomised study showed that early enteral nutrition after stroke reduced length of stay in hospital\(^{21}\). Thus, nutritional support probably improves nutritional parameters, but it is unclear whether this leads to improved clinical outcomes.

**How should stroke patients be fed?**

Even if there is little evidence to support nutritional supplementation, it is obvious that stroke patients require feeding. Ideally, patients would eat normally, but this is not possible for the important minority of patients who cannot swallow safely. Patients with swallowing difficulties are usually put ‘nil by mouth’ and given parenteral fluids believing (but with little scientific justification) that this will reduce the risk of aspiration pneumonia. Of course, these patients must still cope with their saliva. Patients’ swallowing usually recovers over the first few days or weeks to an extent which allows most patients to safely take fluids and food, if necessary with a modified consistency\(^{13,14,22,23}\). Indeed, many patients can swallow safely if carefully positioned, given food and fluids of appropriate consistency and using a variety of compensatory strategies.
It is unclear how we should best support patients' nutritional status during the period when their oral intake is inadequate. How long is it reasonable to wait before starting feeding and what is the best route? Intravenous feeding can be used, but in practice is rarely justified in stroke patients who are able to absorb nutrients from their gut. Peripheral total parenteral nutrition (TPN) offers a less invasive option than that delivered via central venous line and may become more widely used where enteral routes are impractical. In most settings, the choice of support lies between enteral feeding via a nasogastric (NG) or percutaneous endoscopic gastrostomy (PEG) tube (Fig. 1) or one of the closely related alternatives, e.g. a radiologically-guided gastrostomy or a jejunostomy.

**When should tube feeding start after stroke?**

Whilst the patient cannot swallow adequate food, their nutritional status will inevitably deteriorate unless supported. If tube feeding was well tolerated and carried no hazard, then one would lose nothing by starting early. However, patients find tube feeding uncomfortable and it carries a risk of complications which have to be set against the benefits. By filling the patient's stomach, enteral feeding inevitably increases the risk of aspiration in patients who do not adequately protect their airway. In theory, early feeding might be associated with metabolic changes (e.g. hyperglycaemia) which could be detrimental to the ischaemic penumbra\(^2\). The balance of risk and benefit will vary depending on the nutritional status of the patient and whether they are taking any food orally. The risk associated with tube feeding, in turn, will depend on the method used, its duration and local factors (e.g. complication rates associated with PEG insertion). Some clinicians prefer to introduce tube feeding very soon after the stroke, others delay for days and sometimes weeks. There are no completed large randomised trials to guide our use of enteral feeding.

**Is feeding via a PEG better than that via an NG tube?**

Nasogastric (NG) tubes are often inserted to allow fluid and food to be given to patients. However, in patients who are unable to swallow, they are not always easy to insert and they are often pulled out by patients and have to be replaced, because they are uncomfortable. This adds to patients' distress, may necessitate a further X-ray to check position and interrupts any feeding regimen. NG tubes, especially the fine bore variety, may become displaced and cause aspiration. If left *in situ* for prolonged periods, ulceration of the nostril, oesophageal strictures and oesophagotracheal fistulae have been described. Because of these problems, some workers
advocate the increased and earlier use of PEG tubes. This technique, which can be performed with little or no sedation, provides an effective and quite acceptable method of enteral feeding (Fig. 1). However, any advantages of PEG over NG tubes, as far as improved delivery of nutrition is concerned, have to be carefully weighed against their relative complication rates.

Unfortunately, despite the frequency of their use, there are few data concerning the complication rates associated with NG tubes in stroke patients. In contrast, literally hundreds of series have been published reporting the experience with PEG tubes, although relatively few specifically in stroke patients. A systematic review of a large number (but not all) of these studies suggested that there was a 0.3% risk of death related to the procedure itself and a 10% risk of major complications (Table 2). However, these figures are likely to underestimate the risks in stroke patients because: (i) specialist centres which achieve better results are more likely to publish than those with less interest or higher complication rates; (ii) many studies are retrospective and rely on routine recording of complications; and (iii) stroke patients who tend to be elderly and frail may have higher complication rates.

Table 2 Reported frequency of major complications after percutaneous endoscopic gastrostomy (from Wollman)

<table>
<thead>
<tr>
<th>Wound related</th>
<th>3 3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abscess</td>
<td></td>
</tr>
<tr>
<td>Septicaemia</td>
<td></td>
</tr>
<tr>
<td>Necrotising facitis</td>
<td></td>
</tr>
<tr>
<td><strong>Aspiration pneumonia</strong></td>
<td>2 1%</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>0 5%</td>
</tr>
<tr>
<td><strong>Other GI</strong></td>
<td>2 4%</td>
</tr>
<tr>
<td>Perforation</td>
<td></td>
</tr>
<tr>
<td>Gastro-colic fistula</td>
<td></td>
</tr>
<tr>
<td>Haemorrhage</td>
<td></td>
</tr>
<tr>
<td>Dislodged tube requiring repeat procedure</td>
<td>0 9%</td>
</tr>
</tbody>
</table>
Recently, several reports of the complication rates of PEG insertion amongst stroke patients have been published\textsuperscript{26-30}. These included a total of 310 patients of whom about 8\% died within a week or two of the procedure and 25\% died during the hospital admission. The rates of various complications during variable follow-up periods were: aspiration pneumonia 19\%, tube blockage/breakage or removal 11\%, wound infection 8\%, gastrointestinal haemorrhage 0.6\% (one fatal), and fatal perforation 0.3\%. Unfortunately, such studies are of limited value in guiding practice and indirect comparisons of complication rates between NG and PEG tubes are bound to be unreliable.

There have been only three small randomised comparisons of NG and PEG tube feeding. These suggested that the latter provided more effective nutritional support with less interruption of feeding\textsuperscript{30-32}. One of these trials\textsuperscript{30} was in severe stroke patients and showed that those fed by PEG had an implausibly large (70\% relative) reduction in case fatality compared with those fed via NG tube. However, this trial only included 30 patients and little data were provided to allow an assessment of the effectiveness of randomisation in achieving balanced groups. It seems most likely that some imbalance in baseline factors accounted for much of the observed difference in outcome. Thus, the relative merits of the two types of tube are uncertain, at least in the first month or so after the stroke. There is little doubt that a PEG tube is a better option if feeding is to be prolonged. Also, in practice, there may be no alternative to a PEG tube if feeding is required and nasogastric feeding has been unsuccessful.

**The need for more research**

A survey of almost 3000 physicians who manage stroke in the UK demonstrated wide variation in the use of oral supplements and in the timing and method of feeding in dysphagic stroke patients\textsuperscript{33}. Such variation reflects the lack of clear evidence to guide practice. There is clearly a need for large randomised trials to establish how best to feed patients after a stroke. Trials are needed to address several important questions including:

1. Should patients who can take adequate fluids orally routinely receive nutritional supplements to improve their outcome? If not are there particular groups of patients who should?

2. In patients who are unable to take adequate fluid and food orally immediately after the stroke, should we start tube feeding early or wait for a few days to allow their swallowing to improve?

3. If tube feeding is required, is feeding via a percutaneous endoscopic gastrostomy (PEG) superior to that via the traditional nasogastric tube (NG)?
The FOOD trial (Feed Or Ordinary Diet; www.dcn.ed.ac.uk/food) is an on-going multicentre international randomised trial which aims to address these and other important questions relating to nutrition after stroke.

Ethical considerations

Feeding is regarded by some as a basic component of care and by others as a medical intervention. Decisions about whether to feed, when to feed and how to feed stroke patients are among the most difficult to confront the professions involved in their care\textsuperscript{34,35}. Many patients who are unable to eat normally are likely to have a poor functional outcome and perhaps a quality of life which some would judge to be worse than death. It is far from clear whether judgements regarding the quality of life in a dependent state made by the person before their stroke, or by their relatives or involved professionals are valid in making decisions about starting or continuing nutritional support. Unfortunately, most patients in whom this issue arises are unable to communicate their own wishes. Relatives may or may not be able to speak on their behalf. Nurses, doctors and therapists will all have an opinion, but these may not converge and may differ from those of the family. Moreover, the lack of reliable information about the benefits and risks of feeding techniques adds further uncertainty to decision making. Because of these difficulties, it is essential that issues surrounding nutritional support are discussed openly with all concerned, and that lines of communication are kept open so that the best decision can be made to minimize potential conflict.

References

Nutrition after stroke


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