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ORIGINAL RESEARCH

Nutritional intervention in cognitively impaired geriatric trauma patients: a feasibility study

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Background: Most studies focusing on improving the nutritional status of geriatric trauma patients exclude patients with cognitive impairment. These patients are especially at risk of malnutrition at admission and of worsening during the perioperative fasting period. This study was planned as a feasibility study to identify the difficulties involved in including this high-risk collective of cognitively impaired geriatric trauma patients.

Patients and methods: This prospective intervention study included cognitively impaired geriatric patients (Mini–Mental State Examination <25, age >65 years) with hip-related fractures. We assessed Mini Nutritional Assessment (MNA), Nutritional Risk Screening (NRS 2002), body mass index, calf circumference, American Society of Anesthesiologists' classification, and Braden Scale. All patients received parenteral nutritional supplementation of 800 kcal/d for the 96-hour perioperative period. Serum albumin and pseudocholinesterase were monitored. Information related to the study design and any complications in the clinical course were documented.

Results: A total of 96 patients were screened, among whom eleven women (median age: 87 years; age range: 74–91 years) and nine men (median age: 82 years; age range: 73–89 years) were included. The Mini–Mental State Examination score was 9.5 (0–24). All patients were manifestly undernourished or at risk according to MNA and NRS 2002. The body mass index was 23 kg/m^2 (13–30 kg/m^2), the calf circumference was 29.5 cm (18–34 cm), and the mean American Society of Anesthesiologists' classification status was 3 (2–4). Braden Scale showed 18 patients at high risk of developing pressure ulcers. In all, 12 patients had nonsurgical complications with 10% mortality. Albumin as well as pseudocholinesterase dropped significantly from admission to discharge. The study design proved to be feasible.

Conclusion: The testing of MNA and NRS 2002 was feasible. Cognitively impaired trauma patients proved to be especially at risk of malnutrition. Since 96 hours of parenteral nutrition as a crisis intervention was insufficient, additional supplementation could be considered. Laboratory and functional outcome parameters for measuring successive supplementation certainly need further evaluations involving randomized controlled trials.

Keywords: malnutrition, perioperative nutrition management, elderly, cognitive impaired geriatric trauma patients

Introduction

Owing to demographic changes, malnutrition is a continuing source of concern among older people.[1,2] Data show that up to 55% of elderly hospitalized patients and up to 58% of patients with a hip fracture are undernourished on admission.[3–6] Perioperative medical complications, perioperative periods of prolonged fasting while waiting for surgical treatment, and preexisting dementia may also restrict nutritional intake in the perioperative phase.[7,8] It is estimated that ~30% of patients who sustain a hip

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fracture also have cognitive impairment.[9–11] We know that, especially in cognitively impaired patients, oral food intake is challenging. During dementia progression, patients may no longer know what they are supposed to do with the food, and their eating skills are lost.[12] Thus, weight loss is a prominent clinical feature of dementia.[13,14] There is evidence that the association between dementia and weight loss increases in the more severe stages of dementia.[15] There is also some evidence that a low body mass index (BMI) is associated with reduced survival and that older patients with dementia benefit from higher BMIs.[16,17]

For a large number of patients, poor nutritional status represents an underlying cause of falls and fractures.[18] According to a study by Eneroth et al,[19] the intake of energy during hospital stays is considerably lower than is needed. Postfracture loss of body mass and muscle strength causes further impairment of already impaired muscle function.[3] Furthermore, malnutrition has a strong negative impact on wound healing[20,21] and is associated with prolonged hospital stays and higher mortality rates.[22] Thus, the improvement of patients' nutritional status could help optimize care for geriatric trauma patients.

Many of the studies focusing on improving the nutritional status of geriatric trauma patients exclude patients with dementia or other kinds of cognitive impairment.[8,19,23] This is a common problem; in a recent review dealing with hip fracture patients, only 19 of 72 randomized controlled trial studies included both cognitively intact and impaired patients and only 14 reported the use of a validated cognitive assessment tool.[24]

However, these patients are of particular interest, as they are at maximum risk of having malnutrition at admission and of worsening during the perioperative period. Studies focusing on nightly tube feeding have shown inconsistent results but have matched the reporting about some patients' poor tolerance of nasogastric tubes.[25,26] In the mentioned investigations, 25%–82% of included patients did not tolerate tubes until the end point of intervention. The European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines on nutrition in dementia[27] suggest parenteral nutrition if there is an indication for artificial nutrition but tube feeding is contraindicated or not tolerated, if the period is shorter than 10 days, or if central venous line is already in place for other reasons.

In this pilot study, we assessed a treatment of 96 hours of perioperative parenteral nutrition with standardized energy intake in a sample of cognitively impaired geriatric hip fracture patients who were undernourished or at risk of malnutrition. This study was planned as a feasibility study to detect the specific problems and difficulties related to screening, inclusion, nutritional intervention, and outcome measurement in this fragile, high-risk group of cognitively impaired geriatric trauma patients.

Patients and methods

The study was approved by the local ethics committee of the Philipps University of Marburg (Ethikkomission der Universität Marburg), and written informed consent was obtained from participants or from their legal guardians.

The screening procedure of this prospective single-center intervention study included all geriatric patients (age 60 years or older) with proximal femoral fractures (ICD 10 S 72.0–72.2) admitted to our emergency department. The exclusion criteria were pathological fractures or malignancy-associated fractures, multiple traumas, contraindications for parenteral nutrition (such as a soy protein or peanut allergy), and severe liver impairment.

We included all patients identified as being cognitively impaired by Mini–Mental State Examination (<25)[28] in our prospective study design. Subsequently, we used two screening questionnaires, the Mini Nutritional Assessment (MNA) Elderly and the 2002 version of the Nutritional Risk Screening (NRS 2002) to detect malnutrition. We also measured patients' BMI, calf circumference (CC), prefracture Barthel Index, and American Society of Anesthesiologists' classification status.[29] The type of surgery (osteosynthesis or prosthesis) and the lengths of the patients' stays in the intensive care unit and in the hospital were documented.

If patients were identified as being at risk of malnutrition or as being manifestly malnourished, they received parenteral nutritional supplementation (SmofKabiven Peripheral; Fresenius Kabi Austria GmbH, Graz, Austria) offering 800 kcal/d as well as 1.206 L of fluid supplementation for the 96-hour perioperative period. Laboratory parameters such as albumin, pseudocholinesterase (PCHE), and triglycerides were monitored at admission and discharge, and additionally albumin and triglycerides were monitored once a day during the intervention.

Intervention-associated local complications (eg, increased rate of intravenous accesses or local infections) and systemic complications (eg, hypervolemia and elevated liver enzymes or fatty acids) were documented. Further local and systemic complications as well as hospital mortality were recorded. Prefracture mobility was measured using the new mobility score as a validated predictor of long-term mortality and rehabilitation outcome in patients with hip fractures.[30] The scores ranged between 0 and 3 (0, "not at all"; 1, "with

help from another person"; 2, "with an aid"; and 3, "with no difficulty") for each function, resulting in a total score from 0 (indicating no walking ability at all) to 9 (indicating full independence). Our physiotherapists scored postfracture mobilization by assessing the following grades: 0, "no mobilization"; 1, "sitting"; 2, "standing"; 3, "walking"; and 4, "climbing stairs." The Timed Up and Go (TUG) test[31] was used as well, if possible. Risk stratification for decubital ulcers was done according to the Braden Scale.[32]

We collected data in an Excel 2013 database (Microsoft Corporation, Redmond, WA, USA). We used double entry with a plausibility check to improve data quality. We used Predictive Analytics SoftWare Version 22.0 (SPSS Inc., Chicago, IL, USA) for descriptive statistics and explorative data analysis.

Results

We screened 96 patients; after identifying the patients who were cognitively impaired and who did not meet the exclusion criteria, we sought permission from the patients' legal guardians for inclusion. As a result, 25 qualified patients were identified; five of them were excluded due to their moribund status or their lack of the required legal guardianship. The baseline is given in Table 1. The sample included eleven women (median age: 87 years; age range: 74–91 years) and nine men (median age: 82 years; age range: 73–89 years). The median Mini–Mental State Examination score at admission was 9.5 (range: 0–24). All patients in the sample were undernourished or at risk of malnutrition on one or both of the MNA or the NRS 2002. All the tests were interviewer administered, with the assistance of an accompanying relative or legal guardian. In some cases, such as for institutionalized patients, the relatives or legal guardians could not provide enough information. In these cases, the staff of the nursing home helped to acquire further information using their own knowledge or available medical records. The patients' median BMI was 23 kg/m^2 (range: 12.9–29.9 kg/m^2), with five patients being overweight and four patients being underweight. The median CC was 29.5 cm (range: 18–34 cm). All patients who were underweight according to BMI had diminished CC. Another eight patients had CCs >30 cm. The mean Barthel Index was 40 (range: 20–95), and the mean American Society of Anesthesiologists' classification status was 3 (range: 2–4). Of the patients in the sample, three received prostheses and 17 received osteosynthesis. The mean hospital stay lasted 13 days (range: 7–17 days), including a mean of 1 day in the intensive care unit (range: 0–17 days). One patient spent 17 days in the intensive care unit before dying due to pneumonia and respiratory failure. The sample included 12 patients with nonsurgical complications (Table 2); the mortality rate was 10%.

Table 1 Baseline data

ID	Age (years)	Sex	ASA	MMSE	BMI (kg/m^2)	CC (cm)	MNA	NRS 2002	BI-A
1	89	F	4	9	20.8	32	12	3	35
2	78	F	3	10	26.3	33.5	16	3	40
3	82	M	3	20	29.9	36	17	3	70
4	82	M	3	0	20.3	28	6.5	3	20
5	77	F	3	10	23.4	25	7.5	3	40
6	80	F	3	7	24	29	14	2	35
7	90	F	4	24	18	20	10	3	55
8	91	F	4	20	12.9	18	13	5	60
9	87	M	3	15	25.1	–	14.5	3	85
10	87	F	3	3	27.3	31	10.5	3	50
11	75	F	3	15	15.5	19	10	5	40
12	82	M	3	5	–	28	24.5	2	80
13	73	M	4	4	22.9	34	13	2	20
14	88	M	3	2	27	31	16.5	3	35
15	86	F	2	9	26.3	31	18.5	2	25
16	89	F	3	1	25	–	16	3	40
17	85	M	3	0	22.5	30	12	1	55
18	74	F	3	10	18.3	29	11	3	65
19	89	M	3	21	26.5	34.5	23.5	2	95
20	81	M	3	16	22.5	29	18.5	3	35

Notes: Gray-shaded fields highlight patients who did not survive in patient stay. "–" Indicates missing value.
Abbreviations: ASA, American Society of Anesthesiologists; MMSE, Mini–Mental State Examination; BMI, body mass index; CC, calf circumference; MNA, Mini Nutritional Assessment; NRS 2002, Nutritional Risk Score; BI-A, Barthel Index at admission; F, female; M, male.

Table 2 Analytical separation of complications

Complication	Number of patients
Pleural effusion	2[a]
Urinary tract infection	5
NSTEMI	1
Pneumonia	2[a]
Pneumothorax	1
Clostridium difficile infection	1
Anemia	2
Death	2

Note: [a]Same patient.
Abbreviation: NSTEMI, non-ST-segment elevation myocardial infarction.

Parenteral nutrition was started in all cases directly after admission and provided for 96 hours. Two patients did not tolerate peripheral venous line and therefore did not receive more than 48 hours of parenteral nutrition. The venous line was not replaced if a patient reacted with confusion or aggression (as in both cases mentioned earlier).

Hypoalbuminemia was defined as a serum albumin of <36 mg/dL.[33] The median albumin level was 34 mg/dL (range: 18–41 mg/dL) at admission and 29 mg/dL (range: 26–30 mg/dL) at discharge. This difference was statistically significant (Figure 1A; P=0.016). A similarly significant drop was detected in PCHE (Figure 1B). Triglycerides ranged mostly in physiological or mild elevated levels. None of the patients showed triglycerides >500 mmol/L; only one had two measurements >200 mmol/L. All other patients did not pass 200 mmol/L during the intervention. The complete amounts are given in Table 3.

The median new mobility score for pretrauma mobility was only 0.5 (range: 0–5). Postoperative assessments showed that only one patient could perform the TUG test. The mobilization scores included some good results, with 15 patients achieving at least a standing position. The Braden Scale underlined the high risk of developing decubital ulcers, as 18 patients were in the high-risk group (Table 4).

Discussion

Although malnutrition is known to be a frequent finding in geriatric patients, data regarding cognitively impaired geriatric trauma patients are sparse, as this cohort is often excluded from nutritional supplementation studies.[20–22]

By present nutritional intervention pilot study, we aimed to detect the specific problems and difficulties related to screening, inclusion and nutritional intervention, and at least outcome measurement in this fragile, high-risk group of cognitively impaired geriatric trauma patients.

At first, some legal guardians were not available or not appointed at admission and therefore could not agree to participate at admission. Since ESPEN[34] recommends screening for malnutrition to be an integrative part of geriatric assessment, including interventions for improvement of nutritional status in patients identified to be malnourished, a feasible study design for these patients should include the possibility for a subsequent approval when legal guardians are within reach.

Numerous tools are available in the literature to screen for malnutrition, but as mentioned in ESPEN's guidelines on nutrition in dementia,[34] none of these tools have been specifically designed or validated for persons with dementia. Nevertheless, the MNA has shown wide acceptance among cognitively impaired patients, and the MNA Short Form has

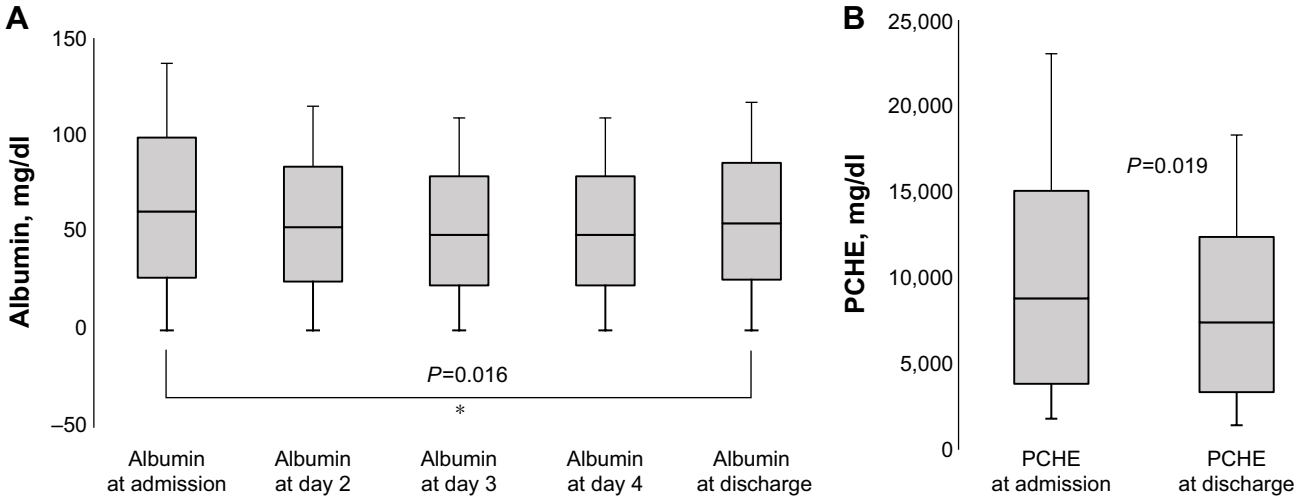

Figure 1 (**A**) Median albumin levels at admission; at days 2, 3, and 4 of nutritional supplementation; and at discharge. (**B**) Median PCHE = PCHE at admission and discharge.
Notes: Data are given as median and quartiles. *P≤0.05.
Abbreviation: PCHE, pseudocholinesterase.

Table 3 Analytical data of serological parameters

Albumin (mg/dL)	Median	Range	PCHE (U/L)	Median	Range	Triglycerides (mmol/L)	Median	Range
Admission	34	18–41	Admission	4,965	2,020–7,991	Admission	77	42–251
Day 2	28	20–35	Day 2	–	–	Day 2	73	28–436[a]
Day 3	26	22–32	Day 3	–	–	Day 3	82	40–381[a]
Day 4	26	22–32	Day 4	–	–	Day 4	78	42–187
Discharge	29	29–31	Discharge	4,065	1,910–5,945	Discharge	106	54–186

Notes: PCHE was measured only at admission and discharge. [a]Both amounts were measured in the same patient. "–" Indicates no planned blood analysis.
Abbreviation: PCHE, pseudocholinesterase.

been validated especially for older people and is reported to be used frequently in populations both with and without dementia.[35–38] Both of the screening tools used, the MNA and NRS 2002, are reported to be, especially, suitable for patients with proximal femoral fractures.[39] Nevertheless, information about a patient's prefracture nutritional status was difficult and time consuming to determine when relatives were not present. Nevertheless, this could be accomplished in most cases, and since all the included patients were shown to be manifestly undernourished or at risk on at least one of the two tests, this study's data underline the importance of this topic.

Furthermore, we tried to add information through anthropometric and serological screening parameters. Recent data showed that higher BMI is associated with decreased risk of mortality,[40] but simultaneously more obese and older patients are known to be more likely to develop adverse outcomes following a primary total hip replacement.[41] Concerning CC, a cutoff of 30.5 cm for both men and women is reported to provide a good diagnostic capacity.[42] Our results showed a correlation of CC among underweight patients (BMI <18 kg/m^2) but not among all patients. Since some patients suffered from cardiac failure, peripheral edemas may have influenced these measurements.

Despite increasing evidence that hepatic protein levels do not depend only on nutritional intake, these proteins continue to be used to assess patients' nutritional states and to diagnose malnutrition.[43,44] Serum albumin levels at admission are known to be a significant independent predictor of complications in geriatric trauma patients.[29] In our collective, one of eleven patients showing hypoalbuminemia at admission died during the study. Keeping in mind that four patients were shown to be underweight according to BMI, three of these patients had hypoalbuminemia and all of them were at risk or malnourished according to MNA and NRS 2002. BMI and albumin proved not to be suitable as the sole screening parameters for malnutrition in our cohort. These findings are in line with the current literature reporting that in the perioperative situation, neither hypoalbuminemia nor BMI is reliable for the diagnosis of protein energy malnutrition.[45]

Table 4 Outcome scores

Test	Item	Results
TUG test	Possible	1 patient –7 seconds
	Not possible	19
Mobilization	0. No mobilization	2
	1. Sitting	3
	2. Standing	7
	3. Walking	7
	4. Climbing stairs	1
NMS, median/range		0.5 (0–5)
BS	≥10 points	2
	6–9 points	18

Abbreviations: TUG, Timed Up and Go; NMS, new mobility score for in-hospital outcome; BS, Braden Scale.

The outcome parameters for the measurement of the success of short-term nutritional supplementation during hospitalization proved to be difficult to identify. Following patients' protein levels in serum was feasible, but as albumin has a long half-life of 18–20 days,[46] it may have reduced sensitivity for detection of recent changes in the nutritional state.

Subsequently, we observed that short-term parenteral supplementation as a crisis intervention did not prevent patients' albumin and PCHE levels from dropping during the 7–17 days between admission and submission. This finding is in line with other intervention studies.[47] Albumin shows an immediate response to surgical stress,[48–50] and the findings of a recent pilot study suggest that postoperative albumin decrease reliably quantifies the magnitude of a surgery.[51] The underlying reasons for postoperative albumin decreases are summarized as an interplay of a decreased fractional synthesis rate, a capillary leak due to the metabolic stress response,[52–54] and hemodilution as a potential confounder. Fractional albumin synthesis increases again during the early postoperative period proportionally to the degree of inflammation; additionally, production can be further stimulated by perioperative nutrition and nutrition being initiated before the operation, as done in our intervention. Recently, it has been published that isolated fracture of the femur elicits an inflammatory response in geriatric trauma patients similar to low injury severity in polytrauma patients.[55] This may

explain the decrease in albumin levels that were observed in our high-risk cohort despite nutritional supplementation. Maybe additional oral nutritional supplements (ONS) would prove the effects, as ONS already proved beneficial in gaining weight in frail or malnourished patients. Nevertheless, improvement in functional status or mortality by ONS was not seen in hip fracture or demented populations.[56] In a meta-analysis of 22 trials, seven reported that nutritionally supplemented patients had shorter overall lengths of their hospital stays.[3] In line with other publications,[57–59] the mean length of stay in our cohort was 13 days but as diagnosis-related groups system used in Germany requires a minimum of 13 days to determine the estimated costs of each stay, this parameter is difficult to interpret.[60] Since the TUG test requires no special equipment or training, we tried to assess it in our cohort. This failed due to prefracture immobility and cognitive decline, which caused patients to simply not understand the instructions. Finally, the intervention-related complications were sparse; we had only few patients who did not tolerate venous line and there was no catheter-associated infection. Severe hyperlipidemia did not occur. Therefore, we can recommend parenteral nutritional intervention as a safe and feasible perioperative crisis intervention but may be not sufficient without further aftercare in this collective.

Our pilot study had some limitations. First, our local ethical authorities allowed including only a small number of patients for pilot study. As we primarily aimed to detect the pitfalls in inclusion of cognitively impaired patients, we did not have a control group. Therefore, we could not compare clinical courses of our patients to those without intervention. Besides, we had ethical concerns, depriving patients classified as malnourished from nutritional supplementation. Finally, two patients were not able to complete more than 48 hours of parenteral nutrition; this may have biased the laboratory outcome parameters.

Conclusion

Summing up the mentioned findings, cognitively impaired trauma patients showed to be especially at risk of malnutrition and at high risk of developing decubital ulcers and experiencing a comparatively high rate of nonsurgical complications. MNA and NRS 2002 proved to be feasible screening methods for identifying these patients. Because 96 hours of parenteral nutrition alone failed to bring out a significant improvement in our cohort, additional application of ONS could be considered in further clinical courses. Laboratory and functional outcome parameters for measuring successive supplementation surely need further evaluations involving randomized controlled trials.

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Author contributions

All authors contributed toward data analysis, drafting and critically revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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