# Dietetic intervention in haemodialysis patients improves malnutrition

Joanne Beer, Emily Mountford and Neil Boudville

*Submitted: 19 October 2017, Accepted: 5 January 2018*


## Abstract

**Objective:** Protein-energy malnutrition is an independent predictor of morbidity and mortality in dialysis patients with a prevalence as high as 75%. It is associated with poor dialysis outcomes, including decreased quality of life, increased hospital admissions and increased mortality. We hypothesised that regular dietetic input following evidence-based guidelines would reduce malnutrition and improve patient health.

**Design and Methods:** Two specialist renal dietitians reviewed patients at a single satellite dialysis unit in Perth over a seven-month period in 2015. Demographic, laboratory and malnutrition data using the Subjective Global Assessment (SGA) were collated at baseline and follow-up. One-to-one, individualised dietetic education was given to patients during the seven-month period. Paired t-test and Wilcoxon signed rank tests were used to assess differences between baseline and follow-up results.

**Results:** One hundred and fifty-two patients were recruited. At baseline, mean age was 71.0±12.4 years and 63% were male. Considerable malnutrition was noted at baseline (46%) with mean hand grip strength of 23.7±12.7 kg (<85% of expected value for healthy age-matched individuals). Mean body mass index (BMI) was 27.7±7.0kg/m2, PG-SGA 6.8±4.5 and 25% had a serum albumin ≤35 g/L. The mean time since the patients' last dietetic review was two years, with 25% over three years. Sixty-nine patients were reaudited at the end of the intervention period. Malnutrition rates (SGA ranking), significantly improved falling from 43.5% to 28.9% (p = 0.02).

**Conclusions:** Dietetic intervention in haemodialysis patients reduced rates of malnutrition, underlining the value of dietetic input in this setting.



## Keywords

**Malnutrition, haemodialysis, dietary intervention, education.**


## Introduction

Protein-energy malnutrition is an independent predictor of morbidity and mortality in dialysis patients and is associated with negative health outcomes, including decreased quality of life, increased risk of cardiovascular disease, other co-morbidities, increased hospital admissions and increased mortality (Chan *et al.,* 2012; Kopple *et al.,* 1999; Atilano-Carsi *et al.,* 2012).


**Joanne Beer,** BSc (Hons), Post Grad Dip, Senior Dietitian, Department of Nutrition and Diet Therapy, Sir Charles Gairdner Hospital, Nedlands, WA, Australia

**Emily Mountford,** BSc, Post Grad Dip, Clinical Dietitian, Department of Nutrition and Diet Therapy, Sir Charles Gairdner Hospital, Nedlands, WA, Australia

**Neil Boudville,** MBBS FRACP FASN MMedSci, University of Western Australia, School of Medicine and Pharmacology and Sir Charles Gairdner Hospital, Department of Renal Medicine, Nedlands, WA, Australia.

**Correspondence to:** Joanne Beer, Senior Dietitian, Osborne Park Hospital, 36 Osborne Place, Stirling, WA 6021, Australia
Email: joanne.beer@health.wa.gov.au

Several studies report malnutrition rates as high as 75% in the haemodialysis population (Kalanter-Zadeh *et al., 2003;* Piccini *et al*., 2014; Pasian *et al*., 2014). A recent study reported that 70% of dialysis patients consumed insufficient calories and 50% inadequate protein (Luis *et al.,* 2016). Many ate excess fat (particularly unhealthy saturated fat), consumed too much phosphorus, calcium and sodium and overall had poor quality diets low in fibre and inadequate to meet their nutrient needs (Luis *et al.,* 2016).

The health and economic burden of end-stage kidney disease (ESKD) on individual patients, carers and the community in Australia is high. At the end of 2014, there were 12,091 people receiving dialysis, with over 2,610 new cases reported in 2014 (ANZDATA, 2015). Rates of treated ESKD (dialysis and transplants) are high among certain groups of the population particularly susceptible to malnutrition, including older Australians (rates are six times as high among those aged 70 years and over compared with those under 50 years) and among Aboriginal and Torres Strait Islander people (where rates of treated ESKD are six times the rate of non-Indigenous Australians) (ANZDATA, 2015). The number of those requiring dialysis is projected to increase by 35% to 16,362 cases in 2020 (AIHW, 2014).

Nutrition care and intervention are vital for those undergoing haemodialysis with international guidelines, for example, Caring for Australians with Renal Impairment (CARI) and National Institute for Health and Clinical Excellence in the United Kingdom (NICE) guidelines recommending regular dietetic assessments and intervention by a specialist dietitian (Kidney Disease: Improving Global Outcomes [KDIGO], 2012; Ash *et al.,* 2006; CARI, 2013; American Dietetic Association [ADA], 2017; NICE., 2007; National Kidney Foundation Kidney Disease outcomes Quality Initiative). However, to date, only limited evidence has been published to show that such interventions are linked to improvements in patients' nutritional status, dietary intake and knowledge, or a reduction in poor dialysis outcomes (Campbell *et al.,* 2009; Hegazy *et al.,* 2013; Hernandez-Morante *et al.,* 2014; Bonanni *et al*., 2011; Ash *et al*., 2014).

There is currently limited data available on the effect of dietetic intervention in satellite dialysis patients in Australia. The aim of this intervention project was to provide regular on-site dietetic input in line with evidence-based guidelines and examine its association with malnutrition and patient health.

## Methods

A north metropolitan satellite dialysis unit was chosen for the project as it is the largest haemodialysis unit in the North Metropolitan Health Service (NMHS), providing dialysis for up to 144 patients per week. Currently, of the 10 metropolitan satellite dialysis units, (including two home dialysis units) there is only one on-site dietetic service for patients receiving dialysis. Patients are therefore advised to attend their local tertiary hospital's outpatient department for a renal dietitian appointment. The principal referral hospital for this satellite dialysis unit (Sir Charles Gairdner Hospital) had a three-month waiting list at the start of the project. Funding was obtained from an unrestricted educational grant from Roche Pharmaceuticals to conduct a baseline audit, provide a seven-month, on-site dietetic service for 3.8 hours per week and an audit after intervention to assess nutritional status.

All patients at the unit were invited to participate in the audit and were offered an initial dietetic consultation of up to 45 minutes. Patients were excluded who had significant language barriers, advanced dementia with no family present to assist with answering questions, and those who declined to be involved in the audit.

A standard audit template was created to gather all relevant information from the baseline and end audits. The data collected included: anthropometric measurements, biochemical data, dialysis vintage, demographic information and past medical history. The results from the baseline audit were used to prioritise dietitian input during the seven-month, on-site service which consisted of two full clinic days per month.

## Demographic information and patient characteristics

Age, gender, dialysis vintage (length of time since starting dialysis), relevant chronic conditions and cause of ESKD were documented. Patients were asked when they last saw a dietitian which was cross-referenced with the allied health statistic (AHS) and iCM (information Clinical Manager) data showing their last dietetic appointment.

## Anthropometry

Information was collected on most recent dry weight (post dialysis), wet weight (pre-dialysis), interdialytic weight gain and height. Body mass index (BMI) was calculated using dry weight divided by height squared. Malnutrition assessment was completed using the Patient-Generated Subjective Global Assessment (PG-SGA). The KDIGO guidelines (KDIGO, 2012) recommend the use of the SGA (Subjective Global Assessment) in maintenance haemodialysis patients to assess nutritional status and malnutrition (Desbrow *et al*., 2005).

The PG-SGA tool has been validated for use in renal patients and the numerical score can be used as a triage tool to prioritise interventions using the following guidelines:

0–1 No intervention required at this time. Reassessment on routine and regular basis during treatment.

2–3 Patient and family education by dietitian, nurse or other clinician with pharmacologic intervention as indicated by symptom survey and laboratory values, as appropriate.

4–8 Requires intervention by a dietitian, in conjunction with nurse or physician, as indicated by symptoms.

> 9 Indicates a critical need for improved symptom management and/or nutrient intervention options[23].

Patients were provided with the PG-SGA patient questionnaire one week prior to the audit and asked to bring it with them on the day of analysis. Student dietitians helped patients complete the form on the day if it had not already been completed. Patients were then categorised as well nourished (SGA A), suspected, mild, or moderately malnourished (SGA B) or severely malnourished (SGA C).

Hand grip strength (HGS) was measured using the Jamar Plus Hand Dynamometer (S.I. Instruments, Hilton, South Australia). The American Society of Hand Therapists (ASHT) protocol was used to ensure consistency of measuring HGS. Three measurements were taken and the average was used in the data analysis.

## Biochemistry

The most recent monthly biochemical results were collected, including sodium, potassium, bicarbonate, urea, creatinine, phosphate, calcium, vitamin D, parathyroid hormone, albumin and total protein. Dialysis adequacy was recorded using the Kt/V measurements.

## Dietetic intervention

Once all data were collected for the baseline audit, patients were scheduled to see the dietitian based on their priority. Patients were given a ranking score of one to four. Priority one and two patients were the most urgent and highest priority. This included patients with mild–moderate or severe malnutrition, high potassium and other nutrition impact symptoms compromising nutritional status. Priority three to four patients were less urgent and were ranked based on the need for a nutrition education refresher and high phosphate levels.

Patients were seen on various occasions, depending on need, over the next seven months and were provided with nutrition advice and intervention. At the end of the seven months, another two-day audit was conducted on all patients present by the two renal dietitians, with the support of nursing staff and student dietitians.

## Statistical analysis

All data were collated in Microsoft Excel spreadsheets and then computed into the *Stata 14.0* (Texas, USA) statistical analysis program. Data were analysed for descriptive statistics of each audit's entire population and the subgroup of 69 patients that participated in both baseline and end audit, and had received dietary intervention during the seven-month period. Variables were expressed as mean +/– standard deviation if normally distributed or median (interquartile range [IQR]) if not. One sample and paired t-tests were used to determine significance of difference of mean values for the same 69 patients. Wilcoxon signed rank test analysed the changes in malnutrition (SGA) ranking between baseline and end results in the same group of patients.

## Results

A total of 152 patients participated in the audit, 99 patients at baseline and 121 patients at the end. Of those initially audited, 85 patients had dietetic intervention. At baseline, 46% of patients were malnourished, 63% were male. The average age was 71.0 ± 12.4 years and average time since starting dialysis was 3.5 years (Supplementary Table 1).

Times since last consultation with a dietitian ranged from two weeks up to eight years, with the median being two years. More than 25% of patients had not seen a dietitian in the three years prior to the audit. Average handgrip strength was 23.7 kg ± 12.7, BMI 27.8 $kg/m^2$ ±7.0 $kg/m^2$ and PG-SGA malnutrition score 6.8 ±4.5. Over 70% of patients had a serum albumin level <35 g/L.

Sixty-nine patients participated in both the baseline and end audits (table 1), with a mean age of 71.2 ± 12.5 years and a mean dialysis period of 2.9 ± 2.4 years. Of these, 43.5% had mild to moderate malnutrition and 13% had suspected malnutrition at baseline based upon the SGA (Table 2). After seven months of nutritional intervention, malnutrition rates had reduced significantly from 43.5% to 28.9% based upon the SGA (p=0.02). Whilst no statistically significant improvements were seen in other malnutrition markers, some had deteriorated. This included baseline handgrip strength of 24.86 kg (± 13.4) which reduced to 20.9 kg (±8.63) (p=0.02) and potassium levels increased from 4.9 mmol/L (±0.59) to 5.09 mmol/L (±0.67) (p=0.02).

## Discussion

Malnutrition is common in dialysis patients and is associated with adverse clinical outcomes, poor quality of life and increased mortality (Chan *et al.,* 2012; Kopple *et al.,* 1999; Atilano-Carsi *et al.,* 2012; Ash *et al*., 2014). Dietetic intervention, in line with nutritional guideline recommendations, has been associated with improvement in nutritional status and dietary intake (Campbell *et al*., 2009; Hagazy *et al*., 2013; Hernandez-Morante *et al*., 2011). However, this is primarily based on low level evidence and isolated randomised clinical trials with small numbers of patients over a limited study period (Ash *et al*., 2014).

Our aim was to establish the nutritional status of maintenance dialysis patients, identify those malnourished or at risk of malnutrition and provide dietary intervention to improve nutritional status.

The initial audit of 99 patients showed 46.0% of patients to be malnourished based upon the SGA. Sixty-nine of those patients also completed the post-intervention audit, with 43.5% showing mild to moderate malnutrition and 13% showing suspected malnutrition at baseline. After seven months of nutritional intervention, malnutrition rates had reduced to 28.9%. A similar retrospective observational study by Campbell *et al.* (2009) of 65 maintenance dialysis patients found that malnutrition rates reduced from 14% to 2% over two years in patients who received regular six-monthly dietitian interventions.

The mean baseline BMI was 27.8 kg/m$^2$, in line with data from similar patient cohorts. ANZDATA (Australia and New Zealand Dialysis and Transplant Registry) data shows that the number of people at the time of first renal replacement therapy (RRT)

*Table 1: Clinical characteristics of patients who participated in both pre- and post-intervention audits*

| | Mean ± SD | Mean ± SD | p-value |
|---|---|---|---|
| ***Demographics*** | | | |
| Male | 65.22% | n/a | n/a |
| Age, years | 71.2 ± 12.5 | n/a | n/a |
| Dialysis vintage, years (n=65) | 2.92 ± 2.4 | n/a | n/a |
| Last dietetic input, years (n=63) | 2.2 ± 2.0 | n/a | n/a |
| ***Anthropometry*** | | | |
| Weight, kg (n=68) | 77.4 ± 24.7 | 77.94 ± 24.7 | n/a |
| Height, cm (n=68) | 166.3 ± 10.0 | 165.8 ± 10.5 | n/a |
| BMI, kg/m$^2$ (n=68) | 27.9 ± 6.91 | 28.0 ± 7.30 | n/a |
| HGS[b], kg (n=58) | 24.86 ± 13.4 | 20.9 ± 8.63 | 0.02 |
| Inter dialytic weight gain, kg (n= 67) | 2.14 ± 1.05 | 2.59 ± 1.32 | 0.01 |
| ***Biochemistry*** | | | |
| Albumin, g/L (n=68) | 37.9 ± 3.19 | 37.8 ± 3.38 | 0.93 |
| K, mmol/L (n=69) | 4.9 ± 0.59 | 5.09 ± 0.67 | 0.02 |
| PO4, mmol/L (n=66) | 1.59 ± 0.43 | 1.66 ± 0.50 | 0.37 |

HGS: Hand grip strength
[b] HGS of dominant hand utilised
n = number

*Table 2: Malnutrition ranking of patients who participated in both pre- and post-intervention audits*

| | **Baseline audit** number/percentage (%) | **End audit** number/percentage (%) | p-value[a] |
|---|---|---|---|
| SGA ranking | | | |
| Well nourished (SGA A) | 28 (40.6) | 38 (55.1) | |
| Suspected malnutrition (SGA B) | 9 (13.0) | 10 (14.5) | |
| Mild–moderate malnutrition (SGA B) | 30 (43.5) | 20 (28.9) | 0.02 |
| Severe malnutrition (SGA C) | 0 (0) | 0 (0) | |
| Unknown | 2 (2.9) | 1 (1.5) | |

SGA: subjective global assessment

[a] Significance of change to SGA score between baseline and end audit calculated using Wilcoxon Signed-Rank test

with a BMI > 25kg/m$^2$ (that is, overweight or obese) has been increasing over time. Between 1980 and1984, approximately 19% were overweight and 7% obese. Three decades later in 2014, this increased to 32% being overweight and 28% obese (ANZDATA, 2015). HGS is an important indicator of nutritional status reflecting muscle mass (Leal *et al*., 2011). Most study patients demonstrated a HGS well below normal, compared to healthy individuals of the same age. During the intervention period, there was a significant reduction in HGS. This may be explained by progression of disease and the small patient population; however, it could also be from the elevation in potassium levels, which can promote muscle weakness and fatigue. Currently, no reference data exist specifically on HGS for patients with CKD or ESKD for comparison with our group.

There was a significant difference in potassium levels and interdialytic weight gain. Whilst it could be interpreted that the dietetic intervention was ineffective, there was also a season change between the initial audit and the final audit. The baseline audit was conducted in April, which is the mid-autumn in Australia. The final audit was completed in December, the first week of summer. Often patients find it difficult to manage their fluid control in summer time due to the warmer temperature; therefore the increase in interdialytic weight gains may have been due to the season change. Stone fruit are also in abundance in the summer months so could potentially have an impact on potassium levels. Cheung *et al.* (2002) concluded that seasonal variations in clinical and laboratory values are common in chronic haemodialysis patients with the outdoor temperature inversely associated with BP, ultrafiltration rate and volume, as well as serum sodium and bicarbonate concentrations.

Average albumin levels were within normal range during the study period (Table 1), which could be because most patients at this unit were medically stable, and on maintenance dialysis with no acute illness to contribute to any change. Phosphate levels were also not significantly changed during the study period. However, at the end audit the study organisers were informed that some patients had been enrolled in another research trial in which they were required to temporarily cease their phosphate binders. Without this unexpected intervention, it is possible that phosphate levels would have fallen at the end audit.

A recent study (Koefoed *et al.*, 2016) compared the nutritional status of haemodialysis and peritoneal dialysis patients attending a Danish dialysis centre in 1986 and 2014 and found that nutritional status had improved over the last three decades. Whilst the reasons for this could not be identified in the study, the authors attributed it to the higher prevalence of obesity in the general population, less pre-dialysis malnutrition and an improved focus on nutrition in maintenance dialysis patients. A more recent meta-analysis has indicated that the risk of all-cause mortality decreased in individuals with BMIs >30 kg/m$^2$ (Rahimlu *et al*., 2017). Interestingly, Chan *et al.*

*Supplementary Table 1: Clinical characteristics of all patients who participated in pre- and post-intervention audits*

| | Pre<br>Mean ± SD<br>(n=99) | Post<br>Mean ± SD<br>(n=121) |
|---|---|---|
| ***Demographics*** | | |
| Male | 63.6% | 62.8% |
| Age, years | 71.0 ± 12.4 | 68.2 ± 14.3 |
| Dialysis vintage, years (n=65) | 3.5 ± 3.3 | n/a |
| Last dietetic input, years (n=63) | 2.0 ± 1.83 | n/a |
| ***Anthropometry*** | | |
| Weight, kg (n=68) | 76.0 ± 22.7 | 78.1 ± 22.0 |
| Height, cm (n=68) | 165.7 ± 10.2 | 166.5 ± 11.2 |
| BMI, kg/m$^2$ (n=68) | 27.8 ± 7.0 | 27.0 ± 6.5 |
| HGS[b], kg (n=58) | 23.7 ± 12.7 | 21.5 ± 9.3 |
| Interdialytic weight gain, kg (n=67) | 2.2 ± 1.0 | 2 ± 1 |
| ***Biochemistry*** | | |
| Albumin, g/L (n=68) | 37.2 ± 3.4 | 37.2 ± 3.6 |
| K, mmol/L (n=69) | 5.0 ± 0.6 | 5.2 ± 0.7 |
| PO4, mmol/L (n=66) | 1.6 ± 0.4 | 1.7 ± 0.5 |

HGS: Hand grip strength
[b] HGS of dominant hand utilised
n = number

(2012) found that overweight or obese dialysis patients showed a threefold increase in mortality, compared with those who were well nourished with a BMI ≤ 26 kg/m$^2$.

Evidence-based guidelines recommend that established dialysis patients are reviewed by a renal dietitian every six months, with additional intervention in the case of malnutrition, pre-transplant weight control and co-morbidities (Ash *et al*., 2006). The length of time since any form of dietetic consultation was of concern in this audit. This averaged two years, with a range between one week and eight years.

We identified a number of potential barriers to the provision of optimal dietetic input at the satellite unit. Firstly, patients in need of nutritional education must be identified, which requires appropriate screening and auditing of all dialysis patients, such as through a PG-SGA by a dietitian. The availability of an appropriately qualified dietitian is limited in many settings due to insufficient funding or staffing levels. This means that many patients must rely on their tertiary hospital outpatient services for support, which may involve additional travel and waiting times. Logistical difficulties are experienced by many patients, who already attend dialysis three to four times per week as well as other medical appointments with local average outpatient waiting times of more than three months.

Our study supports guideline recommendations regarding dietary intervention, and supports provision of dietetic services through on-site consultations. The presence of a dietitian on-site raised awareness of the importance of nutrition to both patients and nursing staff. Patients could also be prioritised for intervention and waiting times at the dialysis unit were markedly decreased to only two to three weeks for high-risk individuals. With alleviation of appointment pressures at the tertiary referral hospital, waiting list times were also reduced to just two weeks.

## Limitations

Only 70% of patients were available in both the initial and post-intervention audits, indicating the transient nature of the dialysis population. Whilst more patients were audited at the end, this final cohort included new patients at the dialysis unit. The remaining 30% of patients from baseline that were not seen in the final audit was due to a number of factors, including hospital admissions, change of dialysis modality, change of location, renal transplantation or death. As there was no control group, it is therefore unclear if our findings reflect survival bias.

## Practical application

Our study demonstrates that on-site dietetic input can reduce malnutrition rates in satellite haemodialysis patients. There is a need for increased dietetic input for patients in satellite dialysis units in Western Australia. Current practice falls short of the evidence-based guideline recommendations of dietetic assessment and support for haemodialysis patients at least every six months (Campbell *et al*., 2009; Ash *et al*., 2014; Campbell *et al*., 2007).

## Acknowledgements

Special thanks are given to Rebecca Tippett, student dietitian, who collated and entered data from the assessments as well as nursing staff at Stirling Dialysis Unit who assisted with the patients. This work was supported by an unrestricted educational grant from Roche Pharmaceuticals.

## References

Australian Institute of Health and Welfare (AIHW). (2014). *Projections of the prevalence of treated end-stage kidney disease in Australia. 2012–2020*. Cat. No. PHE 176. Canberra: AIHW. http://www.aihw.gov.au/publication-detail/?id=60129547202. Accessed 30 April 2017.

American Dietetic Association. (2010). *CKD Evidence Based Nutrition Practice Guideline*. https://www.andeal.org/category.cfm?cid=14. Accessed 30 April 2017.

Australia & New Zealand Dialysis and Transplant Registry (ANZDATA). (2015). *Australia & New Zealand Dialysis & Transplant Registry Annual Report*. http://www.anzdata.org.au/v1/report_2015.html. Accessed 30 April 2017.

Ash, S., Campbell, K. L., Bogard, J., & Millichamp, A. (2014). Nutrition prescription to achieve positive outcomes in chronic kidney disease: A systematic review. *Nutrients, 6*, 416–451.

Ash, S., Campbell, K., MacLaughlin, H., McCoy, E., Chan, M., Anderson, K., Corke, K., Dumont, R., Lloyd, L., Meade, A., Montgomery-Johnson, R., Tasker, T., Thrift, P., & Trotter, B. (2006). Evidence based practice guidelines for the nutritional management of chronic kidney disease. *Nutrition and Dietetics, 63*, S33–S45.

Atilano-Carsi, X., Campos-Collado, A. X., Miranda-Alatriste, P., Leyva-Rendón, F., Rosas-Jiménez, M., Correa-Rotter, R., & Espinosa-Cuevas, M. A. (2012). Prevalence of hospital malnutrition in renal patients. *Kidney Research Clinical Practice, 31*(2), A30.

Bonanni, A., Mannucci, I., Verzola, D., Sofia, A., Saffioti, S., Gianetta, E., & Garibotto, G. (2011). Protein energy wasting and mortality in chronic kidney disease. *International Journal Environmental Research Public Health, 8*, 1631–1654.

Campell, K. L., Ash, S., Bauer, J., & Davies, P. S. W. (2007). Critical review of nutritional assessment tools to measure malnutrition in chronic kidney disease. *Nutrition and Dietetics, 64*, 23–30.

Campbell, K. L., Ash, S., Zabel, R., Mcfarlane, C., Juffs, P., & Bauer, J. D. (2009). Implementation of standardised nutrition guidelines by renal dietitians is associated with improved nutritional status. *Journal of Renal Nutrition, 19*, 136–144.

Caring for Australians with Renal Impairment (CARI Guidelines). (2013). http://www.cari.org.au/CKD/ckd_guidelines.html. Accessed 30 April 2017.

Chan, M., Kelly, J., Batterham, M., & Tapsell, L. (2012). Malnutrition (subjective global assessment) scores and serum albumin levels not body mass index values, at initiation of dialysis are independent predictors of mortality: a 10-year clinical cohort study. *Journal of Renal Nutrition, 22*(6), 547–557.

Cheung, A. K., Guofen, V., & Greene, T. (2002). Seasonal Variations in Clinical and Laboratory Variables among Chronic Hemodialysis Patients. *Journal American Society Nephrology, 13*, 2345–2352.

Desbrow, B., Bauer, J., Blum, C., Kandasamy, A., McDonald, A., & Montgomery, K. (2005). Assessment of Nutritional Status in Hemodialysis Patients Using Patient-Generated Subjective Global Assessment. *Journal of Renal Nutrition, 15*, 211–216.

European Renal Association/European Dietitian and Transplant Nurse Association. (2007). *European Best Practice Guideline on Nutrition*. http://www.vision-fmc.com/download/guidelines_ak2.pdf. Accessed 30 April 2017.

Hegazy, I. S., Raghy, E. L., Abdel-Aziz, S. B., & Elhabashi, E. M. (2013). Study of effect of dietary counselling on the improvement of end stage renal disease. *East Mediterranean Health Journal*, *19*, 45–51.

Hernandez-Morante, J. J., Sanchez-Villazala, A., Canavate-Cutillas, R., & Carmen Conesa Fuentes, M. (2014). Effectiveness of a nutrition education program for the prevention and treatment of malnutrition in end stage renal disease. *Journal of Renal Nutrition, 24*, 42–49.

Kalanter-Zadeh, K., Ikizler, T. A., Block, G., Avram, M. M., & Kopple, J. D. (2003). Malnutrition-inflammation complex syndrome in dialysis patients: causes and consequences. *American Journal Kidney Disease*, *42*, 864–881.

Kidney Disease: Improving Global Outcomes (KDIGO). (2012). Clinical practice guideline for evaluation and Management of CKD. http://www.kdigo.org/clinical_practice_guidelines/pdf/CKD/KDIGO_2012_CKD_GL.pdf. Accessed 30 April 2017

Koefoed, M., Kromann, C., Hvidtfeldt, D., Julussen, S., Andersen, J., & Marckmann, P. (2016). Historical Study (1986–2014): Improvements in Nutritional Status of Dialysis Patients. *Journal of Renal Nutrition, 26*, 320–324.

Kopple, J. D., Zhu, X., Lew, N. L., & Lowrie, E. G. (1999). Body weight-for-height relationships predict mortality in maintenance haemodialysis patients. *Kidney International, 56*, 1136–1148.

Leal, V., Mafral, D., Fouque, D., & Anjos, L. (2011). Use of handgrip strength in the assessment of the muscle function of chronic kidney disease patients on dialysis: a systematic review. *Nephrology, Dialysis, Transplantation, 26*, 1354–1360.

Luis, D., Zlatkis, K., Comenge, B., Garcia, Z., Navarro, J., Lorenzo, V., & Carrero, J. J. (2016). Dietary quality and adherence to dietary recommendations in patients undergoing haemodialysis. *Journal of Renal Nutrition, 26*, 190–195.

National Institute for Health and Clinical Excellence in the United Kingdom (NICE). (2014). *CKD in adults: assessment and management*. https://www.nice.org.uk/guidance/cg182. Accessed 30 April 2017.

National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI). *Nutrition in CKD*. 1997–2016.

Pasian, C., Guebre-Egziabher, F., Kalbacher, E., Pommero, C., & Fouque, D. (2014). Nutritional care and clinical improvement in a renal ward: a pilot multimodal approach. *Nephrology Therapeutique, 10*, 236–44.

Piccini, S., Fairburn, A., Gill, E., Budgeon, C. A., & O'Sullivan, T. (2014). Predictors of malnutrition in Australian haemodialysis patients and comparison of dietary protein intakes to national guidelines. *Renal Society of Australasia Journal, 10*, 133–140.

Rahimlu, M., Shab-Bidar, S., & Djafarian, K. (2017). Body Mass Index and All-cause Mortality in Chronic Kidney Disease: A Dose-response Meta-analysis of Observational Studies. *Journal of Renal Nutrition, 27*, 225–232.