Malnutrition in Patients With Moderate to Severe Acquired Brain Injury: Prevalence During 4 Weeks of Subacute Rehabilitation

NCPD 2.0 ANCC Contact Hours

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ABSTRACT

BACKGROUND: Malnutrition is associated with high rates of complication, longer hospital stays, and increased morbidity and mortality. Malnutrition defined as undernutrition is common in patients with acquired brain injury (ABI); however, estimates vary remarkably. This study aimed to describe malnutrition at admission and after 4 weeks of subacute inpatient neurorehabilitation in patients with ABI using the new global consensus definition of malnutrition. **METHODS:** One hundred thirty-three patients with moderate to severe ABI consecutively admitted to a specialized neurorehabilitation hospital within a period of 4 months were screened for inclusion, of which 92 were included. Malnutrition was defined as at least 1 phenotypic criterion (weight loss, low body mass index, low muscle mass) and at least 1 etiologic criterion (reduced food intake, inflammation). Malnutrition on admission and after 4 weeks was compared using the McNemar test. **RESULTS:** The proportion of patients with malnutrition at admission was 42%, with more men (46%) than women (36%) fulfilling the criteria for malnutrition. The most frequent phenotypic and etiologic criteria were weight loss (56%) and inflammation (74%), respectively. During the 4 weeks of rehabilitation, the proportion of male patients fulfilling the individual criteria "weight loss" (difference, −21.4%) and "inflammation" (difference, −18.9%) decreased significantly; "low muscle mass" decreased borderline significant (difference, −8.9%), whereas "low body mass index" did not change. The proportion of female patients fulfilling individual criteria for malnutrition was stable or increased nonsignificantly. **CONCLUSION:** Malnutrition was common at admission to neurorehabilitation in patients with moderate to severe ABI, with more men than women fulfilling the criteria for malnutrition. The nutritional status improved after 4 weeks of rehabilitation in male patients, whereas it was largely unchanged in female patients. The results provide the basis for monitoring high-quality nutritional nursing care.

Keywords: bioimpedance analysis, brain injuries, GLIM criteria, malnutrition, nursing, nursing research, nutritional status, rehabilitation, stroke, weight loss

Prevention of malnutrition defined as undernutrition is an essential aspect of fundamental nursing care.[1] In hospitalized patients, malnutrition is a serious health problem associated with higher complication rates, longer length of hospital stay, and increased morbidity and mortality.[2] As such, high-quality nutritional nursing care is crucial to prevent and treat potential malnutrition. Patients with moderate to severe acquired brain injury (ABI) are at an extremely high risk of malnutrition for several reasons. First, metabolism after the injury is significantly increased because of increased production of corticosteroids, counterregulatory hormones, and cytokines,[3,4] and the metabolic elevations may sustain into the subacute rehabilitation period.[5]

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The authors declare no conflicts of interest.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.jnnonline.com).

https://doi.org/10.1097/JNN.0000000000000688

Second, sympathetic activation, inflammation, and immobilization can further aggravate the patients' challenges in meeting the increased nutritional needs.[4,6]

To monitor and develop the quality of nutritional nursing care, for example, through nursing-sensitive indicators in national clinical quality databases,[7] it is necessary to know the prevalence of malnutrition in patients with ABI. However, there has been a fundamental lack of consensus on the diagnostic criteria of malnutrition in clinical settings,[8] and therefore, the definition and prevalence of malnutrition vary remarkably across studies.[4,6,9,10] The recently recommended criteria to diagnose malnutrition from the Global Clinical Nutrition Community (GLIM) consist of 3 phenotypic criteria (nonvolitional weight loss, low body mass index [BMI], and low muscle mass) and 2 etiologic criteria (reduced food intake or assimilation, and inflammation or disease burden).[8] Malnutrition according to the GLIM criteria is defined as presence of at least 1 phenotypic criterion and at least 1 etiologic criterion. The GLIM criteria could be used by nurses to unambiguously define malnutrition when monitoring and developing the quality of nutritional nursing care, but to our knowledge, the GLIM criteria have not yet been used in neither nursing research nor nursing developmental projects. However, the prevalence of malnutrition has recently been estimated according to the GLIM criteria to be between 35% and 54% in patients with stroke admitted for neurorehabilitation in Japan.[11,12]

To measure muscle mass, the GLIM recommends using bioelectrical impedance analysis (BIA).[8] Bioelectrical impedance analysis is increasingly used to measure body compartments in different patient populations, including in patients with stroke.[12–18] In a recent study, we explored the use of BIA in patients with other types of ABI.[19] To facilitate future monitoring and development of nutritional nursing care, we in the current study use the data to describe the nutritional status at admission and after 4 weeks of subacute in-patient neurorehabilitation in patients with moderate to severe ABI using the GLIM criteria for the diagnosis of malnutrition.

Methods

This prospective, descriptive cohort study was conducted in patients with moderate to severe ABI consecutively admitted to a specialized neurorehabilitation hospital between November 2016 and April 2017 (n = 133). Most patients are admitted directly from acute care. The hospital provides 2 levels of interdisciplinary, team-based rehabilitation: highly specialized neurorehabilitation for the most severely injured ABI patients from a background population of 3.1 million citizens (55% of the Danish population) and

The GLIM criteria could be used by nurses to unambiguously define malnutrition.

in-patient neurorehabilitation for patients with moderate ABI.[20,21]

Patients were excluded who: did not want to participate (1); were younger than 18 years (13); stayed at the rehabilitation hospital for <7 days (2); had chronic ABI, that is, admitted for constrained induced movement therapy (4); or were injured ≥6 months before admission to the rehabilitation hospital (6). During the study, we excluded 2 patients who were unable to fast, 11 were discharged before follow-up, and 2 transferred to another hospital ≥3 days during follow-up. Following exclusions, 92 patients (56 men and 36 women) with a median age of 52 years (range, 18–77 years) were included. The etiology of injury was primarily stroke (57%) and traumatic brain injury (26%). Habitual BMI was distributed with 37% normal BMI, 12% low BMI, and 52% high BMI.[19] The study was approved by the Danish Data Protection Agency. Because data were gathered as an integrated part of daily practice, informed consent from patients or relatives as well as ethical approval was not required according to Danish legislation.

Nutritional Assessment

Data on muscle mass were obtained with BIA (Maltron BioScan 920 multiple 4-frequency) using full body analysis performed according to standardized procedures, by the same nurse. A bladder scan followed by sterile intermittent catheterization was conducted if the patients had residual urine.[22,23] The device provided measurements of the fat free mass (FFM) in kilograms according to the equation provided by the Maltron software. Electrodes were placed at the hand and foot, respectively. Measurements were performed on both sides, and FFM was subsequently computed as the mean values of left- and right-side values. In patients with hemiparesis, the values from the nonaffected side were used. The FFM index (FFMI; kg/m^2) was calculated by dividing the FFM by height squared in meters. Low muscle mass was defined according to the GLIM criteria for malnutrition as FFMI of <14.6 kg/m^2 in women and <16.7 kg/m^2 in men.[8]

Habitual weight was obtained from medical records defined as the first weight measured by professionals at the intensive care unit at the time of the present injury, or secondarily reported by the patient or relatives. During the rehabilitation stay, weight was measured on admission, twice a week, and within 1 hour before the BIA assessment. Individuals were weighed at the same machine at all measurements using calibrated Guldmann digital scale for ceiling lift, Mettler Toledo Spider one wheelchair weight, or a standing person weighing scale. The project nurse measured height lying in a flat position using a dimensionally stable tape measure with a precision of 0.5 cm. Weight loss and low BMI were defined in accordance with the GLIM criteria for malnutrition, that is, involuntary weight loss > 5% and BMI < 20 kg/m^2 in patients 70 years or younger and BMI < 22 kg/m^2 in patients older than 70 years.[8,22] Overweight was defined as a BMI > 25 kg/m^2.[24]

The patient's energy requirements were calculated by a trained dietician using the Schofield[25] formula. Protein requirements were set as 15% to 20% of the total energy needs within the interval of 1.2 to 1.8 g of protein per kilogram of body weight, depending on nutritional intake, activity level, and health condition.[26] For overweight patients, the energy requirements were based on 25% of the weight in kilograms above the BMI of 25 (27 in patients older than 65 years), and the protein requirements were set as 1.1 g of protein per kilogram of total body weight.

Nutritional intake was registered for the first 3 days after admission. The healthcare professionals and/or relatives assessed and registered the weight of oral intake. Intake through oral nutrition supplements, tube feeding, or parenteral routes was registered by nurses in the patient's medication charts. The total intake of energy and protein was summed up daily in the medical records by dedicated nurses or the dietician. For the current study, the proportion of patients with an intake of <75%, 75% to 110%, and >110% of requirements was calculated for both energy and protein intake, respectively.[27] Patients were defined as having a reduced intake if the energy or protein intake were below <75% of requirements.

C-reactive protein and albumin were obtained from blood samples at baseline and after 4 weeks of rehabilitation. The severity of inflammation was measured using the Glasgow prognostic score[28] calculated as follows: patients with C-reactive protein > 10 mg/L and albumin (<35 g/L) were assigned 2 points. Patients with only one of the abnormal values were assigned 1 point, and patients who had neither were assigned 0 points.

Statistical Analyses

Values in the nutritional assessments were not normally distributed and hence presented with medians and interquartile range. Wilcoxon signed rank test assessed the difference between admission and after 4 weeks of rehabilitation. The proportion of patients with each individual criterion for the diagnosis of malnutrition according to the GLIM criteria[8] was calculated at admission and after 4 weeks of rehabilitation and compared using the McNemar test. In addition, the proportion of patients with at least 1 phenotypic, at least 1 etiologic, and at least 1 phenotypic concurrent with 1 etiologic criteria of malnutrition was calculated and compared. All analyses were stratified by sex. Analyses were performed using STATA, version 15 (StataCorp LP).

Results

Overall, 92 patients were included. Median values in the nutritional assessment were generally within the reference range at both admission and after 4 weeks of rehabilitation. However, the median of energy and protein intake at admission indicated a low intake compared with the required intake (Table 1). Details on the proportion of patients with energy and protein intakes below 75%, between 75% and 110%, and above 110% of the calculated need, overall and stratified by sex, can be found in Supplemental Figure S1, available at http://links.lww.com/JNN/A439.

Table 2 presents the proportion of patients fulfilling the phenotypic and etiologic criteria for malnutrition at admission and follow-up according to the GLIM criteria. Details on differences between admission and follow-up can be found in Supplemental Table S1, available at http://links.lww.com/JNN/A440. The proportion of patients with at least 1 phenotypic criterion and at least 1 etiologic criterion of malnutrition was 42% at admission, with more men (46%) than women (36%) fulfilling the criteria. The most frequent phenotypic criterion was weight loss (56%), whereas the most frequent etiologic criterion was inflammation (74%).

Overall, the proportion of patients with at least 1 phenotypic criterion decreased from 49% at admission to 41% after 4 weeks of rehabilitation. The decrease was driven by a significant decrease in male patients (difference, −17.9%; 95% confidence interval [CI], −30.8 to 4.9), whereas the proportion with overall at least 1 phenotypic criterion in female patients increased slightly but nonsignificantly.

In male patients, the decrease in patients fulfilling individual phenotypic criteria was present for low muscle mass (difference, −8.9%; 95% CI, −18.2 to 0.3; P = .06) and weight loss (difference, −21.4%; 95% CI, −37.9 to −5.0; P = .01), whereas the proportion with low BMI did not change after 4 weeks of rehabilitation. Among female patients, there were no significant changes in the proportion of patients fulfilling the individual phenotypic criteria for malnutrition, although the proportion with low BMI increased slightly but nonsignificantly.

The proportion of patients with at least 1 *etiologic criterion* for malnutrition was 82% at admission. The proportion of male patients fulfilling the etiologic criterion of inflammation decreased significantly from admission to after 4 weeks of rehabilitation (difference

TABLE 1. Nutritional Assessment in Patients With ABI at Admission and After 4 Weeks of Inpatient Neurorehabilitation: Muscle Mass, BMI, Nutritional Intake, and Inflammation Markers

			Admission		After 4 wk	
	Reference Range	N	Median (IQR)	N	Median (IQR)	P^a
Muscle mass						
FFMI, kg/m^2						
Female	≥14.6	36	15.6 (15.4-17.5)	36	16.3 (15.5-18.0)	.07
Male	≥16.7	56	18.5 (17.5-19.4)	55	18.7 (17.7-19.8)	.00
BMI, kg/m^2						
Female	>20 to <25	36	23.8 (21.4-29.7)	36	24.5 (21.7-30.1)	.57
Male	>20 to <25	56	24.0 (21.7-27.0)	55	24.2 (21.4-27.2)	.00
≤70 y	>20 to <25	81	23.9 (21.0-27.5)	81	24.1 (21.4-27.7)	.00
>70 y	>22 to <25	11	25.4 (22.8-26.9)	10	24.9 (23.0-26.9)	.70
Energy intake, kJ						
Female	8280 (7638-8950)[b]	36	7724 (6934-8905)			
Male	9780 (8925-10,363)[b]	55	9615 (8140-10,555)			
Protein intake, g						
Female	96 (82.5-107)[b]	36	81.2 (72.7-94.6)			
Male	106.6 (95-118)[b]	55	90.7 (77.5-113)			
Inflammation markers in blood samples						
CRP, mg/L	<8.0					
Female		36	3.3 (1.2-8.4)	35	2.4 (0.6-5.1)	.35
Male		56	4.2 (2.2-12.8)	54	1.9 (0.9-6.8)	.06
Albumin, g/L	36-45					
Female		36	31.5 (30-35.5)	36	32 (30-36)	.40
Male		56	31.0 (29.0-35.5)	54	33.5 (32-37)	.00

Abbreviations: ABI, acquired brain injury; BMI, body mass index; CRP, C-reactive protein; FFMI, fat free mass index; IQR, interquartile range; N, number of patients with complete data.

[a]Wilcoxon signed rank test for difference between admission and follow-up.
[b]Required intake calculated based on Schofield[25] formula.

in the 53 patients with fully complete data, −18.9%; 95% CI, −32.5 to −5.2), whereas there were no significant changes in female patients.

Discussion

We in this study, aimed to investigate malnutrition on admission and after 4 weeks of subacute inpatient neurorehabilitation in patients with moderate to severe ABI using the GLIM criteria for the definition of malnutrition. We found that 42% of our patients were malnourished, which is in line with the previously reported prevalence of malnutrition among stroke patients in Japan[11] based on the same criteria for malnutrition (GLIM at admission to rehabilitation). However, the prevalence of malnutrition for men (46%) and women (36%) differed from the prevalence in Japan, where slightly less men (35%) and substantially more women (54%) were malnourished according to the GLIM criteria.[11]

Looking at the individual GLIM criteria for malnutrition, we found less patients with low muscle mass (17%) and low BMI (16%), and substantially more patients with weight loss (56%) and inflammation (74%) compared with those in Japan.[11] The reasons for the differences could be the different settings (Denmark vs Japan), brain injury etiologies (mixed brain injury vs stroke), age groups (younger vs older), and diagnostics (eg, blood samples for inflammation vs unspecified).

In line with the Japanese study,[11] approximately every 4 patients had reduced intake at admission, especially reduced protein intake. Therefore, nurses working in neurorehabilitation should pay attention to meet patients' required protein need to prevent further aggravation of loss of muscle tissue. This in particular applies

TABLE 2. Proportion of Patients Fulfilling Phenotypic and Etiologic Criteria for Malnutrition in Patients With ABI at Admission and After 4 Weeks of Inpatient Neurorehabilitation

	Admission		After 4 wk	
Criteria	**N***	**% (95% CI)**	**N***	**% (95% CI)**
Overall	92	42.4 (32.1-53.1)	—	—
Female	36	36.1 (20.8-53.8)		
Male	56	46.4 (33.0-60.3)		
Phenotypic criteria				
Overall at least 1 criterion	92	48.9 (38.3-59.6)	92	41.3 (31.1-52.1)
Female	36	41.7 (25.5-59.2)	36	50.0 (32.9-67.1)
Male	56	53.6 (39.7-67.0)	56	35.7 (23.4-49.6)
• Low muscle mass[a]	92	17.4 (10.3-26.7)	92	10.9 (5.3-19.1)
Female	36	11.1 (3.1-26.1)	36	8.3 (1.8-22.5)
Male	56	21.4 (11.6-34.4)		12.5 (5.2-24.1)
• Weight loss[b]	68	55.9 (43.3-67.9)	68	39.7 (28.0-52.3)
Female	26	53.8 (33.4-73.4)		46.2 (26.6-66.6)
Male	42	57.1 (41.0-72.3)	42	35.7 (21.6-52.0)
• Low BMI[c]	92	16.3 (9.4-25.5)	92	16.3 (9.4-25.5)
Female	36	16.7 (6.4-32.8)		22.2 (10.0-39.2)
Male	56	16.1 (7.6-28.3)	56	12.5 (5.2-24.1)
Etiologic criteria				
Overall at least 1 criterion	92	81.5 (72.1-88.9)	—	—
Female	36	77.8 (60.8-89.9)		
Male	56	83.9 (71.7-92.4)		
• Reduced intake[d]	91	25.3 (16.7-35.5)	—	—
Female	36	25.0 (12.1-42.2)		
Male	55	25.5 (14.7-39.0)		
• Inflammation[e]	92	73.9 (63.7-82.5)	88	61.4 (50.4-71.6)
Female	36	69.4 (51.9-83.7)	35	62.9 (44.9-78.5)
Male	56	76.8 (63.6-87.0)	53	60.5 (46.0-73.5)

Abbreviations: ABI, acquired brain injury; BMI, body mass index; CI, confidence interval; FFMI, fat free mass index; N, number of patients with complete data.
[a]Fat free mass index, <14.6 kg/m^2 in women and <16.7 kg/m^2 in men.
[b]Greater than 5% compared with habitual weight.
[c]Less than 20 kg/m^2 in patients 70 years or younger and <22 kg/m^2 in patients older than 70 years.
[d]Less than 75% of the calculated need.
[e]Glasgow prognostic score ≥ 1.
*McNemars test for difference between admission and follow-up.

to female patients, considering that the proportion of female patients fulfilling at least 1 phenotypic criterion for malnutrition increased slightly (although nonsignificantly) during the 4 weeks of rehabilitation.

Finding that the proportion of male patients fulfilling each individual criterion for malnutrition decreased from admission to after 4 weeks of neurorehabilitation indicates that the overall prevalence of malnutrition after 4 weeks of rehabilitation was lower. This is in line with the lower discharge prevalence of malnutrition (29%) in stroke patients in another study from Japan, also using the GLIM criteria to define malnutrition.[12]

Our study has some limitations. First, although we included all relevant patients at the rehabilitation hospital during the study period, caution should be taken when considering the statistical precision of the estimates because of the low sample size, as reflected by the width of the 95% CIs. This in particular applies to the nonsignificant results for female patients (n = 36) and estimates for weight loss as the first weight measured by professionals at acute care admission was missing in 24 of the 92 patients (weighing is contraindicated in the acute stage of some severe brain injuries). Second, estimates for weight loss may be imprecise because habitual weight may not be accurately recalled by patients or relatives.

Knowing the prevalence of malnutrition in patients with ABI is necessary to monitor high-quality nutritional nursing care and to compare the prevalence of malnutrition across different studies. The current study is, to our knowledge, the first study to use the recommended GLIM criteria for malnutrition in a general ABI population. There is a need to further explore the use of these criteria among patients with ABI, including exploring the use of BIA in patients with ABI. A starting point could be to explore the impact of hydration status (eg, edema in paretic extremities) on the assessments of body tissue because overhydration may increase the measured FFMI[23] and, consequently, underestimate malnutrition. We also suggest that future studies include more data on activity level, muscle strength, and food intake because nutritional status, including the gain in FFMI, may be affected by these factors.

Conclusion

Malnutrition according to the GLIM criteria was common at admission to neurorehabilitation in patients with moderate to severe ABI. In male patients, the nutritional status generally improved after 4 weeks of rehabilitation, whereas the proportion of female patients fulfilling individual criteria for malnutrition was stable or increased nonsignificantly. Using the GLIM criteria for describing malnutrition is important to provide the basis for monitoring and developing high-quality nutritional nursing care. Future studies should further explore the use of these criteria for describing malnutrition in patients with ABI.

Acknowledgments

The authors acknowledge Marianne Køhler and Pernille Hagemann for their technical support, Lene Ommel for her nutritional expertise, and Tove Kilde for coordination and inclusion of patients.

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