Title

Multicenter Study of the Validity and Reliability of Subjective Global Assessment in the Hemodialysis Population

Journal

Journal of Renal Nutrition, 17(5)

ISSN

1051-2276

Authors

Steiber, Alison
Leon, Janeen B
Secker, Donna
et al.

Publication Date

2007-09-01

DOI

10.1053/j.jrn.2007.05.004

Multicenter Study of the Validity and Reliability of Subjective Global Assessment in the Hemodialysis Population

Alison Steiber, PhD, RD, LD, Janeen B. Leon, MS, RD, LD,† Donna Secker, MS, RD,‡ Maureen McCarthy, MPH, RD, CSR, LD,§ Linda McCann, RD, LD,¶ Monica Serra, MS, RD,* Ashwini R. Sehgal, MD,† and Kamyar Kalantar-Zadeh, MD, PhD, MPH‖*

Objective: Subjective Global Assessment (SGA) is a nutrition assessment tool recommended by the 2000 NKF K/DOQI Nutrition Guidelines. However, the validity and reliability of this tool have not been established in hemodialysis (HD) patients. The purpose of this observational study was to determine the reliability and validity of SGA in the HD population. Renal dietitians (RD) were recruited to perform SGA (7-point scale version) and collect data on demographics, clinical status, biochemistries, dietary intake, and quality of life (Medical Outcomes Short Form-36) on 3 HD patients at baseline and 6 months later.

Design: The 54 participating RDs were trained to perform SGA and collect data via a website created for this study. Interrater reliability for SGA was tested in a subset of 76 patients, via an SGA performed by a second RD at baseline, while intrarater reliability was assessed by the original RD repeating the SGA at 1 month. Data collection occurred at HD facilities in the United States (109 patients), Canada (35 patients), and New Zealand (9 patients).

Results: Of the 153 patients, 46% were female, 64% were Caucasian, 6% were Hispanic, 21% were African American, and 6% were Asian. The primary etiologies were hypertension (33%), type 2 diabetes mellitus (DM) (27%), type 1 DM (10%), and glomerular nephritis (10%); 59% had cardiovascular disease. The mean age, body mass index (BMI), serum albumin, and duration on HD were 64 ± 14 years (mean ± SD), 28 ± 7 kg/m^2, 3.7 ± 0.4 mg/dL, and 41 ± 34 months, respectively. SGA scores were well nourished (7)–30%; mildly malnourished (MN 6)–41%; moderately MN 5–21%, 4–7%, and 3–2%; and severely MN (2 and 1)–0%. SGA training via the Internet achieved fair interrater reliability (weighted Kappa = 0.5, Spearman's Rho = 0.7) and substantial intrarater reliability (weighted Kappa = 0.7, Spearman's Rho = 0.8) ($P < .001$). Validity was demonstrated through statistically significant differences in mean BMI and serum albumin across the 5 categories of SGA (7–28 ± 7, 6–29 ± 7, 5–28 ± 8, 4–21 ± 4, 3–24 ± 2, $P < .05$; and 7–3.8 ± 0.3, 6–3.8 ± 0.4, 5–37 ± 0.05, 4–3.4 ± 0.07, 3–2.9 ± 1.2, $P < .001$, respectively). Nutritional status varied by age ($P < .05$), but not ethnicity or nationality.

Conclusion: We conclude that the 7-point scale SGA is a reliable and valid tool for nutritional assessment in adults on HD.

This article has an online CPE activity available at www.kidney.org/professionals/CRN/ceuMain.cfm

DIAGNOSIS OF MALNUTRITION in chronic kidney disease (CKD) patients is challenging and increasingly controversial. No single marker consistently identifies malnutrition in this population. Many of the markers are skewed in a variety of ways by kidney disease and the multiple comorbidities that influence nutritional, inflammatory, and clinical status. Nutri-

**Department of Nutrition, Case Western Reserve University, Cleveland, Ohio.*

†*Department of Medicine, Division of Nephrology, MetroHealth Medical Center, Cleveland, Ohio.*

‡*Division of Nephrology, Department of Clinical Dietetics, Hospital for Sick Children, Toronto, Ontario, Canada.*

§*Department of Dietetics and Nutrition, Oregon Health and Science University, Portland, Oregon.*

¶*Satellite Health, Inc., Redwood City, California.*

‖*Department of Medicine and Pediatrics, Harbor-University of California at Los Angeles, David Geffen School of Medicine, University of California at Los Angeles, Torrance, California.*

Address reprint requests to Alison Steiber, PhD, RD, LD, Department of Nutrition, School of Medicine, WG-48, Case Western Reserve University, 10900 Euclid Ave., Cleveland, OH 44106-4954. E-mail: Alison.steiber@case.edu

1051-2276/07/1705-0007$32.00/0

doi:10.1053/j.jrn.2007.05.004

tional biochemical indices are altered by fluid and inflammation status (e.g., serum albumin), or need to be interpreted using different thresholds (e.g., serum prealbumin) for the CKD population. Anthropometric measures (e.g., bioelectric impedance, or skinfold measurements) for the CKD population must be carefully administered posttreatment to prevent confounding influences of fluid status. This is often challenging because of a lack of training by healthcare providers. Dietary interviews are often problematic, because they rely on patient memory of recent intake, and in this patient population may be negatively influenced by age-related and uremia-related influences on patients' memories. These collective issues compound the already challenging task of determining CKD patients' nutritional status. For example, clinicians must determine whether malnutrition exists when serum albumin is low although 24-h dietary recall and body mass index (BMI) indicate sufficient nutrient intake, or whether unintentional weight loss in a patient with normal serum prealbumin and albumin concentrations indicates insufficient nutritional intake vs. disease-related protein catabolism.

Subjective global assessment (SGA) is a nutritional tool commonly used by both clinicians and researchers.[1,2] It is a comprehensive nutritional assessment technique that can be used easily in many disciplines, requires no laboratory testing, and was shown to be valid and reliable in CKD populations.[2–5] Research studies compared and contrasted different nutrition status markers with SGA in CKD patients. Early studies analyzed SGA in two groups: those with or without some degree of nutritional loss. Statistically significant differences were observed between the two groups using established nutrition indices such as BMI, mid-arm muscle circumference (MAMC), lean body mass, serum albumin, creatinine, total iron-binding capacity, ferritin, and C-reactive protein.[2,6–9] More recent studies examining reliability and specificity found that SGA does not always correspond with other nutritional markers.[2,3] Therefore, questions regarding the ability of SGA to detect nutritional status and to distinguish differing levels of nutritional loss have been raised. The purpose of the present National Research Question was to examine the intrarater and interrater reliability, and concurrent and predictive validity, of SGA in stage 5 CKD patients receiving hemodialysis by utilizing clinical renal dietitians for patient recruitment and data collection.

Patients and Methods

Subjects

Renal dietitians were recruited for participation in this study through the National Kidney Foundation's Council on Renal Nutrition and the Canadian Association of Nephrology Dietitians. Two batches of letters were sent to dietitians, explaining the study and asking them to participate. Participation required that they complete an online training course, including a pretest and posttest. They were also asked to provide contact information for their local institutional review board (IRB). Researchers located at Case Western Reserve University fulfilled the requirements for each IRB. The online training course[10] (available at https://secure.kidneytools.com/sga) was designed and maintained by Linda McCann, R.D., C.S.R., at Satellite Healthcare, Inc. (Mountain View, CA). Upon completion of online training and approval from each facility's governing IRB, the participating dietitians fol-

Table 1. Variables Measured

Variables Collected	Baseline	At 6 Months
Demographic data	X	
Disease etiology, comorbidities, residual renal function	X	
Laboratory data: albumin, pre- and posttreatment BUN, creatinine, prealbumin, C-reactive protein, fasting total cholesterol	X	X
Anthropometrics: weight, height	X	X
Treatment time, duration of treatment	X	X
Quality-of-life questionnaire (SF-36)	X	X
Hospitalization (no. and days hospitalized)		X
24-h recalls (nondialysis and dialysis days)	X	X
Subjective global assessment	X	X

BUN, blood urea nitrogen; SF-36, short form-36.

lowed a process to randomly recruit three patients from their center. Patients indicated their willingness to participate by signing a written consent form. Dialysis centers with more than one renal dietitian were encouraged to have a second dietitian participate for assessment of interrater reliability.

Data Collection

At baseline and 6 months from baseline, participating dietitians used standard forms to collect the data outlined in Table 1. The SGA examination was repeated at baseline by a second dietitian (if available) to test interrater reliability, and was performed again after 1 month by the initial dietitian, to test intrarater reliability. The frequency and duration of hospitalizations within the 6-month collection period were documented. All data were sent to Case Western Reserve University for compilation and analysis.

Dietary intake data were collected using the multiple-pass method.[11] This method reviews the food intake of patients over a 24-h period five times to elucidate information on food items' brand names, serving sizes, and preparation methods. Dietary data were analyzed using Nutritionist Pro, version 2.5.1 (Axxya Systems, Stafford, TX).

The SGA was performed using the same core components as those of Detsky et al.[4] (weight status, dietary intake, gastrointestinal symptoms, functional status, metabolic stress, and a physical examination) and the 7-point scale developed during the Canada-USA Peritoneal Dialysis (CANUSA) Study.[5] A rating of 7 indicates no nutritional loss, and a rating of 1 indicates severe nutritional loss. Information on weight and metabolic status for SGA was collected from the patient's medical record. Information on the remaining components of SGA was obtained from the patient interview. Dietitians were asked to evaluate all areas on the physical-examination portion, as described on the study website. Current medical records and laboratory results were used to collect other specific clinical and biochemical data.

Data Analysis

Statistical analysis was performed using SPSS, version 14.0 (SPSS, Inc., Chicago, IL). Distribution of variables was examined, and analyses were performed, according to the individual variables examined. Descriptive analyses were used to describe the sample of patients studied and the frequency of distribution of variables. Correlation analyses were used to test bivariate associations.

Table 2. Patient Demographics of Total Sample

Patient Characteristic	SGAVP (n = 154)	USRDS[13]
Gender (%)		
Male	54	55
Female	46	45
Median age (y)	64.5 (current)	57 (at time of initiation)
Ethnicity (%)		
White	64.0	61.4
Black	20.5	32.0
Native American	1.5	1.3
Asian	6.0	4.0
Hispanic	5.5	13.0
Non-Hispanic	94.5	87.0
Primary etiology (%)		
Type 1 diabetes	9	7
Type 2 diabetes	28	29
Hypertension	31	25
Glomerulonephritis	10	17
Serum albumin (g/dL)*	3.7 ± 0.4	3.2
Blood urea nitrogen (mg/dL)*	57 ± 18	89
Serum creatinine (mg/dL)*	9 ± 7	7.6
Body mass index*	28 ± 7	27

SGAVP, Subjective Global Assessment Validation Project; USRDS, United States Renal Data System.
*Data are presented as mean (± SD where available).

Table 3. Patient Demographics by Country

Characteristic	United States	Canada	New Zealand
Ethnicity (%)			
White	63	77	25
Black	29	0	0
Native American	0	6	0
Asian	<1	17	0
Hispanic	5	0	38
Non-Hispanic	3	0	38
Gender (%)			
Male	53	60	44
Female	47	40	56
Comorbidities (%)			
Diabetes (types 1 and 2)	38	29	33
Hypertension	76	83	56
Cardiovascular disease	56	66	56
Body mass index* ($P < .03$)	$28.6 \pm 7.3^{a,c}$	$24.9 \pm 5.7^{a,b}$	$31.9 \pm 6.9^{b,c}$
Age (y)*	63.5 ± 14.1	64.6 ± 13.1	67.8 ± 12.1
Duration of hemodialysis*	40.8 ± 32.9	37.8 ± 27.3	54.7 ± 64.5
Serum albumin* ($P < .001$)	3.8 ± 0.4^{a}	$3.5 \pm 0.5^{a,b}$	3.9 ± 0.3^{b}

[a,b,c]Indication that mean values are significantly different.
*Data are presented as mean ± SD.

The SGA was treated as a categorical variable; therefore, both one-way analysis of variance (ANOVA) and Kruskal-Wallis analyses were used to compare continuous variables across the SGA categories for criterion (concurrent and predictive) validity. When the variable was significantly different between SGA categories, a Tukey post hoc analysis was used to determine which SGA categories were significant compared with the others. Weighted and unweighted kappa scores were used to measure intrarater and interrater reliability. Statistical significance was defined as $P < .05$.

Results

Baseline characteristics of patients (n = 154) were compared to the United States Renal Data System,[13] and by country (Tables 2 and 3). Seventy percent of patients had some degree of malnutrition according to SGA, ranging from very mild to moderate (Fig. 1). Among patients with malnutrition, 29% had moderate nutritional loss (scores of 3-5 on the 7-point scale), and no patient was categorized as severely malnourished (a score of 1 or 2). After 1 and 6 months, the number of patients with malnutrition increased to 75% and 76%, respectively.

Interrater reliability was measured from 76 duplicate assessments. Agreement for these assessments (two dietitians at baseline) was 54%, the unweighted kappa score was 0.33 (95% confidence interval [CI], 0.17-0.50), and the weighted kappa score was 0.52 (95% CI, 0.39-0.66), indicating fair agreement between dietitians.

Intrarater reliability for baseline and 1-month assessments performed by the same dietitian was measured in 111 patients. The agreement was 68% (unweighted kappa = 0.56; 95% CI, 0.44-0.68; weighted kappa = 0.68; 95% CI, 0.58-0.78), indicative of substantial intrarater reliability. Figure 2 depicts rater discordance, i.e., the difference between scores for the same patient. When ratings differed, the vast majority differed by a single point on the 7-point scale, and never

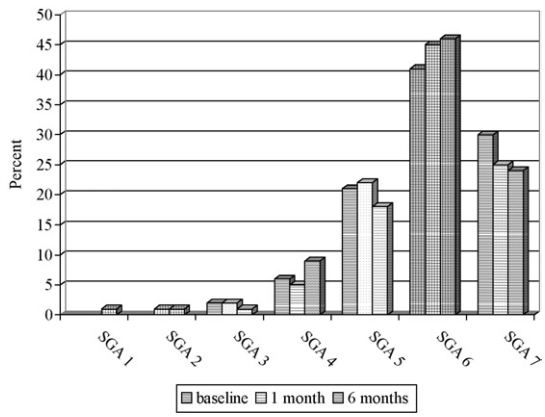

Figure 1. Distribution of patients (n = 154) by subjective global assessment (SGA). SGA 1, severe nutritional loss; SGA 7, no nutritional loss.

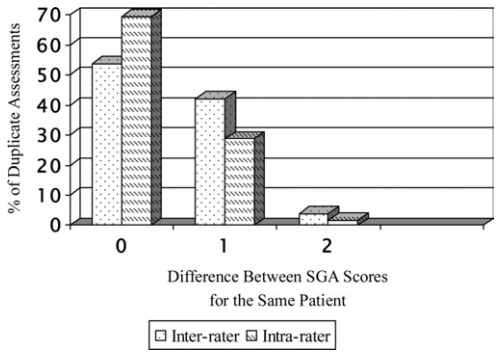

Figure 2. Rates of disagreement between raters according to degree of disagreement. Zero represents complete agreement; 1 represents a 1-point difference between raters on the 7-point scale; 2 represents a 2-point difference. There were no occasions when raters disagreed by >2 points on the 7-point scale. SGA, subjective global assessment.

differed by >2 points. This demonstrates parallelism, even when scores were not identical.

To establish concurrent validity, baseline BMI and serum albumin were examined across baseline SGA scores of 1-7. Body mass index differed between SGA scores ($P < .004$, Kruskal-Wallis nonparametric test for skewed distribution). Specifically, both SGA scores 3 and 4 were different from both scores 6 and 7 ($P < .05$, Tukey's honestly significant difference [HSD]). Serum albumin was significantly different between separate SGA scores ($P < .001$, one-way ANOVA). Specifically, a score of 3 was significantly different from scores 5, 6, and 7 ($P < .05$, Tukey's HSD) (Table 4). To tease out the different influences of malnutrition and inflammation, an analysis was performed, examining the incidence of patients with low (<3.8 mg/dL) and normal (≥3.8 mg/dL) serum albumin within each SGA score. It could be hypothesized that those patients with a low SGA score, but normal albumin concentrations, have pure malnutrition. Likewise, patients with low serum albumin and a normal SGA score could have inflammation alone, with no loss of nutritional status. Table 4 depicts these scenarios.

To establish predictive validity, the frequency and duration of hospitalization during the 6-month study period were examined across baseline SGA scores of 1-7. Frequency of admission was significantly different between SGA scores ($P < .05$, Kruskal-Wallis test for skewed distribution), and duration of hospitalization approached statistical difference ($P = .089$) (Fig. 3). When patients were analyzed by serum albumin concentration (<3.8 or ≥3.8 mg/dL), patients with a concentration ≥3.8 mg/dL were not significantly different according to either number of admissions or days of hospital stay between SGA scores. However, patients with serum albumin <3.8 mg/dL were significantly different in terms of number of times hospitalized ($P < .05$), but not in terms of number of days hospitalized by SGA score.

Discussion

The purpose of this National Research Question was to examine the reliability and validity of SGA in hemodialysis patients. The methods used to achieve these aims were novel in that all the renal dietitians who participated were trained by way of an interactive website, and the training was monitored through pretests and posttests. The dietitians were active practitioners from Canada, New Zealand, and 30 different states throughout the United States (US). These dietitians had markedly different levels of educational backgrounds, years of work experience, and familiarity and training in terms of SGA.

Table 4. Descriptive Variables by SGA Category

Body mass index ($P < .004$)	23.6 ± 2.2	21.2 ± 3.9	27.6 ± 7.9	28.9 ± 7.5	28.7 ± 6.1
Age (y) (NS)	56.5 ± 12.0	69.3 ± 13.4	63.4 ± 14.7	65.6 ± 13.3	61.4 ± 13.9
Duration of dialysis (NS)	47.0 ± 48.1	45.4 ± 43.1	41.8 ± 32.6	39.3 ± 34.5	41.5 ± 34.0
Serum albumin (mg/dL) ($P < .001$)	2.9 ± 1.2	3.4 ± 0.7	3.7 ± 0.5	3.8 ± 0.4	3.8 ± 0.3
Percent with albumin <3.8 mg/dL	67%†	56%†	63%†	39%¶	41%¶
Sample size (n)	2	5	20	25	19
Mean ± SD	2.3 ± 0.5	2.9 ± 0.5	3.4 ± 0.3	3.5 ± 0.2	3.5 ± 0.2
Percent with albumin ≥3.8 mg/dL	33%‡	44%‡	37%‡	61%	59%
Sample size (n)	1	4	12	39	27
Mean ± SD	4.2	4.0 ± 0.3	4.1 ± 0.2	4.1 ± 0.3	4.0 ± 0.2

SGA, subjective global assessment category; NS, not significantly different.
†Serum albumin <3.8 + SGA (score of 3–5) = malnutrition with inflammation.
‡Serum albumin ≥3.8 + SGA (score of 3–5) = malnutrition alone.
¶Serum albumin ≤3.8 + SGA (score of 6–7) = inflammation alone.

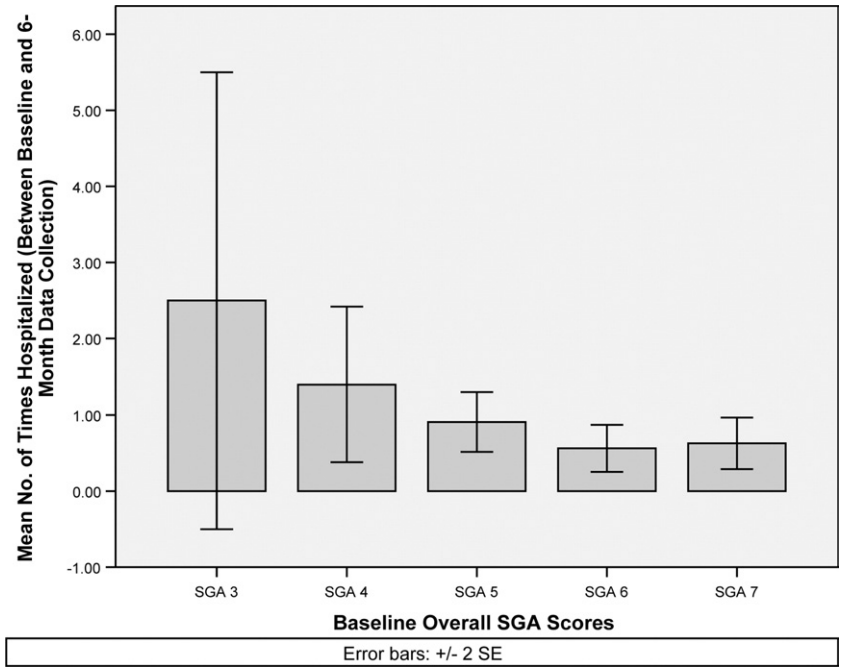

Figure 3. Distribution of number of times patients (n = 112) were hospitalized between baseline and 6 months (Kruskal-Wallis analysis, $P < .05$). SGA, subjective global assessment.

The patients randomly recruited for this study had characteristics similar to those reported for the US dialysis population in general.[13] Therefore, extrapolation of this study's results to the US dialysis patient population is reasonable. The results of this study also indicate that even when a large number of dietitians with different backgrounds are trained on conducting SGA through a web-based course, SGA has substantial intrarater reliability, fair interrater reliability, and moderate concurrent and predictive validity.

Visser et al. (n = 22; 13 hemodialysis and 9 peritoneal dialysis patients),[8] Kalantar-Zadeh et al. (n = 12 hemodialysis patients),[14] and Cooper et al. (n = 76; 52 hemodialysis and 24 peritoneal dialysis patients)[3] all measured interrater reliability in stage 5 CKD patients, using two clinicians to conduct all SGA assessments. These studies reported significant reliability using intercorrelation coefficients (ICCs), percent agreement, or kappa scores. Our study found the same weighted kappa scores as did Cooper et al.,[3] but lower percent agreement than in Kalantar-Zadeh et al.[14] and Visser et al.[8] Differences in study design included use of the Detsky 3-point (A, B, and C) version of SGA vs. the 7-point scale, using two assessors to conduct SGA vs. 54 different dietitians, and in-person vs. web-based training. Only one other published study of renal patients measured intrarater reliability.[8] That study had a much higher ICC for intrarater reliability than this study, possibly because of the shorter time (2 weeks) between assessments and the limited number of assessors (n = 2). During a 2-week period, there would be a decreased chance for actual clinical changes to occur. However, both studies found statistically significant results.

Many different studies examined the concurrent validity of SGA.[2,3,8,9,12,14–17] A landmark study of SGA was the international CANUSA Study.[5] The prospective, cohort CANUSA Study followed a large number of peritoneal dialysis patients from 14 dialysis centers across Canada and the United States. It found SGA to be independently predictive of death ($P < .05$) and days hospitalized ($P < .05$).

Jones et al.[2] studied SGA in a sample of 72 hemodialysis patients. They used both the original 3-point (A, B, and C) and 7-point scale methods of rating SGA, and compared SGA to biochemical and anthropometric nutritional markers as well as the composite nutritional score (CNS). They demonstrated concurrent validity through significantly different mean values for mid-arm circumference, MAMC, serum creatinine, C-reactive protein, and dietary sodium intake between SGA categories A and B (all $P < .05$). Using the 7-point scale, significant differences were found between SGA categories for the same variables, except for dietary sodium

intake. Discrepancies were seen between CNS and SGA, causing concern about the reliability of SGA compared with CNS.

In this study, we teased out the influence of inflammation by examining serum albumin (<3.8 mg/dL and ≥3.8 mg/dL) to determine whether patients had malnutrition alone, malnutrition and inflammation, the presence of inflammation alone, or neither inflammation nor malnutrition. Our data indicate that malnutrition alone (SGA score of 3-5, with albumin ≥3.8 mg/dL) existed in 11% of our sample, and 18% had a combination of malnutrition and inflammation. Interestingly, when those patients with a low SGA but normal serum albumin were analyzed for differences in rate of hospitalization, no statistical significance was found. Significance was found only in the number of times hospitalized between baseline and 6 months in those patients with both low serum albumin and a low SGA score.

A limitation of our study was the 1-month period between the two assessments for intrarater reliability, which may have influenced agreement between the two assessments, because actual changes in nutritional status could have occurred, in which case it would have been accurate for the assessments not to agree.

In conclusion, this study found SGA to have fair interrater reliability, substantial intrarater reliability, and both concurrent and predictive validity when performed in a diverse hemodialysis population by a large and varied group of dietitians who were prepared for study participation using a web-based training program.

References

1. Stenvinkel P, Heimburger O, Paultre F, Diczfalusy U, Wang T, Berglund L, et al: Strong association between malnutrition, inflammation, and atherosclerosis in chronic renal failure. Kidney Int 55:1899-1911, 1999

2. Jones CH, Wolfenden RC, Wells LM: Is subjective global assessment a reliable measure of nutritional status in hemodialysis? J Ren Nutr 14:26-30, 2004

3. Cooper BA, Bartlett LH, Aslani A, Allen BJ, Ibels LS, Pollock CA: Validity of subjective global assessment as a nutritional marker in end-stage renal disease. Am J Kidney Dis 40:126-132, 2002

4. Detsky AS, McLaughlin JR, Baker JP, et al: What is subjective global assessment of nutritional status? J Parenter Enteral Nutr 11:8-13, 1987

5. Adequacy of dialysis and nutrition in continuous peritoneal dialysis. association with clinical outcomes. Canada-USA (CANUSA) Peritoneal Dialysis Study Group. J Am Soc Nephrol 7:198-207, 1996

6. Jones CH, Newstead CG, Will EJ, Smye SW, Davison AM: Assessment of nutritional status in CAPD patients: serum albumin is not a useful measure. Nephrol Dial Transplant 12: 1406-1413, 1997

7. Kalantar-Zadeh K, Kleiner M, Dunne E, et al: Total iron-binding capacity-estimated transferrin correlates with the nutritional subjective global assessment in hemodialysis patients. Am J Kidney Dis 31:263-272, 1998

8. Visser R, Dekker FW, Boeschoten EW, Stevens P, Krediet RT: Reliability of the 7-point subjective global assessment scale in assessing nutritional status of dialysis patients. Adv Perit Dial 15:222-225, 1999

9. Lawson JA, Lazarus R, Kelly JJ: Prevalence and prognostic significance of malnutrition in chronic renal insufficiency. J Ren Nutr 11:16-22, 2001

10. McCann L: https://secure.kidneytools.com/netnutrition/. Redwood City, CA: Satellite Health, Inc., 2004

11. Moshfegh AJ, Borrud L, Perloff B, et al: Improved method for the 24-hour dietary recall for use in national surveys. FASEB J 13:A603, 1999

12. Ware JE, Kosinskia M: SF-36 physical and mental health summary scales: a manual for users of version 1. 2nd ed. Lincoln, RI: Quality Metric, Inc., 2002

13. US renal data system. Bethesda, MD: National Institutes of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, 2003

14. Kalantar-Zadeh K, Kleiner M, Dunne E, Lee GH, Luft FC: A modified quantitative subjective global assessment of nutrition for dialysis patients. Nephrol Dial Transplant 14:1732-1738, 1999

15. Detsky AS, Baker JP, Mendelson RA, Wolman SL, Wesson DE, Jeejeebhoy KN: Evaluating the accuracy of nutritional assessment techniques applied to hospitalized patients: methodology and comparisons. J Parenter Enteral Nutr 8:153-159, 1984

16. Young GA, Kopple JD, Lindholm B, et al: Nutritional assessment of continuous ambulatory peritoneal patients: an international study. Am J Kidney Dis 17:461-471, 1991

17. Enia G, Sicuso C, Alati G, Zoccali C: Subjective global assessment of nutrition in dialysis patients. Nephrol Dial Transplant 8:1094-1098, 1993