Renal Replacement Therapy

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Association of inadequate energy intake on admission with activities of daily living at discharge in patients undergoing unplanned hemodialysis initiation: a retrospective case-series study

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Abstract

Background: In a previous study, patients who underwent unplanned hemodialysis initiation did not have improved nutritional status and activities of daily living (ADL) at discharge compared with patients whose initiation of hemodialysis was planned. Therefore, the aim of this study was to analyze the factors that delayed or made it difficult to improve nutritional status and ADL in patients undergoing unplanned hemodialysis initiation.

Methods: Participants were patients with end-stage kidney disease who experienced unplanned initiation of new maintenance hemodialysis between April 2017 and March 2020. Patients were divided into two groups: a group who required assistance with ADL at discharge (assistance group) and a group who did not require assistance (independence group). Patient characteristics, nutritional management, and blood tests data obtained from medical records were retrospectively analyzed using univariate and multivariate analyses.

Results: In total, 95 patients who experienced unplanned dialysis initiation were included in the analysis. Of these, 55 (58%) patients were in the assistance group and 40 (42%) were in the independence group. The assistance group was significantly older than the independence group and contained significantly fewer male patients. In the assistance group, energy intake on admission and serum albumin at discharge were significantly lower, and C-reactive protein was significantly higher, than in the independence group. The multivariate analysis showed that age, sex, and energy intake on admission were associated with requirement for assistance with ADL at discharge.

Conclusions: Inadequate energy intake on admission was associated with requirement for assistance with ADL at discharge for patients who experienced unplanned hemodialysis initiation. This suggests that active nutritional management from the time of admission could reduce the requirement for assistance with ADL and could increase independence.

Keywords: Activities of daily living, Energy intake, Hemodialysis, Nutritional disorders, Unplanned

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Background

Renal failure owing to diabetic nephropathy, undernutrition, and other numerous complications is associated with poor prognosis; however, unplanned initiation of dialysis and requirement for assistance with activities of daily living (ADL) should also be recognized as poor prognostic factors [1]. Susceptibility to malnutrition in the global hemodialysis community can be iatrogenic or non-iatrogenic (or both) in origin. In addition, dietary inadequacy (e.g., suboptimal energy and protein intake) owing to poor appetite and low diet quality are modifiable non-iatrogenic factors associated with malnutrition in hemodialysis patients [2].

In a previous study, patients who had experienced unplanned hemodialysis initiation did not have improved nutritional status and ADL at discharge compared with patients who experienced planned hemodialysis initiation [3]. Therefore, it was necessary to analyze the factors that delayed or made it difficult to improve the nutritional status and ADL of patients who started unplanned hemodialysis. However, to our knowledge, no studies have investigated how unplanned hemodialysis initiation affects nutritional status and ADL at discharge. Therefore, the purpose of this study was to identify factors related to ADL at discharge and nutritional management problems in patients who experienced unplanned initiation of new maintenance hemodialysis.

Methods

Study design

This was a retrospective case-series study conducted in a single center.

Setting and patient characteristics

Figure 1 shows a flow diagram of the study participants. A total of 243 patients with end-stage kidney disease experienced initiation of new maintenance hemodialysis at the Department of Nephrology, Kitasato University Hospital, between April 1, 2017, and March 31, 2020. The exclusion criteria were patients who experienced planned initiation of new maintenance hemodialysis, patients who had transitioned from kidney transplant to hemodialysis, patients who had transitioned from peritoneal dialysis to hemodialysis, patients who had acute kidney injury, and patients

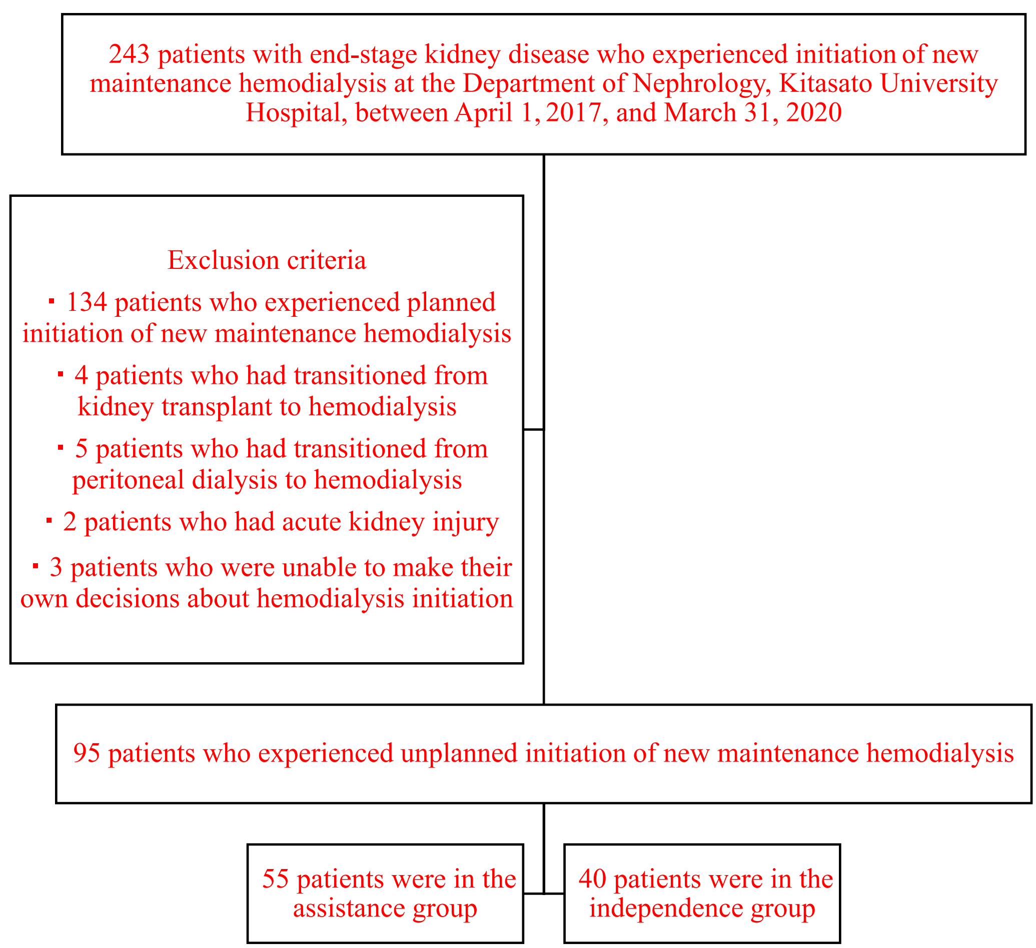

Fig. 1 Flow diagram of the study participants

who were unable to make their own decisions about hemodialysis initiation. Participants were patients who started unplanned new maintenance hemodialysis during the study period. Patients were divided into two groups: a group who required assistance with ADL at discharge and a group who did not require assistance (independence group).

There is no established consensus definition of unplanned hemodialysis initiation [4]. Therefore, in this study, planned hemodialysis was defined as the initiation of hemodialysis treatment, which had been chosen before the need for hemodialysis, with ready access for the initiation of hemodialysis [5] and scheduled hospitalization. Hemodialysis initiation that did not fit this definition was defined as unplanned initiation.

We surveyed ADL records to ascertain each patient's condition. The requirement for assistance was evaluated by nurses under the direction of physicians. The nurses assessed the patient's ADL status and requirement for assistance every day. The first set of evaluation data was collected on the day after admission and the last set on the day before discharge, to avoid differences in evaluation depending on the time of admission and discharge. To assess ADL, patients were individually evaluated as independent or requiring assistance in turning over, transferring, oral care, eating, and putting on and taking off clothes. Patients who required assistance in at least one of these activities at discharge were assigned to the assistance group; patients who did not require such assistance were assigned to the independence group.

This study was approved by the Institutional Review Board of the Kitasato University Medical Ethics Organization (KMEO: B20-094).

Data collection

The following data were collected from medical records: age, sex, unscheduled hospitalization, availability of vascular access on admission, duration of hospitalization, requirement for assistance with ADL on admission and at discharge, height, ideal body weight, body mass index on admission and at discharge, cause of chronic kidney disease, comorbidities, cardiothoracic ratio on admission, history of hospitalization in our hospital for 1 year before hemodialysis initiation (excluding vascular access surgery), rehabilitative intervention, outcome, nutritional risk screening on admission, duration of not eating after admission, dietary intake rate and energy intake of oral ingestion patients on admission, nutrition support team intervention, energy and protein intake on admission and at discharge, and blood tests on admission and at discharge.

Comorbidities

We measured the following comorbidities: cardiovascular disease, infectious diseases, and diabetes mellitus. We investigated the onset on admission and medical history of the following cardiovascular diseases: heart failure, ischemic heart disease, arrhythmia, valvular heart disease, cerebrovascular disease, and peripheral arterial disease. We investigated the onset on admission and during hospitalization of pneumonia, access-related infection, urinary tract infection, and other infectious diseases. Presence of diabetes mellitus was investigated on admission.

Nutritional assessment and management

We examined each patient's nutritional management plan, which included their nutritional status on admission as assessed by physicians, nurses, and dietitians. At our hospital, nutritional status risk assessment is conducted using subjective global assessment of the following characteristics: continued weight loss or gain, reduced food intake for more than 1 week, gastrointestinal symptoms for more than 1 week, edema or loss of subcutaneous fat and muscle, decubitus, infections that affect nutritional status, problems with swallowing and chewing, lack of independence in daily living (requirement for assistance), and admission to the intensive care unit.

We investigated patients' dietary intake rate 5 days from the date of admission and 5 days retroactively from the date of discharge. The nutrition support team discussed diet and nutrition at conferences, or dietitians interviewed patients with poor dietary intake and changed their diet under the direction of physicians. We calculated energy and protein intake per ideal body weight for a total of 5 days of diet, enteral nutrition, and parenteral nutrition.

Statistical analysis

Normally distributed continuous variables were expressed as means ± standard deviations, non-normally distributed continuous variables as medians and interquartile ranges, and categorical data as percentages. Univariate analysis was performed using the (two-sided) *t* test, Mann–Whitney *U* test, χ^2 test, and Fisher's exact test. The *t* test or Mann–Whitney *U* test was selected by examining whether the data were normally distributed. We performed multivariate analysis to generate two models. In the first model, the objective variable was requirement for assistance with ADL at discharge, and the explanatory variables were energy intake on admission, serum albumin and C-reactive protein on admission, age, and sex. In the second model, the objective variable was requirement for assistance with ADL at discharge, and the explanatory variables were energy intake on admission, serum albumin and C-reactive protein at discharge, age, and sex. For all analyses, a two-tailed p value of <0.05 was considered significant. Statistical analyses were performed using Stat Flex, version 7.0 (Artec, Osaka, Japan).

Results

In total, 95 patients (39% of all patients who had started new maintenance hemodialysis during the study period) who had started unplanned dialysis were included in the analysis (Table 1). Of these, 55 (58%) patients were in the assistance group and 40 (42%) were in the independence group. The assistance group was significantly older than the independence group ($p=0.000$), with 65% aged ≥ 75 years, and included significantly fewer male patients than the independence group ($p=0.013$). Independence in ADL on admission was significantly lower in the assistance group than in the independence group ($p=0.007$). There was no difference between the cause of chronic kidney disease and comorbidities. History of hospitalization in our hospital for 1 year before hemodialysis initiation was significantly higher in the assistance group than in the independence group ($p=0.039$). Rehabilitative intervention was significantly higher in the assistance group than in the independence group ($p=0.000$), as were hospital transfers ($p=0.000$).

Table 1 Characteristics of patients who experienced unplanned dialysis initiation

	Overall ($n=95$)	**Assistance group ($n=55$)**	**Independence group ($n=40$)**	***p* value**
Age, years	75 (65–81)	77 (73–83)	69 (50–76)	0.000[†]
≥ 75 years	48 (51%)	36 (65%)	12 (30%)	0.001[‡]
Sex, male	68 (72%)	34 (62%)	34 (85%)	0.013[‡]
Unscheduled hospitalization	79 (83%)	51 (93%)	28 (70%)	0.003[‡]
Nonvascular access on admission	52 (55%)	30 (55%)	22 (55%)	0.965[‡]
Duration of hospitalization, days	44 (31–57)	46 (31–64)	40 (30–50)	0.141[†]
Independence in ADL on admission	11 (12%)	2 (4%)	9 (23%)	0.007[¶]
Height, cm	160.5 ± 9.4	157.1 ± 8.8	165.3 ± 8.0	0.000[*]
IBW, kg	56.9 ± 6.6	54.4 ± 6.1	60.2 ± 5.8	0.000[*]
BMI on admission, kg/m^2	24.0 (21.9–26.7)	24.1 (20.9–26.4)	23.9 (22.4–29.7)	0.374[†]
BMI at discharge, kg/m^2	21.0 (19.0–23.6)	20.8 (18.6–23.0)	21.1 (19.9–25.3)	0.170[†]
Cause of CKD				
Diabetic nephropathy	30 (32%)	16 (29%)	14 (35%)	0.541[‡]
Chronic glomerulonephritis	15 (16%)	9 (16%)	6 (15%)	0.857[‡]
Nephrosclerosis	14 (15%)	8 (15%)	6 (15%)	0.951[‡]
Unknown	23 (24%)	13 (24%)	10 (25%)	0.878[‡]
Other	13 (14%)	9 (16%)	4 (10%)	0.373[‡]
Comorbidities				
Cardiovascular disease	72 (76%)	44 (80%)	28 (70%)	0.261[‡]
Infectious diseases	50 (53%)	30 (55%)	20 (50%)	0.661[‡]
Diabetes	44 (46%)	22 (40%)	22 (55%)	0.148[‡]
Cardiothoracic ratio on admission, %	57.0 (51.8–60.8) $n=83$	58.6 (53.9–61.6) $n=48$	55.5 (49.2–59.0) $n=35$	0.023[†]
History of hospitalization[a]	45 (47%)	31 (56%)	14 (35%)	0.039[‡]
Rehabilitative intervention	67 (71%)	47 (85%)	20 (50%)	0.000[‡]
Outcome				
Home or facility	74 (78%)	34 (62%)	40 (100%)	0.000[‡]
Transfer to hospital	18 (19%)	18 (33%)	0 (0%)	0.000[‡]
Mortality	3 (3%)	3 (5%)	0 (0%)	0.261[¶]

Values are mean ± standard deviation, median and interquartile range, and *n* (%)

ADL: activities of daily living, IBW: ideal body weight, BMI: body mass index, CKD: chronic kidney disease

[a] History of hospitalization: hospitalization for 1 year before hemodialysis initiation (excluding vascular access surgery)

[*] t test, [†]Mann–Whitney *U* test, [‡]χ^2 test, [¶]Fisher's exact test

Table 2 Nutritional assessment and nutritional intake

	Overall ($n=95$)	Assistance group ($n=55$)	Independence group ($n=40$)	*p* value
At least one characteristic on risk assessment of nutritional status	64 (67%)	38 (69%)	26 (65%)	0.675‡
Patients who did not eat on admission	25 (26%)	19 (35%)	6 (15%)	0.033‡
Duration of not eating since admission, days	2.7 (1.7–4.7) $n=25$	2.3 (1.7–4.2) $n=19$	3.5 (1.8–4.5) $n=6$	0.702†
Dietary intake rate for oral ingestion on admission, %	78.9 (67.1–98.1) $n=70$	74.5 (65.1–90.2) $n=36$	92.0 (71.5–99.9) $n=34$	0.003†
Dietary energy intake for oral ingestion on admission, kcal/kg/day	24.7 (20.4–28.2) $n=70$	22.8 (19.6–25.8) $n=36$	26.0 (21.9–29.6) $n=34$	0.012†
Intervention by nutrition support team	49 (52%)	35 (64%)	14 (35%)	0.006‡
Energy intake[a] on admission, kcal/kg/day	21.2 (14.9–26.4)	19.2 (13.0–24.1)	25.4 (19.3–29.0)	0.003†
Protein intake[a] on admission, g/kg/day	0.61 (0.41–0.76)	0.53 (0.39–0.71)	0.70 (0.55–0.82)	0.003†
Energy intake[a] at discharge, kcal/kg/day	29.2 (25.8–31.1)	29.1 (24.5–30.9)	29.5 (27.3–31.3)	0.145†
Protein intake[a] at discharge g/kg/day	0.95 (0.85–1.03)	0.94 (0.80–1.04)	0.96 (0.89–1.02)	0.541†

Values are median and interquartile range, and *n* (%)

[a] Energy intake and protein intake: diet, enteral nutrition, and parenteral nutrition

† Mann–Whitney *U* test, ‡χ^2 test

Nutritional assessment and nutritional intake data are shown in Table 2. There was no difference in the number of patients rated as having at least one characteristic on the risk assessment of nutritional status on admission. The number of patients who did not eat on admission was significantly higher in the assistance group than in the independence group ($p=0.033$), but there was no difference in duration of not eating. Even for patients who orally ingested food on admission, dietary intake rate and energy intake were significantly lower in the assistance group than in the independence group ($p=0.003$ and $p=0.012$, respectively). The need for involvement by the nutritional intervention support team was significantly higher in the assistance group than in the independence group ($p=0.006$). Energy and protein intake on admission (which was the sum of diet, enteral nutrition, and parenteral nutrition) were significantly lower in the assistance group than in the independence group ($p=0.003$ and $p=0.003$, respectively). However, there was no difference in energy and protein intake at discharge.

Table 3 shows data for blood tests on admission and at discharge. There was no difference in serum albumin on admission, but serum albumin at discharge was significantly lower in the assistance group than in the independence group ($p=0.001$). Serum creatinine at discharge was significantly lower in the assistance group than in the independence group ($p=0.001$). In contrast, C-reactive protein at discharge was significantly higher in the assistance group than in the independence group ($p=0.005$).

The associations between ADL at discharge and each parameter are shown in Tables 4 and 5. In the first multivariate analysis model (Table 4), age (odds ratio [OR] 1.07, 95% confidence interval [CI] 1.03–1.11; $p=0.001$), sex (OR 0.22, 95% CI 0.06–0.75; $p=0.016$), and energy intake on admission (OR 0.93, 95% CI 0.87–0.99; $p=0.022$) were associated with requirement for assistance with ADL at discharge. In the second multivariate analysis model (Table 5), age (OR 1.06, 95% CI 1.02–1.10; $p=0.003$), sex (OR 0.19, 95% CI 0.05–0.73; $p=0.016$), and energy intake on admission (OR 0.94, 95% CI 0.88–1.00; $p=0.049$) were associated with requirement for assistance with ADL at discharge.

Discussion

In a previous study, we reported that patients undergoing unplanned hemodialysis initiation did not have improved nutritional status and ADL at discharge compared with patients who received planned hemodialysis initiation [3]. Therefore, we examined identifying factors related to require assistance with ADL at discharge and nutritional management problems in patients starting new unplanned maintenance hemodialysis. The results showed that older female patients with low energy intake on admission were more likely to require assistance with ADL at discharge.

First, the number of patients who did not eat on admission was significantly higher in the assistance group than in the independence group, but there was no difference in duration of not eating. Additionally, energy and protein intake on admission (which was the sum of diet, enteral nutrition, and parenteral nutrition) was significantly lower in the assistance group than in the independence group. In patients with end-stage kidney

Table 3 Blood tests on admission and at discharge

	Overall ($n=95$)	Assistance group ($n=55$)	Independence group ($n=40$)	p value[a]
Admission				
Hemoglobin, g/dL	9.5 (8.0–10.1)	9.6 (8.1–10.2)	9.5 (8.1–10.0)	0.684
Serum albumin, g/dL	3.2 (2.8–3.4)	3.2 (2.9–3.5)	3.2 (2.8–3.4)	0.656
Blood urea nitrogen, mg/dL	101.3 (88.3–127.2)	103.6 (90.2–130.4)	99.7 (81.7–118.2)	0.460
Serum creatinine, mg/dL	8.88 (7.32–11.20)	8.46 (7.30–11.02)	9.45 (7.32–13.42)	0.232
eGFR (mL/min/1.73 m^2)	5 (4–6)	5 (4–6)	5 (3–6)	0.786
Serum potassium, mmol/L	4.9 (4.2–5.6)	4.9 (4.3–5.6)	4.8 (4.0–5.3)	0.645
Serum phosphorus, mg/dL	6.2 (5.3–7.4) $n=91$	6.2 (5.4–7.4) $n=51$	6.2 (5.3–7.5)	0.713
C-reactive protein, mg/dL	0.88 (0.25–3.01) $n=87$	1.37 (0.21–3.43) $n=50$	0.68 (0.27–1.64) $n=37$	0.192
Brain natriuretic peptide, pg/mL	627.8 (324.2–1229.6) $n=82$	692.4 (311.8–1227.6) $n=47$	522.8 (362.1–1219.9) $n=35$	0.649
Discharge				
Hemoglobin, g/dL	9.1 (8.4–10.1)	9.0 (8.3–10.0)	9.3 (8.5–10.2)	0.384
Serum albumin, g/dL	3.0 (2.6–3.3)	2.8 (2.3–3.1)	3.2 (2.8–3.4)	0.001
Blood urea nitrogen, mg/dL	41.2 (34.3–48.6)	41.2 (35.6–48.1)	40.8 (34.0–49.1)	0.670
Serum creatinine, mg/dL	6.42 (5.44–8.19)	5.83 (5.04–6.85)	7.47 (6.17–9.58)	0.001
eGFR (mL/min/1.73 m^2)	7 (5–9)	7 (5–9)	6 (5–7)	0.099
Serum potassium, mmol/L	4.0 (3.7–4.2)	4.0 (3.8–4.3)	4.0 (3.7–4.1)	0.261
Serum phosphorus, mg/dL	4.1 (3.5–5.0) $n=94$	3.9 (3.5–4.7)	4.2 (3.6–5.3) $n=39$	0.220
C-reactive protein, mg/dL	0.19 (0.08–0.60) $n=88$	0.30 (0.12–1.06) $n=52$	0.15 (0.05–0.26) $n=36$	0.005

The results for admission were collected on the day of admission. The results for discharge were collected before the final hemodialysis. Some items have missing values for *n*. The concentration of brain natriuretic peptide was not measured at discharge

Values are median and interquartile range

[a] Mann–Whitney *U* test

eGFR: estimated glomerular filtration rate

Table 4 Association between requirement for assistance with ADL at discharge and each parameter

	OR	95% CI	p value
Age, years	1.07	1.03–1.11	0.001
Sex, male, n	0.22	0.06–0.75	0.016
Energy intake[a] on admission, kcal/kg/day	0.93	0.87–0.99	0.022
Serum albumin on admission, g/dL	1.32	0.57–3.04	0.516
C-reactive protein on admission[b], mg/dL	1.06	0.94–1.20	0.326

The objective variable was requirement for assistance with ADL at discharge, and the explanatory variables were age, sex, energy intake on admission, serum albumin on admission, and C-reactive protein on admission

ADL: activities of daily living, CI: confidence interval

[a] Energy intake includes diet, enteral nutrition, and parenteral nutrition

[b] For missing values of C-reactive protein on admission, the values before hemodialysis on the day after admission were used

Table 5 Association between requirement for assistance with ADL at discharge and each parameter

	OR	95% CI	p value
Age, years	1.06	1.02–1.10	0.003
Sex, male, *n*	0.19	0.05–0.73	0.016
Energy intake[a] on admission, kcal/kg/day	0.94	0.88–1.00	0.049
Serum albumin at discharge, g/dL	0.42	0.14–1.23	0.115
C-reactive protein at discharge[b], mg/dL	3.00	0.79–11.43	0.108

The objective variable was requirement for assistance with ADL at discharge, and the explanatory variables were age, sex, energy intake on admission, serum albumin at discharge, and C-reactive protein at discharge

ADL: activities of daily living, CI: confidence interval

[a] Energy intake includes diet, enteral nutrition, and parenteral nutrition

[b] For missing values of C-reactive protein at discharge, the values before hemodialysis on the day closest to the discharge date were used

disease, pulmonary and peripheral edema, digestive disorders, and anorexia were significantly more common in those who started unplanned dialysis compared with those for whom dialysis was planned [6]. In polymorbid medical inpatients with reduced food intake and poor nutritional status, at least 75% of the calculated energy and protein requirements should be achieved to reduce the risk of adverse outcomes [7]. In Japan, an intake of

30–35 kcal/kg/day is recommended for hemodialysis patients [8]; 75% of this recommended intake is equivalent to 23–26 kcal/kg/day. In this study, energy intake on admission of patients requiring assistance with ADL at discharge was less than 20 kcal/kg/day, and was less than 23 kcal/kg/day even for patients who ingested food orally. There was no difference in the duration of lack of oral intake, which suggests that energy intake may have been low because of the content and dosage of enteral nutrition and parenteral nutrition, and the oral intake rate.

Second, there was no difference in serum albumin on admission; however, serum albumin at discharge was significantly lower and C-reactive protein was significantly higher in the assistance group than in the independence group. Furthermore, the multivariate analysis showed that serum albumin and C-reactive protein on admission and at discharge were not associated with the requirement for assistance with ADL at discharge. In adults with stage 5D chronic kidney disease on maintenance hemodialysis, serum albumin may be used as a predictor of hospitalization and mortality, with lower levels associated with higher risk [9]. There is evidence that serum albumin and serum prealbumin are inflammatory markers associated with nutrition risk, rather than markers of nutrition status or protein-energy malnutrition [10]. In this study, serum albumin levels on admission indicated that both groups were at mild risk of nutritional disorders; however, only the assistance group had lower serum albumin at discharge than on admission, and had a moderate risk of nutritional disorders at discharge. In addition, C-reactive protein levels were lower in both groups at discharge; however, levels did not increase to normal in the assistance group. Therefore, patients who experienced unplanned hemodialysis initiation and who required assistance with ADL at discharge remained at risk of inflammation-related nutritional disorders. However, requirement for assistance with ADL at discharge was associated with inadequate energy intake on admission rather than with inflammation. Therefore, we believe that prevention of inflammation-related nutritional disorders and active nutritional management from admission (to ensure that patients meet their energy intake requirements) would improve ADL at discharge.

Third, the assistance group was significantly older and contained significantly fewer male patients than the independence group. Rehabilitative intervention and hospital transfers were significantly higher in the assistance group than in the independence group. In patients aged ≥ 65 years, there is a high prevalence of functional decline within the first 6 months after dialysis initiation, and the risk is higher in older, frail patients [11]. In this study, patients who started unplanned hemodialysis who required assistance with ADL at discharge had to be transferred to hospital. This was because hospitalization and hemodialysis initiation coincided, making it unlikely that these patients would regain ADL functionality even with rehabilitation.

There was no between-group difference in the cause of chronic kidney disease and comorbidities. In a previous Japanese study, both severely and moderately impaired functional status was strongly associated with early death after dialysis initiation. Furthermore, patients with substantially impaired (moderate/severe) functional status tended to be older; female; less likely to have chronic glomerulonephritis as the cause of end-stage kidney disease; and to have more comorbidities, a higher prevalence of temporary catheter vascular access, lower serum albumin levels, and higher C-reactive protein levels, all of which can be considered clinically significant factors [12]. However, we found no difference in comorbidities in the present study. We firmly believe that this reflects the difference in the target populations of the two studies: the present study included patients with severe and complex complications who required treatment in acute care hospitals, whereas the previous study included patients receiving dialysis (planned or unplanned) in dialysis facilities throughout Japan.

Finally, patients undergoing unplanned hemodialysis initiation are admitted to hospital with life-threatening emergencies, and their treatment is given the highest priority. The present findings suggest that the initiation of nutritional management after the patient's condition has settled down may be too late, which may affect the requirement for assistance with ADL at discharge.

Age and sex are fixed factors; however, nutritional management can be improved. Therefore, we strongly believe that it is important to provide individualized nutritional management and support that takes age and disease into account. However, such management should begin in the early stage of chronic kidney disease rather than at the time of dialysis initiation.

This study has several limitations. First, it was a single-center study with a small number of patients. Therefore, we were unable to adjust for confounding factors. Second, our hospital initiates hemodialysis, and we could not modify factors such as the characteristics of dialysis membranes, or investigate the development of nutritional disorders and changes in ADL after discharge from our hospital. Third, there is no established consensus definition of unplanned hemodialysis initiation. Therefore, we were unable to examine whether differing definitions of unplanned hemodialysis initiation had any effect on outcomes.

Conclusion

Nutritional management during hospitalization was associated with the requirement for assistance with ADL at discharge in patients undergoing unplanned hemodialysis initiation. Inflammatory markers such as serum albumin and C-reactive protein levels were not associated with requirement for assistance with ADL at discharge but were associated with age, sex, and inadequate energy intake on admission. The findings suggest that active nutritional management from the time of admission could reduce the requirement for assistance with ADL and increase independence.

Abbreviation
ADL: Activities of daily living.

Acknowledgements
We thank Andrea Baird, MD, and Diane Williams, Ph.D., from Edanz (https://jp.edanz.com/ac) for editing a draft of this manuscript.

Authors' contributions
TY collected and analyzed the data, drafted the manuscript, and read and approved the final manuscript. TA collected and analyzed the data, helped to draft the manuscript, and read and approved the final manuscript. YM collected the data and read and approved the final manuscript. YT read and approved the final manuscript. All authors read and approved the final manuscript.

Funding
Not applicable.

Availability of data and materials
The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Institutional Review Board of the Kitasato University Medical Ethics Organization (KMEO: B20-094), and the study adhered to the principles of the Helsinki Declaration. In addition, patients were given the opportunity to opt out of the study via the hospital website.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Received: 21 September 2021 Accepted: 17 March 2022
Published online: 05 April 2022

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