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Research Article

Automated Remote Monitoring for Peritoneal Dialysis and Its Impact on Blood Pressure

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Keywords
Compliance · Remote access technology · Peritoneal dialysis · Health-related quality of life · Pittsburg Sleep Quality Index

Abstract
Introduction: Peritoneal dialysis (PD) provides a safe, home-based continuous renal replacement therapy for patients. The adherence of the patients to the prescribed dialysis fluids cannot always be monitored by physicians. Remote monitoring automated peritoneal dialysis (RM-APD) can affect patients' compliance with treatment and, thus, clinical outcomes. ***Objective:*** We aimed to evaluate the clinical outcomes of patients with a remote access program. ***Methods:*** This was an observational study. We analyzed the effect of RM-APD on treatment adherence, dialysis adequacy, and change in blood pressure control, sleep quality, and health-related quality of life during the 6 months of follow-up. ***Results:*** A total of 15 patients were enrolled in this study. It was found that there was a significant decrease (99 ± 19 vs. 89 ± 11 mm Hg) in mean arterial blood pressure of patients, and a considerable increase in Kt/V was observed in the sixth month after the RM-APD switch (2.11 ± 0.4 vs. 2.25 ± 0.5). A significant increase was found when comparing the 3-month and 6-month ultrafiltration amounts before RM-APD and the ultrafiltration amount within 6 months after RM-APD (800 mL [500–1,000] and 752 mL [490–986] vs. 824 mL [537–1,183]). The daily antihypertensive pill need (4 [0–7] vs. 2 [0–6]) and alarms received from the device decreased (from 4 [3–8] to 2 [0–3]) at the sixth month of the switch. There was no significant change in sleep quality and health-related quality of life within 6 months. ***Conclusion:*** This study showed that treatment adherence and ultrafiltration amounts of patients increased with the use of RM-APD, as well as better blood pressure control with fewer antihypertensive drugs. © 2020 S. Karger AG, Basel

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Introduction

Chronic kidney disease is a worldwide public health problem with an increasing incidence, and the natural process of the disease results in end-stage renal disease (ESRD). Kidney transplantation, hemodialysis, and peritoneal dialysis (PD) are options for renal replacement therapy for the treatment of ESRD [1]. PD provides a safe, home-based continuous renal replacement therapy for patients with comparable and even better clinical treatment outcomes in the first few years than center-based hemodialysis [2, 3]. PD provides greater patient independence with an improved quality of life. However, patients, family members, physicians, and nurses should be in harmony for excellent clinical results in the PD modality [4]. The first automated, intermittent PD cycling devices (APD) for the treatment of ESRD were introduced in the 1960s, and there have been remarkable technological improvements that have increased the applicability and effectiveness of treatment [2, 5, 6]. This has provided better health outcomes, improved adherence, and treatment variety [7]. However, the adherence of the patients to the prescribed PD fluids and treatment cannot always be monitored by physicians, because this treatment modality is home-based and, generally, physicians could evaluate these patients monthly.

Remote monitoring technology that is integrated into APD systems such as cloud-based software (Homechoice Claria with platform Sharesource; Baxter Healthcare Corporation, Deerfield, IL, USA) (RM-APD) has been used for 4 years. This platform makes it possible to receive patient treatment data, including peritoneal volume of patients, alerts during treatment, drainage problems, interruption of therapy, and blood pressure not within range, and to transmit to the PD center [8, 9]. RM-APD has provided many opportunities, such as facilitating patient follow-up, instant monitoring of treatment adherence, early detection of problems that interfere with treatment efficacy, and resolving most of the problems remotely without admittance to the hospital [8]. Few studies in the literature have shown that RM-APD allows physicians to improve APD prescription, early detection of problems, improvement of treatment adherence, and reduction in hospitalization [8, 10, 11].

The aim of this study was to determine the change in patient adherence to APD prescription, to find out the difference in sleep quality and to investigate the effect of RM-APD on quality of life. Also, the change in blood pressure control, the need for antihypertensive treatment for blood pressure control, changes in pill burden, and adequacy will be investigated.

Material and Methods

Study Population

This study is an observational study that was conducted to evaluate the clinical outcomes of RM-APD exposure. All patients included in the present study were treated with traditional APD using the Claria Cycler Equipment (Baxter, Deerfield, IL, USA) at the time of study approach. All participants were switched to RM-APD (Homechoice Claria with platform Sharesource; Baxter Healthcare Corporation, Deerfield, IL, USA) from January 2019, and patients were followed for a 6-month period. The inclusion criteria of the present study were as follows: treatment by maintenance APD for at least 6 months with the same device, age >18 years, and patients who agreed to participate in the study. Exclusion criteria were the presence of active infection, inflammation and malignancy, history of peritonitis within 6 months, and patients with cognitive or other mental health deficits that would preclude them from completing the survey questionnaire. Patients who withdrew their consent or had peritonitis during the 6-month observation period after the RM-APD switch were also excluded from the assessment.

Remote Monitoring Program and Measurement Tools

The same PD nurse checked the record of all the participants included in the study on the ShareSource connectivity platform daily (45 min for 15 patients) and kept records. The information recorded via the system was determined as: (1) important alarms, (2) ultrafiltration profile, (3) initial drainage, (4) blood

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pressure, and (5) body weight. Alarms with a yellow flag were accepted as follows: treatment time lost 20–30 min, bypass drain once, bypass dwell/fill twice, and the number of other events 5–10 times. Alarms with a red flag signified as follows: treatment time lost ≥30 min, bypass drain ≥ twice, bypass dwell/fill ≥3 times, and the number of other events ≥10. Important alarms, which signaled the occurrence of any form of adherence problem through the treatment, were considered as patients missing a treatment, lost connectivity, having 3 yellow flags or 1 red flag [12]. When any important alarms were received, the physician was informed by the nurse, and the physician intervened to solve the problem (i.e., contacting the patients, modification of drugs or dialysis therapy, and call for a clinical visit).

The medical outcome survey short form 36 (SF-36) is a widely used measure of health status and health-related quality of life. Scores for each subscale range from 0 to 100, and higher scores are related to a better quality of life [13]. Subscale measurements consisted of 6 parts: (1) physical functioning, (2) role limitations due to physical health, (3) mental health, (4) role limitation due to mental health, (5) vitality, (6) bodily pain, (7) general health, and (8) social function. The Turkish version was validated in a Turkish population [14]. A self-reported questionnaire was used to assess patients' sleep dysfunction. The Pittsburg Sleep Quality Index (PSQI) assesses the sleep quality of patients, and it consists of 19 questions. Questions were categorized into 7 parts, and component scores are then added to give a global PSQI score. The global PSQI score has a range of 0–21, and higher scores indicate more reduced sleep quality. The PSQI score was adapted and validated in the Turkish population [15].

Clinical Outcomes

The hospital electronic medical records system was used for baseline information such as sex, age, medical prescription, laboratory parameters including blood urea nitrogen, serum glucose, creatinine, calcium, phosphorus, sodium, potassium, ferritin, and cholesterol at baseline and 6 months of follow-up and comorbidities. The dialysis solutions of the patients were also recorded. Patients using icodextrin were determined, and the average daily amount was calculated. We calculated glucose weight as the sum of the products of the volume and glucose concentration for each exchange [16]. The adequacy of dialysis was determined by measuring the total weekly creatinine clearance, which is normalized to 1.73 m^2 of the body surface area and total weekly urea clearance (Kt/V) using the Watson formula for body water. Peritoneal solute transport was evaluated according to a peritoneal equilibrium test as follows: the dialysate-to-plasma ratio of creatinine and ratio of glucose at 0 and 4 h of the dwell [17]. Also, urinary creatinine clearance was calculated for all the patients at the beginning and the sixth month of the study. Participants completed the Turkish translated and validated SF-36 and PSQI questionnaires at the beginning of RM-APD and the 6 months of follow-up. The blood pressures of the participants before switching to the RM-APD were recorded at monthly clinical visits and averaged with home measurement. After the device switch, patients were asked to record their daily blood pressure by the device, and results were averaged with the blood pressure at clinical visits. In the clinical visits, the patient was allowed to rest at least 30 min before blood pressure measurement, and the measurement was performed at the arm-heart level with an appropriate cuff. The same measurement precautions were requested to be taken at home. Mean arterial blood pressure (MAB) was calculated as follows: (systolic blood pressure + 2× diastolic blood pressure)/3. The mean MAB value was calculated for all patients every month. We determined target blood pressure as <140/90 mm Hg for all patients. If the patient had signs of hypotension when he or she was in the euvolemic state (orthostatic hypotension, blood pressure <110/70 mm Hg or symptoms including nausea, blurred vision, and syncope which were explained by low blood pressure), the antihypertensive drug dose was reduced. During this period, the blood pressure of the patient was monitored, and drug dose adjustment was performed. Important alarms (which are mentioned above) that were received from the device were recorded daily. The total number of alarms per month was recorded, and alarms related to adherence were calculated per participant monthly.

Statistical Analysis

Continuous variables are reported as means and standard deviation or as median and interquartile range according to data distribution. Categorical variables are reported by percentages. The Shapiro-Wilk W test was used in testing for normality. For comparisons between baseline and end of 6-month evaluation, the Wilcoxon matched-pairs test was used. p values ≤0.05 were considered to indicate statistical significance. Analyses were performed with SPSS 21.0.0.1 (SPSS, IBM, Armonk, NY, USA) software for Windows.

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Table 1. Baseline characteristics of patient population

Total patients, *n*	15
Gender female, *n*	9 (60%)
Age, years	47 (19–81)
School level, *n*	
Illiteracy or reading	1 (7%)
Elementary	3 (20%)
High school	6 (40%)
University	5 (33%)
CKD cause, *n*	
Hypertension	5 (33%)
Diabetes	4 (27%)
Autoimmune	2 (13%)
Other	4 (27%)
Smoking, *n*	3 (20%)
Alcohol, *n*	2 (13%)
PD choice reason, *n*	
Physician proposal	8 (53%)
Patient selection	6 (40%)
Compulsory	1 (7%)
RRF, %	10 (67%)
Total follow-up, months	60 (25–72)

CKD, chronic kidney disease; PD, peritoneal dialysis; RRF, residual renal function.

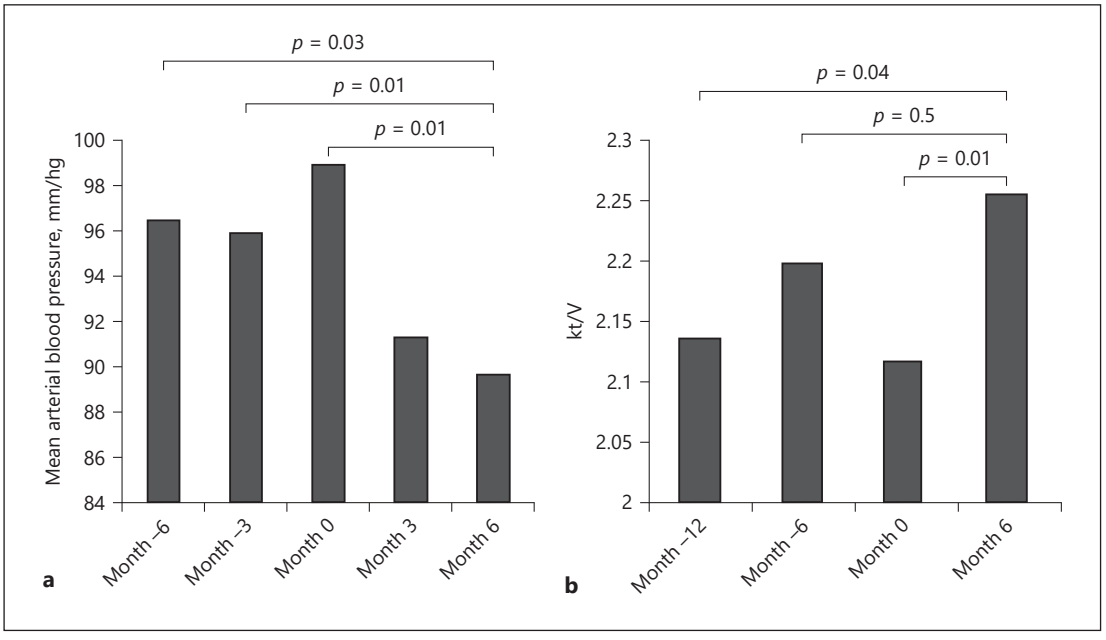


Fig. 1. a Comparison of mean arterial blood pressure of patients during 12 months of follow-up. Month 0 indicates the beginning of remote monitoring automated peritoneal dialysis (RM-APD). **b** Comparison of mean Kt/V of the peritoneal equilibrium test during the 18 months of follow-up. Month 0 indicates the beginning of RM-APD.

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Table 2. Treatment and medical evaluation before and after RM-APD

	Before RM-APD	After RM-APD	*p* value
MAB, mm Hg	99±19	89±11	*0.01*
PET			
Kt/V	2.11±0.4	2.25±0.5	*0.03*
CrCl, mL/min	57 (42.8–120.3)	63.1 (46.4–141)	0.1
Urinary volume, mL	600 (0–2,600)	700 (0–2,400)	0.5
Urinary CrCl, mL/min	1.17 (0–15.8)	1.39 (0–14.3)	0.7
Permeability, *n*			
Slow	1 (7%)	0	
Average	11 (73%)	11 (73%)	
Fast	3 (20%)	4 (27%)	
UF, mL			
–3 to 0 month vs. 0 to 6 months	800 (500–1,000)	824 (537–1,183)	*0.03*
–6 to 0 month vs. 0 to 6 months	752 (490–986)	824 (537–1,183)	*0.009*
Drugs			
EPO, *n*	8 (53%)	7 (47%)	0.3
Antihypertensive drug, *n*	10 (67%)	9 (60%)	0.8
Antihypertensive group	2 (0–4)	2 (0–4)	0.3
Antihypertensive drug count, daily	4 (0–7)	2 (0–6)	*0.05*
Phosphate binder, *n*	8 (53%)	8 (53%)	
Calcium-based phosphate binder, *n*	4 (27%)	2 (13%)	0.3
Sevalemer, *n*	5 (33%)	6 (40%)	0.3
Diuretic, *n*	10 (67%)	10 (67%)	
Total drug count, daily	11 (6–22)	8 (5–22)	0.08
Dialysis fluid			
Glucose weight, g/day[1]	123.87	124.9	0.1
Icodextrin			
n	10 (66%)	10 (66%)	
mL	1,610	1,610	

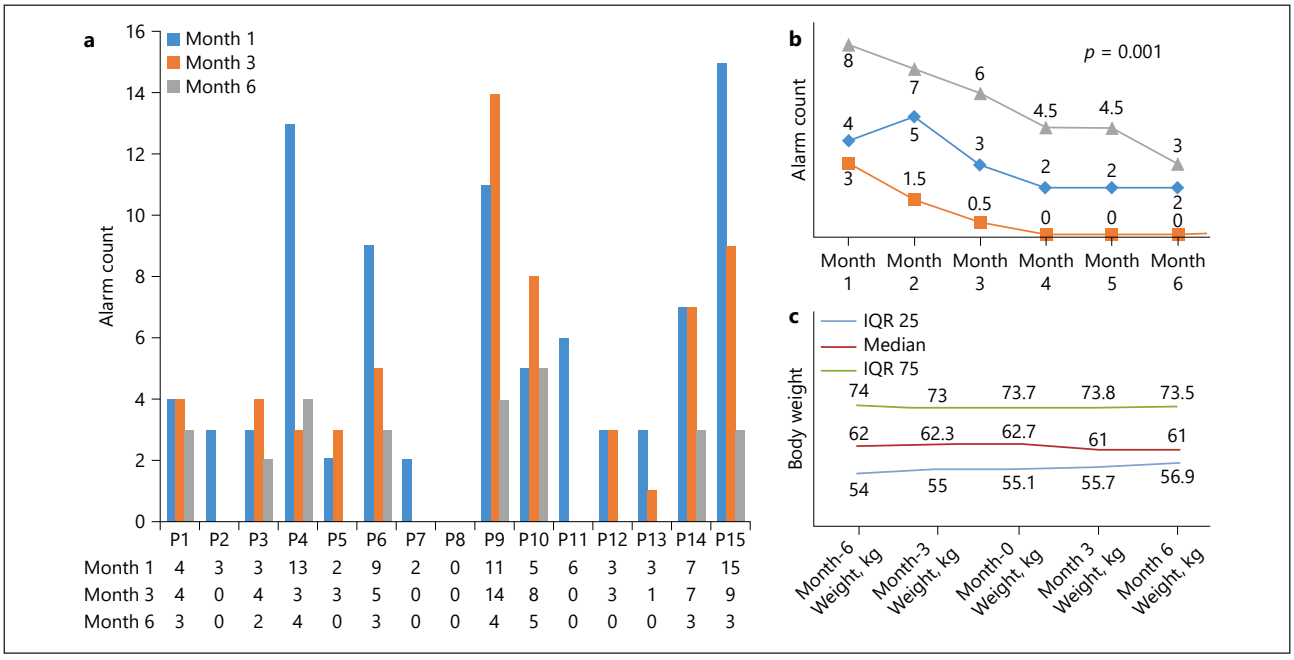
MAB, mean arterial pressure; PET, peritoneal equilibrium test; CrCl, creatinine clearance; UF, ultrafiltration; EPO, erythropoietin-stimulating agent; RM-APD, remote monitoring automated peritoneal dialysis. [1] Average daily glucose load in the 6-month period before RM-APD versus average daily glucose load in the 6-month period during RM-APD. Statistically significant *p* values are italicized.

Results

A total of 15 patients were enrolled in this study (60% female and median age 47 years). The literacy rate of the study population was high (40% of total patients were high school, and 33% of total patients were university), and 53% of the patients underwent PD with the recommendation of a physician. The median follow-up time was 60 months, whereas 67% of patients still had a residual renal function. Baseline characteristics of the study population are demonstrated in Table 1.

When the MAB of the study population before switching to RM-APD was compared with the MAB 6 months after switching to RM-APD, it was found that there was a statistically significant decrease (99 ± 19 vs. 89 ± 11 mm Hg, $p = 0.01$). As shown in Figure 1, MAB in the sixth month of the RM-APD switch was significantly lower when compared to baseline, 3, and 6 months before the device switch ($p = 0.01$, $p = 0.01$, and $p = 0.03$, respectively). Also, a statistically significant increase in Kt/V was observed performed in the sixth month of the RM-APD

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Fig. 2. a Change of important signals received during the peritoneal dialysis session. **b** Median and interquartile range (IQR) 25–75 values of the important alarms received from the device and treatment lost after remote monitoring automated peritoneal dialysis. The median number of the signal was statistically significant between month 6 and month 1 ($p = 0.001$). **c** Median and interquartile range (IQR) 25–75 values of the weight of the patients during the 1-year follow-up.

switch (2.11 ± 0.4 vs. 2.25 ± 0.5, $p = 0.03$). However, the mean Kt/V value of the patients was also significantly higher than the mean Kt/V 12 months before the switch to RM-APD ($p = 0.04$) (Fig. 1). A statistically significant increase was found when comparing the median 3-month and 6-month ultrafiltration amounts before RM-APD and the median ultrafiltration amount within 6 months after RM-APD (800 mL [500–1,000] vs. 824 mL [537–1,183] and 752 mL [490–986] vs. 824 mL [537–1,183], $p = 0.03$ and $p = 0.009$). When the pill use of patients was evaluated, the daily antihypertensive pill need at the sixth month of device switch was significantly reduced compared to baseline (4 [0–7] vs. 2 [0–6], $p = 0.05$) (Table 2). Figure 2 was depicted to demonstrate how patients' treatment adherence has changed after switching to RM-APD. According to Figure 2, alarms received from the device decreased within months, and treatment adherence of patients increased (from 4 [3–8] to 2 [0–3], $p = 0.001$). Also, patient median body weight decreased from 62.7 to 61 kg within 6 months.

When the laboratory parameters of patients were compared, it was determined that there was no significant change between baseline and sixth month of RM-APD switch (Table 3). Also, there was no significant change in PSQI and SF-36 questionnaires, which were used to evaluate sleep and quality of life in the sixth month of RM-APD switch when compared to baseline (Table 4).

Discussion

RM-APD is a relatively new technology for clinical use, and therefore, there is limited knowledge in the literature on its effect on patients. There is a need for data about the effect of this technology on patient adherence, treatment efficacy, and other clinical outcomes,

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Table 3. Laboratory evaluation before and after RM-APD

	Before RM-APD	After RM-APD	*p* value
Hemoglobin, g/dL	10.8±1.9	11±1.5	0.6
Glucose, mg/dL	92±12	86±8	0.2
BUN, mg/dL	46±11	42±9	0.08
Creatinine, mg/dL	7.8±2.8	7.9±2.4	0.4
Alkaline phosphatase, U/L	110 (55–380)	106 (16–296)	0.8
Calcium, mg/dL	9.1±0.7	9.1±0.6	0.7
Phosphorus, mg/dL	4.75±1.2	4.9±1	0.4
Total protein, g/dL	6.55±0.6	6.35±1.5	0.3
Albumin, g/dL	3.66±0.3	3.65±0.3	0.9
Cholesterol, mg/dL	196±67	207±59	0.6
LDL, mg/dL	121±45	117±50	0.4
Sodium, mEq/L	137±3	137±1.98	0.2
Potassium, mEq/L	3.9±0.5	4±0.7	0.3
PTH, pg/mL	338 (108–1,180)	309 (84–1,100)	0.4
Ferritin, ng/mL	244 (25–805)	206 (100–960)	0.4

BUN, blood urea nitrogen; LDL, low-density lipoprotein; PTH, parathyroid hormone; RM-APD, remote monitoring automated peritoneal dialysis.

Table 4. Quality of life assessment before and after Sharesource system

	Before RM-APD	After RM-APD	*p* value
PSQI	6 (4–12)	5 (3–11)	0.3
SF-36 domains			
Physical function	45 (30–70)	55 (45–65)	0.5
Role limitation (physical health)	20 (0–75)	25 (0–75)	0.9
Role limitation (mental health)	33 (33–100)	45 (35–60)	0.6
Vitality	45 (35–60)	45 (35–60)	0.8
Mental health	72 (60–80)	64 (56–80)	0.1
Social function	62 (50–75)	50 (38–88)	0.7
Bodily pain	78 (68–100)	78 (58–100)	0.7
General health	50 (35–55)	45 (35–50)	0.9

PSQI, Pittsburg Sleep Quality Index; SF-36, medical outcomes survey short form 36; RM-APD, remote monitoring automated peritoneal dialysis.

including blood pressure control and pill burden. The result of this study showed that patients' treatment adherence and blood pressure control increased within months, and daily antihypertensive pill requirements decreased. Our results also demonstrated that sleep patterns and quality of life of patients were not affected adversely.

Although the majority of ESRD patients undergo in-center hemodialysis, PD is the dominant home-based dialysis therapy worldwide, and it is estimated that between 9.7 and 16.3% of the total dialysis population use it in developed countries including the USA, Europe, and Canada [2]. Since this treatment modality is applied at home, the patient must comply with the prescription given. It has been shown that nonadherence to dialysis prescription is associated with increased mortality, hospitalization, higher peritonitis rates and decreased technical survival [18, 19]. The overall nonadherence rates to PD prescription were 2.6–85% in the literature [18, 20–22]. In the

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APD application, being connected to the device only at night increases adherence when compared to continuous ambulatory peritoneal dialysis, which requires multiple manual exchanges by the patients and/or caregivers [22]. However, in a review published in 2014, nonadherence to the APD prescription was reported to be 5–20% [22].

In 2015, Baxter launched a new APD device, the Homechoice Claria, which transfers therapy and biometric data of the patient to the clinician via the Internet [23]. This allows the physician to monitor the patient in real time. When a problem is detected, the physician and/or PD nurse could interfere actively by either arranging the remote treatment (change the prescription using remote connection) or contacting the patient. It has been shown that dialysis prescription adherence became more than 90% with the use of RM-APD [5]. A study that is focused on outcomes of using RM-APD and published in 2019 showed that the use of RM-APD is associated with reduced hospital visits, nonsignificant but increased technical survival and reduced health costs during 1 year of follow-up [8]. However, they did not find any significant change in dialysis adequacy, and also there are no data about blood pressure changes and pill burden during the 1-year follow-up. We found that this system significantly improved the adherence of the patients in the 6-month observation period. Although we do not have pre-RM-APD data of patients, it iss shown in Figure 2 that the number of important alarms and treatment loss signals received from the device decreased significantly from the first month to 6 months with the RM-APD treatment. The most crucial reason to conclude that RM-APD improves the treatment adherence is that after each important alarm and/or in case of loss of treatment, the PD nurse and/or the physician contact the patients and ensure that the dialysis treatment is performed without interruption. Also, before RM-APD treatment, patients could be generally evaluated monthly at clinical visits, and treatment adherence could only be questioned once a month. After initiation of the RM-APD treatment, interruptions were addressed within 24 h, and the importance of PD adherence was frequently recalled to the patients via phone calls. This might result in active participation and awareness of patients under PD treatment.

Dialysis adequacy is another critical parameter in dialysis, which is associated with better outcomes and survival [24, 25]. In two clinical outcome studies related to RM-APD in the literature, there was no change in Kt/V of the patients during the follow-up [8, 11]. However, both studies made changes in peritoneal dialysis prescriptions over time. Therefore, it was difficult to evaluate the effects of RM-APD on Kt/V. In our study, there was no significant change in the PD prescriptions, and this provided a more accurate assessment of the effect of RM-APD on dialysis adequacy. Thus, RM-APD may improve Kt/V through the increase in treatment adherence of patients.

Patients with chronic kidney disease receive several pills to control blood pressure, calcium-phosphorus metabolism, and acid-base disturbances. There is a greater pill burden in this patient population. A recent study showed that patients are treated with a mean of 6–12 medications in the early stages of chronic kidney disease, and as the stage progresses, the median number of pills increases to 19 [26]. Nonadherence to medication is an important problem as nonadherence to dialysis prescription has an estimated range between 3.9 and 85% [22]. It has been shown that a higher pill burden is associated with a lower health-related quality of life [27]. In our study, the decrease in pill burden after RM-APD tended to be statistically significant. However, contrary to the literature, there was no change in the health-related quality of life. Besides, the most significant complaint of the patients during the trial period of the device was that the new device is louder and more disturbing than the old version, but we showed that the quality of sleep was similar to the baseline at the end of 6 months.

Also, the significant result obtained in our study was a more effective blood pressure control with fewer antihypertensive pills. Blood pressure control is essential in patients with peritoneal dialysis. Because elevated or uncontrolled blood pressure is associated with worse outcomes,

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and also increased mortality [28]. It is known that elevated blood pressure is a risk factor for the development of left ventricular hypertrophy, and this process is the most important contributory factor for the increased cardiovascular disease in patients with ESRD [29]. Elevated blood pressure is also associated with an increased risk of stroke [29, 30]. The studies on RM-APD have been designed in general concerning patient adherence, technical survival, and impact on health costs. To our knowledge, this is the first study in the literature which shows that RM-APD decreases mean blood pressure and reduces the patients' need for antihypertensive pills. Management of hypertension in patients with PD should be at the basis of dietary sodium restriction, preservation of residual renal function, an adaptation of the PD regimen to peritoneal transport characteristics, use of the icodextrin solution, and individualized pharmacological interventions [28, 31]. One of the essential steps in blood pressure control is to achieve dry weight target. It is determined in the literature that subclinical hypervolemia was found in 47–67% of PD patients, and approximately 24% of PD patients had hypervolemia [28, 32] clinically. Skipping or not completing PD sessions may contribute to subclinical or even clinical hypervolemia in this patient population and impair blood pressure control. Our study demonstrated that the decrease in weight of patients compared to baseline and the increase in ultrafiltration also support the increase in the amount of fluid removed from the body with treatment adherence. It is also important to note that these findings could facilitate blood pressure control. RM-APD may be thought to increase blood pressure control by decreasing the frequency of skipped or uncompleted PD sessions via increasing patient adherence.

The study has several limitations. Firstly, the number of patients was low due to the single-center design of the study. This reduces the statistical power of the study. Secondly, 6 months of follow-up time are not adequate to reflect long-term effects such as technical survival, peritonitis, mortality, and cardiovascular outcomes of RM-APD. Because of the positive effects of RM-APD on blood pressure control, which has been demonstrated in this study, a prospective randomized controlled study should be designed in which long-term follow-up and cardiovascular outcomes are examined.

Conclusion

Long-term treatment adherence is an important problem in patients undergoing PD. Treatment nonadherence causes a decrease in dialysis efficiency and ultrafiltration and an increase in blood pressure. This condition increases the pill burden of the patients. With RM-APD, remote control of patients is ensured, and patients are actively kept in treatment. As a result, ultrafiltration and dialysis efficiency of patients increase with improved treatment adherence, and blood pressure regulation can be achieved with fewer drugs.

Acknowledgment

I would like to express my sincere thanks to our peritoneal dialysis nurses Leyla Tekeli and Nurdan Cetin for their dedication and help at every stage of this study.

Statement of Ethics

The design and procedures of the study were approved by the Ethics Committee of the University (protocol ID: 08, date: January 14, 2019) in agreement with the principles of the World Medical Association Declaration of Helsinki and ethical standards for human experimentation. Written informed consent was obtained from all participants.

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Disclosure Statement

The authors have no conflict of interest to declare.

Author Contributions

Conception and design of the research: H.H.Y and O.F.A. Acquisition of data: H.H.Y. and O.F.A. Analysis and interpretation of the data: H.H.Y. and O.F.A. Statistical analysis: H.H.Y. Supervising the work: U.D. and C.R. Drafting the manuscript: U.D. and C.R. Critical revisions: U.D. and C.R.

References

1 Levey AS, Coresh J, Bolton K, Culleton B, Harvey KS, Ikizler TA, et al.; National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis. 2002 Feb;39(2 Suppl 1):S1–266.
2 Li PK, Chow KM, Van de Luijtgaarden MW, Johnson DW, Jager KJ, Mehrotra R, et al. Changes in the worldwide epidemiology of peritoneal dialysis. Nat Rev Nephrol. 2017 Feb;13(2):90–103.
3 Kumar VA, Sidell MA, Jones JP, Vonesh EF. Survival of propensity matched incident peritoneal and hemodialysis patients in a United States health care system. Kidney Int. 2014 Nov;86(5):1016–22.
4 Guilloteau S, Lobbedez T, Guillouët S, Verger C, Ficheux M, Lanot A, et al. Impact of Assisted Peritoneal Dialysis Modality on Outcomes: A Cohort Study of the French Language Peritoneal Dialysis Registry. Am J Nephrol. 2018;48(6):425–33.
5 Sanabria M, Rosner M, Vesga J, Devia M, Molano A, Corzo L, et al. A remote management program in automated peritoneal dialysis patients in Colombia. Nefro Latinoam. 2018;15(2):48–51.
6 Giuliani A, Crepaldi C, Manani SM, Samoni S, Cannone M, De Cal M, et al. Evolution of Automated Peritoneal Dialysis Machines. In: Ronco C, Crepaldi C, Rosner MH, editors. Remote Patient Management in PD. Basel: Karger Publishers; 2019. pp. 9–16.
7 Ronco C, Diaz-Buxó JA. Automated peritoneal dialysis. Revisitation of the past or beginning of a new PD era? Nephron. 2001 Jan;87(1):1–7.
8 Milan Manani S, Rosner MH, Virzì GM, Giuliani A, Berti S, Crepaldi C, et al. Longitudinal experience with remote monitoring for automated peritoneal dialysis patients. Nephron. 2019;142(1):1–9.
9 Blaauw M. Use of Sharesource in remote patient management in peritoneal dialysis: a UK nurse's perspective. In: Ronco C, Crepaldi C, Rosner MH, editors. Remote patient management in PD. Basel: Karger; 2019. p. 73–83.
10 Sanabria M, Buitrago G, Lindholm B, Vesga J, Nilsson LG, Yang D, et al. Remote Patient Monitoring Program in Automated Peritoneal Dialysis: impact on Hospitalizations. Perit Dial Int. 2019 Sep-Oct;39(5):472–8.
11 Milan Manani S, Crepaldi C, Giuliani A, Virzì GM, Garzotto F, Riello C, et al. Remote monitoring of automated peritoneal dialysis improves personalization of dialytic prescription and patient's independence. Blood Purif. 2018;46(2):111–7.
12 Gebhardt AT, Mishra A. Two-Way Patient Monitoring in PD: Technical Description of Sharesource. In: Ronco C, Crepaldi C, Rosner MH, editors. Remote Patient Management in PD. Basel: Karger Publishers; 2019. pp. 17–27.
13 Reynaga-Ornelas L, Baldwin CM, Arcoleo K, Quan SF. Impact of Sleep and Dialysis Mode on Quality of Life in a Mexican Population. Southwest J Pulm Crit Care. 2019;18(5):122–34.
14 Demiral Y, Ergor G, Unal B, Semin S, Akvardar Y, Kivircik B, et al. Normative data and discriminative properties of short form 36 (SF-36) in Turkish urban population. BMC Public Health. 2006 Oct;6(1):247.
15 Agargun M, Kara H, Anlar O. The validity and reliability of the Pittsburgh Sleep Quality Index. Turk Psikiyatr Derg. 1996;7(2):107–15.
16 Davies SJ, Phillips L, Naish PF, Russell GI. Peritoneal glucose exposure and changes in membrane solute transport with time on peritoneal dialysis. J Am Soc Nephrol. 2001 May;12(5):1046–51.
17 Nolph KO, Khanna R, Prowant BF, Ryan LP, Moore HL, Nielsen MP. Peritoneal equilibration test. Perit Dial Int. 1987;7(3):138–48.
18 Bernardini J, Piraino B. Compliance in CAPD and CCPD patients as measured by supply inventories during home visits. Am J Kidney Dis. 1998 Jan;31(1):101–7.
19 Bernardini J, Nagy M, Piraino B. Pattern of noncompliance with dialysis exchanges in peritoneal dialysis patients. Am J Kidney Dis. 2000 Jun;35(6):1104–10.
20 Bernardini J, Piraino B. Measuring compliance with prescribed exchanges in CAPD and CCPD patients. Perit Dial Int. 1997 Jul-Aug;17(4):338–42.
21 Hollis J, Harman W, Goovearts T, Paris V, Chivers G, Hooper JM, et al. Managing peritoneal dialysis (PD)—factors that influence patients' modification of their recommended dialysis regimen. A European study of 376 patients. J Ren Care. 2006 Oct-Dec;32(4):202–7.
22 Griva K, Lai AY, Lim HA, Yu Z, Foo MW, Newman SP. Non-adherence in patients on peritoneal dialysis: a systematic review. PLoS One. 2014 Feb;9(2):e89001.

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23 Wood E, McCarthy K, Roper M. Remote monitoring of peritoneal dialysis: evaluating the impact of the Claria Sharesource system. J Kidney Care. 2019;4(1):16–24.
24 Szeto CC, Wong TY, Chow KM, Leung CB, Law MC, Li PK. Independent effects of renal and peritoneal clearances on the mortality of peritoneal dialysis patients. Perit Dial Int. 2004 Jan-Feb;24(1):58–64.
25 Lo WK, Bargman JM, Burkart J, Krediet RT, Pollock C, Kawanishi H, et al.; ISPD Adequacy of Peritoneal Dialysis Working Group. Guideline on targets for solute and fluid removal in adult patients on chronic peritoneal dialysis. Perit Dial Int. 2006 Sep-Oct;26(5):520–2.
26 Burnier M, Pruijm M, Wuerzner G, Santschi V. Drug adherence in chronic kidney diseases and dialysis. Nephrol Dial Transplant. 2015 Jan;30(1):39–44.
27 Chiu YW, Teitelbaum I, Misra M, de Leon EM, Adzize T, Mehrotra R. Pill burden, adherence, hyperphosphatemia, and quality of life in maintenance dialysis patients. Clin J Am Soc Nephrol. 2009 Jun;4(6):1089–96.
28 Vaios V, Georgianos PI, Liakopoulos V, Agarwal R. Assessment and Management of Hypertension among Patients on Peritoneal Dialysis. Clin J Am Soc Nephrol. 2019 Feb;14(2):297–305.
29 Ataş N, Erten Y, Okyay GU, Inal S, Topal S, Öneç K, et al. Left ventricular hypertrophy and blood pressure control in automated and continuous ambulatory peritoneal dialysis patients. Ther Apher Dial. 2014 Jun;18(3):297–304.
30 Goldfarb-Rumyantzev AS, Baird BC, Leypoldt JK, Cheung AK. The association between BP and mortality in patients on chronic peritoneal dialysis. Nephrol Dial Transplant. 2005 Aug;20(8):1693–701.
31 Menon MK, Naimark DM, Bargman JM, Vas SI, Oreopoulos DG. Long-term blood pressure control in a cohort of peritoneal dialysis patients and its association with residual renal function. Nephrol Dial Transplant. 2001 Nov;16(11):2207–13.
32 Ortega LM, Materson BJ. Hypertension in peritoneal dialysis patients: epidemiology, pathogenesis, and treatment. J Am Soc Hypertens. 2011 May-Jun;5(3):128–36.

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