ORIGINAL RESEARCH

A Comparison of 8 Nutrition-Related Tests to Predict Mortality in Hemodialysis Patients

Camiel L. M. de Roij van Zuijdewijn, MD,[*,†] *Piet M. ter Wee, MD, PhD,*[*,†] *Isabelle Chapdelaine, MD,*[‡] *Michiel L. Bots, MD, PhD,*[§] *Peter J. Blankestijn, MD, PhD,*[¶] *Marinus A. van den Dorpel, MD, PhD,*[**] *Menso J. Nubé, MD, PhD,*[*,†] *and Muriel P. C. Grooteman, MD, PhD*[*,†]

Objective: Protein-energy wasting (PEW) describes a state of decreased protein and energy fuels and is highly prevalent in hemodialysis patients. As PEW is associated with mortality, it should be detected accurately and easily. This study investigated which nutrition-related test predicts mortality and morbidity best in hemodialysis patients.

Design and Subjects: Data were used from CONTRAST, a cohort of end-stage kidney disease patients. Subjective Global Assessment (SGA), Malnutrition Inflammation Score (MIS), Geriatric Nutritional Risk Index (GNRI), composite score of Protein-Energy Nutritional Status (cPENS), serum albumin, serum creatinine, body mass index, and normalized protein nitrogen appearance rate were assessed at baseline. End points were all-cause mortality, cardiovascular events, and infection. Discriminative value of every test was assessed with Harrell's C statistic and calibration tested using the Hosmer-Lemeshow goodness-of-fit test. Ultimately, in every test, 4 groups were created to compare (1) hazard ratios (HR; worst vs best group), (2) HR increase per group, and (3) HR of worst group versus other groups.

Results: In total, 489 patients were analyzed. Median follow-up was 2.97 years (interquartile range, 1.67-4.47 years). MIS, GNRI, albumin, and creatinine discriminated all-cause mortality equally. SGA, cPENS, body mass index, and normalized protein nitrogen appearance were inferior. cPENS and creatinine were inadequately calibrated. Of the remaining tests, GNRI predicted mortality less when comparing HRs. MIS and albumin predicted mortality equally well. In a subanalysis, these also predicted infection equally well, but MIS predicted cardiovascular events better.

Conclusion: Of the 8 investigated nutrition-related tests, MIS and albumin predict mortality best in hemodialysis patients. As one has no added value over the other, we conclude that mortality is most easily predicted in hemodialysis patients by serum albumin.

Introduction

DESPITE CONTINUOUS IMPROVEMENT in the treatment of hemodialysis (HD) patients, morbidity and mortality remain unacceptably high.[1,2] Protein-energy wasting (PEW) is highly prevalent[3–7] among HD patients and strongly associated with all-cause mortality[8,9] as well as cardiovascular mortality[3,10] and morbidity.[4] The term PEW was introduced by the International Society of Renal Nutrition and Metabolism in 2008 to describe the state of decreased body stores of protein and energy fuels. The following diagnostic criteria were proposed: (1) low value of 1 of 3 blood chemistry parameters (albumin, prealbumin, or cholesterol), (2) low or decreasing body mass, (3) low or decreasing muscle mass, and (4) low dietary intake.[11] As patients may benefit from treatment of malnourishment[12] by supplementation of proteins and energy,[13,14] it appears important to detect PEW accurately and easily.

Several nutrition-related tests have been proposed to assess nutritional status. The 3-point scaled Subjective Global Assessment (SGA-3)[15] scores patients as A (well nourished), B (moderately malnourished), or C (severely

[*]*Department of Nephrology, VU University Medical Center, Amsterdam, The Netherlands.*

[†]*Institute for Cardiovascular Research VU University Medical Center (ICaR-VU), VU University Medical Center, Amsterdam, The Netherlands.*

[‡]*Department of Nephrology, Hôpital de Sacre-Coeur de Montréal, Montréal, Canada.*

[§]*Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht, The Netherlands.*

[¶]*Department of Nephrology, University Medical Center Utrecht, Utrecht, The Netherlands.*

[**]*Department of Internal Medicine, Maasstad Hospital, Rotterdam, The Netherlands.*

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Address correspondence to Camiel L.M. de Roij van Zuijdewijn, MD, Department of Nephrology, VU University Medical Center, PO Box 7075, Amsterdam 1007 MB, The Netherlands. E-mail: c.deroijvanzuijdewijn@vumc.nl

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malnourished). Although this test was validated in HD patients,[16,17] its semiquantitative character and the fact that it does not adequately detect the degree of malnutrition[16] led to modifications like the 7-point scaled SGA (SGA-7)[18,19] and the Malnutrition Inflammation Score (MIS).[20-22] Other clinical nutritional scores or parameters that have been related to mortality in HD patients include the Geriatric Nutritional Risk Index (GNRI),[23-26] the composite score of protein-energy nutritional status (cPENS),[27,28] serum albumin,[17,29-31] normalized protein nitrogen appearance (nPNA) rate,[32,33] and body mass index (BMI).[34] It is currently unknown which test should be used to assess PEW most adequately.[19,35] Therefore, we investigated which nutrition-related test or parameter predicts all-cause mortality best in patients with end-stage kidney disease (ESKD). In a subanalysis, we also investigated which test predicts cardiovascular events and infections best.

Methods

A prospective cohort study was performed using data from the CONvective TRAnsport STudy (CONTRAST; NCT00205556). Methods are described elsewhere.[36,37] In brief, CONTRAST was a randomized controlled trial evaluating the survival effect of postdilution online hemodiafiltration compared to low-flux HD. In total, 714 ESKD patients were enrolled in 29 facilities in 3 countries: the Netherlands (n = 26), Canada (n = 2), and Norway (n = 1). Adult patients (≥18 years) were eligible if treated for >2 months with HD 2 or 3 times per week. Exclusion criteria were severe incompliance to dialysis prescription, treatment with hemodiafiltration or high-flux HD in the 6 months preceding randomization, or a life expectancy ≤3 months owing to nonrenal disease. Written informed consent was obtained from all participants before randomization. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice Guidelines and approved by a central medical ethics review board.

Patients from the CONTRAST cohort were selected for this analysis if all nutrition-related tests could be assessed. For this, data at baseline had to be complete on the following items: SGA-7, answers to questions on stomach problems ("do you experience nausea or other gastrointestinal problems?") and functional capacity ("can you do simple tasks in and around the house?"), gender, BMI, dry body weight, medical history, dialysis vintage, albumin, creatinine, nPNA, and total iron-binding capacity (TIBC).

Assessment of Nutrition-Related Tests

The 7-Point Scaled Subjective Global Assessment

In this score, first described as a nutritional tool in 1987 in nonrenal hospitalized patients preoperatively,[15] 4 items were scored 1 (severely abnormal) to 7 (normal): (1) change in dry body weight, (2) dietary intake change and gastrointestinal symptoms, (3) decrease of subcutaneous fat, and (4) muscle atrophy. Patients were subjectively scored 1 (severely malnourished) to 7 (well nourished).

Malnutrition Inflammation Score

The MIS, a modified version of the SGA, was developed for maintenance HD patients and contains 10 items: (1) change in weight after dialysis, (2) dietary intake, (3) gastrointestinal symptoms, (4) functional capacity, (5) comorbidity or dialysis vintage, (6) decreased fat stores or loss of subcutaneous fat, (7) signs of muscle wasting, (8) BMI, (9) serum albumin, and (10) serum TIBC. Each item was scored 0 (normal) to 3 (severely abnormal), resulting in a score between 0 (well nourished) and 30 (severely malnourished). The SGA-7 items mentioned previously (MIS items 1, 2, 6, and 7) were converted to a score of 0-3. Gastrointestinal symptoms (MIS item 3) and functional capacity (MIS item 4) were assessed on a 5-point scaled questionnaire and were also converted to a score between 0 and 3. MIS items 5, 8, 9, and 10 (dialysis vintage or comorbidity, BMI, serum albumin, and serum TIBC) were all assessed and converted to a score of 0-3 as described previously.[20] Conversions of the subjective scores were independently performed by 2 investigators (C.L.M.d.R.v.Z. and I.C.), which led to 2 minor disagreements. Consensus was quickly obtained. The definitive conversions are summarized in Table 1.

Geriatric Nutritional Risk Index

The continuous GNRI score is calculated using the equation described by Bouillanne et al[26] and was validated in 181 and 2,474 hospitalized, elderly patients: GNRI = (1.489 × albumin [g/L]) + [41.7 × {body weight/ideal body weight}], in which the fraction (body weight/ideal body weight) was set to 1 if ideal weight exceeded body

Table 1. Conversions to Malnutrition Inflammation Scores

MIS Score	SGA	Questions Assessed on a 5-Point Scale	TIBC (mg/dL)	BMI (kg/m^2)	Albumin (g/dL)	Dialysis Vintage* (y)
0	7	1	≥250	≥20.00	≥4.00	≤1.00
1	5-6	2	200-249.99	18-19.99	3.50-3.99	1.01-4.00
2	3-4	3-4	150-199.99	16-17.99	3.01-3.49	≥4.00
3	1-2	5	<150	≤15.99	≤3.00	

BMI, body mass index; SGA, Subjective Global Assessment; TIBC, total iron-binding capacity.
*Score +1 if patient has a history of a cardiovascular event.