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Critical review of nutrition assessment tools to measure malnutrition in chronic kidney disease

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A critical review of nutrition assessment tools to measure malnutrition in chronic kidney disease

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Introduction

In chronic kidney disease (CKD), uraemic symptoms and the presence of inflammation can contribute to poor dietary intake and an increase in metabolic stress[1]. Collectively, this leads to a reduction in body protein synthesis, hence a decline in nutritional status, herein termed malnutrition[2]. Malnutrition in CKD is an independent predictor of morbidity and mortality[3, 4].

Malnutrition remains a critical risk factor for poor outcome in CKD[5] despite the increasing BMI of the Australian population[6]. Prospective data suggests a high BMI may be predictive of reduced morbidity and mortality compared to a lower BMI in haemodialysis populations[7]. Recent evidence indicates weight loss and reduction in appetite are key precipitating factors for malnutrition and independent predictors of poor outcome for CKD patients[8,9]. Therefore, despite the increase in overweight and obesity in the population, there is sufficient evidence supporting the need for a consistent method of nutrition assessment to capture symptoms leading to unintentional weight loss, wasting, and the diagnosis of malnutrition.

Assessment of malnutrition is an important component of dietetic practice and improves the dietitians ability to prioritise intervention to those most at risk. A clinically useful marker should be able to identify malnutrition, assess the resulting risk of morbidity and mortality and also evaluate the response to nutrition intervention [10]. Interpretation of methods to assess nutrition status in CKD including anthropometric (e.g. weight change, skin-fold assessments) and biochemical (e.g. serum albumin) can have limitations due to the nature of CKD[10]. For example, weight change may be due to fluid shifts and hypoalbuminemia due to acute inflammation therefore, may not be true markers of nutrition status. Therefore current evidence-based practice guidelines for nutrition management in CKD guidelines recommend use of a panel of parameters in clinical practice, including the clinical tool, Subjective Global Assessment (SGA)[11-13].

SGA provides a comprehensive appraisal of nutrition status considering a medical and physical assessment (combining parameters of weight change, dietary intake, symptoms of gastro-intestinal distress and a physical examination) and classify's nutrition status as well-

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nourished (A), mild to moderately malnourished (B), or severely malnourished (C)[14]. Therefore, SGA is recommended to assist in determining who to target for nutrition support, as it represents quick, cost-effective, multi-disciplinary assessment, not influenced by the metabolic anomalies of CKD[15].

The prevalence of malnutrition in CKD as assessed by SGA has remained consistent over past 20 years. Since SGA was first introduced in CKD in 1987, international prevalence of malnutrition ranges around 30-40% (Table 1) and studies conducted over the last 5 years in Australia indicate a rate from 20 to 48%[16-20].

Rating nutrition status on three broad categories has brought recent criticism of SGA's ability to measure the degree of malnutrition[20] and identify small, yet clinically significant changes in nutrition status[21]. A number of modified and/or scored SGA-based assessment tools have appeared in the CKD literature, creating confusion about which is the most appropriate tool to use (Table 2)[15].

Given the number of SGA-based tools available for use in CKD, it is critical to evaluate their validity and reliability[15], to build an evidence base and promote consistency in nutrition assessment in clinical practice. There are a number of types of validity and reliability outlined in Table 3. The strength and applicability of validation studies depends on the study design, sample selection, administration and reference parameters or outcome measures used[22].

This review aims to critically evaluate studies investigating the SGA and associated tools to provide insight into informing best practice and consistency in methods used for nutrition assessment in CKD.

Methods

A literature search was conducted to answer the research question: 'What SGA-based tools were available to assess the nutrition status of CKD patients?' The articles were then

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evaluated to answer, 'To what extent has this particular tool been tested for validity/reliability in CKD patients?' The review will include nutrition assessment at all stages of CKD.

Inclusion Criteria: Articles introducing, validating or assessing the feasibility of a SGA-based assessment tool in CKD, where screening or assessment tools were completed by dietitian, nurse or trained physician were included. Particular emphasis was placed on articles where the assessment method is measured against a reference standard or evaluated against clinical follow-up. Original research articles not fulfilling the criteria of a validation study were only evaluated for prevalence of malnutrition (Table 1).

Search Strategy: Cochrane, MEDLINE and CINAHL databases using the MeSH terms "Nutrition assessment", "Malnutrition" and "Chronic Kidney Disease" OR "Kidney Failure". In addition the subject "Subjective Global Assessment" or "SGA" was used in combination with the MeSH terms. Limits of "Valid*"; "Reliab*" used where necessary.

Evaluation of Methodological Quality: Each study was assessed for quality using criteria guided by Quality Assessment of Diagnostic Accuracy Studies tool (QUADAS)[23]and Jones (2004)[24] The studies were evaluated against the NHMRC draft levels of evidence (Table 3)[25]. Tools are assigned a level of diagnostic evidence depending on the study design and reference standards for clinical and/or criterion validity. Tools indicating predictive validity are assigned level II prognostic evidence if the tool had displayed sufficient diagnostic evidence (Table 3).

Results

In the CKD literature, at least eight different SGA-based tools were evident[11, 18, 21, 26-30]. Table 4 is a summary of the SGA-derived tools, validity, reliability, design comments and NHMRC levels of evidence for the tools featured in this article. Reference standards are used to test clinical, predictive and criterion validity[18-21, 26, 28, 31-34] and multiple raters and internal consistency checks to investigate reliability[18, 20, 27].

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Validity

Original SGA: The original SGA was first investigated in a validation study in haemodialysis (HD) and peritoneal dialysis (PD) patients in 1993[26], where SGA appeared to display clinical validity with albumin, bioimpedance (BIA) phase angle, mid arm muscle circumference (MAMC), percent body fat (%BF) and normalised protein catabolic rate (nPCR) with multiple regression analysis confirming the strong relationship between SGA and the combined objective measures (multiple r = 0.77). Lawson et al (1999), in a 12-month follow-up study further investigated the predictive validity of the SGA in HD patients, determining SGA B or C rating results in significantly increased mortality, likelihood of acute hospitalisation, and depleted FFM (as measured by BIA)[19].

In an investigation by Cooper *et al* (2000), Nitrogen Index (measured total body nitrogen compared to sex- age- height matched general population), was significantly lower in patients rated SGA B and C compared to A [20]. However, when criterion validity was assessed using <85% of expected Nitrogen Index (NI) as a gold-standard for malnutrition, SGA could not confidently differentiate between well-nourished, malnourished and degree of malnutrition (B and C)[20]. According to this criterion, 29% of the subjects were malnourished (NI <85% of predicted), compared to >40% by the SGA[20]. However, as malnutrition is a progressive wasting disease, there is a risk with using cross-sectional body composition measures to "diagnose" malnutrition. Significant wasting by an overweight patient (BMI > 25kg/m^2), and/or moderate weight loss with significant uraemic symptoms, anorexia and lethargy contributing to a legitimate SGA B rating, is unlikely to register under the reference cut-off of a low NI (i.e. <85% of predicted).

Retrospective modified-SGA: Pifer *et al* (1999) reported the mSGA predicted 25% increased mortality for SGA C, compared to SGA A and B at 6 months[31]. In this study, there was a greater proportion of "severely malnourished" (11%) than "moderately malnourished" (7%)[31] patients.

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7-point SGA: The introduction of the 7-point SGA, revealed predictive validity for 12-month survival, indicating a reduction in one category of the 7-point scale equating to a 25% increased relative risk of death[33] determined by Cox proportional hazard model. In a more recent paper, Jones *et al* (2004) investigated the criterion validity of both the original SGA, and the 7-point SGA by a "composite nutrition score" (higher score, lower nutrition status; derived from parameters including BMI, albumin and anthropometry)[32]. The mean difference in composite scores of SGA A vs. B and each of the categories 3 to 7 was statistically significant (using correlation analysis), however, both tools had considerable overlap of composite scores between categories, particularly for 7-point SGA[33].

Scored-SGA: In its initial investigation, the Dialysis Malnutrition Score (DMS) significantly correlated with a number of nutrition-related biochemical parameters[21]. In a 12-month prospective study, the DMS was included in an investigation of the Malnutrition Inflammation Score (MIS) and SGA and were compared with a range of biochemical indices and morbidity/mortality outcomes. The MIS correlated the most significantly with 12-month survival and hospitalisation, creatinine level, hematocrit, and CRP, which is not surprising considering it contains biochemical parameters related to iron and inflammatory status (TIBC, Alb) [28]. A more recent paper of 378 HD subjects with a similar study design confirmed the predictive validity of MIS >8 to predict poor clinical outcome (mortality and hospitalisation)[34].

The Patient-Generated SGA (PG-SGA), previously validated in oncology patients, was published in HD by Desbrow *et al* (2005)[18] investigating criterion and clinical validity. Criterion validity, using the original SGA as the gold-standard, was demonstrated by a significant difference in PG-SGA scores between well-nourished (A, median (range) = 2 (0-13) and malnourished (B, median score = 16(7-26))[18]. Clinical validity to serum albumin was demonstrated by a significant correlation with the PG-SGA score (Table 4).

Reliability

The initial reliability study for the original SGA in surgical patients revealed good inter-rater reliability (kappa = 0.78)[14]. In CKD, agreements between the ratings of the SGA categories

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appear to be not as sensitive. Cooper *et al* (2002) attained fair agreement between a physician and dietitian (weighted kappa = 0.60)[20]. Visser *et al* (1999) investigated the reliability of the 7-point SGA administered by nursing staff on a small number of dialysis patients indicating fair inter-rater reliability (ICC=0.72)[27] (Table 4). Of the scored tools, the DMS, inter-rater reliability was good, with a kappa of 0.83 investigated on approximately 30% of the sample[21]. Satisfactory internal reliability of the PG-SGA components was determined by α-Cronbach coefficient of 0.73[18].

Discussion

SGA is a core assessment tool evidenced by the volume of studies utilising SGA. Modifications of the SGA present in the CKD literature include tools that expand the scale of the SGA to a larger number of categories (4-point[30], 7-point[33]), allow retrospective assessment[31], provide a continuous score for components of the SGA[18, 21] and incorporate objective measures[28]. SGA along with modified versions have shown clinical and/or predictive validity in CKD for both dialysis and non-dialysis populations[4, 19, 28, 33-35].

When considering which tool is best to apply, it is important to consider the purpose of the nutrition assessment. Tools displaying diagnostic evidence indicate the ability to distinguish between other known measures of nutrition status, by clinical and/or criterion validity. Prognostic evidence refers to the ability of the tool to predict negative outcomes, such as morbidity and mortality, achieved via predictive validity (Table 3 and 4).

Presence of malnutrition: As a prognostic and diagnostic tool, SGA has level II and III-1 evidence, respectively. Merging the SGA groups representing “malnourished” (B & C, or <5 on 7-point or >2 on 4 point scales) appears adequate for clinical and predictive validity, with reasonable reliability (Table 4). Using the scored tools, an MIS >8 appears to predict greater morbidity and mortality over 12 months [34], and PG score >9 has good reliability with SGA B [18].

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By definition, the SGA in its original and modified categorical form (ABC, 4 or 7-point) rank nutrition status on an ordinal scale. This means the rating is given relative to the distribution of nutrition status and cannot be assigned a number on a scale, as nutrition status may not be of equal value across the rating spectrum. In all studies, the 7-point SGA, has been treated as an *interval* or *continuous* score[27, 32, 33, 35] (Table 4). Therefore, relative validity and reliability results are based on the assumption that the 7-point scale of the SGA is directly linear (interval), which is debateable. Jones *et al* (2004) investigated the criterion validity of 7-point SGA against a composite nutrition score, containing a variety of measures, including the original SGA[32]. Although statistically there appeared to be agreement, the composite score distribution between the 7 categories had a large overlap, and non-systematic distribution of scores, particularly over ratings 4 to 6 (representing the spectrum of moderate malnutrition) therefore the 7-point SGA did not appear linear with this score as the measure of nutrition status.

Monitoring nutrition status over time It appears tools providing a continuous score, such as the PG-SGA, DMS and MIS have added merit for use in the clinical setting to monitor small changes in nutrition status over time, all appear to have clinical validity to key nutrition-related variables, and reach Level III-2 evidence[18, 21]. The MIS shows promise as a potential predictor of outcome and indicate the degree of Malnutrition Inflammation Cachexia Syndrome[34]. Similarly, small changes in PG-SGA score has previously reflected important clinical changes, such as quality of life in oncology[36] and length of hospitalisation for general medical patients[37]. The recent study in HD patients indicates the scored PG-SGA may have similar merit for use in CKD as it has for oncology patients[18]. Tools that monitor nutrition status on a continuous scale are also beneficial in research, with less reliance on subjectivity, and provide greater statistical power than a categorical rating of nutrition status (Table 1). However, the linearity of these scored tools has yet to be confirmed, and may have similar issues as stated for the 7-point SGA.

Conclusion

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SGA (A vs. B & C) is a valid method for assessing the presence of malnutrition for diagnostic and prognostic purposes. Continuous scores may improve the clinician's ability to assess small changes in nutrition status, as an ideal nutritional marker should reliably measure change in nutrition status, not just predict clinically important outcomes. In combination, these tools can provide a comprehensive assessment for both clinical and research settings.

Recommendations for future research: Future validation studies need to focus on how change in nutrition status can be adequately measured. Longitudinal assessments of nutrition status are necessary to determine most appropriate tool for use in CKD to measure nutrition status prospectively.

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Table 1: Prevalence of malnutrition by SGA tool and administrator in CKD

Author Year	Rating scale	Country	Population	Administrator	Definition of Malnutrition	Prevalence of malnutrition
Fenton 1987[38]	A,B,C	Canada	118 PD	Physician or nurse	SGA B or C	**23%**
Young 1991[39]	A,B,C & obj	Europe, US	224 PD	Physician	SGA B or C	**41%**
Enia 1993[24]	A,B,C	Italy	36 HD; 23PD	Physician	SGA B or C	**31%**
Jones 1997[40]	A,B,C	England	76 PD	Not stated	SGA B or C	**47%**
Julien 2001[41]	A,B,C	France	32 HD	Nurses	SGA B or C	**76%**
Lawson 2001[15]	A,B,C	Australia	50 HD	Dietitian	SGA B or C	**28%**
Cooper 2002[16]	A,B,C	Australia	52 HD; 24 PD	1) Physician & 2) Dietitian	SGA B or C	**48%** **42%**
Cupisti 2004[42]	A,B,C	Italy	70 pre-dialysis	Physician	SGA B; no C	**29%**
Desbrow 2005[14]	A,B,C	Australia	60 HD	Dietitian	SGA B; no C	**20%**
Pifer 2002[29]	mSGA A,B,C	USA	7719 HD	Retrospective	SGA B or C	**19%**
Churchill 1996[31]	1-7	Canada and US	680 commencing PD	Not stated	SGA 1or2=C 3,4or5 = B	**55%**
Visser 1999[25]	1-7	Netherlands	13 HD, 9PD	Nurses	SGA 1or2=C 3,4or5 = B	**36%**
Jones 2004[30]	1-7 & A,B,C	England	72 HD	Dietitian	SGA B; no C	**31%**
Qureshi 1998[43]	1-4	Sweden	128 HD	Physician	Rating 2 – 4	**64%**
Stenvinkel 1999[28]	1-4	Sweden	119 commencing dialysis	Physician	Rating 2 – 4	**44%**
Stenvinkel 2002[32]	1-4	Sweden	206 commencing dialysis	Not stated	Rating 2 – 4	**39%**

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Table 2: Description, advantages and disadvantages of SGA-based nutrition assessment tools utilised in CKD.

Tool	Method	Modification from SGA	Advantages	Disadvantages
Retrospective mSGA	Rating A,B,C	Retrospective 'self rating' on A, B, C scale	Conducted as a survey (self-report)	Relys on self-report and carer's physical assessment
4-point SGA	Rating 1 to 4	Expands the "B" category to two. Ratings >2 represent malnutrition.	May delineate poor nutrition status	Similar issues to original, difficult to note changes over time
7-point SGA	Rating 7 to 1	Expands the 3 categories of the original SGA, to 7 on a Likert-type scale.	May delineate levels of nutrition status	May increase inter-observer variation
Dialysis Malnutrition Score (DMS)	Scored 7 to 35	Scores 7 components of the SGA as 1 (normal) to 5 (very severe).	Scored so less subjectivity	Allocation of scores not based on evidence
Malnutrition Inflammation Score (MIS)	Scored 0 to 30	10 components, the DMS with BMI, serum albumin and total-iron binding capacity, scored according to severity 0 (normal) to 3 (very severe).	Includes objective categories - less reliance on subjectivity	Requires biochemistry (albumin and iron studies), and weight/height measures for BMI
Patient-Generate Subjective Global Assessment (PG-SGA)	Scored 0 to 35 and A,B,C	Provides a numerical score, dependant on the impact of each SGA component on nutrition status.	Patient completes medical history, scored so less subjective	May require more patient input

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Table 3: Definition and study design for validity and reliability testing corresponding draft NHMRC level of evidence in reference to nutrition assessment tools in CKD

	Definition[37]	Study design and NHMRC level of evidence[23]
Clinical validity	Explores the relationship that exists in known parameters associated with nutrition status, but not used in the tool. Validity is then only established against the parameter within that investigation	Cross-sectional comparison with reference that is not a gold standard, and/or is not blinded (Level III-2, Diagnosis)
Predictive Validity	Explores the correlation with another measure assessed in the future (e.g. morbidity and mortality)	Prospective, cohort (Level II, Prognosis, applies only to studies of diagnostic accuracy)
Criterion Validity	Evaluates agreement and performance (sensitivity/specificity) of the tool, against a valid, gold-standard reference measure.	Cross-sectional blinded comparison in consecutive or non-consecutive patients (Level II or III-1, Diagnosis)
Inter-rater Reliability	Tool can provide good agreement between users	Cross-sectional
Intra-rater Reliability	Tool is reproducible after test-retest assessment	Test-Retest
Internal Reliability	An assessment of the correlation across items within the assessment tool	Cross-sectional

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Table 4: Validation studies for SGA-derived tools in CKD

Tool	Studies included Author, year, study type (sample)	Clinical Validity	Predictive Validity	Criterion Validity	Reliability	Design comments
SGA	**Enia 1993** Clinical validity (36HD; 23PD) **Lawson 2001** Clinical and predictive validity 50 CKD (Pre-dialysis) **Cooper 2002** Criterion validity and reliability (24PD; 52HD)	Albumin, BIA, ($p<0.001$) MAMC, % BF, nPCR ($p<0.05$); Fat-free mass	Mortality/Morbidity (12 months)	Not established (Nitrogen Index <85%= malnutrition)	**Inter-observer reliability** Moderate (weighted k=0.60)	Clinical and criterion validity: blinded to objective results Criterion validity: Question Choice of gold-standard cut-off
Retrospective mSGA	**Pifer 2002** Predictive (7719 HD)		Mortality (6 months)			Question face validity ↓ death risk for B
7-point SGA scale	**Chruchill 1996** Clinical and Predictive validity (680 starting PD) **Visser 1999** Clinical validity and Reliability 22 Dx (13HD; 9PD) **Jones 2004** Criterion validity (72 HD)	Rating <5: Albumin 1-7 BMI, MAMC, %BF	Mortality/Morbidity (2-3 years)	Composite nutrition score (incl SGA, BMI, TSF, MAMC, Alb)	**Inter-observer** ICC=0.72 **Intra-observer** ICC=0.88	Interpreted 7-point SGA as interval Reliability on small sample (n=16) Criterion Validity: Large overlap scores between groups indicate lack of linearity.
Dialysis Malnutrition Score	**Kalantar-Zadah 1999** Clinical validity and Reliability (41 HD)	MIS Alb, Cr, BUN, Iron, Chol, MAMC ($p<0.001$)			**Inter-observer** K=0.83	No report on "risk" score or malnutrition cut-off, or number that refused study. Reliability on small sample (n=13)
Malnutition Inflammation Score	**Kalantar-Zadah 2001** Clinical and Predictive validity (83 HD) **Kalantar-Zadah 2004** Clinical and Predictive validity (378 HD)	Albumin, CRP, Cr, Hct IL-6	Morbidity/Mortality (12 months)			MIS appears to be a "risk assessment/ outcome predictor" MIS >8 = high risk Advantageous to predict outcome over SGA and DMS
Patient-Generated Subjective Global Assessment	**Desbrow 2005** Clinical and Criterion validity and Reliability (60 HD)	Albumin		**>9** SGA PG score ≥9 good reliability to SGAB: 83% sens, 92% spec;	**Internal Reliability** α-coefficient 0.73	NHMRC III-I Nature of the gold-standard did not allow 'blinding' of the SGA to PG-SGA

SGA Subjective Global Assessment ; PG-SGA Patient-Generated Subjective Global Assessment ; DMS Dialysis Malnutrition Score ; MIS Malnutrition Inflammation Score
HD Haemodialysis, PD Peritoneal Dialysis, Pre-Dx Pre-Dialysis,
Alb Albumin, nPCR normalised Protein Catabolic Rate, BIA Bio-imedence Phase angle
MAMC Mid-arm muscle circumference, BF Body Fat, TSF Tricep Skin-fold, FFM Fat Free Mass
Cox PHM Cox Proportional Hazards Model, MW Mann-Whitney, MV Multivariate, ICC Interclass correlation

For Peer Review