Which Reported Estimate of the Prevalence of Malnutrition After Stroke Is Valid?

Norine C. Foley, MSc; Katherine L. Salter, BA; James Robertson, MSc; Robert W. Teasell, MD; M. Gail Woodbury, PhD

Background and Purpose—The reported prevalence of malnutrition after stroke varies widely, whereas it remains unclear which of the estimates is most accurate. The aim of this review was to explore possible sources of this heterogeneity among studies and to evaluate whether the nutritional assessment techniques used were valid.

Methods—A literature search was conducted to identify all studies in which the nutritional state of patients was assessed after inpatient admission for stroke. The percentages of patients identified as malnourished in each study and method of nutritional assessment are reported. For the purposes of this study, an assessment technique was considered valid if at least one form of validity had been demonstrated previously through psychometric evaluation.

Results—Eighteen studies meeting inclusion criteria were identified. The reported frequency of malnutrition ranged from 6.1% to 62%. Seventeen different methods of nutritional assessment were used. Four trials used previously validated assessment methods: Subjective Global Assessment, “an informal assessment,” and Mini Nutritional Assessment. The nutritional assessment methods used in the remaining studies used had not been validated previously.

Conclusions—The use of a wide assortment of nutritional assessment tools, many of which have not been validated, may have contributed to the wide range of estimates of malnutrition. If so, this underscores the need for valid and reliable assessment tools to further our understanding of the relationship between stroke and nutritional status. (Stroke. 2009;40:e66-e74.)

Key Words: nutritional assessment ■ nutritional indices ■ protein–energy malnutrition ■ stroke ■ validity

The reported prevalence of protein–energy malnutrition (PEM) after stroke varies widely among published reports.1–5 Given that many factors could have influenced the precision of the estimates such as differences in patient characteristics and method and timing of nutritional assessment, it is impossible to know which estimate(s) most closely approximate the truth. Establishing a patient’s true nutritional state can be a daunting task because there is not a universally accepted definition of malnutrition or a gold standard for nutritional assessment. Furthermore, nonnutritional metabolic sequelae after stroke can mimic signs of malnutrition, hampering the process of detection.6 The term “malnutrition” is used to describe a host of nutritional abnormalities, although, typically, it refers to protein–energy malnutrition resulting from a longstanding negative imbalance of both energy and protein, whereby metabolic requirements chronically exceed actual nutritional intake. Although many forms of nutritional assessment are in use, few are known to be valid and reliable.

Declines in nutritional status associated with stroke are important to identify and treat because of their negative impact on functional recovery and mortality.7,8 Although considerable resources are expended assessing a patient’s nutritional status, providing interventions such as oral supplements, and monitoring the response to treatment, a clear association between nutritional interventions and improved outcome such as decreased morbidity and mortality is lacking.9 One of the reasons for the failure to demonstrate a positive response may be the inability to identify those patients who are truly malnourished and, therefore, are most likely to benefit from nutritional interventions.

The purpose of this review was to survey the published literature to identify studies in which the nutritional status of patients was assessed in hospital following stroke to: (1) describe the form of nutritional assessment that was used; (2) identify the percentage of subjects identified as malnourished; and (3) establish whether a valid form of nutritional assessment was used.

Methods

Relevant studies were identified through a literature search encompassing the years 1985 to January 2008. The following databases were searched: The Cumulative Index to Nursing and Allied Health Literature (Cinahl), MEDLINE, EMBASE, and the Cochrane Controlled Trials Register (CCTR). Search terms varied slightly across databases but included: “cerebrovascular accident” or “stroke” and

Received July 2, 2008; final revision received July 18, 2008; accepted July 25, 2008.

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Stroke is available at http://stroke.ahajournals.org

DOI: 10.1161/STROKEAHA.108.518910

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the terms “nutrition or diet or malnutrition or nutrition assessment and outcome” as MESH terms, key words, or subject headings. The search was limited to: “human,” “all adults; 19+ years,” and the language “English.” Hand searching of the bibliographies of the included studies was conducted to identify potential articles not recovered using the search terms.

Studies were included if the nutritional status of subjects was reported on at least one occasion during the inpatient hospitalization period after a first or recurrent stroke and the method of nutritional assessment was described. To be included, the authors were required to differentiate between well-nourished and malnourished subjects. No limits were placed on study design or purpose and both interventional and noninterventional studies were included. Studies were excluded if the study’s sample included a proportion of patients who had not sustained a stroke. Abstracts, conference proceedings, and letters to the editor were excluded because of lack of reporting detail.

The percentages of patients identified as malnourished at each assessment point and the timing and method of the nutritional assessment were abstracted from each article. The references cited within each of the articles pertaining to the description of the nutritional assessment tool used were identified and those article(s) were retrieved. We continued the process of retrieving cited articles, if required, until the original validation studies, if they existed, were identified. To determine if a nutritional assessment technique was valid, we looked for evidence that some form of psychometric evaluations had been published previously. We did not assess the sufficiency of these validation efforts nor did we seek to determine the scope of any subsequent validation efforts. Given that criterion validity cannot be established due to the lack of a gold standard for comparison, we looked for other forms of construct validity, including concurrent validity, discriminant validity, or predictive validity. All results are reported descriptively.

Results

Literature Reviewed

The initial search strategy returned 413 results. On the basis of the title or abstract, 378 studies were excluded. The remaining 35 articles, which suggested that a nutrition assessment had been conducted, were examined. Of these, 19 articles were excluded because: (1) patients with diagnoses other than stroke were included; (2) the authors failed to discriminate between well-nourished and malnourished individuals; and (3) 2 non-English studies were retrieved. Sixteen studies remained that met the inclusion criteria. The reference lists of these articles were hand searched and yielded 3 hits.1,2,16 Two studies were considered duplicates and subsequently excluded. Finestone et al10 described and reported the nutritional status of the same group of patients in a previously identified publication.11 The Food or Ordinary Diet (FOOD) trial collaborators also reported the preliminary findings from their larger family of trials investigating enteral feeding and oral supplementation.7 Therefore, a total of 18 studies remained for review.1–5,10,12–23

Nutritional Assessments

The nutrition assessment techniques used in each of the studies, are described in Table 1. The percentage of patients identified as malnourished, at any point after the stroke, based on the authors’ primary criteria, ranged from 6.1%12 to 62%.1 If the criteria were widened to include the secondary criteria used in 2 studies, the range of estimates broadened from 1.3%20 to 73%.21 Clinical evaluations based entirely on subjective criteria were used in 5 studies.14–17,19 In 2 of these studies, the FOOD Trial Collaborators15,16 permitted clinicians at each of the 125 participating centers to classify a patient’s nutritional status based on their own standard of care. An informal assessment to estimate weight, was used as the sole marker of nutritional state in the absence of a more comprehensive assessment. Nine studies used an approach that included both anthropometric and biochemical measurements.15,16,18,21,23 Among these studies, a total of 31 to 81 individual nutrition markers were measured, whereas one to 3 or more subnormal markers were required to fulfill the criteria for malnutrition, although the cutoff points used varied. Six of these studies used a population-based reference standard, which was identified by the authors as a basis of comparison for anthropometric measurements.2–5,13,22

Weight, used to establish either weight loss or percentage of a reference value or to calculate body mass index (BMI), was the most consistently used anthropometric measurement. Serum albumin was used as a marker in all of the studies that included biochemical measurements, although the cutoff points to fulfill the criteria for malnutrition varied and ranged from 25 g/L12 to 40 g/L18 Serum transferrin was the next most commonly used visceral protein with cutoff values between 1.51 and 2.0 g/L.2 Hemoglobin, delayed hypersensitivity skin testing, and sustained ketonuria were the least frequently used indicators.

Validity of Nutritional Assessment Methods

Four trials used nutritional assessment methods validated previously: Subjective Global Assessment, (SGA) “an informal assessment,” and Mini Nutritional Assessment.14–16,20 Two trials used modified versions of SGA.17,19 The details of the original validation studies are presented in Table 2. None of the techniques used in the remaining studies were previously validated. Seven trials used study-specific methods of nutrition assessment that appeared to be developed by the authors.1,5,10,12,18,21,23 Five trials all referenced previously published works that were retrieved and reviewed. On review of the cited articles, it became apparent that the nutrition assessment techniques used were all modified versions of the original methods or a combination of several previously documented methods.1–5,10,12–23

Discussion

In the 18 studies reviewed, the reported prevalence of malnutrition after stroke varied widely, from 1.3% to 73%. If the estimates from 2 trials using secondary criteria are excluded, the estimates narrow in range from 6.1% to 62%, the span of which is still greater than would be expected to occur naturally and suggests that in some cases, malnutrition was either over- or underreported. One would expect that some of the variability may be attributed to differences in patient characteristics and the timing of assessments among studies. The effect of factors such as the timing of assessment, stroke type (ischemic versus hemorrhagic), comorbid medical conditions, and stroke complications undoubtedly influenced the variability of the reported estimates but were not examined in our study. However, we propose that, in addition to this expected variability, a substantial proportion of the variation in estimates may be explained by the heterogeneity of nutritional assessment. This hypothesis is of interest given
<table>
<thead>
<tr>
<th>Study/Design/Aims</th>
<th>Percentage of Subjects Identified as Malnourished/the Timing of Assessment (Total Sample Size)</th>
<th>Indicators and Cutoff Points Used To Determine Nutritional Status</th>
<th>Criteria Used to Establish Malnutrition</th>
<th>Was a Valid Tool Used?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axelsson et al, 1988(^5)</td>
<td>16% within 4 days of symptom onset (n=100)</td>
<td>Serum albumin (&lt;38 g/L male, &lt;37 g/L female)</td>
<td>≥2/6 nutrition variables below reference limits</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>22% at hospital discharge (n=78)</td>
<td>Serum prealbumin (&lt;0.18 g/L)</td>
<td></td>
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<tr>
<td>To describe the nutritional status and risk factors for malnutrition after acute stroke</td>
<td></td>
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<tr>
<td>De Pippo et al, 1994(^12)</td>
<td>6.1% at any point between rehabilitation hospital admission (median of 4.6 weeks poststroke) and discharge (n=115)</td>
<td>Albumin &lt;25 g/L</td>
<td>At least one variable below reference limits</td>
<td>No</td>
</tr>
<tr>
<td>Randomized, controlled trial</td>
<td></td>
<td>Sustained ketonuria without glycosuria &gt;2 weeks</td>
<td></td>
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<tr>
<td>To investigate the effect of graded levels of dysphagia interventions provided by a therapist on a variety of outcomes</td>
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<tr>
<td>Unosson et al, 1994(^4)</td>
<td>8% within 2 days of symptom onset (n=50)</td>
<td>Weight (&lt;80% of reference value), triceps skinfold (&lt;6 mm male, &lt;12 mm female), arm muscle circumference (4 levels based on age and sex), delayed hypersensitivity skin testing (&lt;10 mm induration), serum albumin (&lt;36 g/L), serum prealbumin (&lt;0.20 g/L male, &lt;0.18 g/L female)</td>
<td>≥3/6 nutrition variables below reference limits including one of each of the anthropometric, serum protein, and skin test measurements</td>
<td>No</td>
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<tr>
<td>Prospective cohort</td>
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<tr>
<td>To describe the nutritional status of elderly patients with acute stroke and to evaluate its relationship to food intake and feeding dependence</td>
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<tr>
<td>Finestone et al, 1995(^2)</td>
<td>49% on admission to rehabilitation unit (mean of 22 days poststroke; n=49)</td>
<td>Serum albumin (&lt;35 g/L), transferrin (&lt;2.0 g/L), total lymphocyte count (&lt;1000/(mm^3)), body weight (&lt;90% of reference weight, or &lt;95% of usual weight, or BMI &lt;20 kg/m(^2))</td>
<td>≥2/6 nutrition variables below reference limits</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>34% at 1 month (n=32)</td>
<td>Sum of 4 skinfolds (&lt;5th percentile of reference population), midarm muscle circumference (&lt;5th percentile of reference population)</td>
<td></td>
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</tr>
<tr>
<td>To investigate the association between nutritional parameters and length of stay and functional outcome</td>
<td>22% at 2 months (n=9)</td>
<td>Serum albumin (&lt;35 g/L), triceps skinfold or midarm muscle circumference (10th percentile of reference population)</td>
<td></td>
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<tr>
<td>Davalos et al, 1996(^3)</td>
<td>16.3% within 24 hours of hospital admission (n=104)</td>
<td>Any single indicator below reference limits</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>26.4% after 1 week (n=91)</td>
<td>Serum albumin (&lt;35 g/L), triceps skinfold or midarm muscle circumference &lt;10th percentile of reference population</td>
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<tr>
<td>To determine the prevalence of malnutrition at 1 week after hospitalization and to evaluate its relationship between the stress response and neurological outcome</td>
<td>35% after 2 weeks (n=43)</td>
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</tbody>
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Table 1. Continued

<table>
<thead>
<tr>
<th>Study/Design/Aims</th>
<th>Percentage of Subjects Identified as Malnourished/the Timing of Assessment (Total Sample Size)</th>
<th>Indicators and Cutoff Points Used To Determine Nutritional Status</th>
<th>Criteria Used to Establish Malnutrition</th>
<th>Was a Valid Tool Used?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choi-Kwon, 1998(^1)</td>
<td>25% patients with ischemic stroke admitted within 1 week of stroke (n=67)</td>
<td>Lean body mass, abdominal skinfold thickness, subcapsular skinfold, triceps skinfold, all &lt;80% of reference values, BMI &lt;20 kg/m(^2), total lymphocyte count &lt;1500/ mm(^3), hemoglobin &lt;12 g/dL, serum albumin &lt;35 g/L</td>
<td>&gt;1 biochemical indicator and ≥2 anthropometric indicators below reference values</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>62% patients with hemorrhagic stroke (n=21)</td>
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<tr>
<td>Aquilani et al, 1999(^10)</td>
<td>30% at admission to rehabilitation (30±10 days poststroke; n=150)</td>
<td>Loss of usual weight ≥5% or 10%</td>
<td>Loss of weight ≥10% but with actual weight lower than reference weight</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>13% control subjects (n=122)</td>
<td>Arm muscle area &lt;5th percentile</td>
<td>Serum albumin &lt;35 g/L</td>
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<tr>
<td>Westergren et al, 2001(^13)</td>
<td>8% within 24 hours of symptom onset (n=24)</td>
<td>BMI &lt;20 kg/m(^2) or body weight ≤80% of reference weight or weight loss &gt;5% since admission; subnormal triceps skinfold or mid–upper arm muscle circumference or serum albumin &lt;36 g/L</td>
<td>One abnormal weight measurement and at least one other abnormal marker</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>29% at 1 month (n=24)</td>
<td></td>
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<tr>
<td>Westergren et al, 2001(^19)</td>
<td>32% within 6 days following hospital admission (n=162)</td>
<td>Author’s modified version of SGA</td>
<td>SGA classes B or C or D=malnourished</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>33% at 3 months (n=24)</td>
<td>A=well-nourished B=well-nourished but at risk of becoming malnourished C=suspected of being malnourished D=severely malnourished</td>
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<tr>
<td>Davis et al, 2004(^14)</td>
<td>16% within 24 hours of symptom onset (n=185)</td>
<td>Subjective Global Assessment</td>
<td>B or C=malnourished</td>
<td>Yes</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td></td>
<td>A=well-nourished B=moderately (or suspected of being) malnourished C=severely malnourished</td>
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<td></td>
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<tr>
<td>FOOD 2005 (B)(^15)</td>
<td>7.8% within 7 days of symptom onset (n=4023)</td>
<td>Clinical judgement used to determine if a patient was undernourished, normal, or overweight</td>
<td>Undernourished=malnourished</td>
<td>No</td>
</tr>
<tr>
<td>Randomized, controlled trials</td>
<td></td>
<td>(a more comprehensive assessment was carried out in 37% of patients)</td>
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</tbody>
</table>

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Table 1. Continued

<table>
<thead>
<tr>
<th>Study/Design/Aims</th>
<th>Percentage of Subjects Identified as Malnourished/the Timing of Assessment (Total Sample Size)</th>
<th>Indicators and Cutoff Points Used To Determine Nutritional Status</th>
<th>Criteria Used to Establish Malnutrition</th>
<th>Was a Valid Tool Used?</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD 2005 (I)16</td>
<td>8.6% at acute hospital admission</td>
<td>Same as FOOD 2005 (I)</td>
<td>Undernourished=malnourished</td>
<td>No</td>
</tr>
<tr>
<td>Randomized, controlled trial</td>
<td>Trial I; n=859</td>
<td>(a more comprehensive assessment may have also been carried out on a portion of the patients)</td>
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<td></td>
<td>Trial II; n=321</td>
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<tr>
<td></td>
<td>To establish: (1) whether early enteral (versus delayed) feeding improved stroke outcomes; and (2) if enteral feeding with a gastrostomy feeding device (versus nasogastric feeding tube) improved stroke outcomes</td>
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<tr>
<td>Martineau et al, 200517</td>
<td>19.2% within 2 days of symptom onset (n=73)</td>
<td>Patient-Generated Subjective Global Assessment</td>
<td>B or C=malnourished</td>
<td>No</td>
</tr>
<tr>
<td>Retrospective audit</td>
<td>To assess the nutritional status of patients with stroke on admission to the hospital; to compare health outcomes of well-nourished versus malnourished patients</td>
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<tr>
<td></td>
<td>22% within the first day of admission to a rehabilitation hospital an average of 44 days poststroke based on serum albumin (n=51)</td>
<td>Serum albumin&lt;40 g/L</td>
<td>Either marker below the cutoff points</td>
<td>No</td>
</tr>
<tr>
<td>Hama et al, 200518</td>
<td>57% based on BMI</td>
<td>BMI &lt;19 kg/m²</td>
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<tr>
<td>Prospective cohort</td>
<td>To evaluate the effects of malnutrition and nonthyroidal illness syndrome on functional dependence</td>
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<tr>
<td></td>
<td>26.3% within mean of 2.2 days after hospital admission based on MNA score (n=76)</td>
<td>Primary: MNA (maximum score=30)</td>
<td>Primary criteria: MNA score &lt;23.5</td>
<td>Yes</td>
</tr>
<tr>
<td>Crary et al, 200620</td>
<td>1.3% based on BMI</td>
<td>Secondary: BMI &lt;18 kg/m²</td>
<td>Secondary criteria: BMI below threshold</td>
<td></td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>To estimate the prevalence of malnutrition and dysphagia and to identify their associations with global stroke outcome</td>
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<tr>
<td></td>
<td>35% at 1 week poststroke (n=100)</td>
<td>Serum albumin &lt;550 μmol/L</td>
<td>Two or more abnormal nutritional variables</td>
<td>No</td>
</tr>
<tr>
<td>Brynningsen et al, 200722</td>
<td>33% at 5 weeks</td>
<td>Serum transferrin &lt;49 μmol/L</td>
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<tr>
<td>Prospective cohort</td>
<td>20% at 3 months</td>
<td>Triceps skin fold &lt;10th percentile</td>
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<tr>
<td></td>
<td>22% at 6 months (n=89)</td>
<td>Arm muscle circumference &lt; 10th percentile</td>
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<tr>
<td></td>
<td>To determine the prevalence of malnutrition and to investigate associations between nutritional status and stroke outcomes</td>
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</tr>
<tr>
<td>Poels et al, 200621</td>
<td>Primary criteria: 35% at admission to rehabilitation (34 days poststroke; n=69)</td>
<td>Primary: unintentional weight loss of more than 5% in 1 month or 10% in 6 months</td>
<td>Primary: malnutrition was established if either criteria were met</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>3% at 4 weeks after admission (n=60)</td>
<td>BMI &lt;18 kg/m² for subjects &lt;65 years or &lt;22 kg/m² for subjects ≥65 years</td>
<td>Secondary: the presence of at least one subnormal primary or secondary outcome criteria</td>
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that (1) with the single exception of the 2 related FOOD trials,15,16 no 2 studies used the identical assessment technique; and (2) only 3 validated tools were used to identify the presence or absence of PEM, in so much as some type of validity had been reported previously. Frequently, justification for a particular assessment method was that it had been used previously either in part or whole form. Prior use, in itself, does not constitute evidence of validity.

The 3 valid assessment tools, used in 22% of the studies, were created for differing purposes. The informal “eyeball” assessment was developed specifically to classify patients into 3 distinct groups based on nutritional state within the context of a large, multicentered randomized, controlled trial poststroke.24 Subjective Global Assessment was designed for use in the prediction of risk for complications after general surgery based on preoperative nutritional state,25 whereas Mini Nutritional Assessment, the third valid tool, was developed as a screening and assessment tool to identify geriatric patients at risk for malnutrition.32 Although both SGA and Mini Nutritional Assessment have been validated subsequently for use in other disease or injury states, neither has been validated for the assessment of individuals with stroke.

The Patient-Generated Subjective Global Assessment method used by Martineau et al,17 was adapted from the original SGA tool specifically for use in the population of individuals with cancer.27 The Patient-Generated Subjective Global Assessment tool itself was never validated formally because it represented an intermediate step in the development of the final product, the scored Patient-Generated Subjective Global Assessment (F. Ottery, personal communication, April 2007). Therefore, although the modifications were slight, we questioned whether (unscored) Patient-Generated Subjective Global Assessment was a valid tool. No evidence of validity was provided for a study-specific modification of SGA,19 in which the administration of the tool appeared to be identical to the original version of SGA, but the scoring system was altered such that a fourth category (D) was added, thereby changing the interpretation of categories B and C from the original version. Because neither the relationship to the parent tool was established nor other evidence of validity provided, there is no way of knowing whether this modified tool is valid.

The remaining 12 studies used methods that, overall, consisted of 12 different sets of criteria/indicators/markers that had not been examined for their collective ability to provide a reliable or valid assessment of nutritional status/malnutrition. Given that the criteria used to identify malnutrition were different in each of these studies, the variability in the reported prevalence of malnutrition among them should not be surprising. All of these studies used assessment techniques that included some combination of anthropometric and/or biochemical components, which varied in terms of the individual criteria used to define malnutrition. Usually, 2 to 3 abnormal values were required to fulfill the criteria for malnutrition. Although single markers are not believed diagnostic of PEM,28 5 trials required only one subnormal value.3,12,18,21,23 The use of differing combinations of nutritional measurements and the associated selection of a variety of cutoff values profoundly influenced the estimates of malnutrition. Generally, if an investigator chose a lower cutoff level for a given nutritional measurement, or increased the number of abnormal markers required to diagnose malnutrition, the prevalence of malnutrition decreased. For example, 73% of subjects were diagnosed as malnourished if one abnormal measurement was required compared with only 2% if 4 abnormal markers were considered indicative of malnutrition.21 When serum albumin was used by itself to indicate malnutrition, 22% and 6.1% of subjects were identified as malnourished based on values of <40 g/L18 and <25 g/L,12 respectively. In 3 studies, each subject was assessed using 2 different nutritional assessment methods or criteria. Depending on which method was used, the number of subjects identified as malnourished varied from 22% to 57%,18 1.3% to 26%,20 and from 35% to 73%.21

The estimates of malnutrition obtained from trials that had not used a validated tool tended to be higher and more

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<tr>
<th>Study/Design/Aims</th>
<th>Percentage of Subjects Identified as Malnourished/the Timing of Assessment (Total Sample Size)</th>
<th>Indicators and Cutoff Points Used To Determine Nutritional Status</th>
<th>Criteria Used to Establish Malnutrition</th>
<th>Was a Valid Tool Used?</th>
</tr>
</thead>
<tbody>
<tr>
<td>To describe the prevalence of malnutrition and to evaluate the association with eating difficulties and feeding dependence</td>
<td>Secondary criteria: 73% at admission to rehabilitation 54% at 4 weeks</td>
<td>Secondary: serum albumin &lt;35 g/L Fat-free mass &gt;16 kg/m² (men) or 15 kg/m² (women), triceps skinfold &lt;90% of 12.5 mm (men) or 16.5 mm (women), midarm muscle circumference &lt;90% of 25.3 cm (men) or 23.3 cm (women)</td>
<td>Any single indicator below reference limits</td>
<td>No</td>
</tr>
<tr>
<td>Yoo et al, 200823</td>
<td>12.2% within 24 hours of symptom onset (n=131)</td>
<td>Weight loss of ≥10% for the past 3 months or ≥6% during first week of admission</td>
<td>Any single indicator below reference limits</td>
<td>No</td>
</tr>
<tr>
<td>Prospective cohort</td>
<td>19.8% at 1 week</td>
<td>Weight index (actual weight in relation to reference weight) &lt;80%</td>
<td>Serum albumin &lt;30 g/L Serum transferrin &lt;1.5 g/L Serum prealbumin &lt;0.10 g/L</td>
<td>MNA indicates Mini Nutritional Assessment.</td>
</tr>
</tbody>
</table>
Evidence suggests that the use of unpublished outcome assessment scales is associated with an overestimation of the treatment effect as demonstrated in pharmacology trials of schizophrenia. In contrast, the estimates of malnutrition were lower and the range of values narrower from the 4 studies that used a valid tool (7.8%, 8.6%, 16%, 16%, and 26.3%). The subjects in all of these trials were assessed within 1 week of stroke onset, eliminating any variability that might have occurred due to timing of assessment. None of the valid assessment methods included hematology or biochemical components, the values of which may rise or fall quickly after stroke onset. Instead, these tools were comprised of subjective, clinical criteria or anthropometric measurements, which are more static.

Because the prestroke nutritional status of patients in any of the studies reviewed was unknown, it remains unclear whether malnutrition pre-existed at the time of the initial assessment or developed as a consequence of stroke, although at least one group of authors, using a valid assessment method that did not contain biochemical measures, assumed that nutritional state, assessed shortly after stroke onset, was the equivalent of the prestroke nutritional state. The prevalence of malnutrition in the community-dwelling elderly is estimated at 5% to 8% but is much higher among those who are

<table>
<thead>
<tr>
<th>Tool/Citation for Original Validation Study</th>
<th>Sample Characteristics</th>
<th>Items Included in Nutritional Assessment Tool Under Construction</th>
<th>Diagnostic Standard</th>
<th>Validity/Reliability Statistics (Type of Validity Demonstrated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGA25</td>
<td>n=59 general surgery patients, representing every fifth consecutive admission from a single facility</td>
<td>Two-part clinical assessment performed by 2 physicians History: focus on weight loss, edema, anorexia, vomiting, diarrhea, decreased food intake, chronic illness</td>
<td>Objective measurements including a variety of anthropometric and biochemical variables</td>
<td>Validity: statistically significant differences in the means of serum albumin, ideal body weight, ideal lean body weight, creatinine height index, percentage body fat, total body potassium, and length of stay among patients in Groups A, B, and C (construct validity)</td>
</tr>
<tr>
<td>An informal assessment24</td>
<td>n=101 consecutive admissions from 3 hospitals during a 2-month period</td>
<td>Eyeball assessment of nutritional status, whereby a subject was categorized based on subjective assessment</td>
<td>Length of hospital stay, need for antibiotics, incidence of infections</td>
<td>Significant difference in proportion of patients developing infections and requiring antibiotics among groups (discriminant validity)</td>
</tr>
<tr>
<td></td>
<td>n=40 acute stroke</td>
<td></td>
<td></td>
<td>Interrater reliability (kappa): 0.72</td>
</tr>
<tr>
<td></td>
<td>n=61 admissions from geriatric or medical wards with nonstroke diagnoses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mini Nutritional Assessment (MNA)26</td>
<td>n=120</td>
<td>Anthropometric measurements</td>
<td>Comprehensive nutritional assessment including anthropometrics, biochemical markers, and dietary intake</td>
<td>Validity: sensitivity of MNA to identify subjects with scores &lt;17 indicating malnutrition: 92% (discriminant validity)</td>
</tr>
<tr>
<td></td>
<td>n=30 healthy community-dwelling elderly, n=90 frail elderly (30 hospitalized, 60 hospitalized, but returning home)</td>
<td>Global assessment (6 questions related to lifestyle, medication, and mobility)</td>
<td></td>
<td>Specificity: 92%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dietary questionnaire</td>
<td></td>
<td>Reliability: not reported</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subjective assessment (self-perception of health and nutrition)</td>
<td></td>
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</tbody>
</table>
institutionalized (30% to 60%). The prestroke living arrangements for subjects in the included studies were not usually reported so it is difficult to know whether a larger or smaller percentage of subjects were malnourished at the time of entry into the study.

On the basis of this review, we cannot claim to have established the true prevalence of malnutrition poststroke; however, because it is now generally accepted that reliable and valid measurement is essential for the generation of meaningful and replicable data and interpretable results,31,32 the estimates obtained from the 4 studies using a valid nutritional assessment method may have been less biased and more likely to have yielded a truthful result. If so, then malnutrition is less prevalent than previously thought. At the same time, we recognize that there were limitations associated with the 3 valid tools we did identify. The “informal assessment” technique used by the authors of the FOOD trials was not designed for patient-level assessment. The method, which likely captures a large proportion of the construct “malnutrition” through an estimation of body weight, may provide an inadequate assessment of an individual’s nutritional state. It is also generally accepted that assessment tools need to be validated within the populations that they are to be used. Given that Mini Nutritional Assessment and SGA have never been validated in a sample of subjects recovering from stroke, their appropriateness for this group may also be questionable, although it could be argued that because stroke occurs more frequently in older individuals, Mini Nutritional Assessment, which was developed for use in this population, may be a suitable tool. We do not suggest that any of the assessment techniques identified in this review are invalid or that new ones need necessarily to be developed; however, if we want to further our understanding of the association between stroke and malnutrition, it is essential that whatever assessment method(s) are chosen should be demonstrated to be valid and reliable within the stroke population.

Summary

Estimates of malnutrition poststroke reported in the 18 studies we reviewed ranged from 6.1% to 62%. Although factors such as the timing of assessment and differences in patient characteristics among studies may have contributed to the inherent or expected variability, we suggest that a greater portion of the variation in the estimates of malnutrition may be attributed to the differences in nutritional assessment methods. Only 3 previously validated nutritional assessment tools were identified and used in 4 studies. All of these methods relied on clinical, subjective, and anthropometric components and did not include biochemical measurements. Of these tools, only one method, “an informal assessment” used by the authors of the FOOD trials, had been validated specifically for use after stroke. In the majority of the remaining studies, a combination of anthropometric and biochemical markers was used. Although many of these methods included the same individual markers such as serum albumin and weight, none of these methods appeared to have been validated previously. Therefore, the clinician should be aware of the strengths and limitations associated with each of the individual components that they are using to determine nutritional state. We conclude that to further our understanding of how stroke affects nutritional status, (1) consensus needs to be achieved as to what is the best method to assess nutritional state; and (2) these methods need to be subjected to rigorous evaluation to establish their validity and reliability within the stroke population.

Source of Funding

This project was supported by funds from the Canadian Stroke Network.

Disclosures

None.

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*Stroke*. 2009;40:e66-e74; originally published online January 22, 2009;
doi: 10.1161/STROKEAHA.108.518910

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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