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Implementation of Standardized Nutrition Guidelines by Renal Dietitians Is Associated With Improved Nutrition Status

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Objective: Standardized nutrition guidelines that focus on a nutrition care process have been used by dietitians treating renal patients in Australia for over 3 years. We show the impact of this implementation on the nutritional status of a cohort of hemodialysis patients.

Design: We conducted a retrospective observational study, investigating a cohort of maintenance hemodialysis patients after the implementation of a systematic approach to the patient's nutritional care.

Setting: This stufy took place in public and private in-center hemodialysis units.

Patients: Patients included a cohort of 65 maintenance hemodialysis patients (mean age ± SD, 64 ± 15 years; 58% male; dialysis vintage median [interquartile range], 22 [10 to 46] months).

Interventions: All participants were provided with a dietary interview at least every 6 months, with intensive follow-up where required, and were monitored monthly regarding weight and biochemistry. Outcomes were assessed annually between May 2004 and December 2006, after the implementation of this model of care.

Main Outcome Measure: Energy and protein intake according to dietary interview, nutritional status according to subjective global assessment, and data regarding dry weight and biochemistry (including albumin, potassium, and phosphate) were collected by the dietitian at each facility. Change in each outcome measure over time was assessed using repeated-measures analysis.

Results: The proportion of patients with malnutrition (subjective global assessment B or C) decreased from 14% at baseline to 3% after 2 years. Serum albumin, potassium, and dry weight remained stable throughout the study period, and there was a significant decrease in serum phosphate over time (mean ± SD,1.8 ± 0.5 to 1.5 ± 0.5 mmol/L, $P = .004$). Dietary energy and protein intake changed significantly over the study period ($P = .001$ and $P = .022$, respectively), with the highest mean intake recorded during the final follow-up assessment.

Conclusions: The implementation of a systematic approach to patient care, in line with nutrition management guideline recommendations, was associated with an improvement in nutritional status and dietary intake in this cohort of maintenance hemodialysis patients, without the need for increased resources or dietitian time.

CLINICAL PRACTICE guidelines for the management of chronic kidney disease (CKD) have become popular in recent years as a means to promote consistency of care and improve outcomes. Nutrition management in CKD is guided by a number of published clinical practice guidelines.[1–6] These guidelines include the National Kidney Foundation Kidney Dialysis Outcomes Quality

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Initiative (K/DOQI),[3] Caring for Australians with Renal Impairment (CARI),[2] American Dietetic Association (ADA) Medical Nutrition Therapy Evidence-Based Guides for Practice: Chronic Kidney Disease (Nondialysis),[4] ADA Guidelines for Nutritional Care of Renal Patients (3rd Edition),[5] and the European Guideline on Nutrition.[6] Recently, evidence-based practice guidelines for the nutritional management of CKD were published,[1] comprising a set of evidence-based practice statements linked to the nutrition care process,[7] and endorsed by the Dietitians Association of Australia. These guidelines represent a summary of the evidence provided in the aforementioned guidelines,[2–5, 8, 9] against the classification system of the Australian National Health and Medical Research Council.[10] Because of the paucity of well-designed studies, many of the statements in these guidelines were largely based on expert consensus rather than levels of evidence.

The ultimate goals of implementing guidelines that inform practice are to promote consistency among practitioners, objective decision-making, and the measurement of quality and effectiveness of care.[11,12] Further, the implementation of best-practice management for a patient population theoretically equates with promoting outcomes of improved survival, reduced morbidity, increased efficiency of care, and improved quality of life.[3]

There is a lack of evidence in the literature regarding the effectiveness of practice after the implementation of guideline recommendations.[13] In particular, there is a need to evaluate the effectiveness of guidelines concerning the implementation, monitoring, and evaluation components of the nutrition care process in CKD, which is largely opinion-based.[1] A recommendation common to clinical practice guidelines in CKD is that patients on maintenance hemodialysis are regularly monitored for risk of malnutrition and receive a dietary interview and intervention with a dietitian, at least Q4 six-monthly. To achieve this, a systematic process to capture each and every patient at least once every 6 months is required.[2–4] Such a system can only be justified by an improvement in patient outcomes. Importantly, when evaluating the effectiveness of medical nutrition therapy, optimizing the intermediate outcomes of appropriate dietary intake, biochemistry, and nutritional status is critical in achieving positive long-term outcomes.[14]

The principle aim of this study was to evaluate a model of nutritional management that applied a systematic approach to capturing all maintenance hemodialysis patients at least once every 6 months for a thorough dietary and nutrition status assessment, in addition to monthly biochemistry monitoring. This was undertaken by evaluating changes in nutrition-related outcomes in patients receiving hemodialysis in public and a private tertiary dialysis centers, over a 3-year period.

Methods

Study Design

This was a retrospective evaluation of observational data collected over the study period, from guideline implementation in 2004 to 2006. The renal dietitians at each intervention site (one public tertiary teaching hospital and one private facility) initiated specific nutrition care guidelines for hemodialysis patients, as described in the Evidence-Based Practice Guidelines for the Nutritional Management of Chronic Kidney Disease.[1] Renal dietitians provided each patient with structured nutrition care, and assessed nutritional status and dietary intake at least every 6 months, in addition to monthly assessments of biochemistry and weight. The Research Ethics Committee at each investigator's institution provided approval for the study.

Study Subjects

Data were collected at the Royal Brisbane and Women's Hospital, a public tertiary teaching hospital, and the Wesley Hospital, a private tertiary facility in Brisbane. Patients undergoing maintenance hemodialysis for longer than 3 months at baseline, and who were maintained on regular, in-center hemodialysis (on average, three times per week), were eligible for inclusion. Data from participants were excluded if they had died, changed modes of renal replacement therapy (e.g., transplantation or home-based therapy), or if their care had been transferred to another facility.

Data Collection

Demographic data on age, gender, dialysis vintage, and presence of comorbidities were obtained from medical case notes at baseline. Changes in patient outcomes from baseline, including dry (post-dialysis) weight, body mass index, biochemistry, nutritional status, and dietary intake, were monitored ~~6-monthly~~ from 2004 to 2006. However, because data were only documented annually at one site, annual data were included in this investigation. Q5 Q6

Dry weight was recorded on ~~Wedderburn~~ Tanita BWB scales immediately after a dialysis session. Height was measured using a stadiometer. Body mass index was calculated as weight/height (m)^2. Biochemical measures of albumin (bromocresol green), potassium, and phosphate were recorded ~~after collection~~ immediately before the dialysis session after less than a 48-hour break from dialysis in the public facility and after the long break, or more than 60 hours after the last dialysis session at the private facility. As a result of these differences, only the biochemistry data from the public facility will be considered, insofar as midweek collection is consistent with guideline targets.

Nutritional status was assessed using the patient-generated subjective global assessment (PG-SGA), which was validated for use in hemodialysis.[15] An experienced dietitian conducted these assessments every 6 months. In the PG-SGA, patients are assigned a rating of well-nourished (A), moderately malnourished or suspected of being malnourished (B), or severely malnourished (C), based on an assessment that includes a medical history (covering weight change, dietary intake, gastrointestinal symptoms, and changes in functional capacity) and a physical examination (assessment of muscle stores and edema).[16] The PG-SGA, in addition to assigning a category of A, B, or C, also uses a scoring system based on additional questions regarding the presence of nutrition-impact symptoms and metabolic stress. Each component of the PG-SGA provides a score of 0 to 4, depending on the impact of the symptom on nutritional status. All component scores are added (typical scores range from 0 to 35): the higher the score, the greater the risk of malnutrition.

The dietitian at each site assessed dietary intake by a diet-history interview at each of the six~~-~~month~~ly~~ monitoring appointments. This method assessed average current intake over a week, accounting for differences on dialysis and nondialysis days. Dietitians also used a checklist method to crosscheck types and frequencies of foods consumed. References to standard household measures or food models were used to assist in estimating portion sizes. Intake provided from the diet history was recorded as the average number of servings from selected reference food groups. Average daily intake for energy and protein was quantified using corresponding analyses from reference food group estimates. Energy and protein intake estimates were then adjusted relative to body weight, using the standard methodology described elsewhere,[1] to give kJ/kg/day or g/kg/day, respectively.

To establish the validity of dietary-intake results, the proportion of underreporting among participants was assessed using the Goldberg cutoff[17] for energy intake reported at the final data collection point. Participants were identified as "low energy reporters" if their energy intake ratio to basal-energy expenditure (calculated from the Harris-Benedict equation) equaled less than 1.3. Only patients considered weight-stable, as defined by an arbitrary cutoff of less than a 2.5% change in past 6 months, underwent assessment for under-reporting.

Statistical Analysis

Data were analyzed using SPSS for Windows, version 13. Descriptive characteristics between participants at each site were compared using chi-square and independent-sample *t*-tests. Categorical outcomes were compared over time by using the McNemar-Bowker chi-square test. Change over time for each continuous outcome was assessed by repeated measures over the 3-year study period. In each repeated-measures regression model, the assumption of sphericity was tested, and where the assumption was not met, a Greenhouse-Geisser correction was used, and fractional degrees of freedom are presented in the results. For outcome variables not normally distributed, the nonparametric equivalent~~,~~ Friedman's test was used. All tests were two-sided, with statistical significance set at $P < .05$.

Results

Description of Study Participants

Table 1 compares the characteristics of all hemodialysis participants at baseline, based on whether they were included in the final cohort or whether they died or transferred care during the study period. There was no difference between patients who were in the final cohort or those who died during follow-up. Those who transferred care were younger and with a lower BMI, and were more likely to be female compared with the other groups.

As shown in Table 2, participants from both the public and private facilities who were included in the cohort were comparable in terms of most characteristics at entry into the study, with no significant differences at baseline. The dietitian-to-patient

Table 1. Characteristics of Hemodialysis Patients at Baseline, Comparing Cohort With Annual Data Collection With Those Who Died or Were Transferred From 2004 to 2006 (n = 117)

	Cohort from 2004-2006	Died	Transferred Care	*P* Value*
N	65	36	16	
Age (years)	64.3 ± 14.8	67.7 ± 12.0	56.4 ± 16.7	.039
Gender % male	58%	62%	27%	.049§
Location (% private)	32%	38%	30%	.858§
Weight (kg)	74.3 ± 18.1	73.5 ± 16.8	61.3 ± 13.3	.040
BMI (kg/m^2)	26.6 ± 5.7	26.4 ± 5.6	22.3 ± 3.5	.029
Dialysis vintage (months)†	22 (10-46)	24 (17-42)	18 (8-32)	.282‡
Percent malnourished (SGA B)	14%	12.5%	25%	.333§

SGA B, subjective global assessment, mild to moderate malnutrition.
**t*-test.
†Median (interquartile range).
‡Kruskal-Wallis test.
§Chi-square test.

ratio, shown in Table 3 for each hemodialysis facility, was also comparable during the study period. Therefore, the results for both facilities were combined in the prospective evaluation.

Patient Outcomes

In the cohort of patients maintained on dialysis from 2004 to 2006, albumin, potassium, and weight were all stable, as shown in Table 4. Mean serum phosphate levels were significantly reduced over the study period (1.8 to 1.5 mmol/L, P = .004). Although the PG-SGA scores remained stable over time, Table 4 indicates that the proportion of patients classified as malnourished (SGA category B or C) decreased from 14% at baseline to just 3% after 3 years of implementing the guidelines, a clinically significant trend that approached statistical significance: F(1.8) = 2.92, P = .062.

The mean intakes for energy and protein were significantly different at each of the three time-points (Table 4). The proportion of cohort patients meeting what is considered the ideal intake for protein (>1.2 g/kg) and energy (>125 kJ/kg) increased 30% to 48% for protein, and 10% to 20% for energy, over the study period (Figs. 1, 2). Change in energy intake, according to the categories shown in Figure 2, reached statistical significance; McNemar-Bowker chi-square test, X(3) = 20.522, P < .001). The lowest reported intake of energy and protein in 2005 corresponded with the highest prevalence of underreporting, as shown in Figure 3. Although variable, the

Table 2. Baseline Characteristics of Maintenance Hemodialysis Patients in 2004 Upon Implementation of Nutrition Management Guidelines, Presenting Overall Cohort (n = 65), and Comparing Characteristics of Both Private (n = 21) and Public (n = 44) Facilities

	Private Facility	Public Facility	*P* Value*
N	21	44	
Age (years)	66.9 ± 16.9	63.0 ± 13.8	.36
Gender % male (n = 38)	48%	63%	.26§
Weight (kg)	71.6 ± 15.4	75.5 ± 19.5	.55
BMI (kg/m^2)	26.1 ± 5.8	26.9 ± 5.8	.75
% Diabetes Mellitus	14%	36%	.07§
Dialysis vintage (months)†	17 (11-38)	23 (9-58)	.60‡
% Malnourished (SGA B)	10%	16%	.32

SGA B, subjective global assessment, mild to moderate malnutrition.
**t*-test.
†Median (interquartile range).
‡Mann-Whitney test.
§Chi-square test.

Table 3. Ratio of Dietitians to Hemodialysis Patients, and Total Full-Time Equivalent Provided to Hemodialysis Service

	Baseline	2005	2006
Average patient per dietitian	213	208	228
Public (total HD patients/FTE dietitian)	79:0.35	83:0.40	92:0.40
Private (total HD patients/FTE dietitian)	38:0.20	42:0.20	45:0.20

HD, hemodialysis; FTE, full-time equivalent.

reported mean protein intake for 2006 improved to 1.18 ± 0.28 g/kg ~~IBW~~/day. Therefore, on average, these patients were close to achieving the protein intake recommended in the guidelines (1.2 g/kg/day).

Discussion

We sought to establish the effectiveness of implementing a systematic approach to nutritional care in hemodialysis. Conducting a thorough nutritional and dietary assessment of all patients systematically, at least once every 6 months, allows for early recognition and treatment of nutritional issues that may lead to the development of malnutrition, including gastrointestinal symptoms and appetite disturbance. Such an assessment also allows early intervention, to optimize serum potassium and phosphate as well as fluid management. This approach resulted in a decreased prevalence of malnutrition and a trend toward improved dietary intake without the need for increased resources, including dietitian time.

Malnutrition is an independent predictor of morbidity and mortality in maintenance dialysis patients.[18–20] Recently, SGA showed validity as a measure of nutritional status against gold-standard body-composition tools assessing lean muscle tissue in CKD.[21, 22] Other indicators of optimal nutritional status in CKD are maintenance of dry weight[2] and a BMI between 23 and 26 kg/m^2. Although the evidence for treatment or prevention of malnutrition in maintenance dialysis patients is limited, studies show that nutritional intervention, including counseling and the provision of oral supplements, increases serum albumin and improves outcomes in hemodialysis patients.[23–26]

The prevalence of malnutrition in this sample at baseline, as assessed by SGA, was 14%. This is relatively low compared with rates reported in the literature, which can be up to 64% in dialysis populations.[27] Considering the high risk of developing malnutrition in this population and its association with poor outcomes, the results obtained in this cohort, of less than 5% of patients classified as malnourished in 2006, connote a positive outcome. Together with the reduction in rate of malnutrition, dry body weight was stabilized over the data-collection period, and the mean change was within 0.5% over the previous 6 months at each time point.

Table 4. Changes in Dietary Intake, Weight, Nutritional Status, and Biochemistry (Mean ± SD) Over Time for Full Cohort of Maintenance Dialysis Patients (n = 54) After Implementation of Nutrition Care Guidelines

	Baseline	2005	2006	Repeated-Measures Test
Dietary intake				
Protein (g/kg)	1.14 ± 0.26	1.06 ± 0.32	1.18 ± 0.28	F(1.9) = 3.98, *P* = .022*
Energy (kJ/kg)	101.7 ± 28.6	90.9 ± 26.3	104.5 ± 27.1	F(1.9) = 7.82, *P* = .001*
Nutritional status				
SGA (n (%) A:B/C)	56 (86): 9 (14)	60 (92): 7 (8)	63 (97): 2 (3)	F(1.8) = 2.92, *P* = .062
PG-SGA median (IQR)	3.0 (1.0-6.0)	2.0 (1.0-5.0)	2.0 (1.0-5.5)	X(2) 4.798, = 0.091†
Biochemistry‡				
Albumin (g/L)	38.4 ± 4.4	38.8 ± 2.8	38.0 ± 3.7	F(1.9) = 0.82, *P* = .440*
PO_4 (mmol/L)	1.8 ± 0.5	1.6 ± 0.5	1.5 ± 0.5	F(1.8) = 6.29, *P* = .004*
K^+ (mmol/L)	4.9 ± 0.7	5.0 ± 0.6	4.9 ± 0.6	F(1.9) = 0.46, *P* = .621*
Weight status				
BMI (kg/m^2)	26.6 ± 5.7	26.5 ± 5.5	26.2 ± 5.5	F(2) = 0.687, *P* = .505*
Weight change (%)	0.17 ± 8.6	−0.3 ± 4.7	−0.3 ± 11	F(1.8) = 0.370, *P* = .670

SGA, subjective global assessment; A, well-nourished; B/C, malnourished; PG-SGA, patient-generated subjective global assessment; IQR, interquartile range; BMI, body mass index.

*Repeated-measures analysis of variance.

†Friedman test.

‡Biochemistry results from public facility only (n = 33).

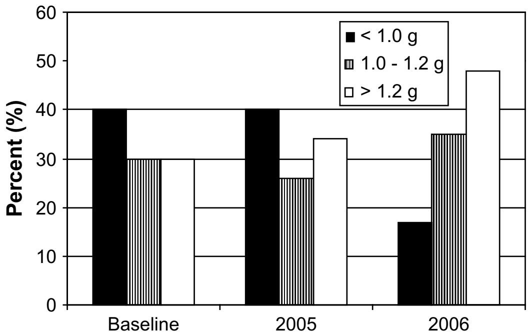

Figure 1. Protein intake of cohort of hemodialysis patients after implementation of systematic approach to nutritional management (n = 65).

A recent survey of renal dietitians in the United States indicated that one of the most frequently implemented guidelines from K/DOQI was the use of dietary interviews to assess intake, promoting dietary protein intakes of 1.2 g/kg and an energy intake of 30 to 35 kcal/kg (126 to 145 kJ/kg).[11] The aim of achieving this level of dietary protein and energy was promoted in this study. As a result, in conjunction with decreased rates of malnutrition, this cohort of patients also demonstrated an increase in reported dietary intake as of the final data collection, with a mean energy intake ~~OF~~ 104.5 ± 27.1 kJ/kg/day and ~~A~~ mean protein intake 1.18 ± 0.28 g/kg/day. The mean values corresponded with an increased proportion of patients meeting guideline targets for intake of protein (>1.2 g/kg) and energy (>125 kJ/kg). This shows that the care process recommended in the guidelines is effective in improving dietary intakes.

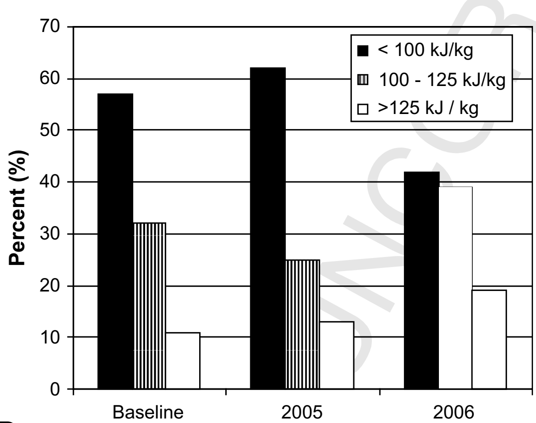

Figure 2. Energy intake of cohort of hemodialysis patients after implementation of systematic approach to nutritional management (n = 65).

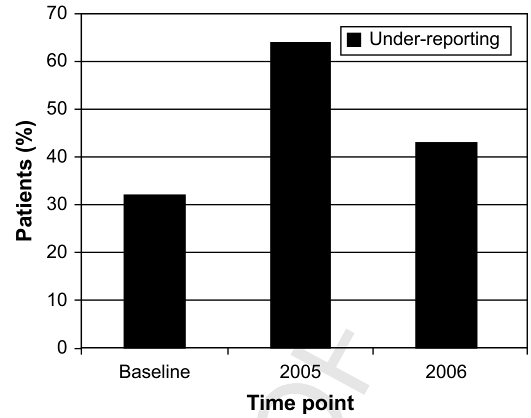

Figure 3. Prevalence of underreporting in a subgroup of weight-stable patients at each time-point in a cohort of maintenance hemodialysis patients from 2004 to 2006 (n = 65). Underreporting = intake <1.3 times basal metabolic rate. Weight-stable = weight change ± 2.5% over previous 6 months.

The reported changes in intake should be considered together with measures of validity. Although the Goldberg cutoff is a crude method of determining low-energy reporting,[17] it does give insights into overall reported intakes. Interestingly, the fluctuations in reported intakes corresponded with the rates of underreporting, e.g., the lowest reported intake (energy, 90.9 ± 26.3 kJ/kg/day; protein, 1.06 ± 0.3 g/kg/day) occurred at the time-point with the greatest rate of under reporting (in weight-stable patients) in 2005. Low energy reporting ~~was evidenced~~ in over 60% of weight-stable hemodialysis patients.[28] Therefore, the rates in this sample (Fig. 3) are not uncommon. Although the mean reported intake remained below recommendations, it is likely that true intake is closer to the recommendations in light of the level of underreporting. The percentage (10% to 20%) of patients meeting energy requirements, over the study period, remained low. However, the majority of these patients were well-nourished and overweight (mean BMI, 26.6 kg/m^2).

Evaluation of reported protein intake was used rather than an objective measure, such as protein nitrogen appearance (PNA). The issue with collection of a single PNA measurement it that it only captures that specific day, and it may fluctuate significantly between days. It also assumes the patient to be metabolically stable.[29] In addition, PNA is also limited because it may be influenced by changes in comorbid status, including inflammation. Finally, a dietary interview is a key component of nutrition care, because it allows the dietitian to capture "usual" intake, account for day-to-day variation, and provide individualized advice to the patient.

Serum albumin, a well-established independent predictor of total and cardiovascular mortality in hemodialysis patients,[30–32] remained stable over the study period. In a recent retrospective analysis of biochemical guidelines targets, the largest independent survival benefit was found for patients with serum albumin ≥38 g/L (hazard ratio, 0.27; 95% confidence interval, 0.24 to 0.31).[33] In this study, the mean albumin level was above 38.0 g/L throughout the 3-year period. Prospective observational studies generally indicate a steady decline in serum albumin in maintenance hemodialysis patients after 12 to 18 months of dialysis,[34,35] a phenomenon that appeared to be attenuated in this sample. Hence this systematic approach to patients' nutritional care may be associated with improved longer-term outcomes. Randomized, prospective clinical trials are needed to confirm this association.

Albumin is cited as the most important method to evaluate nutritional status by renal dietitians in the United States.[11] Although poor dietary intake may contribute to hypoalbuminemia, the presence of inflammation is now regarded as the most prominent cause of low albumin synthesis in CKD patients.[36] Therefore, when considering ~~its~~ unstable nature and ~~influence~~ by non-nutritional factors, it is important to ensure that practitioners undertake more comprehensive and specific ~~measures~~ of nutritional status on a regular basis.

Serum phosphate and potassium are also managed as part of the dietitians' panel of assessment measures and recommendations in practice guidelienes.[1] Serum phosphate significantly decreased after the implementation of this nutrition care model, even while protein intake increased. Evidence suggests that the best management strategy to assist patients in attaining optimal serum phosphate levels is to provide repeated and intensive patient counseling, with progressive adjustments of phosphate-binder dosage.[37] This was facilitated by monitoring every patient's progress regularly, and by conducting routine dietary assessments, enquiries, and education regarding binder usage and general phosphate management, in addition to promoting optimal nutritional status.

In general, barriers to the implementation of practice guidelines tend to include lack of knowledge, lack of awareness or trust in a guideline, inability to implement guidelines, and inability to agree on a uniform unit protocol.[38] In a recent survey of renal dietitians by the National Kidney Foundation, 97% were aware of the K/DOQI guidelines, yet only 5% had implemented all the guidelines.[11] The most common reasons were lack of resources (57%), insufficient time (40%), and inadequate support from the dialysis unit (29%). Although it is commonly perceived that implementing guidelines for dietetic practice is a difficult and costly task, the dialysis units in this study operated a service with a ratio of 1 dietitian full-time equivalent per 200 to 220 patients, and this ratio remained consistent through the study period . Although this ratio is not ideal, as based on recommended targets of 1:135 from the British Workforce Guidelines[39] and 1:100 recommended by the National Kidney Foundation-Council on Renal Nutrition and ADA Renal Practice Group,[40] implementing this systematic approach to patient care enabled effective and efficient use of available dietetic care in this setting. A further increase in the staff ratio would enable more intensive nutrition services to be provided, which may result in additional improvements in nutrition-related outcomes.

There are several limitations to this study. First, it was undertaken as a retrospective, observational study, and therefore there was no control arm. Although it was recognized that a randomized, controlled trial evaluating this service provision would offer the strongest evidence, in this situation it was not feasible, given the design and nature of this study as a quality-assurance activity. Secondly, this study was not designed as a prospective observational study. Therefore, our outcome measures were limited to intermediate nutritional markers, and not indices of morbidity, mortality, or gold-standard body-composition techniques to demonstrate changes in nutritional status. In addition, the collection of biochemical variables was not uniform between sites, and therefore was analyzed in public hospital patients only. Finally, in the data collection, there was little account for the effect of comorbid illness, including markers of inflammation, on changes in dietary intake and nutrition status.

Implementing practice guidelines, changing clinical practice, and improving patient outcomes relies not only on the scientific validity of the guidelines, but also on their usability for clinicians and their proven ability to improve patient outcomes.[38] Although the evidence base from high-quality, randomized, controlled trials focusing on dietetic practice are limited, this study demonstrated that the implementation of a systematic approach to patient care, in line with nutrition management guideline recommendations, had a positive effect on intermediate outcomes. Without the need for increased resources or dietitian time, this approach resulted in improvements in dietary intake, the maintenance of dry body weight and albumin levels, and a reduction in rates of malnutrition to less than 5% in a sample of dialysis patients.

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