Aalborg Universitet

AALBORG UNIVERSITY

Body composition measures may help target fundamental nutritional nursing efforts in rehabilitating patients with acquired brain injury

Aadal, Lena; Odgaard, Lene; Feldbaek Nielsen, Jørgen; Rasmussen, Henrik Højgaard; Holst, Mette

Link to publication from Aalborg University

NursingOpen   WILEY
Open Access

Body composition measures may help target fundamental nutritional nursing efforts in rehabilitating patients with acquired brain injury

Lena Aadal[1,2] [iD] | Lene Odgaard[1] | Jørgen Feldbæk Nielsen[1,2] |
Henrik Højgaard Rasmussen[3] | Mette Holst[3]

[1]Hammel Neurorehabilitation Centre and University Research Clinic, Hammel, Denmark

[2]Department of Clinical Medicine, Aarhus University, Aarhus, Denmark

[3]Centre for Nutrition and Intestinal Failure, Aalborg University Hospital and Department of Clinical Sciences, Aalborg University, Aalborg, Denmark

Correspondence
Lena Aadal, Hammel Neurorehabilitation Centre and University Research Clinic, Hammel, Denmark.
Email: lena.aadal@ki.au.dk

Abstract

Aim: To illuminate using body composition measurements for malnutrition measured by Bio Impedance Analysis (BIA), as opposed to body mass index (BMI), and discuss benefits and burdens for fundamental nursing care.

Design: A second analysis of a prospective, descriptive cohort study, targeting fundamental nursing care elements.

Methods: This postevaluation study explored data from a prospective, descriptive cohort study, which consecutively included 92 patients admitted for neurorehabilitation care. Measures of nutritional status were BMI and FFMI. Chi-Square test and Multivariable logistic regression were used.

Results: Body composition measures rather than BMI contributed to target individual nutritional nursing care as this measure detected more patients at potential risk of malnutrition and indicated minor changes in the nutritional state. Transitions from being malnourished to a normal nutritional status occurred in 29% using the BMI definition while it was the case in 40% of individuals with malnutrition defined by the body composition.

KEYWORDS

brain injury, malnutrition, nursing, nutrition, rehabilitation, subacute

1 | INTRODUCTION

Patients with moderate-to-severe acquired brain injury (ABI) face increased risk of malnutrition by factors related to increased energy expenditure, decreased nutrient ingestion and gastrointestinal changes. Thorough nutritional efforts can improve survival and rehabilitation outcomes and these efforts involve several healthcare professional groups. By tradition, nurses take responsibility for meeting the patients' fundamental needs, including

caring for patients nutritional necessities (Feo, Conroy, et al., 2018; Henderson, 2006; Jefferies et al., 2011). Thus, high-quality nursing care includes targeted meeting the individual patient's nutritional requirements. This study is a further exploration of data from a study of changes to nutritional status during 4 weeks of in-hospital rehabilitation after moderate to severe ABI (submitted). This second analysis illuminates the nursing contributions to nutritional care, and discusses nursing benefits from using body composition measurements by Bio Impedance Analysis (BIA) for nutritional assessment,

as opposed to Body Mass Index (BMI), to target individualized nutritional efforts and thus prevent complications and improve rehabilitation outcomes.

1.1 | Background

Patients with moderate-to-severe ABI often suffer from increased metabolic state and pronounced effects on food intake. Malnutrition is a state of deficiency, excess or imbalance of protein, energy and other nutrients that causes measurable adverse effects on tissue and/or body size and composition (Stratton et al., 2004). Challenges in meeting the increased nutritional needs due to cognitive or physical changes as feeding intolerance, dysphagia and attention disturbances, may worsen the condition (Perry et al., 2013; Wang et al., 2013). Several studies recommend early initiation of systematic enteral or parenteral nutrition focussing on both energy and protein content, in order to fulfil requirements and prevent secondary complications (Carney et al., 2017; Erdman et al., 2011; Krakau et al., 2007; Vizzini & Aranda-Michel, 2011; Wang et al., 2013). However, patients with ABI are still at high risk of undernutrition during hospitalization (Aadal et al., 2015; Krakau et al., 2007; Mosselman et al., 2013). A moderate-to-severe brain injury impedes increased metabolism leading to catabolism including degeneration of muscle tissue or an overall weight loss (Krakau et al., 2006). This might be exacerbated by immobilization following the large spectrum of possible impairments in body function from paralysis and unconsciousness to activity limitations and participation restrictions. Hyper-metabolic and hyper-catabolic conditions have been described in patients who have sustained a traumatic brain injury (TBI), but patients with ischaemic or haemorrhagic brain injury or other critical neurological diseases have comparable nutritional and metabolic challenges (Dickerson et al., 2012; Frankenfield & Ashcraft, 2012) The high inflammatory state and a condition of stress metabolism increases the risk of rapid malnutrition. Hence, assessment of malnutrition includes variables related to the metabolic state and energy expenditure, rather than classical nutrition variables such as BMI, recent weight loss and food intake (Kondrup, 2014) Nutritional screening and assessment tools, such as NRS-2002, MNA, MUST and more, are performed to evaluate the risk of malnutrition and the potential for nutritional intervention. These are not designed to be sensitive to the efficacy of nutrition intervention (Kondrup et al., 2003). However, inflammatory markers as CRP and albumin are not valid predictors for nitrogen loss (Bharadwaj et al., 2016; Fuhrman, 2002). Indirect calorimetry (IC) is the gold standard for predicting energy requirements in critically ill adult patients, but it is unsuitable for people who have difficulty cooperating, for example, due to cognitive impairment (da Rocha et al., 2006). Predictive equations are used to estimate energy expenditure and a variety are available. Unfortunately, the most frequently used formulas are insufficient in estimating energy expenditure compared to IC leaving high degree of interpatient variability as patients experience fluctuating metabolic states (Morbitzer et al., 2019). Taken these challenges into consideration monitoring the nutritional status during rehabilitation remain a complex task.

By tradition, nutritional state has been defined by BMI calculated by weight and height. BMI, however, is only a measured fraction between height and weight and does not evaluate body composition. Thus, the same BMI may be represented in a patient with a high presence of muscle mass, as in one with sarcopenic obesity (Stenholm et al., 2008). At baseline, patients with acquired brain injury represent all sizes on the BMI-scale (Aadal et al., 2015; Krakau et al., 2006). Recent Global Clinical Nutrition Community (GLIM) adds phenotypic criteria to define malnutrition including body composition about fat-free mass and fat mass, eventually measured by BIA. The distribution of body tissue is a primary determinant of health and a predictor of risk (Kyle, et al., 2003). In rehabilitation addressing impaired physical functions muscle tissue and muscle strength appear essential as high-intensive exercise and repetition is a key modality of effective training (Verbeek et al., 2014). Interestingly BIA has, to our knowledge, not previously been investigated in a population with neurological disturbances. However, body tissue composition, especially fat free mass, might permit an increased individual approach and specificity, towards measuring and monitoring nutritional state. While sufficient muscle mass is determined by nutrition intake and physical activity, it may also be relevant to measure fat-free mass along with strength and movements when conducting training and exercise in rehabilitation. In neurorehabilitation, training is of course the epitome of actual training sessions but is to a large extent also the epitome of the daily fundamental nursing with the patient. In our primary study, we found that 42% of patients fulfilled the diagnosis of malnutrition from GLIM. This condition is known to increase risk of complications, extend hospitalizations and cause unfavoured rehabilitation outcome (Allard et al., 2016; Badjatia et al., 2010; Baltazar et al., 2015; Godbolt et al., 2015; Perel et al., 2008). Thus, fundamental nutrition nursing care appears crucial to improve survival and rehabilitation outcomes.

While sufficient muscle mass seems important, high and increasing BMI has been found in a substantial number of patients with ABI in the postrehabilitation period (Dreer et al., 2018; Duraski et al., 2014; Odgaard et al., 2020). In our primary study, we found that the group "overweight/obese" defined by BMI, slightly increased from admission to 4 weeks stay (submitted). Overweight in known to increase the risk of a number of diseases such as type 2 diabetes mellitus, hypertension, myocardial infarction, stroke and dementia, thereby contributing to a decline in both quality of life and life expectancy (Collaborators et al., 2017). Therefore, from a preventive perspective, there is also a need to focus on reducing the risk of overweight, while still securing sufficient nutrition intake.

By tradition, nurses take responsibility for meeting the patient's nutritional needs, taking into account general health, capabilities, preferences and fundamental needs of the patient (Feo, Conroy, et al., 2018; Feo, et al., 2018; Henderson, 2006; Jefferies et al., 2011; Kitson et al., 2010). Nutritional care, as mentioned above, plays a pivotal role in neurorehabilitation and involves professional groups as physician, nurse, dietician, occupational- and physiotherapist

(Badjatia et al., 2010; Denes, 2004; Godbolt et al., 2015; Krakau et al., 2007; Perry et al., 2013; Tulek et al., 2018; Vizzini & Aranda-Michel, 2011; Wang et al., 2013). Research determining the effect of nutrition nursing interventions are scarce, but the importance of including nurses in assessing the patients' nutritional status has been stressed (Richards et al., 2014; Smith et al., 2016). Nurse responsibilities have been described as identification of patients' specific eating-related problems, making individualized nutritional care plans, monitoring intake and weight, co-ordination of assessments and interventions in the interdisciplinary team, securing access to food, taking care of aesthetics around meals and eating environment, and finally, to encourage patients and eventually relatives to engage in nutrition care in a longer-term perspective (Beck et al., 2016, 2019; Capra et al., 2007; Health & T. D. N. B. o., 2008; Holst et al., 2017; Pentecost et al., 2019; Perry et al., 2013).

Despite the many aspects about fundamental nursing care in nutrition being vaguely described, nurses aimed to systematically address disturbances in nutritional status, in terms of protecting, maintaining and promoting person-centred care (Pentecost et al., 2019; Richards et al., 2018). Hence, the focus in fundamental nutritional nursing care following severe ABI should focus more to preserve and increase the patients' muscle tissue, to improve their ability to regain functions of everyday life. In that perspective, making individualized nutritional nursing care plans, and the assessment of how interventions work maybe more sufficiently evaluated and communicated to the interdisciplinary team if measures of the nutritional intervention was more specific than weight and BMI. BIA analysis might be a valuable contribution in measuring changes in the nutritional state in order to support and facilitate rehabilitation efforts and prevent complications following a brain injury.

This postevaluation study aimed to illuminate nursing contributions to nutritional care and discusses nursing benefits from using Bio Impedance Analysis (BIA) for the assessment of body composition, as opposed to using Body Mass Index (BMI) to target individualized nutritional efforts.

1.2 | Design

The study uses data from our previous prospective, descriptive cohort study (Ref X).

2 | METHOD

Briefly, the study population constituted a consecutive sample of patients with moderate to severe ABI (stroke or trauma) admitted to a neurorehabilitation hospital over a 4-month period (2016/2017). One hundred and thirty-three patients were enrolled. Of these, 41 patients were excluded because they were less than 18 years old, stayed at the rehabilitation hospital for less than 7 days, were admitted for constrained induced movement therapy, were transferred to another hospital for 3 days or more during the follow-up period, or

were injured more than 6 months before admission to the rehabilitation hospital. The remaining 92 patients were included in the data analyses.

2.1 | Standard nutritional care at the rehabilitation hospital

In accordance with recent international recommendations (Cederholm et al., 2019), a local guideline states that all patients with moderate to severe ABI admitted for inpatient neurorehabilitation are at risk of malnutrition due to the illness severity. Therefore, nurses are required to prepare a nutrition care plan in 24 hr of admission to rehabilitation. The nutrition care plan closely follows the nutrition care process recommended by The European Society of Clinical Nutrition and Metabolism (ESPEN) (Cederholm et al., 2017). This includes setting relevant short- and long-term nutrition goals. These are continuously evaluated throughout the rehabilitation course. The nutrition care plan is, to the extent possible, developed in close collaboration with the patient or relatives and as such, includes the patient's habits and preferred food. The rehabilitation nurses coordinate the nutrition care plan and communicate it to the interdisciplinary team and appropriate specialist, for example, neurologist, dietician, occupational therapist or speech therapist. Furthermore, nurses have specific fundamental nursing tasks such as helping patients to eat, monitoring weight change and intake, including registering nutrition intake first 3 days following admission to rehabilitation. The nurse also assesses and follows constricts in food and liquid consistency, ensures the intake of the prescribed energy and protein requirements, using the Schofield formula (Schofield, 1985), and provides total or supplemental enteral tube feeding for patients unable to meet nutrition and hydration needs orally, due to disturbances in consciousness, dysphagia or fatigue.

To ensure the intake of prescribed energy and protein requirements, nurses offer energy and protein-dense drinks (including ONS) and small in-between meals, for example, ice cream, porridges and soups which are placed in a cooler or a fridge at each department. Patients eat in their hospital room or whenever possible, in the social eating environment in the dining room. A good patient–nurse relation is established to motivate, encourage and support the patient in order to improve nutritional intake (Pentecost et al., 2019). Patients who are physically disabled are positioned, supported or helped eating while patients with cognitive disturbance only, are supported by verbal/tactile prompts and repeating instructions as cues.

2.2 | Nutritional measurement

The collection of nutritional measures for the study have been previously described (submitted). Weight was measured twice a week using the same calibrated person weighing scale for each individual at all times. Habitual weight was defined as the first weight measured by professionals after current injury at hospitalization in either

intensive or stroke units. Height was measured with a precision of 0.5 cm by the same nurse using a tape measure. Low BMI was defined as BMI below 18.5 kg/m^2 (Beck et al., 2016; Feo, Kitson, et al., 2018).

Bio impedance analysis estimated the body's tissue composition as fat-free mass (FFM) and fat mass (FM) (Kyle, et al., 2003; Kyle, Schutz, et al., 2003) using full-body analysis performed with a Maltron BioScan 920 single frequency 50 kHz. Measurements were performed on both the affected and non-affected side since the BIA measurement is affected by the distribution of tissue fluid in intra- and intercellular spaces, which might be disturbed by water retention and senso-motor changes. FFM and FM were subsequently computed as the mean values of left and right-side values. In patients with hemiparesis, the values from the non-affected side were used. The FM index (FMI, kg/m2) and the FFM Index (FFMI, kg/m^2) were calculated by dividing the FM and FFM by height squared in metres, respectively. In the current study, FFMI and FMI defined nutritional status (Table 1). Using this definition, individuals with any BMI may be at potential nutritional risk due to decreased FFMI or high FMI (Kyle, Piccoli, et al., 2003; Kyle, Schutz, et al., 2003).

Route of feeding (parenteral, tube, oral) was collected from the medical charts as the number of days with each type of feeding and described as "fully by tube/parenteral," "partially by tube/parenteral" and "full oral." Data on energy and protein intake were collected from the nutrition charts completed by dedicated nurses with patient-centred care responsibility. Intake about oral nutritional supplements, enteral and parenteral routes was collected from the fluid balance and medication charts in electronic patient records.

For the current study, we calculated the proportion of patients with an intake of <75%, 75%–90%, >90%–110% and >110% of the calculated requirements for energy and protein intake, respectively.

2.3 | Other measures

Data about age, sex, cause and severity of brain injury and treatment-requiring infections, were collected from the patient's medical records. Treatment-requiring infections were defined as administration of antibiotics.

Severity of the injury was described using the Functional Independence Measure (FIM), and the Early Functional Abilities (EFA) at admission (Heck et al., 2000; Uniform Data System for Medical Rehabilitation. The FIM System Clinical Guide. Version 5.2, 2009).

2.3.1 | Analysis

All data analyses were performed using STATA, version 15 (StataCorp LP).

To explore the distribution of BMI groups in the body composition groups, BMI and body composition was cross-tabulated. To characterize the impact of targeted nutritional nursing care on nutritional status, we mapped nutritional status transitions between admission and after 4 weeks of neurorehabilitation and calculated the change in BMI and FFMI for those who did not change "nutritional status group." Additionally, we cross-tabulated the intake at admission and the route of nutrition with the nutritional status after 4 weeks of rehabilitation. Finally, we explored the impact of nutritional nursing care on infections, by examining the association between nutritional status on admission and infections, using multivariable logistic regression adjusting for sex and age.

2.3.2 | Ethics

This prospective, descriptive cohort study was carried out as a quality development study. In accordance with the Danish legislation, Research Ethics Committee approval was not required. The study was approved by the Danish Data Protection Agency and notified to Danish Patient Safety Authority journal number 1-16-02-526-16.

3 | RESULTS

Overall, we included 92 individuals (36 females, 56 males) with a median age of 52 years (range 18–77). The most frequent causes of injury were stroke (46%) and TBI (26%). The mean habitual BMI was 25.9 (SD 5.1). Of these, three per cent had a habitual BMI below 18.5 kg/m^2. At admission, the median score of FIM and EFA was 32 (range 18–122) and 60.5 (range 29–100), respectively. FIM and EFA scores were lower among individuals with low BMI. Most patients with low BMI or malnutrition were admitted to the rehabilitation hospital between 15 and 60 days after the injury (Table 2).

TABLE 1 Clinical definition of nutritional status using bioimpedance measurements

	FMI, kg/m^2		
FFMI, kg/m^2	Men: <1.8	Men: 1.8–8.3	Men: >8.3
	Women: <3.9	Women: 3.9–11.8	Women: >11.8
Men: ≥16.7 Women: ≥14.6	Normal underweight	Normal	Normal overweight
Men: <16.7 Women: <14.6	Malnutrition	Malnutrition	Malnutrition

Abbreviations: FFMI, Free Fat Mass index; FMI, Fat Mass Index.

TABLE 2 Characteristics of the study population stratified by low BMI and malnutrition after 4 weeks of rehabilitation (N = 92)

Characteristics	Total	Low BMI after 4 weeks of rehabilitation		Malnutrition after 4 weeks of rehabilitation according to body composition	
	N = 92	No (N = 87)	Yes (N = 5)	No (N = 81)	Yes (N = 10)
Female sex, %	39.1	39.1	40.0	40.7	30.0
Age, median years (range)	52 (18–77)	52 (18–77)	48 (21–68)	51 (18–77)	55 (28–74)
Cause of brain injury, %					
Traumatic brain injury	26.1	26.4	20.0	27.1	20.0
Stroke	45.7	47.1	20.0	48.2	30.0
Subarachnoid hemorrhage	10.9	10.3	20.0	9.9	20.0
Other	17.4	16.1	40.0	14.8	30.0
Time from injury to admission, % (missing N = 2)					
≤14 days	30.0	31.8	0.0	31.7	20.0
15–30 days	31.1	29.4	60.0	29.1	50.0
31–60 days	30.0	29.4	40.0	30.4	30.0
>60 days	8.9	9.4	0.0	8.9	0.0
Habitual BMI, % (missing N = 24)					
<18.5 kg/m^2	2.9	1.5	33.3	1.6	14.3
18.5–25 kg/m^2	45.6	44.6	66.7	41.0	85.7
25–30 kg/m^2	36.8	38.5	0.0	41.0	0.0
>30 kg/m^2	14.7	15.4	0.0	16.4	0.0
FIM at admission, median sum score (range) (missing N = 1)	32 (18–122)	33 (18–121)	20 (18–122)	33 (18–122)	20.5 (18–114)
EFA at admission, median sum score (range) (missing N = 22)	60.5 (29–100)	62 (29–100)	47.5 (44–66)	62 (29–100)	53 (41–87)

Abbreviations: BMI, Body Mass Index; EFA, Early Functional Ability; FIM, Functional Independence Measure.

TABLE 3 Body composition at admission and after 4 weeks of rehabilitation in three BMI groups

	BMI groups, kg/m^2					
	Admission (N = 92)			After 4 weeks (N = 91)		
Body composition	Low, N (%) (N = 7)	Normal, N (%) (N = 45)	Increased, N (%) (N = 40)	Low, N (%) (N = 5)	Normal, N (%) (N = 44)	Increased, N (%) (N = 42)
Normal underweight	1 (14.3)	1 (2.2)	0 (0.0)	1 (20.0)	2 (4.6)	0 (0.0)
Normal	0 (0.0)	34 (75.6)	23 (57.5)	0 (0.0)	36 (81.8)	27 (64.3)
Normal overweight	0 (0.0)	0 (0.0)	17 (42.5)	0 (0.0)	0 (0.0)	15 (35.7)
Malnutrition	6 (85.7)	10 (22.2)	0 (0.0)	4 (80.0)	6 (13.6)	0 (0.0)

Abbreviation: BMI, Body Mass Index.

3.1 | Exploring the influence of fundamental nutrition nursing care on nutritional status

Beyond the assessment and monitoring of intake and nutritional status, nurses documented taking the relational aspects into account aimed at providing an emotionally supportive partnership with the patient and relatives. When possible, they prioritized dialogue in order to contrive the patient's capabilities and unique everyday habits in preparing meals, formulating aims and decision making.

Patients who were partly nourished by enteral nutrition continuously had amount and administration method (continued by pump or bolus) adjusted, facilitating the opportunity for patients to engage in meals without struggling to achieve the requirements. The constant observation and emotionally supportive partnership with patients and relatives were essential in considering when patients were for instance too tired and not able to eat safely, about risk of aspiration. Hence the need for supplemental feeding was constantly assessed, as the individual for some meals was able to meet needs

and for some not. Furthermore, the nurses, in consultation with the multi-professional team, oversaw continuous evaluation of the patient's physical and cognitive rehabilitation process, also giving the opportunity to observe and adjust nutritional care to progressing eating capabilities. Results which may partly be derived from these efforts are presented in Tables 3 and 4, and Figure 1a,b, describing how the nutritional status evolved from admission to after 4 weeks of rehabilitation using BMI and FFM, as measured by the nurses. From admission to after 4 weeks of rehabilitation, the prevalence of malnutrition decreased from 86% to 80% in individuals with a low BMI and from 22% to 14% in individuals with a normal BMI. None of the individuals with increased BMI was malnourished at admission or after 4 weeks according to the body composition measurement. Among patients with increased BMI, the percentage of patients with normal body composition according to BIA, increased from 58% to 64% and the percentage of patients with overweight decreased from 43% to 36% (Table 3). As such, the sensitive measures of FFMI and FMI gave the nurses the opportunity to share information with the individual patients that their targeted efforts with training and nutrition gave results, and thus motivate them to keep up the good work.

Of the seven individuals with low BMI at admission, two (29%) had achieved a normal BMI after 4 weeks of rehabilitation (Figure 1a). Although the five remaining patients continued to have low BMI, BMI also increased in this group (median change 0.89) (Table 4). Among the 40 patients with high BMI at admission, 39 patients continued to have a high BMI after 4 weeks of rehabilitation (Figure 1a), however, the change in BMI was low (median change 0.17) (Table 4).

Of the 16 malnourished individuals according to body composition at admission, seven (44%) had achieved normal weight or normal underweight after 4 weeks of rehabilitation (Figure 1b). Although the nine remaining individuals were still malnourished, FFMI had also increased in this group (median 0.64) (Table 4).

Among the 17 patients with overweight body composition at admission, three achieved normal body composition after 4 weeks of rehabilitation (Figure 1b). The median FFMI increased among the remaining 14 patients (Table 4).

3.2 | Fundamental nutritional nursing care

Energy intake on admission was below 90% of calculated requirements in four of five individuals with low BMI and in five of 10 patients who were malnourished according to body composition. By contrast, protein intake was above 90% in all individuals with malnutrition regardless of BMI, and all achieved oral nutrition intake during follow-up. In relation to calculated needs, energy intake was below 90% among one-third, and more than half of these patients received less than 90% of calculated protein needs. Regardless of the criteria of malnutrition all malnourished individuals received oral nutrition during follow-up. (See Table 5).

3.3 | Association between nutritional status and infections

No association was found between nutritional status at admission and outcomes after 4 weeks of rehabilitation (Table 6).

4 | DISCUSSION

Nurses establish a supportive partnership with the patient to identify and meet care needs related to specific nutrition-related challenges. This patient–nurse relation is essential in order to ensure patient encouragement and support, in order to optimize nutrition intake. We interpret the improved body composition and the lack of association between malnutrition at admission and infections during follow-up, as the result of good quality nutritional nursing care during the follow-up period. We find that close measurement of malnutrition including BIA analyses indicate an increased sensitivity as opposed to using BMI. However, the study also raises concern in relation to the orally nourished patients especially in relation to energy intake. These items will be discussed in the following.

TABLE 4 Change in BMI and FFMI between admission and after 4 weeks of rehabilitation among those who remained in the group

| | | Change | | |
	N	Median	IQR	Range
BMI, kg/m^2				
Remained low	5	0.89	0.37–0.89	−0.26–1.54
Remained normal	41	0.41	−0.23–0.41	−1.54–2.24
Remained high	39	0.17	−0.36–0.17	−2.14–1.50
FFMI, kg/m^2				
Remained malnourished	9	0.64	0.46–0.64	−0.12–1.83
Remained normal underweight	2	0.79	0.61–0.79	0.61–0.96
Remained normal weight	54	0.08	−0.35–0.08	−1.69–2.93
Remained normal overweight	14	0.31	0.13–0.31	−1.98–2.48

Abbreviations: BMI, Body Mass Index; FFMI, Fat-Free Mass Index; IQR, Inter Quartile Range.
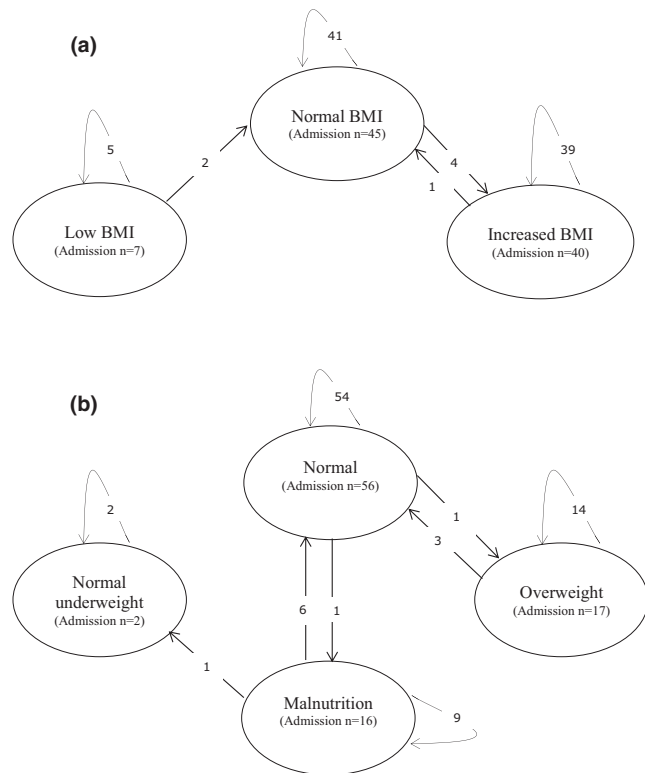
FIGURE 1 Transitions between admission and after 4 weeks of inpatient rehabilitation in (a) BMI groups and (b) Body composition groups. The numbers in the arrows are the number of individuals in the particular group at admission, who had remained in the group or transferred to another group after 4 weeks of inpatient rehabilitation. No arrow means no transition

4.1 | How to monitor nutritional status

Continuous monitoring is needed. However nutritional status can be assessed in a variety of ways. In the current study, BMI was used as a standard measure of malnutrition. Combining BMI with the measures from the BIA analysis, we showed that some patients with normal BMI were malnourished according to the body composition measures, and similarly, some patients with low BMI were normal weight according to the body composition measures (Table 3). Similarly, there were no transitions from normal BMI at admission, to low BMI after 4 weeks, but one transition from normal FFMI at admission to malnutrition after 4 weeks (Figure 1). Finally, the BIA analysis showed, that FFMI increased in most patients, including in overweight patients (Table 4). Therefore, measures of body composition may support BMI in assessing nutritional status in patients with ABI and may demonstrate higher sensibility in detecting changes in nutritional status better than BMI alone. Changes in the body composition reflect the specific changes in the body tissue where FFMI as a measure of muscle mass, offers an opportunity to elucidate targeted nursing contributions in relation to the nutritional status. The nursing contribution also includes mobilization and prevention of infections in order to facilitate anabolic processes and improved potential for participation in high-intensive exercise and repetition training activities.

The composition of body tissue might support BMI, but the use of BIA in this population may be criticized. Special care was taken to avoid invalid measurements due to hydration abnormalities. Fluid imbalance remains a statistically significant limitation to the use of

TABLE 5 Fundamental nutritional care during follow-up stratified by malnutrition after 4 weeks of rehabilitation

	Malnutrition after 4 weeks of rehabilitation according to BMI		Malnutrition after 4 weeks of rehabilitation according to body composition	
	No, N (%) (N = 86)	Yes, N (%) (N = 5)	No, N (%) (N = 81)	Yes, N (%) (N = 10)
Energy intake at admission (missing N = 1)				
<75% of calculated need	7 (8.1)	1 (20.0)	8 (10.0)	0 (0.0)
75%–90% of calculated need	22 (25.6)	3 (60.0)	20 (25.0)	5 (50.0)
>90%–110% of calculated need	38 (44.2)	0 (0.0)	35 (43.8)	2 (20.0)
>110% of calculated need	19 (22.1)	1 (20.0)	17 (21.3)	3 (30.0)
Protein intake at admission (missing N = 1)				
<75% of calculated need	22 (25.6)	0 (0.0)	22 (27.5)	0 (0.0)
75%–90% of calculated need	22 (25.6)	0 (0.0)	22 (27.5)	0 (0.0)
>90%–110% of calculated need	35 (40.7)	4 (80.0)	31 (38.8)	7 (70.0)
>110% of calculated need	7 (8.1)	1 (20.0)	5 (6.3)	3 (30.0)
Nutrition during the follow-up period, %				
Parenteral or tube nutrition	11 (12.6)	0 (0.0)	11 (13.6)	0 (0.0)
Oral nutrition	49 (56.3)	2 (40.0)	45 (55.6)	5 (50.0)
Combined parenteral, tube and oral nutrition	27 (31.0)	3 (60.0)	25 (30.9)	5 (50.0)

Abbreviation: BMI, Body Mass Index.

Body composition at admission	Infections		Adjusted OR (95% CI)
	No, % (N = 40)	Yes, % (N = 50)	
Normal	60.0	62.0	1
Normal underweight	2.5	2.0	0.55 (0.03–9.98)
Normal overweight	17.5	20.0	0.66 (0.20–2.18)
Malnutrition	20.0	16.0	0.68 (0.20–2.27)

TABLE 6 Association between body composition at admission and infections

Abbreviations: Adjusted OR, Odds Ratio adjusted for sex and age; CI, Confidence Interval.

BIA equation in clinical evaluation (Kyle, Schutz, et al., 2003). As oedema might be prevalent in paretic or paralytic limps we measured at both sides. We found no differences between the paretic side and non-paretic side about bioelectrical and body composition variables.

Malnutrition at symptom debut or during the acute phase after a brain injury is associated with higher risk of mortality, complications and decreased outcome of rehabilitation efforts. In accordance with earlier studies, we found that malnutrition was associated with low functional score indicating the severity of the brain injury (Krakau et al., 2007; Vizzini & Aranda-Michel, 2011). Despite that FFMI and FMI reference values correspond to BMI values (Kyle, Piccoli, et al., 2003; Kyle, Schutz, et al., 2003) more patients were at increased nutritional risk when defined with the body composition measures (18% at admission; 10% after 4 weeks) compared to the definition with BMI (6% at admission; 4% after 4 weeks) in the current study. This may be due to the unequal graduation of malnutrition severity or in particular, that low FFMI rather than BMI is related to increased health risks and mortality (Kyle, Schutz, et al., 2003).

4.2 | Nursing contributions in nutritional care

Improvements in nutritional status is an indication of decreasing metabolic and katabolic responses to the injury (Foley et al., 2008; Krakau et al., 2006). Eating disabilities characterized as either physical disabilities such as dysphagia or paralysis, or neuropsychological impairments such as apraxia, attention or memory still may persist, and require fundamental, however, highly specialized nursing care (Aadal et al., 2015; Medin et al., 2011). These challenges might also explain that five individuals continued to have low BMI and nine remained malnourished according to body composition after 4 weeks of rehabilitation. Remarkably, a vast amount of patients with malnutrition improved nutritional status. These positive changes might indicate high-quality nutritional care. However, the energy intake at admission was below 90% in 4 of 5 individuals with malnutrition according to BMI and in 5 of 10 patients with malnutrition according to the body composition, which gives rise to concern. Remarkably the protein intake was above 90% of calculated needs in all individuals regardless of the definition of malnutrition at admission. The defiance between calculated needs and actual intake is in line with another study

among individuals without malnutrition (Chapple et al., 2016). This might explain that one individual became malnourished but the uncertainty of estimated needs must be taken into consideration as most frequent formulas are insufficient in this population (Esper et al., 2006; Foley et al., 2009). Remarkably all malnourished individuals, regardless of the definition of malnutrition, received oral nutrition during follow-up. Thus, the discrepancy between calculated needs and intake might also be a result of our institutional practice of discouraging enteral nutrition in those who are awake and potentially able to take oral nutrition. Or, that requirements are calculated too high in this group since most patients gained muscle regardless of not meeting nutritional requirements. Regardless of measures, these patients require special attention. Special attention is needed during meals especially, as they often suffer from statistically significant fatigue and dysphagia due to inattention. The influence of constant observation and emotionally supportive partnership with patients and relatives as a focal point in inclusion and integration of the individual's desires, needs and preferences is difficult to outline exhaustively. Surprisingly, we found no association between the occurrence of infection and malnutrition at admission that might, among other reasons, indicate high nursing care standards in hygiene and other preventive interventions.

4.3 | Limitations

According to the Global Clinical Nutrition Community (GLIM), malnutrition is defined as at least one *phenotypic (*non-volitional weight loss, low BMI and reduced muscle mass*)* and at least one *etiologic* criterion at (reduced food intake or assimilation, and inflammation or disease burden). The current study only reflects on the phenotypic part of the GLIM criteria for malnutrition. This study was based on a second analysis of our former study, and nurses' records of care, in 92 patients in one hospital rehabilitation setting. A study primarily designed for the purpose of evaluation the implications of using body composition as a target parameter during nursing care of AIB rehabilitation patients in more settings, would be desirable. To reflect the frequently used values in clinical nursing practice, malnutrition using BMI was defined as a BMI below 18.5 kg/m^2 (Stratton et al., 2003; World Health Organization2021). However, this value indicates severe malnutrition according to the latest recommendations (Cederholm et al., 2019; Singer et al., 2019),

whereas moderate malnutrition is defined as BMI below 20 in patients below 70 years and BMI below 22 in patients 70 years or older. Therefore, the number of patients with malnutrition according to BMI was low in the current study, and malnutrition defined as BMI below 18.5 kg/m2 may explain the difference between the prevalence of malnutrition measured by BMI and the BIA criterion, respectively.

5 | CONCLUSION

The study indicates that body composition measures rather than BMI may contribute to target individual nutritional nursing care as this measure may detect more patients at potential risk of malnutrition and indicate minor changes in nutritional state. Measures of FFMI were used in motivational care to promote patient's nutrition intake and rehabilitation incentive. This individualized approach improved the nutritional status among individuals with malnutrition from admission to after 4 weeks stay at a rehabilitation hospital. Fundamental nutritional care is a complex multidisciplinary task where nurse's contributions imply monitoring and a supporting relationship with patient and relatives to facilitate feeding.

5.1 | Clinical implications

Patients with brain injuries have a great risk of worsening nutritional condition during hospitalization and reducing rehabilitation outcomes. The nursing contributions to the interdisciplinary nutritional efforts are personal support, continued nutrition care planning, facilitation of intake and continuous assessment and measurement of nutritional status. Bio Impedance Analyses may offer an improved specificity in measuring nutritional status as it reflects minor changes in body tissue including muscle mass. Therefore, these analyses may illuminate patient motivation and timely changes of nutrition care planning, targeting and improving the quality of individual fundamental nutritional nursing care in rehabilitation.

CONFLICT OF INTEREST
All authors confirm there are no conflicts of interests. The study received no financial support.

AUTHOR CONTRIBUTIONS
The conception and design of the study were done by LA. LA and the nursing team collected the data. The primary analysis and interpretation of data were made by LA and LO. The first draft of the manuscript was made by LA, LO and MH. All authors revised the manuscript. LA, LO and MH wrote the final edition.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on request from the corresponding author [LAa]. The data are not publicly available due to them containing information that could compromise research participant privacy and consent.

ORCID
Lena Aadal https://orcid.org/0000-0001-7365-3916

REFERENCES

Aadal, L., Mortensen, J., & Nielsen, J. F. (2015). Weight reduction after severe brain injury: A challenge during the rehabilitation course. *The Journal of Neuroscience Nursing: Journal of the American Association of Neuroscience Nurses*, 47(2), 85–90. https://doi.org/10.1097/JNN.0000000000000121

Allard, J. P., Keller, H., Jeejeebhoy, K. N., Laporte, M., Duerksen, D. R., Gramlich, L., Payette, H., Bernier, P., Davidson, B., Teterina, A., & Lou, W. (2016). Decline in nutritional status is associated with prolonged length of stay in hospitalized patients admitted for 7 days or more: A prospective cohort study. *Clinical Nutrition (Edinburgh, Scotland)*, 35(1), 144–152. https://doi.org/10.1016/j.clnu.2015.01.009

Badjatia, N., Fernandez, L., Schlossberg, M. J., Schmidt, J. M., Claassen, J., Lee, K., Connolly, E. S., Mayer, S. A., & Rosenbaum, M. (2010). Relationship between energy balance and complications after subarachnoid hemorrhage. *JPEN. Journal of Parenteral and Enteral Nutrition*, 34(1), 64–69. https://doi.org/10.1177/0148607109348797

Baltazar, G. A., Pate, A. J., Panigrahi, B., LaBoy, S., Prosniak, R., Mody, A., & Chendrasekhar, A. (2015). Malnutrition as measured by albumin and prealbumin on admission is associated with poor outcomes after severe traumatic brain injury. *The American Surgeon*, 81(2), E61–E63. https://doi.org/10.1177/000313481508100208

Beck, M., Birkelund, R., Poulsen, I., & Martinsen, B. (2019). Hospital meals are existential asylums to hospitalized people with a neurological disease: A phenomenological-hermeneutical explorative study of the meaningfulness of mealtimes. *Nursing Open*, 6(2), 626–634. https://doi.org/10.1002/nop2.246

Beck, M., Martinsen, B., Poulsen, I., & Birkelund, R. (2016). Mealtimes in a neurological ward: A phenomenological-hermeneutic study. *Journal of Clinical Nursing*, 25(11–12), 1614–1623. https://doi.org/10.1111/jocn.13161

Bharadwaj, S., Ginoya, S., Tandon, P., Gohel, T. D., Guirguis, J., Vallabh, H., Jevenn, A., & Hanouneh, I. (2016). Malnutrition: Laboratory markers vs nutritional assessment. *Gastroenterology Report (Oxf)*, 4(4), 272–280. https://doi.org/10.1093/gastro/gow013

Capra, S., Collins, C., Lamb, M., Vanderkroft, D., & Chan, S. W. (2007). Effectiveness of interventions for under nourished older inpatients in the hospital setting. *Australian Nursing Journal*, 15(5), 28–31.

Carney, N., Totten, A. M., O'Reilly, C., Ullman, J. S., Hawryluk, G. W. J., Bell, M. J., Bratton, S. L., Chesnut, R., Harris, O. A., Kissoon, N., Rubiano, A. M., Shutter, L., Tasker, R. C., Vavilala, M. S., Wilberger, J., Wright, D. W., & Ghajar, J. (2017). Guidelines for the management of severe traumatic brain injury, fourth edition. *Neurosurgery*, 80(1), 6–15. https://doi.org/10.1227/NEU.0000000000001432

Cederholm, T., Barazzoni, R., Austin, P., Ballmer, P., Biolo, G., Bischoff, S. C., Compher, C., Correia, I., Higashiguchi, T., Holst, M., Jensen, G. L., Malone, A., Muscaritoli, M., Nyulasi, I., Pirlich, M., Rothenberg, E., Schindler, K., Schneider, S. M., de van der Schueren, M., … Singer, P. (2017). ESPEN guidelines on definitions and terminology of clinical nutrition. *Clinical Nutrition (Edinburgh, Scotland)*, 36(1), 49–64.

Cederholm, T., Jensen, G. L., Correia, M. I. T. D., Gonzalez, M. C., Fukushima, R., Higashiguchi, T., Baptista, G., Barazzoni, R., Blaauw, R., Coats, A., Crivelli, A., Evans, D. C., Gramlich, L., Fuchs-Tarlovsky,

V., Keller, H., Llido, L., Malone, A., Mogensen, K. M., Morley, J. E., ... Group, G. W (2019). GLIM criteria for the diagnosis of malnutrition - A consensus report from the global clinical nutrition community. *Clinical Nutrition (Edinburgh, Scotland)*, *38*(1), 1–9.

Chapple, L. S., Deane, A. M., Heyland, D. K., Lange, K., Kranz, A. J., Williams, L. T., & Chapman, M. J. (2016). Energy and protein deficits throughout hospitalization in patients admitted with a traumatic brain injury. *Clinical Nutrition (Edinburgh, Scotland)*, *35*(6), 1315–1322.

Collaborators, G. B. D. O., Afshin, A., Forouzanfar, M. H., Reitsma, M. B., Sur, P., Estep, K., & Murray, C. J. L. (2017). Health Effects of Overweight and Obesity in 195 Countries over 25 Years. *The New England Journal of Medicine*, *377*(1), 13–27. https://doi.org/10.1056/NEJMoa1614362

da Rocha, E. E. M., Alves, V. G. F., & da Fonseca, R. B. V. (2006). Indirect calorimetry: Methodology, instruments and clinical application. *Current Opinion in Clinical Nutrition and Metabolic Care*, *9*(3), 247–256. https://doi.org/10.1097/01.mco.0000222107.15548.f5

Dénes, Z. (2004). The influence of severe malnutrition on rehabilitation in patients with severe head injury. *Disability and Rehabilitation*, *26*(19), 1163–1165. https://doi.org/10.1080/09638280412331270380

Dickerson, R. N., Pitts, S. L., Maish, G. O., Schroeppel, T. J., Magnotti, L. J., Croce, M. A., Minard, G., & Brown, R. O. (2012). A reappraisal of nitrogen requirements for patients with critical illness and trauma. *The Journal of Trauma and Acute Care Surgery*, *73*(3), 549–557. https://doi.org/10.1097/TA.0b013e318256de1b

Dreer, L. E., Ketchum, J. M., Novack, T. A., Bogner, J., Felix, E. R., Corrigan, J. D., Johnson-Greene, D., & Hammond, F. M. (2018). Obesity and overweight problems among individuals 1 to 25 years following acute rehabilitation for traumatic brain injury: A NIDILRR traumatic brain injury model systems study. *The Journal of Head Trauma Rehabilitation*, *33*(4), 246–256. https://doi.org/10.1097/HTR.0000000000000408

Duraski, S. A., Lovell, L., & Roth, E. J. (2014). Nutritional intake, body mass index, and activity in postacute traumatic brain injury: A preliminary study. *Rehabilitation Nursing: The Official Journal of the Association of Rehabilitation Nurses*, *39*(3), 140–146. https://doi.org/10.1002/rnj.138

Erdman, J., Oria, M., & Pillsbury, L. (2011). *Nutrition in Clinical Practice Guidelines for Traumatic Brain Injury Nutrition and Traumatic Brain Injury. Improving Acute ans Subacute health Outcomes in Military Personnel* (Vol. *1*): National Academies Press.

Esper, D. H., Coplin, W. M., & Carhuapoma, J. R. (2006). Energy expenditure in patients with nontraumatic intracranial hemorrhage. *Journal of Parenteral and Enteral Nutrition*, *30*(2), 71–75. https://doi.org/10.1177/014860710603000271

Feo, R., Conroy, T., Jangland, E., Muntlin Athlin, Å., Brovall, M., Parr, J., Blomberg, K., & Kitson, A. (2018). Towards a standardised definition for fundamental care: A modified Delphi study. *Journal of Clinical Nursing*, *27*(11–12), 2285–2299. https://doi.org/10.1111/jocn.14247

Feo, R., Kitson, A., & Conroy, T. (2018). How fundamental aspects of nursing care are defined in the literature: A scoping review. *Journal of Clinical Nursing*, *27*(11–12), 2189–2229. https://doi.org/10.1111/jocn.14313

Foley, N., Marshall, S., Pikul, J., Salter, K., & Teasell, R. (2008). Hypermetabolism following moderate to severe traumatic acute brain injury: A systematic review. *Journal of Neurotrauma*, *25*, 1415–1431. https://doi.org/10.1089/neu.2008.0628

Foley, N. C., Salter, K. L., Robertson, J., Teasell, R. W., & Woodbury, M. G. (2009). Which reported estimate of the prevalence of malnutrition after stroke is valid? *Stroke: A Journal of Cerebral Circulation*, *40*, e66–e74. https://doi.org/10.1161/STROKEAHA.108.518910

Frankenfield, D. C., & Ashcraft, C. M. (2012). Description and prediction of resting metabolic rate after stroke and traumatic brain injury. *Nutrition*, *28*(9), 906–911. https://doi.org/10.1016/j.nut.2011.12.008

Fuhrman, M. P. (2002). The albumin-nutrition connection: Seperating myth from fact. *Nutrition*, *18*, 199–200.

Godbolt, A. K., Stenberg, M., Jakobsson, J., Sorjonen, K., Krakau, K., Stalnacke, B. M., & Nygren DeBoussard, C. (2015). Subacute complications during recovery from severe traumatic brain injury: Frequency and associations with outcome. *British Medical Journal Open*, *5*(4), e007208-002014-007208. https://doi.org/10.1136/bmjopen-2014-007208

Health, T. D. N. B. o (2008). *A guide for doctors, nurses, health care assistants, auxilary nurses and clinical dietians - screening and treatment of patients at nutritional risk*. Retrieved from Copenhagen.

Heck, G., Steiger-Bachler, G., & Schmidt, T. (2000). Early functional abilities (EFA) Eine Skala zur Evaluation von Behandlungsverläufen in der neurologischen Frührehabilitation. *Neurological Rehabilitation*, *6*, 125–133.

Henderson, V. (2006). The concept of nursing. 1977. *Journal of Advanced Nursing*, *53*(1), 21–31; discussion 32–24. doi:JAN3660

Holst, M., Beermann, T., Mortensen, M. N., Skadhauge, L. B., Køhler, M., Lindorff-Larsen, K., & Rasmussen, H. H. (2017). Optimizing protein and energy intake in hospitals by improving individualized meal serving, hosting and the eating environment. *Nutrition (Burbank, Los Angeles County, Calif.)*, *34*, 14–20.

Jefferies, D., Johnson, M., & Ravens, J. (2011). Nurturing and nourishing: The nurses' role in nutritional care. *Journal of Clinical Nursing*, *20*(3–4), 317–330. https://doi.org/10.1111/j.1365-2702.2010.03502.x

Kitson, A., Conroy, T., Wengstrom, Y., Profetto-McGrath, J., & Robertson-Malt, S. (2010). Defining the fundamentals of care. *International Journal of Nursing Practice*, *16*(4), 423–434. https://doi.org/10.1111/j.1440-172X.2010.01861.x

Kondrup, J. (2014). Nutritional-risk scoring systems in the intensive care unit. *Current Opinion in Clinical Nutrition and Metabolic Care*, *17*(2), 177–182. https://doi.org/10.1097/MCO.0000000000000041

Kondrup, J., Allison, S. P., Elia, M., Vellas, B., & Plauth, M. (2003). ESPEN guidelines for nutrition screening 2002. *Clinical Nutrition*, *22*, 415–421. https://doi.org/10.1016/S0261-5614(03)00098-0

Krakau, K., Hansson, A., Karlsson, T., de Boussard, C. N., Tengvar, C., & Borg, J. (2007). Nutritional treatment of patients with severe traumatic brain injury during the first six months after injury. *Nutrition*, *23*, 308–317. https://doi.org/10.1016/j.nut.2007.01.010

Krakau, K., Omne, P., Karlsson, T., & Borg, T. (2006). Metabolism and nutrition in patients with moderate and severe traumatic brain injury: A systematic review. *Brain Injury*, *20*(4), 345–367. https://doi.org/10.1080/02699050500487571

Kyle, U. G., Piccoli, A., & Pichard, C. (2003). Body composition measurements: Interpretation finally made easy for clinical use. *Current Opinion in Clinical Nutrition and Metabolic Care*, *6*(4), 387–393. https://doi.org/10.1097/01.mco.0000078988.18774.3d

Kyle, U. G., Schutz, Y., Dupertuis, Y. M., & Pichard, C. (2003). Body composition interpretation. Contributions of the fat-free mass index and the body fat mass index. *Nutrition (Burbank, Los Angeles County, Calif.)*, *19*(7–8), 597–604.

Medin, J., Windahl, J., von Arbin, M., Tham, K., & Wredling, R. (2011). Eating difficulties among stroke patients in the acute state: A descriptive, cross-sectional, comparative study. *Journal of Clinical Nursing*, *20*(17–18), 2563–2572. https://doi.org/10.1111/j.1365-2702.2011.03812.x

Morbitzer, K. A., Wilson, W. S., Chaben, A. C., Darby, A., Dehne, K. A., Brown, E. R., Rhoney, D. H., & Jordan, J. D. (2019). Energy expenditure in critically ill adult patients with acute brain injury: Indirect calorimetry vs. predictive equations. *Frontiers in Neurology*, *10*, 1426. https://doi.org/10.3389/fneur.2019.01426

Mosselman, M., Kruitwagen, C. J. J., Schuurmans, M. J., & Hafsterinsdöttir, T. (2013). Malnutrition and risk of malnutrition in patients with stroke: Prevalence during hospital stay. *Journal of Neuroscience Nursing*, *45*(4), 194–204. https://doi.org/10.1097/JNN.0b013e31829863cb

Odgaard, L., Aadal, L., Eskildsen, M., & Poulsen, I. (2020). Using clinical quality databases to monitor the quality of fundamental care: Example with weight status after severe traumatic brain injury. *Journal of Clinical Nursing, Special Issue Article*, *29*(11–12), 2031–2038. https://doi.org/10.1111/JOCN.15233

Pentecost, C., Frost, J., Sugg, H. V. R., Hilli, A., Goodwin, V. A., & Richards, D. A. (2019). Patients' and nurses' experiences of fundamental nursing care: A systematic review and qualitative synthesis. *Journal of Clinical Nursing*, *29*, 1–25. https://doi.org/10.1111/jocn.15082

Perel, P., Yanagawa, T., Bunn, F., Roberts, I. G., & Wentz, R. (2008). Nutrititional support for head-injured patients (Review). *The Cochrane Library*, *4*, 1–22.

Perry, L., Hamilton, S., Williams, J., & Jones, S. (2013). Nursing interventions for improving nutritional status and outcomes of stroke patients: Descriptive reviews of processes and outcomes. *WVN World Views on Evidence-Based Nursing*, *10*, 17–40. https://doi.org/10.1111/j.1741-6787.2012.00255.x

Richards, D. A., Coulthard, V., & Borglin, G. (2014). The state of European nursing research: Dead, alive, or chronically diseased? A systematic literature review. *Worldviews on Evidence-Based Nursing*, *11*(3), 147–155. https://doi.org/10.1111/wvn.12039

Richards, D. A., Hilli, A., Pentecost, C., Goodwin, V. A., & Frost, J. (2018). Fundamental nursing care: A systematic review of the evidence on the effect of nursing care interventions for nutrition, elimination, mobility and hygiene. *Journal of Clinical Nursing*, *27*(11–12), 2179–2188. https://doi.org/10.1111/jocn.14150

Schofield, W. N. (1985). Predicting basal metabolic rate, new standards and review of previous work. *Human nutrition Clinical Nutrition*, *39*(Suppl 1), 5–41.

Singer, P., Blaser, A. R., Berger, M. M., Alhazzani, W., Calder, P. C., Casaer, M. P., Hiesmayr, M., Mayer, K., Montejo, J. C., Pichard, C., Preiser, J.-C., van Zanten, A. R. H., Oczkowski, S., Szczeklik, W., & Bischoff, S. C. (2019). ESPEN guideline on clinical nutrition in the intensive care unit. *Clinical Nutrition (Edinburgh, Scotland)*, *38*(1), 48–79.

Smith, S., Westergren, A., Saunders, J., & Hagell, P. (2016). Nutritional screening: A user-friendly tool adapted from Sweden. *British Journal of Nursing (Mark Allen Publishing)*, *25*(4), 208–211. https://doi.org/10.12968/bjon.2016.25.4.208

Stenholm, S., Harris, T. B., Rantanen, T., Visser, M., Kritchevsky, S. B., & Ferrucci, L. (2008). Sarcopenic obesity: Definition, cause and consequences. *Current Opinion in Clinical Nutrition and Metabolic Care*, *11*(6), 693–700. https://doi.org/10.1097/MCO.0b013e328312c37d

Stratton, R. J., Green, C. J., & Elia, M. (2003). Scientific criterias for Defining malnutrition. *Disease-related Malnutrition: An Evidence-based Approach to Treatment* (pp. 1–35). CABI Publishing.

Stratton, R. J., Hackston, A., Longmore, D., Dixon, R., Price, S., Stroud, M., King, C., & Elia, M. (2004). Malnutrition in hospital outpatients and inpatients: Prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults. *The British Journal of Nutrition*, *92*(5), 799–808.

Tulek, Z., Poulsen, I., Gillis, K., & Jonsson, A. C. (2018). Nursing care for stroke patients: A survey of current practice in 11 European countries. *Journal of Clinical Nursing*, *27*(3–4), 684–693. https://doi.org/10.1111/jocn.14017

Uniform Data System for Medical Rehabilitation. The FIM System Clinical Guide. Version 5.2 (2009). Retrieved from Buffalo (NY).

Verbeek, J. M., van Wegen, E., van Peppen, R., van der Wees, P. J., Hendriks, E., Rietberg, M., & Kwakkel, G. (2014). What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. *PLoS One*, *9*(2), e87987. https://doi.org/10.1371/journal.pone.0087987

Vizzini, R. D., & Aranda-Michel, M. (2011). Nutritional support in head injury. *Nutrition*, *27*, 129–132. https://doi.org/10.1016/j.nut.2010.05.004

Wang, X., Dong, Y., Han, X. I., Qi, X.-Q., Huang, C.-G., & Hou, L.-J. (2013). Nutritional support for patients sustaining traumatic brain injury: A systematic review and meta-analysis of prospective studies. *Plus One*, *8*(3), 1–14. https://doi.org/10.1371/journal.pone.0058838

World Health Organization(2021). *Body mass Index- BMI*. Retrieved from euro.who.int