

## Original Communications

# Nutrition Status and Pressure Ulcer: What We Need for Nutrition Screening

Susanne Hengstermann; Andreas Fischer, MD; Elisabeth Steinhagen-Thiessen, MD, PhD; and Ralf-Joachim Schulz, MD, PhD

From the Research Group on Geriatrics at "Evangelisches Geriatriezentrum Berlin," Charité-Universitätsmedizin Berlin, Campus Virchow-Klinikum, Berlin, Germany

**ABSTRACT.** *Background:* Pressure ulcers (PU) and malnutrition exist in elderly hospitalized patients as a significant and costly problem. The aim of the study was to compare different screening tools to assess nutrition status and to verify them for usage in clinical routine. *Methods:* Nutrition status (body mass index [BMI], Mini Nutritional Assessment [MNA], weight loss) was determined in 484 (326 female/158 male) multimorbid elderly patients with mean age of  $79.6 \pm 7.6$  ( $80.9 \pm 7.4$  female/ $76.9 \pm 7.4$  male) years. Bioelectrical impedance analysis (BIA; Nutrigard 2000-M) was used for evaluation of body composition. Activities of daily living (ADL) were measured with the Barthel Index. PUs were divided into stages I–IV (European Pressure Ulcer Advisory Panel [EPUAP]) and were assessed by the Norton scale. *Results:* The prevalence of PU was 16.7%, with a median Norton scale of 20 (range, 17–24). According to MNA, 39.5% of the PU patients were malnourished, and 2.5% were well

nourished. By contrast, 16.6% of the non-PU patients were malnourished, and 23.6% were well nourished. BMI decreased significantly in PU patients ( $p < .008$ ). BIA resulted in no significant resistance and reactance but in a significant reduction of phase angle in PU. According to a significantly reduced body cell mass and lean body mass in PU patients, the ADL decreased in these patients, too. Furthermore, we analyzed a significant effect of age, ADL, MNA, BMI, phase angle, and body cell mass on the Norton scale. *Conclusions:* The MNA as a screening and assessment tool is easy to use to determine the nutrition status in multimorbid geriatric patients with PU. Further studies are needed to show an improved outcome of PU healing if evaluation of nutrition status is part of routine clinical practice in multimorbid elderly risk patients within the first day after admission. (*Journal of Parenteral and Enteral Nutrition* 31:288–294, 2007)

A few years ago, Takeda et al<sup>1</sup> investigated the effects of nutrition deficiency on the development of pressure ulcer (PU). They compared well-nourished and malnourished rabbits and produced skin lesions with a compressive force for 4 hours. Both malnourished and well-nourished rabbits developed PU. But the degree of ischemic skin destruction in malnourished animals was higher than in well-nourished animals. The healing process of PU was strongly suppressed in the malnourished animals.

It is already known that a suboptimal dietary intake has a negative effect on wound healing.<sup>2</sup> Protein-energy malnutrition, in association with a decrease in total body protein, and micronutrient deficiencies are important implications of an impaired nutrition status.<sup>2,3</sup> These alterations have a negative effect on wound healing, wound strength, synthesis of collagen, loss of skin elasticity, immune bodies, general cellular turnover, and an inability to fight infection.<sup>2,3</sup> The risk for PU increases with the combination of immobility,

loss of lean body mass, and the impairment of immune system.<sup>4</sup> Casimiro et al<sup>5</sup> observed a significant association between PU and levels of serum albumin, weight loss, and reduced body mass index (BMI). Adequate nutrition and monitoring nutrition status play an important role in the prevention of malnutrition, as well as in the treatment of PU.

Many clinical trials on malnutrition and PU are available, and all of them show an increase of PU with the presence of malnutrition or a decreased intake of proteins and energy.<sup>6–9</sup> In 1943, Mulholland et al<sup>10</sup> described the association between protein malnutrition and PU. Since then, numerous clinical trials confirmed these data,<sup>4,11,12</sup> but a causal relationship between malnutrition and PU has not been established.

PU guidelines for diagnosis and treatment of PU postulate nutrition screening and assessment at hospital admission. But the research into the association between PU and nutrition status has been complicated by (1) the lack of consensus about the definition of malnutrition, (2) the lack of a gold standard for a specific screening or assessment tool, and (3) insufficient knowledge of whether malnutrition is the cause or the consequence of PU. In addition, the differentiation of malnutrition from underlying diseases is often impossible. Especially in geriatric patients with multimorbidity, malnutrition is a frequent consequence of

Received for publication June 19, 2006.

Accepted for publication February 15, 2007.

Correspondence: Ralf-Joachim Schulz, MD, PhD, Charité-Universitätsmedizin Berlin, Campus Virchow-Klinikum, Research Group on Geriatrics at "Evangelisches Geriatriezentrum Berlin," Reinickendorfer Strasse 61, D-13347 Berlin, Germany. Electronic mail may be sent to ralf-joachim.schulz@charite.de.

diseases. Therefore, it is difficult to find an efficient screening tool to identify an impaired nutrition status in multimorbid geriatric patients at hospital admission. The aim of the study was to identify the most efficient screening tool to determine the nutrition status with a noninvasive parameter or instrument in patients with PU. We must verify the applicability of these tools for clinical routine at hospital admission in geriatric multimorbid patients with PU in order to prevent malnutrition and improve nutrition status.

## MATERIALS AND METHODS

### Patients

Over an 8-month period in 2005, 484 (326 female/158 male) multimorbid geriatric patients in acute medical conditions without cognitive impairment were recruited 48 hours after hospital admission. Acute medical condition was defined as a condition of rapid onset, severe symptoms, and brief duration. It also included conditions resulting from chronic illnesses that can be cured or substantially cured. Multimorbidity was defined as the co-occurrence of multiple diseases within 1 person.

Participants had to give their written informed consent. According to the *International Classification of Diseases and Related Health Problems* (ICD),<sup>13</sup> patients with severe cognitive impairment or depression (ie, vascular dementia, Alzheimer's disease, severe depression), nonaddressable patients, and patients with a lack of consent were excluded. Hyperhydration, cardiac pacemaker, amputation, or chronic renal failure were considered further exclusion criteria for the bioelectrical impedance analysis (BIA).

The recruitment center was the "Evangelisches Geriatriezentrum Berlin," Germany, an acute geriatric institution with 132 stationary beds. The study was approved by the ethics committee of the Charité-Universitätsmedizin Berlin, Germany, with informed consent of every patient.

### Methods

PU is an area of localized damage to the skin and underlying tissue caused by pressure, shear, friction, or a combination of these. According to EPUAP 4-grade classification (2005), PU was divided into grades I–IV:

- Grade I: Nonblanchable erythema of intact skin; discoloration of the skin, warmth, edema, induration, or hardness may also be used as indicators, particularly in individuals with darker skin.
- Grade II: Partial-thickness skin loss involving epidermis, dermis, or both; the ulcer is superficial and presents clinically as an abrasion or blister.
- Grade III: Full-thickness skin loss involving damage to or necrosis of subcutaneous tissue that may extend down to but not through underlying fascia.
- Grade IV: Extensive destruction, tissue necrosis, or damage to muscle, bone, or supporting structures, with or without full-thickness skin loss.

The Norton scale is one of the first risk assessment scales for PU prevention.<sup>14,15</sup> It consists of 5 categories: mental status, incontinence, mobility, activity, and

physical condition, and each subscale is rated from 1 to 4, indicating a very bad or a very good situation. The score ranges from 9 to 32 points (24–25 points indicate low risk, 19–23 points indicate moderate risk, 14–18 points indicate high risk, 9–13 indicate very high risk). Due to the relative ease of use, the Norton scale is widely used.<sup>16,17</sup> In our study, the Norton scale was determined 48 hours after hospital admission.

Nutrition status was assessed by a trained investigator according to Mini Nutritional Assessment (MNA), anthropometric measurement, and analysis of body composition results 48 hours after hospital admission. Body weight was measured in light indoor clothing, without shoes, with a seat scale (Seca, Hamburg, Germany) to the nearest 0.1 kg and height was measured with a stadiometer to the nearest 0.1 cm. The height of bedridden patients was estimated with knee-height measurement and the calculation by Chumlea and Guo.<sup>18</sup> It was measured in the supine position as the distance between the knee and foot, when the leg forms a 90° angle with the thigh. BMI was calculated by weight and height (weight/height<sup>2</sup>). Patients were divided into BMI categories: BMI <20 kg/m<sup>2</sup> indicates malnourished; BMI 20–23.9 kg/m<sup>2</sup> indicates at risk of malnutrition; and BMI 24–29.9 kg/m<sup>2</sup> indicates well-nourished.<sup>19</sup>

### MNA

The MNA was developed by the study group Guigoz et al<sup>20</sup> for the assessment of nutrition status in elderly people. The MNA covers 18 items dealing with anthropometric assessment (BMI, calf circumference, mid-upper-arm circumference), general assessment (medication, acute disease, neuropsychological problems, PU, independent living), dietary assessment (number of meals, daily consumption of protein-containing food, vegetables, fruits, beverages) and self-assessment (consideration of health status, self-view of nutrition status). The nutrition status classification of the patients was carried out according to the scored number of points into categories of "well-nourished" (24–30 points, MNA-A), "moderately malnourished or at risk of malnutrition" (17–23.5 points, MNA-B) or "malnourished" (<17 points, MNA-C).

### BIA

Body composition was assessed by BIA. An electrical current of 50 kHz and 0.8 mA was produced by a generator (Nutrigard 2000-M; Data Input, Frankfurt, Germany). Four surface electrodes were placed on the right wrist and ankle to measure whole-body resistance (R) and reactance (Xc). The phase angle (PhA) is defined as the relation between the 2 vector components of impedance: R and Xc. Although PhA is not completely understood, it might be considered as a global marker of health and can be used as an indicator of body cell mass (BCM). The patients were measured in the morning after an overnight fast, in the supine position with arms and legs abducted from the body.

Fat free mass (FFM) and total body water (TBW) were calculated according to the formula by Kyle et al<sup>21</sup>

and Vaché et al<sup>22</sup>; BCM, according to the formula by Lautz et al.<sup>23</sup> Fat mass was evaluated from the difference between body weight and FFM. Percentiles of PhA were determined according to Bosy-Westphal et al<sup>24</sup> and percentiles of FFM according to Kyle et al.<sup>25</sup>

### Barthel Index

The activities of daily living (ADL) were assessed by Barthel Index (BI). The first version of BI was developed by Mahoney and Barthel<sup>26</sup> to measure the improvement of functional impairment during treatment and rehabilitation. The main aim is to identify the degree of independence from any help, physical or verbal, however minor it may be and for whatever reason. The following items were assessed: bowel status, bladder status, grooming, toilet use, feeding, transfer, mobility, dressing, stairs, and bathing. The BI includes 10 categories about self-supply and mobility. The score ranges between 0 and 100 points.<sup>27</sup>

### Statistics

Statistical analyses were performed using SPSS for Windows, version 12.0 (SPSS Inc, Chicago, IL). Results were considered statistically different at  $p < .05$ , and data were analyzed by mean  $\pm$  SD or median (Q1; Q3).

Differences in age were assessed using the Student's *t*-test and differences in length of stay; BI, number of diagnoses, BMI, MNA, and BCM among PU or non-PU were assessed using Mann-Whitney *U* test. One-way ANOVA and Bonferroni multiple comparison tests were used to identify differences of Norton scale according to EPUAP 4-grade classifications and of MNA-categories to body composition, length of stay, BMI, age, and BI. One-way ANOVA was used to determine factors associated with PU. The dependent variable was the Norton scale. Spearman correlation coefficient was used for bivariate analysis. The  $\chi^2$  test was used to compare categorical parameters between groups.

## RESULTS

### Patient Characteristics

The clinical and nutrition characteristics of the study population are presented in Table I. We included 484 (326 female and 158 male) multimorbid geriatric patients without cognitive impairment 48 hours after hospital admission between January and August 2005.

Patients were aged 65 and older, without significant age difference between patients with and without PU. Admission diagnoses covered neurologic (31.2%), orthopedic (16.8%) and oncologic diseases (6.4%). The prevalence of diabetes mellitus did not differ significantly between PU and non-PU patients. The clinical picture was characterized by the significant presence of 16 (range 13–19) diseases in PU patients in comparison to patients without PU (13 [range 11–16];  $p < .001$ ). PU patients (21 [range 15–29] days) had a significantly longer length of stay in the hospital than non-PU patients (18 [range 12–27] days,  $p < .001$ ).

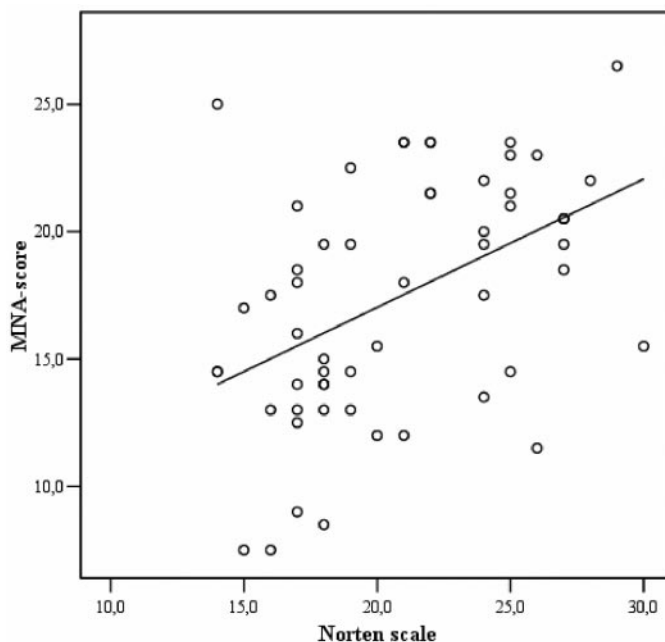


FIGURE 1. Nutrition status according the Mini Nutritional Assessment (MNA) correlates well with the Norton scale in patients with pressure ulcer, with a correlation coefficient of  $r = 0.455$  ( $p < .001$ ).

### PU

The prevalence of PU was 16.7%. According to the EPUAP 4-grade classification, 23.5%\* of the patients showed grade I, 61.7%\* grade II, 12.3%\* grade III, and 9.9%\* grade IV (\* multiple description: 7 of the patients exhibited >1 PU [analyses apply to  $n = 81$ ]; therefore, the total amount is 107%). Two PUs have been found in 7 of 81 patients (grade II + III:  $n = 3$ ; grade I + II:  $n = 2$ ; grade I + IV:  $n = 1$ ; II + not specific:  $n = 1$ ). The median score of the Norton scale was 20 (17, 24) and characterized patients with a moderate risk of PU. Patients with grade I PU showed a median Norton scale of 24 (range 18–25) points, grade II 21 (range 17–24) points, grade III 17 (range 15–22) points, and PU patients with grade IV had a median Norton scale of 16 (range 14–19) points. We did not find significant differences of Norton scale between the EPUAP 4-grade classifications. Age, length of stay, number of diseases, the prevalence of diabetes mellitus, or BI did not differ between PU and non-PU patients, and therefore we considered all PU patients in 1 group. The significant effects of selected risk factors are presented in Table II.

### Nutrition Status

According to the MNA, nutrition status of PU patients was significantly reduced in comparison to non-PU patients ( $p < .001$ ). The fraction of well-nourished PU patients was marginal. The fraction of malnourished PU patients (39.5%) was more than twice the fraction of non-PU patients with malnutrition (16.6%; Table I). MNA score of malnourished patients with PU ( $12.9 \pm 2.3$ ) decreased significantly ( $p = .006$ ) compared with non-PU patients with malnutrition ( $14.3 \pm 2.1$ ). Malnourished PU patients (18 [range

TABLE I  
Patients' characteristics

	Pressure ulcer	Nonpressure ulcer	<i>p</i>
Number of patients	81	403	<.001
Gender, M/F	24/57	134/269	—
Age, y*	79.3 ± 7.4	79.7 ± 7.7	NS
Length of stay, d†	21 [15; 29]	18 [12; 27]	.019
Barthel Index <sup>25</sup> †	30 [10; 50]	50 [30; 65]	<.001
Number of diagnoses†	16 [13; 19]	13 [11; 16]	<.001
Diabetes mellitus, %	32.1	34.2	NS
BMI <20, %	42.9	15.2	—
BMI 20–23.9, %	26.5	38.3	—
BMI 24–29.9, %	30.6	46.5	—
MNA-A, %	2.5	23.6	—
MNA-B, %	58.0	59.8	—
MNA-C, %	39.5	16.6	—
Resistance, Ω†	635 [536; 722]	597 [523; 688]	NS
Reactance, Ω†	39 [30; 47]	39 [33; 47]	NS
Phase angle, °†	3.4 [2.7; 4.2]	3.8 [3.2; 4.3]	.014
Total body water, L†	27.1 [24.7; 30.3]	29.8 [25.4; 35.2]	.020
Lean body mass, kg†	36.5 [33.7; 42]	40.4 [35.1; 48]	.013
Fat mass, kg†	23 [15.6; 29]	23.3 [19.4; 29.8]	NS
Body cell mass, kg†	14 [10.6; 17.5]	17.1 [13.7; 21]	<.001

BMI, body mass index; M, male; F, female; Mini Nutritional Assessment-A, well-nourished; Mini Nutritional Assessment-B, at risk of malnutrition; Mini Nutritional Assessment-C, malnourished; NS, nonsignificant.

\*Quantitative data are expressed as mean ± SD, with a significant difference at  $p < .05$ , using the unpaired Student's *t*-test.

†Quantitative data are expressed as median [Q1; Q3], with a significant difference at  $p < .05$ , using the Mann-Whitney test.

16–20] points) showed a significantly reduced Norton scale than PU patients at risk of malnutrition (22 [range 17–25] points;  $p = .022$ ). There was a significant correlation between MNA score and Norton scale ( $r = 0.455$ ;  $p < .001$ ; Figure 1).

PU patients showed a significantly reduced nutrition status according to BMI ( $22.8 \pm 5.3$  vs  $24.8 \pm 5.2$  kg/m<sup>2</sup>,  $p = .003$ ). In total, 15.2% of non-PU patients and 42.9% of PU patients showed a BMI <20 kg/m<sup>2</sup> and were malnourished. The fraction of non-PU patients with BMI 20–23.9 kg/m<sup>2</sup> was significantly higher (38.3%) than the fraction of PU patients (26.5%). The fraction of well-nourished patients without PU (46.5%) with desirable BMI (24–29.9 kg/m<sup>2</sup>) was almost twice the fraction of PU patients (30.6%). There were no BMI differences between PU and non-PU patients according to MNA or Norton scale, but there was a significant correlation between BMI and Norton scale ( $r = 0.308$ ;  $p = .026$ ).

In the last 3 months, 43% of PU patients lost >3 kg weight (28.6% non-PU). Only 19% of PU patients did not lose weight in the last 3 months (32.1% non-PU patients). But differences were not significant. Fur-

thermore, there were no significant differences of weight loss between patients with and without PU when patients were divided into BMI groups.

#### Body Composition

According to MNA groups, nutrition status did not influence body composition of patients with PU. Overall, no significant differences of R and Xc have been found in patients with PU and without PU (Table I). PhA of PU patients (3.4 [range 2.7–4.2]°) was 10% lower in comparison to patients without PU (3.8 [range 3.2–4.3]°) and was significantly reduced ( $p = .014$ ). In total, 69.2% (71.8%) of PU patients and 56.2% (74.2%) of non-PU patients showed a PhA less than the fifth percentile. PhA did not differ between MNA categories.

FFM, BCM, and TBW decreased significantly in PU patients. About 56% of PU patients (45.5% of non-PU patients) showed an FFM <25<sup>th</sup> percentile. BCM was reduced about 20% in PU patients. We have found a significant correlation between the Norton scale and BCM ( $r = 0.450$ ;  $p = .045$ ), as well as between the Norton scale and PhA ( $r = 0.401$ ;  $p = .009$ ).

#### ADL

BI was significantly decreased in patients with PU, especially in patients with PU at risk of malnutrition or with malnutrition in comparison to well-nourished patients with PU ( $p < .001$ ). We found the highest significant correlation between BI and MNA ( $r = 0.455$ ;  $p < .001$ ), BI and PhA ( $r = 0.421$ ;  $p = .004$ ), BI and BCM ( $r = 0.332$ ;  $p = .026$ ). There was no significant relation between BI and BMI. Furthermore, the Norton scale decreased with impaired ADL ( $r = 0.827$ ;  $p < .001$ ; Figure 2).

TABLE II  
Effect of different parameters on the Norton scale

Indicator	Norton scale ( <i>p</i> value)*
Age	.025
Length of stay	.061
Barthel Index <sup>25</sup>	<.001
Number of diseases	.059
Mini Nutritional Assessment <sup>19</sup>	<.001
Body mass index	.009
Phase angle	<.001
Body cell mass	.023

\*Effect of indicators on Norton scale analyzed with the 1-way analysis of variance.

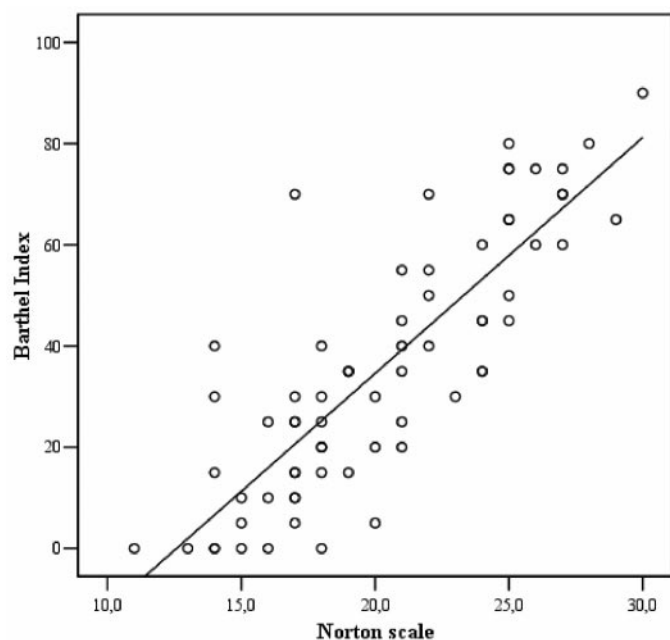


FIGURE 2. The comparison of Norton scale and the activities of daily living in patients with pressure ulcer showed a strong correlation, with  $r = 0.827$  ( $p < .001$ ).

#### DISCUSSION

In this investigation, the prevalence of PU in multimorbid geriatric patients is 16.7% at hospital admission and is comparable with acute care hospitals (5%–15%), rehabilitation centers (30%–50%), geriatric institutions, and nursing homes (30%).<sup>28–34</sup> MNA, BMI, weight loss, and analysis of body composition appear to be noninvasive and easy-to-use nutrition screening and assessment tools/parameters in multimorbid geriatric patients to identify malnutrition in PU patients. In patients with PU, the prevalence of malnutrition remains the same, whether measured by MNA, BMI, or weight loss. However, measuring malnutrition with PhA indicates that nearly twice as many patients with PU are malnourished as compared with measurements using MNA or BMI. The current investigation confirms the results from past clinical trials<sup>4,8,11,35</sup> that nutrition status of PU patients is significantly reduced in comparison to non-PU patients. But the most important question is which of the screening and assessment tools can be recommended for routine clinical practice?

Unintended weight loss >10% in the last 6 months is associated with an adverse clinical course for the patient.<sup>36</sup> Weight loss is a parameter used to easily identify patients at risk of severe malnutrition. Our results show that body weight and weight loss alone are not adequate variables to predict malnutrition in PU patients: (1) patients without PU lost weight as well as those with PU, (2) weight history is often incomplete, (3) the determination of weight is difficult due to bedridden patients, and (4) patients often did not know if they lost weight or not.

The BMI is the most popular component of screening; it is simple and cost-efficient and identifies changes in weight very quickly. Patients with PU

had a significantly reduced BMI in comparison to non-PU patients. This result has been observed by Casimiro et al,<sup>5</sup> but Cunha et al<sup>37</sup> presented that necropsied patients with PU and malnutrition had an equally high BMI like patients without PU. Due to abnormally dehydrated lean body mass and adipose tissue in the elderly, the BMI overestimates well-nourished patients and underestimates patients with risk of malnutrition. Furthermore, the reference range of BMI is apparently not appropriate for the elderly.

The PhA can be directly calculated from R and Xc by BIA. Although PhA is not completely understood, it might be considered as a global marker of health and can be used as an indicator of BCM. New cognitions recommend the use of PhA to identify clinically relevant malnutrition with PhA <10<sup>th</sup> percentile.<sup>38</sup> According to this, >70% of all patients showed a PhA below the 10<sup>th</sup> percentile,<sup>25</sup> and PhA was lower compared with healthy subjects aged older than 69 years.<sup>39</sup> PU patients showed a significantly reduced PhA compared with non-PU patients. Changes in PhA can result from changes in BCM and functional defects of the cellular membrane.<sup>40</sup> The cellular membrane integrity and steadiness was impaired in PU patients and resulted in a significantly reduced ADL.<sup>7,41</sup> Until now, PhA results have been controversial,<sup>42,43</sup> and further investigations in multimorbid geriatric patients are needed to confirm PhA as a valid nutrition screening parameter. In fact, BIA is a simple and noninvasive method to assess body composition at the bedside,<sup>44</sup> but validity and reliability remain controversial.<sup>45,46</sup> In most geriatric institutions, the use of BIA is not applicable due to the lack of investigators and equipment.

The variety of MNA items enables a global screening and assessment of the nutrition status of geriatric patients with and without PU. The 4 MNA subscores enable a noninvasive overview of general, anthropometric, dietary, and self-assessment and determine the nutrition status well in PU patients. Two longitudinal studies did not find a correlation between malnutrition and PU.<sup>9,47</sup> Even though BMI, BCM, and PhA were associated with PU, the MNA showed the strongest correlation to PU in this population. The use of the MNA can be accelerated with extensive training, although the use of the MNA in patients with cognitive impairment is difficult and time consuming.

In the National Pressure Ulcer Long-Term Care Study, Horn et al<sup>48</sup> reported a greater likelihood of developing PU in association with initial severity of illness, significant weight loss, history of recent weight loss, or oral eating problems. The odds ratio of important risk factors like immobility, ADL, or cerebrovascular accident was higher than the odds ratio for nutrition status.<sup>6</sup> Lindgren et al reported<sup>49</sup> that mobility, time of hospitalization, age, surgical treatment, and weight were risk factors for PU development. But in our multimorbid geriatric population, nutrition status and ADL showed the highest risk factors of PU. Furthermore, we found a strong correlation between an impaired nutrition status and an impaired ADL. Con-

sequences of immobility and bed rest can result in changes of the gastrointestinal system, including reduced appetite or constipation, which can lead to malnutrition and PU.<sup>50,51</sup> Anorexia and immobility may increase mental apathy and muscle wasting.<sup>6</sup>

It is impossible to identify and measure all risk factors for PU in clinical routine. But the timely determination of nutrition status with MNA that includes risk factors like mobility, food intake, loss of weight, and appetite can identify patients with risk of developing PU. And therefore, we recommend the MNA as an easy-to-use, noninvasive, and efficient screening and assessment tool to identify an impaired nutrition status in elderly patients with a risk of PU.

After identification of nutrition-risk patients, nutrition intervention must be initiated to improve nutrition status and accelerate wound healing. The general aim of nutrition intervention is to correct protein-energy malnutrition. In 2001, Thomas<sup>52</sup> reviewed the effect of nutrition intervention on PU healing. The ability of nutrition support to reduce complications or improve wound healing is controversial and a positive outcome from nutrition intervention is difficult to prove.<sup>53,54</sup> If normal feeding is not possible, oral protein-energy supplements could be considered. Until now, the recommendation for supplementation of specific nutrients in PU prevention is unclear.<sup>55</sup> In total, a higher protein intake achieved with oral supplementation or enteral feeding may increase the rate of wound healing but may not improve other physiologic parameters of nutrition.<sup>3,9,56–59</sup>

In addition to nutrition screening and assessment, the PU prevention should also include limiting bed rest, decreasing the effects of pressure, recognizing the risk of PU, and preserving the integrity of the skin.<sup>52</sup> Furthermore, the interaction between physician, nurse, and dietitian, as well as the sensitivity for malnutrition and PU with improvement of mobility and nutrition status, could prevent PU or accelerate wound healing.

The limitation of our study was that we only included a small fraction of patients with cognitive impairment; the implementation of the MNA in these patients is difficult and often leads to incomplete results. Furthermore, all patients with PU developed a PU before admission at our hospital. We do not know if the determination of nutrition status with MNA could prevent the development of PU. Nevertheless, many clinical trials reported an improvement of PU healing in association with an improved nutrition status.<sup>3,9,56–59</sup>

#### CONCLUSIONS

In conclusion, the relationship between nutrition status and PU is complex.<sup>60</sup> The aim of nutrition screening is to identify patients at risk of malnutrition or malnourished patients in time when nutrition intervention could prevent further malnutrition.<sup>54</sup> The MNA as a screening and assessment tool is easy to use in determining nutrition status in multimorbid geriatric patients with PU at hospital admission. Further studies are needed to show an improved outcome of PU

healing when evaluation of nutrition status is part of routine clinical practice in multimorbid elderly risk patients within the first day after admission.

#### REFERENCES

1. Takeda T, Koyama T, Izawa Y, Makita T, Nakamura N. Effects of malnutrition on development of experimental pressure sores. *J Dermatol.* 1992;19:602–609.
2. Collins CE, Kershaw J, Brockington S. Effect of nutritional supplements on wound healing in home-nursed elderly: a randomized trial. *Nutrition.* 2005;21:147–155.
3. Chernoff R. Protein and older adults. *J Am Coll Nutr.* 2004;23(6 suppl):627S–630S.
4. Harris CL, Fraser C. Malnutrition in the institutionalized elderly: the effects on wound healing. *Ostomy Wound Manage.* 2004;50:54–63.
5. Casimiro C, Garcia-de-Lorenzo A, Usan L. Prevalence of decubitus ulcer and associated risk factors in an institutionalized Spanish elderly population. *Nutrition.* 2002;18:408–414.
6. Mathus-Vliegen EM. Old age, malnutrition, and pressure sores: an ill-fated alliance. *J Gerontol A Biol Sci Med Sci.* 2004;59:355–360.
7. Allman RM, Goode PS, Patrick MM, et al. Pressure ulcer risk factors among hospitalized patients with activity limitation. *JAMA.* 1995;273:865–870.
8. Berlowitz DR, Brandeis GH, Anderson JJ, et al. Evaluation of a risk-adjustment model for pressure ulcer development using the Minimum Data Set. *J Am Geriatr Soc.* 2001;49:872–876.
9. Brandeis GH, Ooi WL, Hossain M, Morris JN, Lipsitz LA. A longitudinal study of risk factors associated with the formation of pressure ulcers in nursing homes. *J Am Geriatr Soc.* 1994;42:388–393.
10. Mulholland JH, Tui C, Wright AM, Vinci V, Shafiroff B. Protein metabolism and bedsores. *Ann Surg.* 1943;118:1015–1023.
11. Pinchcofsky-Devin GD, Kaminski NW Jr. Correlation of pressure sores and nutritional status. *J Am Geriatr Soc.* 1986;34:435–440.
12. Berlowitz DR, Wilking SV. Risk factors for pressure sores: a comparison of cross-sectional and cohort-derived data. *J Am Geriatr Soc.* 1989;37:1043–1050.
13. Deutsches Institut für Medizinische Dokumentation und Information (DIMDI). International Classification of Diseases and Related Health Problems (ICD). Available at: <http://www.dimdi.de/dynamic/de/index.html>. Accessed April 30, 2007.
14. Norton D. *An Investigation of Geriatric Nursing Problems in Hospitals.* London, England: National Corporation for the Care of Old People; 1962.
15. Norton D. Calculating the risk: reflections on the Norton scale. *Decubitus.* 1989;2:24–31.
16. Bridel J. Assessing the risk of pressure sores. *Nurs Stand.* 1993;7:32–35.
17. Hamilton F. An analysis of the literature pertaining to pressure sore risk assessment scales. *J Clin Nurs.* 1992;1:185–193.
18. Chumlea WC, Guo S. Equations for predicting stature in white and black elderly individuals. *J Gerontol.* 1992;47:M197–M203.
19. Beck AM, Ovesen L. At which body mass index and degree of weight loss should hospitalized elderly patients be considered at nutritional risk? *Clin Nutr.* 1998;17:195–198.
20. Guigoz Y, Vellas B, Garry PJ. Mini Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. *Facts Res Gerontol.* 1994;(suppl 2):15–59.
21. Kyle UG, Genton L, Karsegard L, Slosman DO, Pichard C. Single prediction equation for bioelectrical impedance analysis in adults aged 20–94 years. *Nutrition.* 2001;17:248–253.
22. Vache C, Rousset P, Gachon P, et al. Bioelectrical impedance analysis measurements of total body water and extracellular water in healthy elderly subjects. *Int J Obes Relat Metab Disord.* 1998;22:537–543.
23. Lautz HU, Selberg O, Korber J, Burger M, Muller MJ. Protein-calorie malnutrition in liver cirrhosis. *Clin Invest.* 1992;70:478–486.
24. Bony-Westphal A, Danielzik S, Dorhofer RP, Later W, Wiese S, Muller MJ. Phase angle from bioelectrical impedance analysis: population reference values by age, sex, and body mass index. *JPEN J Parenter Enteral Nutr.* 2006;30:309–316.

25. Kyle UG, Genton VL, Karsegard CA, et al. Percentiles (10, 25, 75 and 90th) for phase angle (PhA), determined by bioelectrical impedance (BIA), in 2740 healthy adults aged 20–75 yr [abstract]. *Clin Nutr*. 2004;23:758.
26. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. *MD State Med J*. 1965;14:61–65.
27. Granger CV, Dewis LS, Peters NC, Sherwood CC, Barrett JE. Stroke rehabilitation: analysis of repeated Barthel Index measures. *Arch Phys Med Rehabil*. 1979;60:14–17.
28. Smith DM. Pressure ulcers in the nursing home. *Ann Intern Med*. 1995;123:433–442.
29. Coleman EA, Martau JM, Lin MK, Kramer AM. Pressure ulcer prevalence in long-term nursing home residents since the implementation of OBRA '87: Omnibus Budget Reconciliation Act. *J Am Geriatr Soc*. 2002;50:728–732.
30. Bours GJ, Halfens RJ, Abu-Saad HH, Grol RT. Prevalence, prevention, and treatment of pressure ulcers: descriptive study in 89 institutions in the Netherlands. *Res Nurs Health*. 2002;25:357–362.
31. Shannon ML, Skorga P. Pressure ulcer prevalence in two general hospitals. *Decubitus*. 1989;2:38–43.
32. Olson B, Langemo D, Burd C, Hanson D, Hunter S, Cathcart-Silberberg T. Pressure ulcer incidence in an acute care setting. *J Wound Ostomy Continence Nurs*. 1996;23:15–22.
33. Schoonhoven L, Grobbee DE, Donders AR, et al, and the pre-PURSE Study Group. Prediction of pressure ulcer development in hospitalized patients: a tool for risk assessment. *Qual Saf Health Care*. 2006;15:65–70.
34. Lahmann NA, Halfens JG, Dassen T. Prevalence of pressure ulcers in Germany. *J Clin Nurs*. 2005;14:165–172.
35. Hudgens J, Langkamp-Henken B, Stechmiller JK, Herrlinger-Garcia KA, Nieves C Jr. Immune function is impaired with a Mini Nutritional Assessment score indicative of malnutrition in nursing home elders with pressure ulcers. *JPEN J Parenter Enteral Nutr*. 2004;28:416–422.
36. Klein S, Kinney J, Jeejeebhoy K, et al. Nutrition support in clinical practice: review of published data and recommendations for future research directions: summary of a conference sponsored by the National Institutes of Health, American Society for Parenteral and Enteral Nutrition, and American Society for Clinical Nutrition. *Am J Clin Nutr*. 1997;66:683–706.
37. Cunha DF, Frota RB, Arruda MS, Cunha SF, Teixeira VP. Pressure sores among malnourished necropsied adults: preliminary data. *Rev Hosp Clin Fac Med Sao Paulo*. 2000;55:79–82.
38. Schuetz T, Pirlich M, Norman K, Lochs H. Relevance of phase angle percentiles in hospitalized patients [abstract]. *Clin Nutr*. 2005;24:558.
39. Barbosa-Silva MC, Barros AJ, Post CL, Waitzberg DL, Heymsfield SB. Can bioelectrical impedance analysis identify malnutrition in preoperative nutrition assessment. *Nutrition*. 2003;19:422–426.
40. Barbosa-Silva MCG, Barros AJD. Bioelectrical impedance analysis in clinical practice: a new perspective on its use beyond body composition equations. *Curr Opin Clin Nutr Metab Care*. 2005;8:311–317.
41. Bergstrom N, Braden B, Kemp M, Champagne M, Ruby E. Multi-site study of incidence of pressure ulcers and the relationship between risk level, demographic characteristics, diagnoses, and prescription of preventive interventions. *J Am Geriatr Soc*. 1996;44:22–30.
42. Maggiore Q, Nigrelli S, Ciccarelli C, Grimaldi C, Rossi GA, Michelassi C. Nutritional and prognostic correlates of bioimpedance indexes in hemodialysed patients. *Kidney Int*. 1996;40:2103–2108.
43. Fein PA, Gundumalla G, Jordan A, Matza B, Chattopadhyay J, Avram MM. Usefulness of bioelectrical impedance analysis in monitoring nutrition status and survival of peritoneal dialysis patients. *Adv Perit Dial*. 2002;18:195–199.
44. Kyle UG, Piccoli A, Pichard C. Body composition measurements: interpretation finally made easy for clinical use. *Curr Opin Clin Nutr Metab Care*. 2003;6:387–393.
45. Chumlea WC, Guo SS, Kuczmarski RJ, Vellas B. Bioelectric and anthropometric assessments and reference data in the elderly. *J Nutr*. 1993;123(2 suppl):449–453.
46. Tagliabue A, Cena H, Trentani C, Lanzola E, Silva S. How reliable is bio-electrical impedance analysis for individual patients? *Int J Obes Relat Metab Disord*. 1992;16:649–652.
47. Guralnik JM, Harris TB, White LR, Corroni-Huntley JC. Occurrence and predictors of pressure sores in the National Health and Nutrition Examination Survey follow-up. *J Am Geriatr Soc*. 1988;36:807–812.
48. Horn SD, Bender SA, Ferguson ML, et al. The National Pressure Ulcer Long-Term Care Study: pressure ulcer development in long-term care residents. *J Am Geriatr Soc*. 2004;52:359–367.
49. Lindgren M, Unosson M, Fredrikson M, Ek AC. Immobility: a major risk factor for development of pressure ulcers among adult hospitalised patients: a prospective study. *Scand J Caring Sci*. 2004;18:57–64.
50. Harper CM, Lyles YM. Physiology and complications of bed rest. *J Am Geriatr Soc*. 1988;36:1047–1054.
51. Rousseau P. Immobility in the aged. *Arch Fam Med*. 1993;2:169–177.
52. Thomas DR. Prevention and treatment of pressure ulcers: what works? What doesn't? *Cleve Clin J Med*. 2001;68:704–722.
53. Albina JE. Nutrition and wound healing. *JPEN J Parenter Enteral Nutr*. 1994;18:367–376.
54. Thomas DR. The role of nutrition in prevention and healing of pressure ulcers. *Clin Geriatr Med*. 1997;13:497–511.
55. Thomas DR. Improving outcome of pressure ulcers with nutritional interventions: a review of the evidence. *Nutrition*. 2001;17:121–125.
56. Breslow RA, Hallfrisch J, Goldberg AP. Malnutrition in tubefed nursing home patients with pressure sores. *JPEN J Parenter Enteral Nutr*. 1991;15:663–668.
57. Fiatarone MA, O'Neill EF, Ryan N, et al. Exercise training and nutritional supplementation for physical frailty in very elderly people. *N Engl J Med*. 1994;23:1769–1775.
58. Kirk SJ, Hurson M, Regan M, Holt DR, Wasserkrug HL, Barbul A. Arginine stimulates wound healing and immune function in elderly human beings. *Surgery*. 1993;114:155–159.
59. Finucane TE. Malnutrition, tube feeding and pressure sores: data are incomplete. *J Am Geriatr Soc*. 1995;43:447–451.
60. Green SM, Winterberg H, Franks PJ, Moffatt CJ, Eberhardie C, McLaren S. Nutritional intake in community patients with pressure ulcers. *J Wound Care*. 1999;8:325–330.