J Nephrol
DOI 10.1007/s40620-014-0144-2

ORIGINAL ARTICLE

Efficacy of a disease management program focused on acquisition of self-management skills in pre-dialysis patients with diabetic nephropathy: 24 months follow-up

Kana Kazawa · Yae Takeshita · Noriaki Yorioka · Michiko Moriyama

Received: 9 May 2014 / Accepted: 11 September 2014
© Italian Society of Nephrology 2014

Abstract
Purpose We previously performed a preliminary 6-month controlled trial to examine the effect of a disease management education program on prolongation of the time to renal replacement therapy (RRT) and/or avoidance of RRT for patients with diabetic nephropathy. However, its duration was too short to follow the changes of renal function, so we performed the present study for 24 months.
Methods This was a two-group comparative study. The intervention group received self-management education from disease management nurses and was supported by the nurses in cooperation with their primary physicians for 12 months. Then this group was followed for a further 12 months. The control group received standard care and was followed for 24 months.
Results Of the 31 subjects enrolled in each group, 26 subjects in the intervention group and 27 subjects in the control group were analyzed after excluding drop-outs. During the study period, 0 and 2 subjects in the intervention and the control group started RRT, respectively. In the intervention group, renal function was maintained, while significant worsening was observed in the control group. Hemoglobin A1c (HbA1c) improved in the intervention group, but became significantly worse in the control group. In the intervention group, all process indicators of behavior modification increased significantly after intervention.
Conclusion A well-designed disease management program might be useful for maintaining renal function and improving HbA1c in patients with diabetic nephropathy. It is considered that modification of patient behavior contributed to these results.

Keywords Diabetic nephropathy · Patient education · Self management · Disease management

K. Kazawa (✉) · M. Moriyama
Division of Nursing Science, Institute of Biomedical and Health Sciences, Hiroshima University, Kasumi 1-2-3 Minami-Ku, Hiroshima 734-8553, Japan
e-mail: kanak1016@gmail.com

Y. Takeshita
Division of Nursing Science, Graduate School of Biomedical and Health Sciences, Hiroshima University, Kasumi 1-2-3 Minami-Ku, Hiroshima 734-8553, Japan

N. Yorioka
Hiroshima Kidney Organization, Yanoshinmachi 2-2-19 Aki-Ku, Hiroshima 736-0084, Japan

Introduction

In recent years, there has been an increase worldwide in patients with diabetic nephropathy requiring renal replacement therapy (RRT) [1–4], which has led to the current situation of declining quality of life (QOL) and increasing healthcare costs [5, 6]. A similar situation exists in Japan [7, 8].

Background healthcare issues also exist in Japan, in addition to lifestyle changes. First, the importance of nephropathy management is often overlooked, and patients may only see a nephrologist for the first time when they need RRT [9]. Early referral to a nephrologist and appropriate treatment could prolong the period before initiation of RRT, as well as improving the prognosis and reducing hospitalization and healthcare costs [10]. Second, appropriate management for staging diabetic nephropathy according to evidence-based clinical guidelines is very important [11, 12], but patient education has not kept pace with the rise in diabetic nephropathy [9]. To solve these issues, cooperation of medical institutions and training of

Published online: 24 September 2014

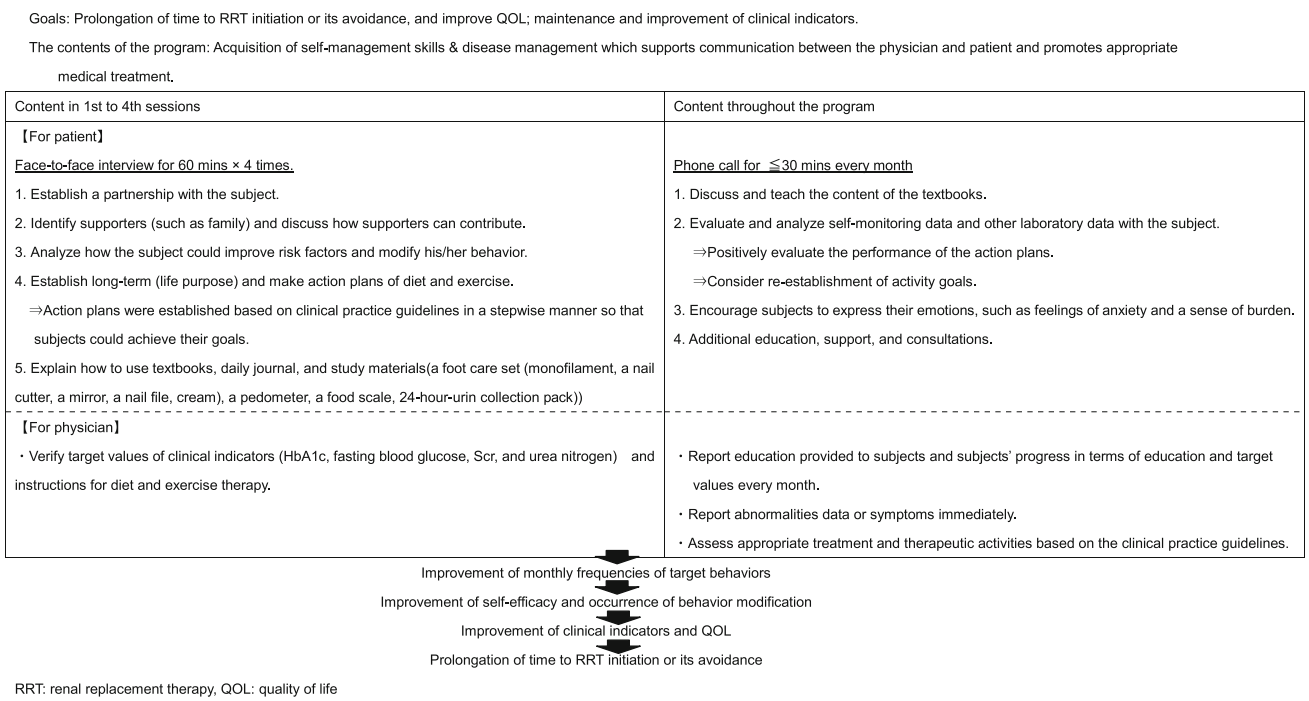


Fig. 1 Disease management program outline

nurses and dietitians to provide care are required [9]. Therefore, we focused on disease management. This is a system of coordinated health care interventions and communications for patients with conditions for which patient self-care can be significant. It supports communication between the physician and patient, which promotes appropriate medical treatment and patient education based on clinical guidelines [13]. We performed two preliminary studies for 6 months by (1) extracting patients with advanced diabetic nephropathy, (2) setting up a disease management center, and (3) providing nurses with specialized training as disease management nurses to support physicians and patients [14, 15]. After 6 months, patients who received our intervention showed a significant increase of adherence to medication/insulin therapy and self-monitoring behavior, which led to improvement of hemoglobin A1c (HbA1c). In addition, serum creatinine (Scr) levels and estimated glomerular filtration rate (eGFR) were maintained. Unfortunately, the duration of these studies was too short to follow the changes of renal function. Furthermore, in patients with diabetic nephropathy, several studies have shown that intensive treatment aimed at lifestyle improvement, in addition to diet, medication, and exercise, can improve clinical indicators [16, 17]. However, those studies did not include a structured program based on behavior modification theory, which we consider highly important for managing and educating the huge number of patients with diabetic nephropathy in a reproducible, high quality, and cost-effective manner. Accordingly, we performed this two-group comparative study for 24 months to investigate the effect of a disease management education program based on behavior modification theory for patients with diabetic nephropathy, following the hypotheses described in Fig. 1.

Methods

Subjects

The subjects were adult patients aged between 53 and 72 years with type 2 diabetic nephropathy attending any of the 20 hospitals or clinics in Kure city and Hiroshima city, Japan. Inclusion criteria were an eGFR between 15–59 ml/min/1.73 m^2 and age from 20 to 74 years. Exclusion criteria were current RRT, cognitively impaired or mental disorders, or pregnancy.

Study design and sample size

This study was performed from March 2010 to December 2012. It was a non-randomized, controlled trial comparing patients who underwent a disease management program conducted by nurses with other patients who received conventional treatment. Sample size was determined by Kure City medical insurance staff based on their budget.

Recruitment and registration

Intervention group: Kure City medical insurance staff identified all insured persons with diabetic nephropathy as their current diagnosis. After their primary physicians confirmed whether they met the study criteria, we asked them to participate.

Control group: After selecting the intervention group, the control group (non-intervention) was selected from hospitals in Kure and Hiroshima in such a way that it matched the intervention group for baseline.

Disease management program for the intervention group

The objective of this program was for the subjects to acquire self-management skills (Fig. 1). Prochaska et al. [18] stated that behavior modification is maintained if the modified behavior persists after 6 months of fulfilment of the program. To provide skills for managing seasonal events, we set the duration of the program at 12 months. Subject education was conducted via face-to-face interviews every 2 weeks from enrollment to the end of month 2 at the subject's home or at a collaborating research center and phone calls every month from month 3 to 12. Each subject was always assigned to the same nurse to allow building of a relationship between them and for continuity of care. Education focused on diet, drug therapy, and exercise/rest balance, etc. (see Table 1). Original materials used for education included booklets created by the researchers (authors) based on evidence-based clinical guidelines for chronic kidney disease (CKD) and for diabetes [19, 20], and on an ethnographical field study we performed in order to identify patients' viewpoints on self-management and the expert opinions of nephrologists and endocrinologists. The text included explanations and illustrations of disease mechanisms, methods for self-monitoring of symptoms, blood pressure, blood glucose, and body weight, and the method of foot care. There were also photographs to provide assistance in choosing foods and making decisions about menus for self-management. The program aimed at the acquisition of knowledge and skills that patients could use, and we supported them to increase their adherence and enhance the efficacy of self-management [21]. This program incorporated several behavior modification theories such as the transtheoretical model [18], motivation interviewing method, and social support theory. In cooperation with the primary care physician, target values of blood pressure, weight, and laboratory parameters were verified, as well as instructions for diet and exercise. Physicians received monthly progress reports from the nurses, while abnormal data or symptoms were reported immediately.

Table 1 Contents of education

Diet
Reduced salt intake (<6 g/day)
Low protein (0.8 g/kg/day)
Appropriate energy intake (27–30 kcal/kg/day)
Restriction of K and P based on laboratory data.
Drug therapy
Medication complied with the instructions of physicians and clinical guidelines
Method of insulin inject
Exercise
Exercise/rest balance based on their CKD stages
Aerobic exercise, Strech, Mascle training
Alcohole intake
Amount of pure alcohol a day less than 20 g, it is allowed by physician
Smoking cessation
Preventing infection and sick day rule
Stress management
Self-monitoring
Blood pressure, body weight, blood glucose, symptoms, foot sensory check

Control group (non-intervention)

Subjects received on a monthly basis usual care. After registration, they completed and sent questionnaires to us and we collected laboratory data from their medical records periodically during the 24-month study period.

Quality assurance

In this study, trained nurses had the main role in patient education, but were supported by a consultation system that had been previously established by them to form a therapeutic alliance with nephrologists, endocrinologists, and registered dietitians [22]. In order to ensure the quality of patient education, the intervention protocol was designed so that five disease management nurses who possessed knowledge and skills with regard to patient education could carry out the intervention. Before intervention, the research nurses received training on methods to control diabetic nephropathy, and knowledge and skills related to disease management and patient education such as disease mechanisms, treatment, diet, drug therapy, exercise, and stress management. The research nurses also received lectures on the methods of supporting behavior modification and performed role play exercises. Furthermore, they learned about teamwork with doctors and registered dietitians. During the program, the treatment and education of each patient was assessed regularly based on the clinical practice

guidelines, and the nurses received advice from nephrologists, endocrinologists, or registered dietitians when necessary, and discussed issues with them. The research nurses provided education for the patients and discussed treatment details with the attending doctors to support the optimization of treatment.

Data collection

During the 12-month intervention period, renal function indicators (Scr, eGFR) and process indicators for behavioral modification were collected every three months, while data on other variables were collected every 6 months, in both groups. To investigate the effect on primary outcomes, subjects were also followed for 24 months.

Primary and secondary endpoints

The primary endpoint was the number of patients who initiated RRT. Secondary endpoints comprised (1) physiological indicators: HbA1c (National Glycohemoglobin Standardization Program, NGSP), Scr, eGFR, blood urea nitrogen (BUN), hemoglobin (Hgb), total protein (TP), albumin (Alb), potassium (K), inorganic phosphate (P), non high-density lipoprotein cholesterol (non HDL-c), blood pressure, body mass index (BMI), and urine protein; (2) psychological indicators: the Self-Efficacy Scale of Health Behavior in Patients with Chronic Disease [23], and the World Health Organization Quality of Life (WHO-QOL26) scale, Japanese version [24]; (3) process indicators: the percentage of days per month that subjects performed the following self-management behaviors (dietary and exercise target behaviors, i.e. self-monitoring of blood pressure, body weight, and blood glucose levels; and medication complying with the instructions of their physician).

eGFR was calculated as follows: eGFR (ml/min/1.73 m^2) = 194 × Scr−1.094 × age−0.287 (× 0.739 for females) (Japanese Society of Nephrology, JSN) [19]. Non HDL-c (mg/dl) was calculated as total cholesterol–high-density lipoprotein cholesterol. Furthermore, we obtained and collected scores according to the following scale: <300 mg/g Cr (0 points), ≥300 and <1 g/g Cr (1 point), ≥1 and < 3 g/g Cr (2 points), and ≥3 g/g Cr (3 points).

Statistical analysis

To compare two groups, repeated-measures two-way factorial analysis of variance was performed on variables for which a normal distribution was confirmed. When normality was not confirmed, Friedman's test was performed. About process indicators, Friedman's test was also used. Significance was set at $p < 0.05$.

Table 2 Comparison of baselines

	Intervention group		Control group		*p* value	Statistical test
	n	Mean ± SD	*n*	Mean ± SD		
Age	31	66.9 ± 4.3	31	64.1 ± 5.8	0.035*	a
Sex	31	20 men/11 women	31	20 men/11 women	0.288	b
Disease duration of diabetes (year)	31	14.5 ± 8.9	28	15.5 ± 11.1	0.733	a
Scr (mg/dl)	31	1.55 ± 0.50	31	1.64 ± 0.68	0.574	a
eGFR (ml/min/1.73 m^2)	31	36.1 ± 12.8	31	36.8 ± 13.9	0.826	a
BUN (mg/dl)	31	30.3 ± 12.5	31	27.1 ± 12.9	0.321	a
Hgb (mg/dl)	31	12.3 ± 2.0	31	12.3 ± 1.9	0.934	a
HbA1c (%)	31	7.3 ± 1.4	31	7.8 ± 1.1	0.125	a
TP (g/dl)	31	7.1 ± 0.8	29	7.2 ± 0.5	0.661	a
Alb (g/dl)	31	4.1 ± 0.6	29	4.3 ± 0.4	0.218	a
K (mEq/l)	30	4.7 ± 0.6	29	4.5 ± 0.5	0.458	a
P (mg/dl)	29	3.5 ± 0.6	26	3.7 ± 0.6	0.481	a
non HDL-c (mg/dl)	27	123.6 ± 28.3	29	123.7 ± 36.7	0.989	a
Systolic blood pressure (mmHg)	31	131.9 ± 16.4	31	131.6 ± 17.4	0.934	a
Diastolic blood pressure (mmHg)	31	71.6 ± 11.2	31	70.8 ± 11.9	0.776	a
BMI	31	25.6 ± 4.5	30	25.0 ± 4.9	0.602	a
Urine protein	31	0.9 ± 1.1	31	1.2 ± 1.3	0.249	c
QOL[a]	30	3.34 ± 0.47	30	3.06 ± 0.42	0.017*	a
Self-efficacy[b]	30	76.3 ± 10.0	30	75.4 ± 10.5	0.725	a

SCr serum creatinine, *eGFR* estimated glomerular filtrationrate, *BUN* blood urea nitrogen, *Hgb* hemoglobin, *HbA1c* hemoglobin A1c, *TP* total protein

Alb albumin, *K* potassium, *P* inorganic phosphate, *non HDL-c* non high-density lipoprotein cholesterol, *BMI* body mass index

a *t* test, *b* x^2test, *c* Mann–Whitney *U* test

[a] QOL score 0–5 points, with a higher score indicating higher QOL

[b] Self-efficacy score 0–96 points, with a higher score indicating greater self-efficacy

* $p < 0.05$

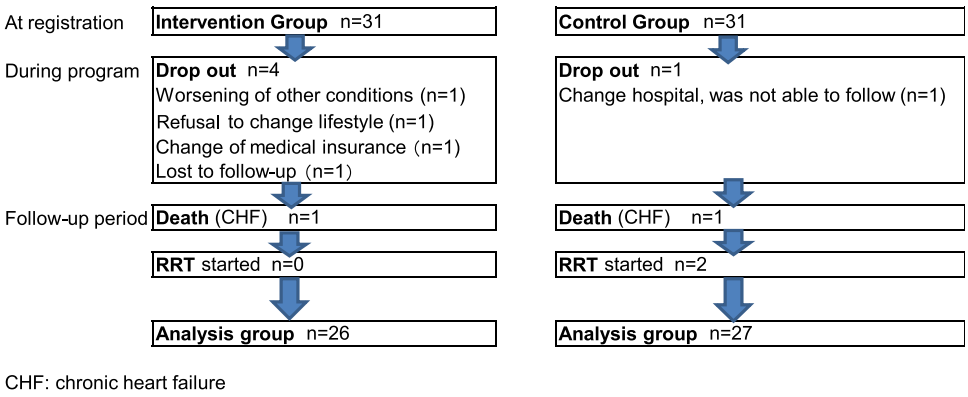


Fig. 2 Subjects of this study

Results

Outcomes and initiation of dialysis

We enrolled 31 patients in the intervention group and 31 patients in the control group. At baseline, only age ($p = 0.035$) and QOL ($p = 0.017$) showed a significant difference (Table 2). As for CKD stages, there were no significant differences in CKD stage G3 (intervention/control: 20 patients/19 patients), and CKD stage G4 (intervention/control: 11 patients/12 patients).

During the 24-month study period, one patient from each group died of heart failure in the 15th month (eGFR at enrollment: 21.5 and 16.1, respectively). No patient in the intervention group commenced dialysis, while two patients in the control group started dialysis after 18 and 21 months (eGFR at enrollment was 27.4 and 25.3, respectively). As risk factors associated with worsening of renal function, one patient had a urine protein level higher than 1 g/Cr and poorly controlled hypertension, while the other patient had a urine protein level higher than 1 g/Cr. A total of five patients in the intervention group and four patients in the control group dropped out (Fig. 2).

Medication usage: the numbers of patients taking medications at the time of enrollment did not differ between the two groups (renin angiotensin [RA] system inhibitors, erythropoiesis stimulating agents, insulin, oral hypoglycemic agents, lipid-lowering agents, hyperkalemia improving drugs, and oral adsorbents).

Changes of physiological indicators

Analysis of changes over 24 months was performed in 26 patients of the intervention group and 27 of the control group, excluding patients who died, initiated dialysis, or dropped out. There were no significant differences of baseline factors between the drop-outs and the analyzed patients. For each indicator, we analyzed changes in both groups, excluding patients with missing values (Table 3).

1. Changes of renal function and related data: Scr and eGFR remained at baseline levels in the intervention group. On the other hand, Scr showed a significant increasing and eGFR a significant decreasing trend in the control group (Fig. 3). Despite the low protein diet of the intervention group, mean BUN values showed no difference and there were no changes over time in either group. Hgb remained at the baseline value in both groups. With respect to urine protein, the intervention group showed a slight decrease, although the standard deviation was large in both groups and there were large individual variations. TP showed no significant in interaction, but showed significant inter-group variance. Mean values of TP were stable over time. Mean values of Alb, K, and P were stable over time, showing no significant differences.
2. Changes of blood pressure: Blood pressure was stable in both groups over time, with no significant differences.
3. Changes of glucose metabolism: In the control group, HbA1c showed significant worsening 6 months after enrollment ($p < 0.01$), but thereafter remained stable from 12 to 24 months. In the intervention group, a decrease of HbA1c was observed, although it was not significant.
4. Changes of non HDL-c and BMI: Non HDL-c showed no significant interaction, but a significant in inter-group difference. Mean values of non HDL-c were stable over time. BMI showed no significant changes.

Changes of psychological indicators

In the intervention group, both QOL and Self-efficacy increased after 6 months, but gradually decreased thereafter, reaching levels equal to those observed at the time of

Table 3 Changes in physiological indicators

	n	Changes over time					Two-way repeted measures of ANOVA (top: *F* value, bottom: *p value*)			Friedman's test
		BL	6 M	12 M	18 M	24 M	Interaction	Intra-qorup	Inter-group	*p* value
Scr (mg/dl)										
Intervention	24	1.59 ± 0.52	1.58 ± 0.53	1.61 ± 0.64	1.65 ± 0.63	1.76 ± 0.82				0.689
Control	27	1.57 ± 0.63	1.68 ± 1.04	1.76 ± 0.98	1.92 ± 1.30	2.23 ± 1.71				0.000***
eGFR (ml/min/1.73 m^2)										
Intervention	24	36.1 ± 13.6	37.2 ± 14.6	36.2 ± 13.8	36.2 ± 15.0	34.5 ± 14.8				0.754
Control	27	37.6 ± 13.4	39.6 ± 18.1	36.8 ± 16.5	34.2 ± 18.0	32.0 ± 17.9				0.000***
BUN (mg/dl)										
Intervention	24	30.1 ± 13.3	30.4 ± 11.2	30.2 ± 15.0	31.4 ± 13.5	33.5 ± 15.0				0.274
Control	26	26.2 ± 12.3	28.2 ± 15.1	26.6 ± 11.5	28.2 ± 14.1	31.3 ± 19.4				0.408
Hgb (mg/dl)										
Intervention	23	12.3 ± 2.1	12.5 ± 2.2	12.3 ± 2.3	12.6 ± 2.0	12.4 ± 1.9	0.309	0.073	0.754	
Control	27	12.3 ± 2.0	12.3 ± 1.7	12.2 ± 1.8	12.4 ± 1.6	12.2 ± 1.7	0.819	0.789	0.521	
HbA1c (%)										
Intervention	23	7.2 ± 1.4	6.8 ± 0.8	6.8 ± 1.1	7.0 ± 1.4	6.7 ± 0.6				0.051
Control	27	7.9 ± 1.1	8.3 ± 1.6	7.5 ± 1.2	7.7 ± 1.2	7.6 ± 1.1				0.001**
TP (g/dl)										
Intervention	22	7.1 ± 0.6	7.1 ± 0.7	7.0 ± 0.5	7.0 ± 0.5	7.0 ± 0.6	0.745	0.002	3.437	
Control	22	7.2 ± 0.5	7.1 ± 0.5	7.0 ± 0.5	6.9 ± 0.5	7.1 ± 0.5	0.542	0.969	0.015*	
Alb (g/dl)										
Intervention	21	4.2 ± 0.3	4.2 ± 0.4	4.1 ± 0.4	4.1 ± 0.4	4.1 ± 0.4	0.739	0.840	2.191	
Control	24	4.3 ± 0.4	4.2 ± 0.5	4.2 ± 0.5	4.1 ± 0.4	4.2 ± 0.4	0.567	0.364	0.072	
K (mEq/l)										
Intervention	21	4.6 ± 0.5	4.6 ± 0.5	4.6 ± 0.3	4.6 ± 0.5	4.6 ± 0.5	0.709	0.788	0.692	
Control	26	4.6 ± 0.6	4.4 ± 0.5	4.5 ± 0.5	4.6 ± 0.6	4.5 ± 0.5	0.587	0.379	0.599	
P (mg/dl)										
Intervention	10	3.6 ± 0.6	3.6 ± 0.5	3.8 ± 0.8	3.6 ± 0.5	3.8 ± 0.5	0.859	0.208	1.114	
Control	22	3.7 ± 0.6	3.4 ± 0.8	3.5 ± 0.6	3.5 ± 0.8	3.7 ± 0.8	0.491	0.652	0.353	
non HDL-c (mg/dl)										
Intervention	18	119 ± 29	124 ± 34	131 ± 37	117 ± 32	111 ± 35	1.933	0.329	4.238	
Control	27	123 ± 37	121 ± 27	114 ± 38	107 ± 32	110 ± 36	0.107	0.569	0.003**	
Systolic blood pressure (mmHg)										
Intervention	20	130.5 ± 17.6	128.5 ± 15.9	128.5 ± 14.8	130.4 ± 15.9	125.1 ± 12.0	0.547	0.189	0.513	
Control	27	131.7 ± 18.3	129.7 ± 17.1	132.0 ± 16.5	128.2 ± 20.6	130.0 ± 22.3	0.702	0.666	0.726	
Diastolic blood pressure (mmHg)										
Intervention	20	71.3 ± 11.7	70.0 ± 11.3	66.7 ± 9.1	69.2 ± 8.6	68.0 ± 8.5	0.406	0.019	1.473	

Table 3 continued

	n	Changes over time					Two-way repeted measures of ANOVA (top: *F* value, bottom: *p value*)			Friedman's test
		BL	6 M	12 M	18 M	24 M	Interaction	Intra-qorup	Inter-group	*p* value
Control	27	70.9 ± 12.7	70.4 ± 12.6	69.3 ± 10.3	67.9 ± 12.3	68.5 ± 13.2	0.804	0.890	0.212	
Urine protein										
Intervention	9	1.2 ± 1.3	1.0 ± 1.3	1.3 ± 1.2	1.2 ± 1.3	1.0 ± 1.2				0.320
Control	25	1.1 ± 1.2	1.1 ± 1.1	0.9 ± 1.0	1.0 ± 1.1	0.8 ± 1.0				0.252
BMI										
Intervention	20	25.1 ± 4.4	25.0 ± 4.5	25.0 ± 4.4	25.3 ± 4.5	24.9 ± 4.3	1.161	0.061	0.299	
Control	27	25.3 ± 5.0	25.7 ± 4.8	25.3 ± 5.0	25.2 ± 4.8	25.4 ± 4.9	0.326	0.805	0.813	

SCr serum creatinine, *eGFR* estimated glomerular filtrationrate, *BUN* blood urea nitrogen, *Hgb* hemoglobin, *HbA1c* hemoglobin A1c, *TP* total protein, *Alb* albumin, *K* potassium, *P* inorganic phosphate, *non HDL-c* non high-density lipoprotein cholesterol, *BMI* body mass index, *BL* baseline, *6 M* post 6 month, *12 M* post 12 month, *18 M* post 18 month, *24 M* post 24 month

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

24 months after enrollment. In the control group, QOL did not change and Self-efficacy was decreased at 24 months (Table 4).

Changes of process indicators

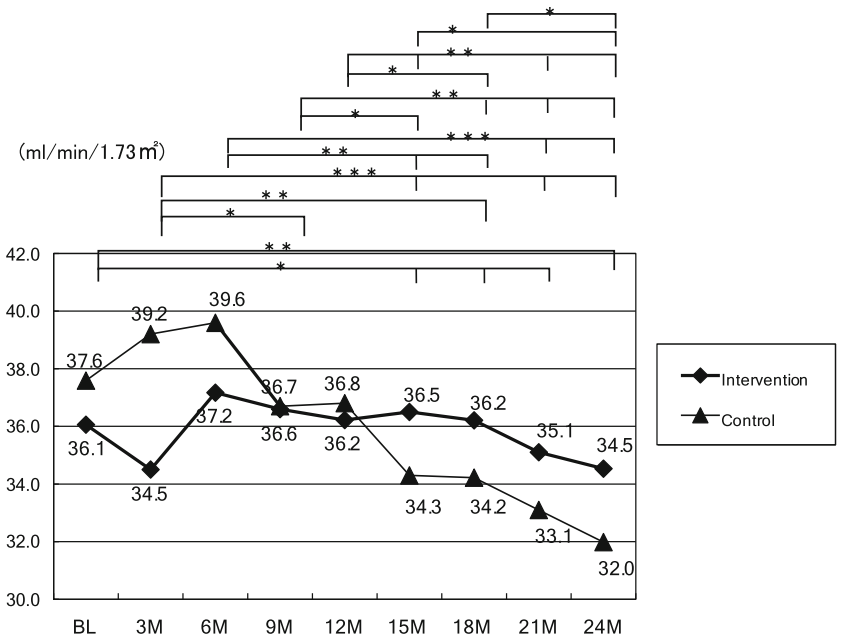
The achievement rate of behavioral goals was assessed in the intervention group (Fig. 4). Behavioral goals for diet, activity, and rest all improved significantly after intervention ($p < 0.05$). Self-monitoring and compliance with medication increased significantly after intervention ($p < 0.01$).

Discussion

Diabetic nephropathy requires complex management of nephropathy and diabetes and patients need to keep acquiring complex self-management skills. The effects of a multifactorial intervention on prevention of the progression of diabetic nephropathy were previously assessed by the Steno-2 study [16, 25]. However, the study targeted early stages and there was no structural program based on behavior modification theories. With respect to systematic reviews of the effects of educational programs on patients with diabetic nephropathy, one randomized controlled trial (RCT) for dialysis patients and one cohort study for patients at early stages of disease have been reported. The latter study performed psychological educational programs: effects were observed on patient knowledge and prolongation of the time to RRT [26]. Therefore, further research was required to perform the education program based on behavior modification theories and report on the acquisition of self-management behavior, physiological indicators, and even transition to dialysis in patients at advanced stages.

In this study, we performed an intervention on patients with advanced diabetic nephropathy. The results indicate that our structured disease management program based on behavior modification theory supports the acquisition of self-management knowledge and skills by patients. In the intervention group, patients changed their lifestyle to improve their renal function and tried hard to achieve their behavioral goals every month. They also communicated well with their primary physicians by bringing their self-monitoring data to appointments. To teach patients how to handle seasonal events which often lead to loss of self-control, a 12-months program worked well. The results partially support our hypothesis that education provided by nurses combined with setting of feasible monthly goals and feedback can significantly improve patient behavior and maintain self-efficacy. As for the reasons why self-efficacy was maintained in the intervention group, it can be

Fig. 3 Changes in eGFR



eGFR: estimated glomerular filtrationrate

BL; baseline, 3M; post 3month, 6M; post 6month, 9M; post 9month, 12M; post 12month

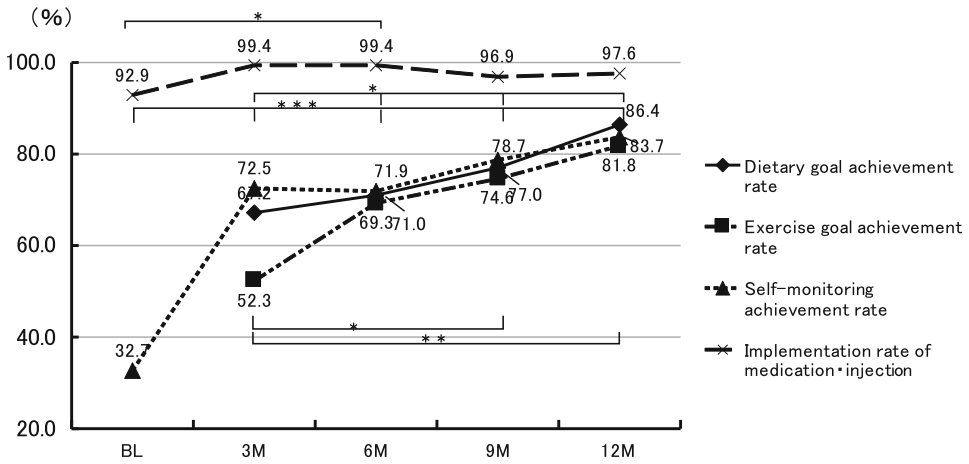
15M; post 15month, 18M; post 18month, 21M; post 21month, 24M; post 24month

eGFR showed significant decreasing in the control group

Wilcoxon signed rank test

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Fig. 4 Changes in process indicators



BL; baseline, 3M; post 3month, 6M; post 6month, 9M; post 9month, 12M; post 12month

Wilcoxon signed rank test

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

mentioned that the nurses provided psychological support for the subjects along with the behavior modification. In addition, the target behavior implementation rate was visualized in the process of behavior modification, and nurses evaluated the results positively. It is thought that adherence to self-management with maintenance of self-efficacy resulted in an improved lifestyle. In addition, maintenance of modified behavior improved HbA1c and maintained renal function, with no patient requiring RRT in the intervention group. Although prolongation of the time to introduction of RRT was achieved, there were no significant changes of self-efficacy, QOL, and some physiological data. With respect to self-efficacy, the intervention group showed improvement at 6 months after nurse-patient communication started, and the level was maintained thereafter. In the non-intervention group, however, the level of self-efficacy was lower after

Table 4 Changes in phychological indicators

	n	Changes over time					Two-way repeted measures of ANOVA (top: *F* value, bottom: *p* value)			Friedman's test
		BL	6M	12M	18M	24M	Interaction	Intra-gorup	Inter-group	*p* value
QOL[a]										
Intervention	19	3.35 ± 0.40	3.44 ± 0.33	3.27 ± 0.40	3.24 ± 0.43	3.29 ± 0.46				0.180
Control	24	3.08 ± 0.43	3.01 ± 0.42	3.04 ± 0.44	3.07 ± 0.48	3.05 ± 0.44				0.932
Self-efficacy[b]										
Intervention	19	78.2 ± 9.2	82.2 ± 8.4	77.4 ± 9.8	77.5 ±11.2	78.2 ± 10.4	4.167	4.097	0.729	
Control	24	75.5 ± 10.2	70.8 ±11.4	73.4 ± 10.0	73.2 ± 9.6	72.8 ± 10.3	0.289	0.003**	0.573	

BL baseline, *6 M* post 6 month, *12 M* post 12 month, *18 M* post 18 month, *24 M* post 24 month

[a] QOL score 0–5 points, with a higher score indicating higher QOL

[b] Self-efficacy score 0–96 points, with a higher score indicating greater self-efficacy

** $p < 0.01$

24 months than at enrollment. Diabetic nephropathy requires complex treatment, so effective self-management is only possible with education provided over a sufficient period of time. The results in the intervention group were likely obtained due to the effects of the intervention by disease management nurses, which helped improve self-management skills and enabled maintenance of self-efficacy.

On the other hand, two patients initiated RRT in the control group and significant worsening of renal function was observed. The rate of GFR decline in this stage of diabetic nephropathy was reported to be $-2 \sim 20$ ml/min/1.73 m^2/year [27]. Although the results were only for a 24-month period, maintenance of renal function and avoidance of RRT were achieved by cooperation with disease management nurses, even when the patient's physician was not a specialist. However, death due to heart failure was reported at 15 months in both groups, suggesting that management of heart failure should have been included in the program with measures such as strict weight control. It is also suggested that research nurses may need to acquire knowledge and skills about the management of cardiovascular disease. In other words, not only collaboration with nephrologists and endocrinologists, but also with cardiologists may be necessary because management of patients with severe complications is complex. This is an important consideration in the care of patients with end-stage renal failure.

Disease management aims to provide high quality health care that is appropriate for the patient's disease and risk factors, based on multidisciplinary collaboration. However, the family doctor, specialist physicians, nurse specialists, and registered dietitians do not belong to one institution. In such a situation, the most appropriate self-management strategy for the patients and how they can access each expert are unclear. We believe that the nurse is the most appropriate person to provide connections between multidisciplinary health care workers and patients in order to improve the quality of health care. Even though the attending physicians of the subjects were not nephrologists, appropriate management was implemented with the support of trained disease management nurses, resulting in prolongation of the time to RRT, reduction of hospitalization by avoiding emergency hemodialysis, and avoidance of RRT. Since these outcomes all led to a reduction of healthcare costs, this study suggests that this program run by nurses could be highly cost-effective.

However, there was a limitation to this study. In order to obtain a significant difference of the primary endpoint, we needed 80 patients per group (sample size). In the future, it will be necessary to confirm our findings by performing a randomized study on a larger scale.

Acknowledgments We would like to express our deepest gratitude to the Kure City medical insurance staff who provided the field for this study. We are also indebted to the disease management nurses for their support.

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical standards Approval was obtained from the ethics committees of Hiroshima University Hospital and the participating medical institutions. All subjects gave written consent to participation and the study was performed according to the Declaration of Helsinki.

References

1. Williams ME (2010) Diabetic CKD/ESRD 2010: a progress report? Semin Dial 23:129–133

2. Iseki K (2005) Predictors of diabetic end-stage renal disease in Japan. Nephrology 10:S2–S6
3. Grace BS, Crayton P, Mcdonald SP (2012) Increases in renal replacement therapy in Australia and New Zealand: understanding trends in diabetic nephropathy. Nephrology 17:76–84
4. Locatelli F, Pozzoni P, Vecchio L (2004) Renal replacement therapy in patients with diabetes and end-stage renal disease. J Am Soc Nephrol 15:S25–S29
5. Ginieri-Coccossis M, Theofilou P, Synodinou C, Tomaras V, Solldatos (2008) Quality of life, mental health and health beliefs in haemodialysis and peritoneal dialysis patients: Investigating differences in early and later years of current treatment. BMC Nephrol 9:14
6. Mapes DL, Lopes AA, Satayathum S et al (2003) Health-related quality of life as a predictor of mortality and hospitalization: The dialysis outcomes and practice patterns study(DOPPS). Kidney Int 64:339–349
7. Japanese Society of Nephrology (2013) Evidence-based practice guideline for the treatment of CKD. Tokyo Igakusha, Tokyo (in Japanese)
8. Nakatani T, Uchida J, Nitta Y et al (2008) Medical economics of treatment for chronic renal failure (transplantation/dialysis). Tranplantation Now 23:143–148 (in Japanese)
9. Ministry of Health, Labour and Welfare Renal disease control committee (2008): The future of renal disease control. http://www.mhlw.go.jp/bunya/kenkou/jinshikkan/01.html Accessed 4 April 2014
10. Wauters JP, Bosson JL, Forneris G et al (2004) Patient referral is influenced by dialysis center structure in the Diamant Alpin Dialysis cohort study. Nephrol Dial Transplant 19:2341–2346
11. Buren PNV, Toto R (2013) Current update in the management of diabetic nephropathy. Curr Diabetes Rev 9:62–77
12. Alicic RZ, Tuttle KR (2010) Management of the diabetic patient with advanced chronic kidney disease. Semin Dial 23:140–147
13. Howe RS (2005) Disease management context and model. The disease manager's handbook, 1st edn. Jones and Bartlett Learning, Massachusetts, pp 1–5
14. Kazawa K, Moriyama M (2013) Effects of a self-management skills acquisition program on pre-dialysis patients with diabetic nephropathy. Nephrol Nurs J 40:141–149
15. Kazawa K, Moriyama M (2013) Effects of the educational program for pre-dialysis patients with diabetic nephropathy (intervention evaluation for 6 months). J Jpn Acad Nephrol Nurs 14(2):92–100 (in Japanese)
16. Joss N, Ferguson C, Brown C et al (2004) Intensified treatment of patients with type 2 diabetes mellitus and overt nephropathy. QJM: Int J Med 97:219–227
17. Gaede P, Lund-Andersen H, Parving HH et al (2008) Effect of a multifactorial intervention on mortality in type 2 diabetes. N Engl J Med 358:580–591
18. Prochaska JO, Velicer WF (1997) The transtheoretical model of health behavior change. Am J Health Promot 12:38–48
19. Japanese Society of Nephrology (2009) Evidence-based practice guideline for the treatment of CKD. Tokyo Igakusha, Tokyo(in Japanese)
20. Japan Diabetes Society (2009) Evidence-based practice guideline for the treatment of diabetes. Tokyo Nankodo, Tokyo (in Japanese)
21. Bandura A (1977) Self-efficacy: Toward a unifying theory of behavioral change. Psychol Rev 84:191–215
22. Gustafson D, Wise M, Bhattacharya A et al (2012) The effects of combining web-based eHealth with telephone nurse case management for pediatric asthma control: a randomized controlled trial. J Med Internet Res 14(4):e101
23. Kim WS, Shimada H, Sakano Y (1996) The relationship between self-efficacy on health behavior and stress responses in chronic disease patients. Jpn J Psychosoma Med 36:499–505 (in Japanese)
24. Tazaki M, Nakane Y (2007) Introduction to WHOQOL26. Kaneko Shobo, Tokyo (in Japanese)
25. Gaede P, Vedel P, Larsen GV et al (2003) Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. N Engl J Med 348:383–393
26. Scottish Intercollegiate Guidelines Networks (SIGN) (2008) SIGN 103: Diagnosis and management of chronic kidney disease. http://www.sign.ac.uk/pdf/sign103.pdf Accessed 4 April 2014
27. American Diabetes Association (2003) Diabetic nephropathy. Diabetes Care 26:94–98