

Low-protein diet supplemented with ketoanalogues: The role of an integrated approach beyond the start of dialysis (Review)

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Abstract. The traditional paradigm of standardized thrice-weekly hemodialysis is being challenged by personalized incremental and decremental prescriptions aimed at preserving residual kidney function. In this scenario, nutritional therapy maintains a central role even following the onset of renal replacement therapy. The present narrative review synthesizes evidence up to February, 2026 on the efficacy of a low-protein diet (LPD; 0.6 g/kg/day) and very low-protein diet (VLPD; 0.3-0.4 g/kg/day) supplemented with ketoanalogues (KA). Compared to traditional Mediterranean or plant-based regimens, the LPD/VLPD + KA approach strictly minimizes uremic toxin generation, acid load and phosphorus retention, while maintaining a neutral nitrogen balance and preventing protein-energy wasting. In incremental protocols, this combination functions as a reducer of waste products, smoothing interdialytic solute peaks and shifting the gut microbiota away from proteolytic pathways such as indoxyl sulfate and p-cresyl sulfate. Crucially, as a proof of concept for dynamic care and as an emerging and hypothesis-generating approach, combining a safe metabolic workload reduction via LPD + KA with close monitoring allows for decremental dialysis strategies, which can aid in reducing session frequency as long as adequate native clearance is maintained. Consequently, this integrated approach may prove to be useful in reducing annual dialytic expenses. Finally, nephrology nurses act as the essential catalyst, translating these complex dietary restrictions into sustainable lifestyles that preserve patient compliance and quality of life.

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1. Introduction

End-stage renal disease (ESRD) has historically been managed with a standardized thrice-weekly hemodialysis (HD) regimen. It has long been perceived as the definitive therapeutic solution when conservative strategies have failed (1).

Over the past two decades, this concept has been progressively challenged, emphasizing the role of the residual kidney function (RKF) and the related concept of patient-centered individualized dialysis prescriptions. From this came the notion of incremental HD, defined as the start of renal replacement therapy (RRT) at a reduced frequency tailored to RKF, metabolic control and volume status. This strategy aims to preserve RKF, reduce treatment burden, and improve the quality of life of patients without compromising clinical outcomes (2).

In this view, nutritional therapy regains a central role also in patients undergoing dialysis. Indeed, lowering dietary protein intake directly reduces uremic toxin generation, acid load, phosphorus balance and nitrogen metabolism. Low-protein diets (LPDs) supplemented with ketoanalogues (KA) are well-established in advanced chronic kidney disease (CKD) to delay the initiation of dialysis; however, their application following the onset of dialysis remains controversial and poorly investigated (3).

The present narrative review aimed to synthesize pathophysiological principles, clinical experience and emerging evidence supporting the use of a LPD (0.6 g/kg/day) and a very low protein diet (VLPD; 0.3-0.4 g/kg/day) supplemented with

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KA in patients undergoing conservative CKD management and dialysis, adding difference and similarity with other dietetic regimens, such as the Mediterranean diet and plant-based diet (PBD). For this purpose, a search was performed for related studies on the PubMed, Embase and Google Scholar databases until February, 2026. The impact of diet regimens in conservative CKD management and dialysis has been divided into two different sections, with a focus on each, separately.

2. Pathophysiological rationale for the Mediterranean diet, plant-based diet and LPD/VLPD + KA

Mediterranean diet in CKD. The Mediterranean diet has been consistently considered the optimal dietary approach for patients with normal renal function. Indeed, the literature suggests that the Mediterranean diet regimen reduces the risk of developing cardiovascular diseases and the risk of mortality (4). Conversely, the portion of protein appears not to be appropriate for patients with CKD, where LPD would reduce comorbidity and improve renal survival. This hypothesis remains controversial when the palatability of LPDs reflects on reduced caloric intake and poor diet compliance, where large observational studies suggest that reduced diet adherence, added to reduce caloric intake and appetite, is strictly linked to increased mortality and a reduced quality of life (5,6). Indeed, guidelines focused on the importance of the personalized therapeutic and dietetic choice to avoid malnutrition and sarcopenia, considering the Mediterranean diet in patients who do not tolerate LPD (3).

PBD in CKD. The PBD, a dietary approach based on plant-derived foods, represents one of the most challenging in conservative CKD management (7,8). Indeed, the traditional 'renal diet' that markedly restricted fruits and vegetables has been converted to a diet rich in vegetables. The current literature is not unanimous on the progression of CKD when PBD is compared to omnivorous LPD and fails on feasibility; however, it demonstrates improved phosphate and acid-base management (9).

Indeed, unlike animal proteins that contain phosphate in a highly bioavailable organic form, PBD allows for increased phosphate excretion, which is translated into improved phosphate management. It can be physiologically explained as the human digestive tract lacks the phytase enzyme, limiting plant phosphorus absorption to 30-50% (10). In parallel to this, PBD is characterized by a natural alkalizing effect due to a lower potential renal acid load. Furthermore, when a vegetarian regimen is structured as a LPD or VLPD supplemented with KA, it allows for the maintenance of a neutral nitrogen balance and prevents protein-energy wasting (PEW), providing a wider range to patients with CKD (11).

Furthermore, plant proteins appear to reduce glomerular hyperfiltration compared to animal proteins, attenuating the degeneration of functional reserve; however, this hypothesis is based on a small number of observational studies and does not represent strong evidence (12).

LPD and VLPD in conservative CKD management. The LPD and VLPD constitute the main nutritional plan to attenuate the progression of CKD in moderate and severe

CKD. These diets aid in reducing the nitrogen intake and reducing the catabolic products of protein. Complementary to this nutritional therapy, supplements with KA of essential amino acids at the doses of 2 cp/10 kg/day for VLPD or 1 cp/kg/day for LPD provide a potent metabolic management, and aid in preventing malnutrition and sarcopenia (13).

KA exert their metabolic effects primarily through transamination reactions, in which nitrogen is transferred from catabolism and non-essential amino acids to KA to form essential amino acids. This process supports protein synthesis and recycles nitrogen (14) (Fig. 1). The absence of nitrogen and acid load renders KA particularly suitable in patients with severe CKD, in whom uremic toxin accumulation and metabolic acidosis remain major therapeutic challenges. A recent meta-analysis indicated that LPD + KA reduces the rate of estimated glomerular filtration rate (eGFR) decline by ~1.5-2.0 ml/min/year compared to free diets, significantly extending the pre-dialysis interval (15).

Furthermore, Garneata *et al* (16) demonstrated in their trial that a VLPD + KA reduced the risk of reaching the composite endpoint (initiation of dialysis or 50% reduction in eGFR) by 42% compared to a standard LPD. While 42% of patients in the LPD-only group required RRT initiation within 15 months, only 13% of those in the VLPD + KA group progressed to dialysis (17). These findings lend further support to the hypothesis that reducing urea catabolism aids in attenuating the progression of renal disease.

The hypercalcemic effect of KA should be highlighted, mostly since patients with CKD are often treated with calcium and vitamin D supplementation. Furthermore, recent evidence emphasizes the benefits of LPD + KA on the gut-kidney axis, focusing on the modulation performed by the nitrogen balance (17). In detail, a high protein-to-fiber ratio in ESRD promotes the expansion of proteolytic bacterial species, which increases the overproduction of p-cresyl sulfate and indoxyl sulfate; these represent an increased cardiovascular mortality risk and systemic inflammation, and are poorly cleared by conventional HD (18). The implementation of LPD/VLPD + KA reduces the substrate available for these proteolytic bacteria, shifting the intestinal environment toward a saccharolytic profile. It is translated by the reduced generation of these toxins, restored intestinal barrier integrity and reduced systemic inflammatory state. While the Mediterranean diet and PBD increase fiber intake, which promotes the production of short-chain fatty acids, the supplemented LPD reduces the absolute proteolytic fermentation (19). This down-regulates the p-cresol and indoxyl-sulfate pathways, reducing *Enterobacteriaceae* and increasing *Lactobacillaceae*, creating a synergistic effect with incremental dialysis to maintain systemic uremic balance. In the context of incremental dialysis, this nutritional modulation functions as a biological clearance that complements the mechanical clearance of the dialyzer, further protecting RKF from toxin-mediated damage (Fig. 2).

Acid-base balance and mineral metabolism. Metabolic acidosis is a common complication of advanced kidney disease and a key driver of muscle catabolism and inflammation. LPDs reduce endogenous acid production, particularly

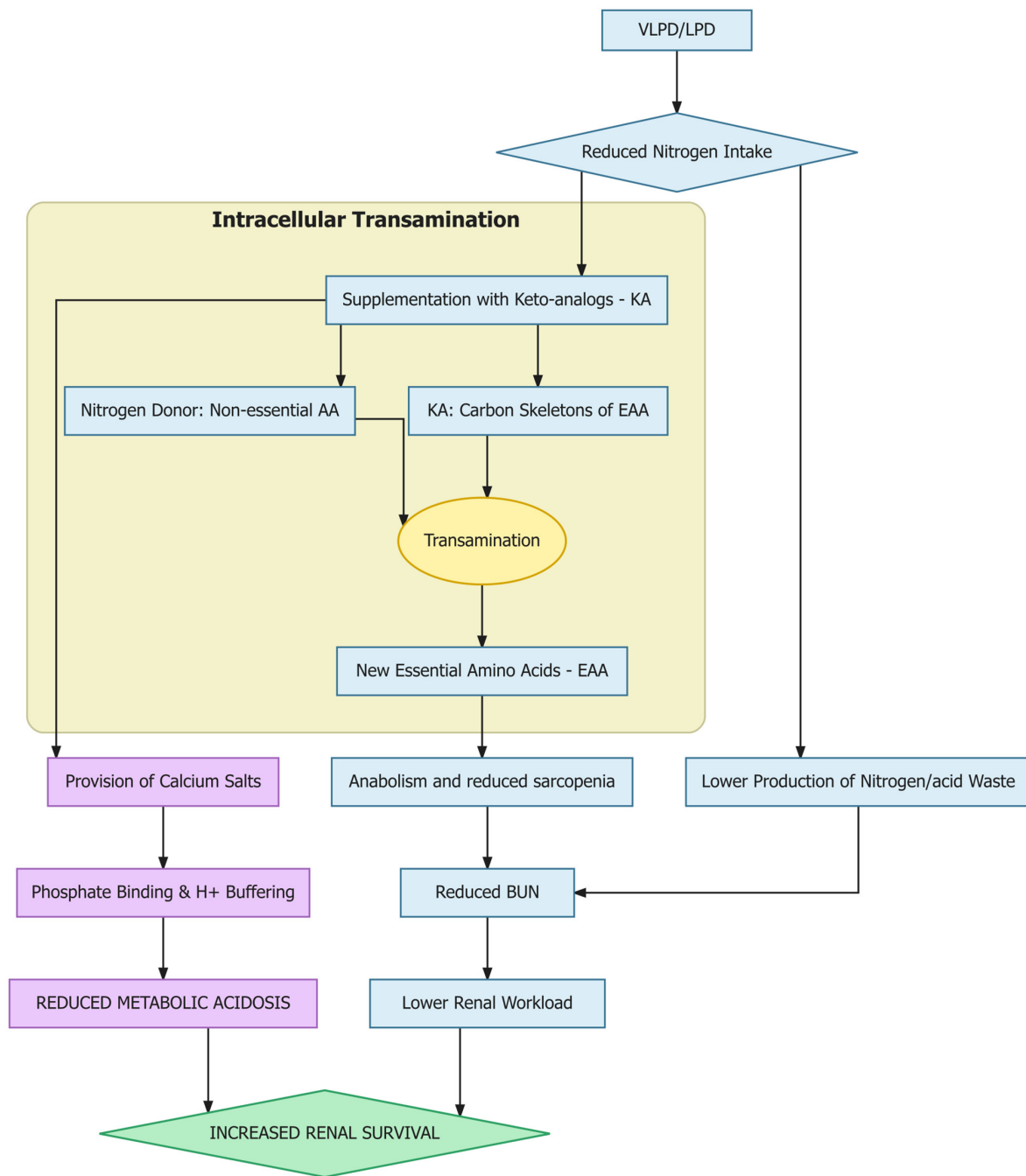


Figure 1. Schematic illustration of the mechanisms, highlighting how ketoanalogues contribute to metabolic clearance complementary to dialytic removal. LPD, low-protein diet; VLPD, very low-protein diet; KA, ketoanalogues; EAA, essential amino acids.

when animal protein intake is limited. KA further contribute to acid-base stability by providing carbon skeletons without associated hydrogen ions. Indeed, recent evidence supported this, highlighting that patients on LPD + KA maintain significantly higher serum bicarbonate levels compared to those on LPD alone, often reducing the oral bicarbonate supplementation and thus avoiding the associated sodium load (20). As regards mineral metabolism, LPD + KA has been shown to reduce serum phosphorus compared to unrestricted diets, where phosphate control represents another major challenge in patients undergoing conservative treatment and dialysis. This reduction is clinically relevant as it is associated with a 30-40% decrease in phosphate binder pill burden (Fig. 1).

This reduction is clinically relevant as it is associated with a 30-40% decrease in phosphate binder pill burden (Fig. 1). To provide a comprehensive overview, the macronutrient targets, metabolic advantages and potential risks of the Mediterranean diet, PBD and LPD/VLPD + KA in the pre-dialysis setting are summarized and compared in Table I.

3. Nutritional assessment in dialysis

The Mediterranean diet in dialysis. As regards conservative CKD management, no univocal results have been reported for the Mediterranean diet in dialysis. Recent literature marks a shift in the nutritional management of patients undergoing

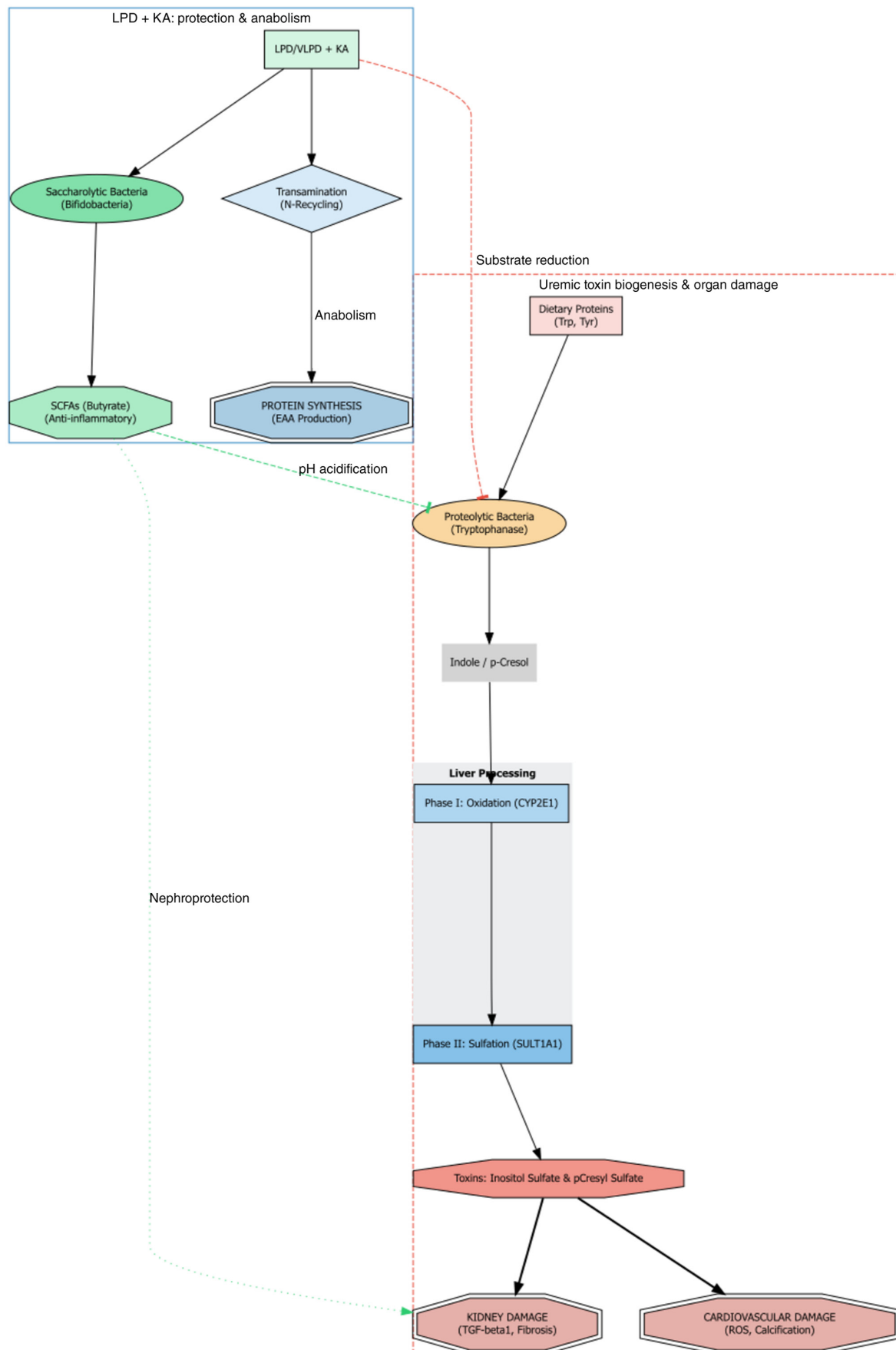


Figure 2. From gut dysbiosis to multi-organ damage. Solid edges represent direct metabolic flows or biochemical conversions; dashed lines represent inhibitory effects or negative feedback; dotted lines represent indirect protective signals or distal metabolic benefits. Red shades represent catabolic/pathological pathway; green shades represent nutritional intervention and protection; blue shades represent biochemical and anabolic recovery. LPD, low-protein diet; VLPD, very low-protein diet; KA, ketoanalogues; EAA, essential amino acids; SCFA, short-chain fatty acids; CYP2E1, cytochrome P450 2E1; SULT1A1, sulfotransferase 1A1; Trp, tryptophan; Tyr, tyrosine; TGF- β 1, transforming growth factor β 1; ROS, reactive oxygen species.

Table I. Advantages and disadvantages of the different diets in conservative CKD management.

Diet regimen	Protein target (g/kg/day)	Main advantages in dialysis	Major risks	Impact on gut microbiota
Mediterranean diet (MD)	0.8-1.2	Cardiovascular protection; high palatability; low risk of PEW; reduced chronic inflammation.	High protein intake; potential risk of hyperkalemia.	Increases short-chain fatty acids (SCFAs); reduces dysbiosis.
Plant-based diet (PBD)	0.6-0.8	Low phosphorus bioavailability; high alkalizing effect.	High risk of micronutrient deficiencies; risk of hyperkalemia; lower amino acid score.	Shifts gut environment toward a saccharolytic profile; reduces pCS and IS pathways.
VLPD/LPD + KA	0.3-0.6 + ketoanalogues	Maximum reduction of uremic toxins; extends pre-dialysis interval; recycles nitrogen via transamination.	High pill burden (6-12 tablets/day); risk of PEW if caloric intake drops below 30 kcal/kg/day; requires strict compliance.	Minimizes proteolytic fermentation; significantly downregulates Enterobacteriaceae; reduces pCS and IS pathways.

VLPD, very low-protein diet; LPD, -protein diet; KA, ketoanalogues; pCS, p-cresyl sulfate; IS, indoxyl sulfate.

HD, from the common restrictive use of vegetables to their moderate use. Indeed, recent evidence, based on a sample of 582 patients, suggests that the Mediterranean diet does not increase the risk of hyperkalemia, cardiovascular events, or mortality, as the high fiber content improves intestinal motility and reduces the bioavailability of potassium and organic phosphorus compared to ultra-processed foods, ameliorating the vitamin and micromineral balance (21). Furthermore, a large DIET-HD trial indicated that, whereas a direct reduction in short-term mortality remained unproven in the dialysis population, the Mediterranean diet was able to reduce chronic inflammation and impair the uremic toxin profile by modulating the gut microbiota (4,22). Last, but not least, higher adherence to the Mediterranean diet translates to a reduced risk of developing sarcopenia and malnutrition, in keeping with the evidence on conservative CKD management.

PBD in dialysis. The integration of scientific evidence regarding the PBD in patients undergoing HD outlines an ambivalent clinical image, where the potential metabolic benefits must be stringently balanced with a risk of nutritional deficit and hyperkalemic risk.

From a pathophysiological point of view, the PBD in patients undergoing dialysis appears to be associated with a reduction in oxidative stress, phosphate and systemic inflammation, due to the high intake of natural phytonutrients and antioxidants, such as vitamins C and E. These elements function as protective factors against the cardiovascular complication which represent the main cause of mortality in the ESRD population (23). In addition, the consumption of vegetable proteins can positively influence the lipid profile and the intestinal microbiota. Indeed, a beneficial impact on

the modulation of the gut-kidney axis has also been shown in PDB. In detail, the high fiber intake serves as a substrate for saccharolytic bacterial flora, which promotes the production of short-chain fatty acids and accelerates the intestinal transit time. This reduces the time for proteins to enter the colon, and reduces the synthesis of indoxyl sulfate and p-cresyl sulfate, as detailed below (Fig. 2) (24). Conversely, the comparative analysis between vegetarian and omnivorous diets highlights significant anthropometric and biochemical criticalities. Indeed, a PBD in patients undergoing HD tends to reduce body mass index, mid-arm muscular circumference and serum albumin compared to the omnivorous counterpart, due to reduced average protein and energy intake (25). However, no difference in subjective global assessment was detected. To avoid the risk of protein-caloric malnutrition and sarcopenia, supplementing KA in these patients could bridge this knowledge gap.

In addition to the protein status, the micronutrient profile requires extremely careful monitoring, where vegetarianism emerges as an independent risk factor for severe vitamin D deficiency (26). The limited bioavailability of heme iron and potential deficiencies of vitamin B12, zinc and fatty acids and long-chain omega-3 (eicosapentaenoic acid and docosahexaenoic acid) further complicate the clinical picture. Although the theoretical risk of hyperkalemia remains a constant concern, requiring food preparation strategies, such as leaching or double boiling reduces the potassium content in vegetables and improves the ability of the gut to excrete potassium, mitigating this risk (27). In summary, although the PBD can also be successfully followed in HD, it requires constant specialist dietary supervision, targeted supplementation of KA or protein powders and careful monitoring of biochemical parameters to prevent cardiovascular benefits

being cancelled by the decline in the overall nutritional status (28).

Nutritional status and PEW. The major complications of protein restriction in patients undergoing dialysis, or in patients who are non-compliant or undergoing conservative treatment, are the risk of malnutrition and PEW. Dialysis itself is a catabolic and pro-inflammatory process. For this reason, conventional guidelines have historically recommended high protein intake in patients undergoing HD (29). Conversely, emerging evidence suggests that protein quality and energy intake play a central role, rather than protein quantity alone. Furthermore, this concept is strictly linked with a phosphate intake, abundant in animal protein, which represents one of the most challenging comorbidities on dialysis (30).

In keeping with this hypothesis, a recent systematic review and meta-analysis by Chen *et al* (31) involving >1,500 patients confirmed that LPD + KA did not have a negative impact on serum albumin, pre-albumin or anthropometric measurements when compared to high-protein diets, provided that energy intake is maintained at 30-35 kcal/kg/day. In fact, the nitrogen-sparing effect of KA supports a positive nitrogen balance even at protein intakes as low as 0.6 g/kg/day. Conversely, LPD without KA supplementation carries a 30% higher risk of causing a decline in lean body mass over a period of 6 months (31). In these patients, with a high number of treatments, the adherence to KA should be well evaluated to avoid PEW exceeding the protein intake, as a minimum of six pills should be taken daily by the patients.

Quality of life and patient-centered outcomes. Beyond improving metabolic tools, patient-centered treatment should include the evaluation of quality of life; this has become a central outcome in recent decades in the management of ESRD. These patient-centered benefits reinforce the concept that therapeutic success in dialysis extends beyond biochemical targets to encompass lived experience and daily functioning.

KDQoL-SF or KDQoL-36 has been structured for patients affected by renal disease, and includes the impact of CKD on their lives. Indeed, some tasks regard the dialysis frequency, symptom burden, fatigue, dietary and water restrictions, as well as the impact on travel ability (32). The improved quality of life in patients undergoing conservative CKD management with LPD + KA constitutes well-consolidated knowledge (33).

A previous study evaluated quality of life in patients undergoing dialysis comparing the LPD and free diet, confirming the same results of conservative CKD, demonstrating significant improvement in the once weekly HD with LPD + KA group compared to the 2-weekly HD with free diet group, perhaps due to the dietary restriction being balanced by the reduced fatigue and by the reduced time spent for treatment (34).

4. The evolution of dialysis

Role of LPDs and KA across the CKD continuum: From pre-dialysis to dialysis. The rationale supporting the use of LPD supplemented with KA should not be limited to the conservative treatment of CKD, but should include nephrotic syndrome and incremental dialysis. In advanced pre-dialysis CKD, the role of LPD and VLPD + KA in delaying RRT has

been consistently demonstrated. Indeed, multiple randomized and observational studies have demonstrated that a VLPD supplemented with KA can safely postpone RRT by several months to years in selected patients (35-37). Furthermore, delaying the initiation of dialysis has major implications both for the quality of life of patients and for healthcare resource utilization (38). In patients with ESRD, intermittent HD results in the cyclical fluctuations of these solutes, with a progressive accumulation and electrolyte dysequilibrium during the intradialytic interval, until a peak before the dialysis session. It contributes to worse overall outcomes, including mortality, systemic inflammation, endothelial dysfunction and oxidative stress. Indeed, standardized kt/V (stdKt/V), which includes intradialytic mean urea, results in a higher accuracy than the Kt/V of the single dialysis session (39). Reducing dietary protein intake lowers the rate of nitrogenous waste generation, reduces the interdialytic solute accumulation, and consequently, improves the stdKt/V.

However, the benefit of LPD + KA is true when the nutritional status is adequately supervised, maintaining adequate caloric intake to avoid malnutrition and sarcopenia. Indeed, it needs to be supported by effective nutritional therapy and by high compliance to implement safety (40).

The mechanism that underlies the nephroprotective and metabolic benefits of LPD, including the maintenance of RRF, in the pre-dialysis setting should be applied in the incremental dialysis (41,42). Indeed, minimal residual clearance is associated with improved volume control, more efficient phosphorus and potassium handling, reduced inflammation, lower erythropoietin requirements and improved survival. The preservation of RKF is therefore a primary therapeutic goal, particularly during the early phases of dialysis (43). Furthermore, reducing renal workload is related to the longer preservation of renal function (44); in addition, the efficacy against sarcopenia could benefit this frail population (45).

Health economic implications and cost-effectiveness considerations. Beyond clinical and metabolic benefits, the integration of LPD + KA in CKD may have relevant health economic implications. Dialysis represents one of the most costly chronic therapies, with costs driven primarily by treatment frequency, vascular access, hospitalization and the management of complications (46).

Delaying the initiation of dialysis through LPD + KA may translate into substantial cost savings. Indeed, the cost of nutritional therapy is significantly lower than that of HD (47). Furthermore, Scalone *et al* (48), as well as Bellizzi *et al* (49) demonstrated that a supplemented VLPD is a cost-effective, and even cost-saving, strategy by postponing the initiation of expensive renal replacement therapy. In the dialysis setting, incremental approaches can reduce annual healthcare expenditures by significantly lowering consumables, transportation and complication costs (50).

In the pre-dialysis phase, delaying the initiation of dialysis through VLPD or LPD supplemented with KA may translate into substantial cost savings by postponing the initiation of RRT. Economic modelling based on the trial by Garneata *et al* (16) and the study by Povero *et al* (51) suggest that postponing RRT by an average of 10.7 months generates a net saving of approximately €35,000 to €50,000 per Italian

patient, even after accounting for the costs of KA and specialized dietetic counselling.

In the dialysis setting, incremental and decremental dialysis strategies inherently reduce treatment frequency, staffing requirements, consumables and transportation costs. In detail, the integration of LPD + KA within incremental protocols can reduce annual costs by up to ~20% (52). At these costs, the reduction of phosphate binders and bicarbonate supplementation related to the improved metabolic control, as well as the reduction of sarcopenia, which contributes to lowering the incidence of frailty-related hospitalizations and infections, should be additionally considered.

Although precise economic quantification requires dedicated cost-effectiveness analyses, existing data suggest that integrated nutritional and incremental dialysis approaches are likely to be economically favorable.

Decremental dialysis as a proof of concept and future perspectives. From a pathophysiological standpoint, dietary protein restriction reduces the generation of nitrogenous waste, thereby smoothing the interdialytic uremic peaks. This biochemical modulation functions synergistically with the RKF of the patient. In patients with a residual urea clearance >1 ml/min/1.73 m² (for twice-weekly regimens) or >3 ml/min/1.73 m² (for once-weekly regimens), the native clearance of the kidney complements the mechanical clearance of the dialyzer. By lowering the metabolic workload through an LPD or VLPD supplemented with KA, RKF can be preserved more efficiently, the primary determinant of survival and volume control in the early years of dialysis, as reported in a recently published pivotal randomized controlled trial (34).

The concept of decremental dialysis challenges the traditional point of view on dialysis as a unidirectional escalating therapy. Instead, it frames dialysis dose and frequency as dynamic parameters adjusted according to RKF, metabolic control and patient-centered outcomes.

Although it refers to a hypothesis-generating consideration, successful decremental strategies require stringent patient selection, close biochemical and clinical monitoring, and sustained metabolic stability. Patient compliance is fundamental, as worse adherence to both pharmacological treatment and nutritional schedule could impair the safety of the patients (53). In this setting, LPD + KA plays a crucial role where urea, phosphate and acid intake are reduced. According to the study by Casino *et al* (54), LPD + KA, together with an RRF >1 ml/min/1.73 m² for two-weekly or 3 ml/min/1.73 m² for once-weekly dialysis, allows for guaranteeing safe blood purification.

The evidence supporting LPD supplemented with KA following the initiation of dialysis remains limited. Randomized controlled trials or longitudinal observational studies are required to define the impact of this strategy on patients undergoing dialysis, expanding the use of KA to patients undergoing dialysis twice or thrice weekly, with the aim of examining the anabolic impact and the safety of KA for the entire CKD spectrum. Moreover, further studies are warranted to evaluate patient-reported outcomes as quality of life and formal cost-effectiveness endpoints. Due to the pill burden and the necessity of extremely high

adherence, this approach should be applied only in a carefully selected patients, under specialist nephrological and dietetic supervision.

Moreover, further studies are required to evaluate patient-reported outcomes, such as quality of life and formal cost-effectiveness endpoints, by reducing post-dialysis fatigue, burden of kidney disease and the effects of kidney disease.

5. The pivotal role of nephrology nursing in patient education and compliance

The clinical feasibility of non-standard dialysis protocols and strict nutritional regimens does not rest solely on scientific validity, but on the genuine ability of a patient to incorporate these prescriptions into the fabric of their daily life. In this delicate balance, the nephrology nurse would emerge as the essential catalyst for clinical success. They could serve as the primary educator in the multidisciplinary team, when they aid in ensuring that clinical and metabolic targets remain achievable, solving the gap between medical theory and patient adherence; this could be implemented considering that the ratio between the number of patients and number of nurses is higher than the patient/nephrologist ratio.

The nursing role is critical in translating medical data into tangible daily food choices, vital for patients transitioning from the familiar Mediterranean diet to LDP + KA. Beyond initial education, the nurse maintains treatment momentum through regular check-ins, triage and validated tools, such as the KDQoL-36 questionnaire (55). Furthermore, nurses can identify psychosocial or physical barriers early, they can provide the specific counselling required to keep the patient on track without them feeling overwhelmed by the complexity of their care.

While dietary and fluid restrictions are often the most problematic hurdles for patients, they remain the cornerstone of effective self-management. In this case, the one-to-one relationship between the nurse and the patient becomes transformative. Nurses empower patients to restructure their lifestyles and coping mechanisms.

Ultimately, the nephrology nurse takes on a daunting medical protocol and transforms it into a sustainable, structured lifestyle. By fostering self-care behaviors and providing a bridge to clinical stability, they ensure that cutting-edge nutritional and dialytic strategies are not just scientifically sound, but safe and manageable for individuals in real life. Through this human-centered approach, what was once a rigid medical mandate becomes a viable pathway toward improved clinical outcomes and an improved quality of life (54).

However, prospective studies are required to determine whether nurse-led education improves adherence, residual kidney function, nutritional outcomes or quality of life in incremental HD programs.

Limitations of the current evidence. Although numerous randomized controlled trials and observational studies on patients with have been performed CKD (35-37,56,57), they have analyzed different outcomes ranging from mortality and cardiovascular events to fistula maturation, eGFR slope, time to dialysis, PEW, quality of life and electrolyte balance. This renders the synopsis of these results difficult. Furthermore,

very few observational studies (58,59) and only a single randomized controlled trial (33) have focused specifically on patients undergoing dialysis. Larger, high-quality studies on both CKD and dialysis populations are urgently required to address the knowledge gaps arising from the marked heterogeneity of the current evidence. Furthermore, adverse events have been poorly reported, rendering analysis difficult.

6. Conclusions

Nutritional therapy remains a cornerstone of nephrological care, maintaining its role also following the initiation of HD. LPDs supplemented with KA may represent a promising strategy for incremental or decremental dialysis; However, the available published data are limited. As this is an emerging and hypothesis-generating approach, and further large-scale trials are warranted to solidify the evidence. Of note however, the current data strongly suggest that personalized, nutrition-centered care should be embraced as an integral component of modern dialysis practice. It should be highlighted though that nephrological care should remain active even following the initiation of dialysis, personalizing treatments patient per patient.

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Authors' contributions

SC, SSi and VCa were involved in the conceptualization of the study. VCa VCu and VF were involved in the methodology (the literature search, and the structure of the review). VCa, IM, IP, FP and IC were involved in the writing and preparation of the original draft of the manuscript. VCa, VF and SSc were involved in data curation (of data from the literature). LM, MCC and GB were involved in the writing, review and editing of the manuscript. All authors have read and agreed to the published version of the manuscript. Data authentication is not applicable.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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