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Original Article

Comparing the Impacts of Computer-Assisted Multimedia Education and Traditional Method on Clinical Parameters of Patients Receiving Hemodialysis

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Abstract

Background and Aim: Patients who receive hemodialysis need effective education in order to maintain their health. One of the effective methods for education is computer-assisted education. The aim of this study was to compare the impacts of computer-assisted multimedia education and traditional method on clinical parameters of patients receiving hemodialysis.

Methods: In this interventional study, all patients referring to four hemodialysis centers located in Tabriz, Iran, were recruited and allocated to the experimental and the control groups. Patients' clinical parameters were measured and documented in a checklist both before and three months after the study intervention. The inter-rate correlation coefficient of the checklist was 0.99. While receiving hemodialysis, patients in the experimental group used the 'Hemodialysis Essential Care (HEC)' multimedia application on a laptop. Patients in the control group were educated by using the traditional face-to-face lecture method. After entering the data into the SPSS software (v. 13.0), they were analyzed by conducting the independent- and the paired samples *t* test, chi-square, McNemar, and Fisher exact tests.

Results: After the study intervention, patients' systolic and diastolic blood pressures, itching, and serum urea decreased significantly in both the experimental (32 patients) and the control (30 patients) groups ($P<0.05$). However, interdialytic weight gain significantly decreased only in the experimental group ($P<0.05$). The differences between the study groups regarding other parameters were statistically significant neither before nor after the study intervention ($P>0.05$).

Conclusion: Computer-assisted education by using the 'HEC' multimedia application was as effective as the traditional face-to-face lecture method in improving patients' clinical parameters. Accordingly, this educational application can be used for facilitating patient education and improving care quality.

Keywords: Hemodialysis, Patient education, Computer-assisted patient education, and Health application.

Introduction

One of the most prevalent health problems around the world is chronic renal failure (1-3). The most important treatment modality for end-stage renal disease (ESRD) is hemodialysis which removes excess fluids and waste products from blood. Nonetheless, hemodialysis, per se, is not effective in managing ESRD-associated problems and hence, patients with ESRD need to follow complex dietary and treatment regimens (1-5). Apparently, patients need educations for being able to adhere to regimens, managing their problems, minimizing complications, protecting their health, and improving their quality of life. The findings of several studies showed the positive effects of education (6-8).

Nurses have a pivotal role in patient education (9) through using methods such as face-to-face lecture or discussion

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and print materials for providing their educations. In ideal conditions, face-to-face lecture or discussion method once accompanied by printed materials can facilitate rapid transfer of information to patients. This is an effective educational method once staffs, time, and money are adequate. However, this method has several pitfalls such as rapid forgetfulness, instructor-learner language mismatch, and time and money shortage (10). Moreover, compared with other patients, educating patients receiving hemodialysis is more difficult due to problems such as rapid physical and psychological changes, complex treatment regimens, huge amount of necessary information, large number of patients, and time and place limitations (1,11). Therefore, these patients' educational needs are not fulfilled completely and they are not competent enough in doing self-care activities. Previous studies have also shown these patients' non-adherence to treatment regimens as a big health problem for healthcare teams (3,12).

Fortunately, advances in information and communication technologies—such as computer-assisted patient education—have led to mitigation of difficulties in patient education, creation of friendly and flexible learning environments, and improvement of the quality of educational services for patients (13,14). Given the multimedia nature of computer-assisted education, it has several benefits such as active involvement of learners in learning, flexibility and repeatability of educations, and the possibility of giving instant feedbacks (15). However, this educational method has weaknesses such as decreased nurse-patient interactions during education (13) and the likelihood of undermining patients' human dignity (16).

Previous studies have shown the effectiveness of computer-assisted education in enhancing knowledge, adherence to treatment regimens, and self-care ability of patients with heart problems (13,17,18) and diabetes mellitus (18,19), pregnant women (20), and adolescents (21). Wang and Chiou (22) allocated patients who referred to six hemodialysis centers to two groups and found that education through an interactive multimedia CD significantly improved patients' knowledge, treatment adherence, and sense of having control over life. The results of another study also revealed that patients with ESRD who had received multimedia interactive education had greater knowledge and less uncertainty about opting for hemodialysis (23). However, we could not retrieve any study on the effectiveness of Persian multimedia computer application on the outcomes of patients receiving hemodialysis. Accordingly, we initially employed the Mayer's principles for designing multimedia learning programs to develop and validate an educational multimedia computer application in Persian for patients who receive hemodialysis (24). The application was entitled, 'Hemodialysis Essential Care (HEC)'.

An important criterion for evaluating patient education programs is their effects on patient outcomes (25). The results of a study showed that patient education by using the HEC multimedia application enhanced knowledge and treatment adherence of patients receiving hemodialysis (26). Clinical parameters such as blood pressure, interdialytic weight gain, and blood urea are good indicators for monitoring the effectiveness of hemodialysis and patient care (12). The findings of previous studies have shown that patient education can positively affect these parameters (3,27,28). The aim of this study was to compare the impacts of computer-assisted multimedia education by using the HEC application and traditional method on the clinical parameters of patients receiving hemodialysis.

Methods

This interventional study was conducted on 62 patients receiving hemodialysis. The study population was all eligible patients who referred to any of the four hemodialysis centers located in Tabriz, Iran, in 2013 for receiving hemodialysis. Sampling from each center was performed independently and by using the simple random sampling method. Each pair of patients was randomly allocated to either the control or the experimental groups by using drawing method.

The inclusion criteria were giving informed consent for participation, not being inflicted by any other conditions such as cancer, cardiac failure, or physical disability, having received hemodialysis at least for 6 months 2-3 times a week and 4 hours per hemodialysis session (11,29), obtaining a score of greater than 23 in the mini–mental state examination (MMSE) (23), being physically able to use computer and educational pamphlet (for instance, having no visual defect and having the ability to use hands), having basic knowledge of computer, and being able to read, write, and speak Persian. Patients were excluded if they underwent kidney transplantation, immigrated to a remote area, participated in other educational programs, and failed to provide further information due to the aggravation of physical problems, developing other problems, facing psychological crisis, or dying.

The study data were collected by using a researcher-made demographic questionnaire and a checklist for documenting patients' clinical parameters. We invited fifteen nursing instructors and nephrologists to assess the qualitative face and content validity of the checklist. The checklist was revised according to their comments. For reliability assessment, the first author and a trained observer completed the checklist for 20 patients who were external to the study. The inter-rater correlation coefficient was 0.99.

Patients in both study groups received routine medical and nursing care services during the study. Before providing educations, patients' demographic characteristics, blood pressure, interdialytic weight gain, edema, and itching were documented in the checklist. Moreover, a blood sample was obtained from each patient for measuring the serum levels of urea, creatinine, uric acid, potassium, phosphorus, calcium, and albumin. Prior to performing

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blood analyses, all laboratory devices were calibrated according to their manufacturers' guidelines and by using centronic serum control. The serum levels of potassium, total calcium, creatinine, uric acid, albumin, phosphorus, and urea were measured respectively by ion-selective electrode, spectrophotometer, Jaffe's, uricase, bromocresol green, phosphomolybdate UV, and Urease UV techniques. The results of these tests were also documented in the checklist and were considered as baseline readings.

Patients in the experimental group received educations on a personal basis through using the HEC application on a computer. The application is user-controlled and consists of seven educational modules in two parts. The main part includes the aims of educations, video and audio clips, pictures, animations, texts, and self-examination tests. While navigating this part, users received step-by-step educations about the function of kidneys, renal failure, hemodialysis principles and management, nutrition, medication therapy, physical activity, and caring for vascular access devices. Moreover, they could refer to other parts of the application and read texts and view pictures in order to fulfill their educational needs. Large pictures and fonts and few command keys have been used in the application to facilitate navigation. The application can be used in offline mode without any need for internet connection. The appendix of the application includes the text of all educations, food pyramid, and tables of nutritional facts.

Given the content of each module, every patient was educated by the first author in seven 14–45-minute sessions. The educational sessions were arranged according to patients' hemodialysis sessions. Patients who were unable to receive educations due to their unstable physical condition were educated in compensatory sessions. Accordingly, each patient received all educations provided in the application for at least one time. Before and during receiving educations, we provided the patients with information about using the application. Moreover, the patients were provided with a CD containing the application for personal use at their homes. The phone number of the first author was given to the patients and they were allowed to call him for asking their questions about installing and using the application.

We educated the patients in the control group by using the traditional lecture method. Educations were provided face-to-face and individually and were complemented by a pamphlet. The educational materials for the patients in the control group were the same as the materials provided to the patients in the experimental group. However, in the control group, the educations were provided without using electronic devices.

In order to prevent information exchange between the study groups, the educational sessions for each group were held in an independent place and time. Moreover, the patients and the nurses of the study setting were blind to the groups and the time of posttest evaluation. Patients' clinical parameters were re-measured and documented three months after educations in the same way as baseline measurement. After conducting the posttest, the patients in the experimental and the control groups were respectively provided with a pamphlet and a CD containing the HEC application.

Study data were analyzed by employing the SPSS software (v. 13.0). The measures of descriptive statistics were used for describing the participants' characteristics. Given the level of measurement, the study groups were compared with each other in terms of the study variables by using independent-samples *t* test, chi-square, and Fisher exact tests. Moreover, within-groups comparisons were performed through conducting the paired-samples *t* test and the McNemar test. *P* values of less than 0.05 were considered as significant.

Results

In total, 67 eligible patients were recruited to the experimental (34 patients) and the control (33 patients) groups. Two patients from the experimental and three patients from the control groups were excluded due to undergoing kidney transplantation, experiencing death, or voluntarily withdrawing from the study. Therefore, the data retrieved from 62 patients were included in final analysis.

The means of patients' age in the experimental and the control groups were 44.58 ± 12.45 and 46.33 ± 21.12 years while the means of dialysis duration in these two groups were 51.06 ± 39.89 and 31.26 ± 25.96 months, respectively. The results of the independent-samples *t* test illustrated that the groups did not differ significantly from each other regarding patients' age ($P = 0.58$). However, the difference between the groups concerning the duration of dialysis was statistically significant ($P = 0.024$). Table 1 shows study participants' demographic characteristics. The chi-square test revealed no significant difference between the two groups regarding patients' gender, marital and educational status, and the center in which they received hemodialysis (Table 1).

Tables 2 and 3 show the means of participants' clinical parameters before and after the study intervention. As it is evident from Table 2, neither before nor after the study intervention the study groups differed significantly from each other regarding patients' clinical parameters such as systolic and diastolic blood pressures, interdialytic weight gain, and the serum levels of urea, creatinine, potassium, calcium, uric acid, phosphorus, and albumin. Within-groups comparisons also revealed that only the levels of systolic and diastolic blood pressures and serum level of urea decreased significantly in both groups after the study. Moreover, interdialytic weight gain decreased significantly following the study intervention only in the experimental group. The two-way analysis of variance (ANOVA) was used for managing the confounding effect of dialysis duration. The results of this test revealed that the study groups did not differ significantly after the intervention regarding patients' clinical parameters ($P > 0.05$).

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Table 1. Patients' Demographic Characteristics

Variable		Experimental Group		Control Group		*P* Value (the Chi-Square Test)
		No.	%	No.	%	
Gender	Female	5	15.625	6	20	0.74
	Male	27	84.375	24	80	
Marital status	Single	3	9.375	3	10	1
	Married	29	90.625	27	90	
Educational status	Junior high school or lower	10	31.25	10	33.34	1
	Senior high school or higher	22	68.75	20	66.66	
Hemodialysis center	Sina	8	25	8	26.66	0.78
	Madani	6	18.75	7	33.34	
	Amir Al-Momenin	8	25	9	30	
	Military hospital (Artesh 522)	10	31.25	6	20	

Table 2. The Mean of Clinical Parameters in Both Study Groups Before and After the Study Intervention

Parameters	Mean ± SD			*P* Value (The Independent-Samples *T* Test)
	Time	Experimental Group	Control Group	
Systolic blood pressure (mm Hg)	Before	133.06 ± 19.17	135.83 ± 15.37	0.53
	After	123.75 ± 20.24	127.33 ± 21	0.49
	P value (the paired-samples *t* test)	0.018[a]	0.031[a]	-
	Mean difference	9.03	8.5	0.91
Diastolic blood pressure (mm Hg)	Before	80.32 ± 9.82	80.5 ± 8.54	0.94
	After	75.31 ± 11.06	74.83 ± 12	0.85
	P value (the paired-samples *t* test)	0.008[a]	0.02[a]	-
	Mean difference	4.51	5.66	0.68
Interdialytic weight gain (kg)	Before	2.92 ± 1.25	2.76 ± 1.12	0.59
	After	2.50 ± 0.88	2.64± 1.02	0.57
	P value (the paired-samples *t* test)	0.017[a]	0.5	-
	Mean difference	0.4	0.12	0.24
Urea (mg/dL)	Before	131.58 ± 54.24	124.30 ± 36.35	0.54
	After	104.68 ± 17.78	109.82 ± 18.16	0.26
	P value (the paired-samples *t* test)	0.01[a]	0.019[a]	-
	Mean difference	27.19	14.48	0.27
Creatinine (mg/dL)	Before	10.67 ± 2.72	10.03 ± 3.04	0.39
	After	10.03 ± 2.24	10.25 ± 2.15	0.69
	P value (the paired-samples *t* test)	0.13	0.63	-
	Mean difference	0.63	-0.22	0.17
Potassium (mEq/L)	Before	5.25 ± 0.62	5.42 ± 0.70	0.32
	After	5.22 ± 0.61	5.32 ± 0.53	0.52
	P value (the paired-samples *t* test)	0.78	0.42	-
	Mean difference	0.02	0.1	0.66
Calcium (mg/dL)	Before	8.12 ± 1.96	8.34 ± 1.17	0.48
	After	8.28 ± 1.06	8.29 ± 0.99	0.97
	P value (the paired-samples *t* test)	0.4	0.83	-
	Mean difference	-0.16	0.04	0.47
Uric acid (mg/dL)	Before	6.74 ± 1.68	6.72 ± 1.59	0.95
	After	6.56 ± 1.89	6.40 ± 1.28	0.7
	P value (the paired-samples *t* test)	0.59	0.24	-
	Mean difference	0.18	0.31	0.75
Phosphorus (mg/dL)	Before	5.92 ± 1.62	5.93 ± 1.22	0.98
	After	5.83 ± 1.67	5.63 ± 1.21	0.59
	P value (the paired-samples *t* test)	0.71	0.27	-
	Mean difference	0.08	0.29	0.55
Albumin (g/dL)	Before	4.31 ± 0.27	4.31 ± 0.17	0.99
	After	4.34 ± 0.39	4.36 ± 0.31	0.81
	P value (the paired-samples *t* test)	0.76	0.34	-
	Mean difference	-0.02	-0.04	0.83

[a] A *P* value of less than 0.05 is significant.

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Table 3. The Frequency of Itching and Edema in Both Study Groups Before and After the Study Intervention

Parameters	Time	Frequency				*P* Value (Fisher Exact Test)
		Experimental Group		Control Group		
		No.	%	No.	%	
Itching	Before	14	45.16	18	60	0.18
	After	3	9.67	6	20	0.20
	P value (McNemar test)	0.003[a]		0.002[a]		-
Edema	Before	7	21.87	4	13.33	0.29
	After	3	9.37	2	6.66	0.53
	P value (McNemar test)	0.21		0.5		-

[a] A *P* value of less than 0.05 is significant.

Finally, the results of the Fisher exact test showed that the differences between the study groups regarding edema and itching were significant neither before nor after the intervention. However, the McNemar test indicated that only itching decreased significantly in both groups after the intervention while the decreases in edema in the groups were not statistically significant (Table 3).

Discussion

In the current study, both computer-assisted multimedia education and education by using the traditional (lecture and pamphlet) method significantly decreased systolic and diastolic blood pressures, itching, and the serum level of urea (Tables 2 and 3). In other words, the decreases in these values were similar in both study groups. Decreases in these parameters are affected by patients' adherence to treatment and dietary regimens (such as limited intake of sodium and fluids) and the adequacy of hemodialysis as well as medical and nursing care (12). In line with our findings, the results of the previous studies also showed that computer-assisted methods for patient education are as effective as or even more effective than traditional methods in enhancing patients' knowledge (22,23) and adherence to treatment regimens (18,22). Wilson et al (30) also reported the effectiveness of multimedia materials compared with print materials. Baraz et al (2) also found that providing self-care educations to patients receiving hemodialysis significantly decreased their systolic and diastolic blood pressures, itching, and the serum level of urea.

The findings of the present study showed that before the study intervention, the difference between the groups in terms of interdialytic weight gain was not statistically significant while after the study, the mean of interdialytic weight gain decreased significantly only in the experimental group. In other words, compared with patients who received educations via traditional method, patients receiving computer-assisted multimedia educations had lower sodium and fluid intake and hence smaller interdialytic weight gain. Excessive interdialytic weight gain due to unrestricted sodium and fluid intake can cause hypertension, heart failure, and pulmonary complications (4). It seems that our computer-assisted multimedia application was more effective than the traditional method in encouraging patients to restrict sodium and fluid intake. The reason behind such greater effectiveness may be the significant effects of the multimedia characteristics of the HEC application on patients' knowledge and behavior. The results of a review study by Dumrongpakapakorn et al (31) also showed that the multimedia characteristic of computer applications facilitates patient education and promotes patients' learning.

Some scholars have introduced nurses' verbal face-to-face communication with patients and their family members as the gold standard method for patient education (32). It is noteworthy that in the present study, education was provided using the traditional method (face-to-face and individually complemented by a pamphlet) in a systematic manner and with high quality for the sake of ethical considerations. While both computer-assisted multimedia education and the traditional method were effective, they were different in terms of their effectiveness although not significantly. Two reasons can be mentioned for the difference. First, the insignificant difference can be attributed to the fact that the traditional education materials were developed and provided to patients in the control group by using the highest standards. If patients in this group solely received routine medical and nursing care services, all differences between the study groups would become statistically significant because in clinical settings, patient education is provided unsystematically and without careful planning and hence, educations are of poor quality. Second, in this study, computer-assisted multimedia education was compared with the gold standard method of education. The results of this comparison showed that computer-assisted method was as effective as the gold standard method of education in improving patient outcomes.

The findings of the study also revealed that although other clinical parameters decreased in both study groups after the intervention, none of the decreases were statistically significant (Tables 2 and 3). This finding can be related to the size of the study sample. Moreover, besides adherence to treatment and dietary regimens, the serum levels of creatinine, uric acid, and calcium depend on other factors such as the adequacy of dialysis (4) which is not controllable by patients. Inadequate dialysis cannot

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effectively remove waste products from the blood and hence, their serum levels will be abnormally high. In agreement with our findings, Baraz et al (11) also reported that self-care education to patients receiving hemodialysis was not effective in decreasing the serum levels of albumin, creatinine, and calcium.

It is noteworthy that for the sake of ethical considerations, all patients in both study groups received routine medical and nursing care services before and during the study. Accordingly, limited effectiveness of educations was not unexpected. Future studies are recommended to recruit larger samples of patients, allocate adequate time and resources, provide educations in the early phases of renal failure, and manage the effects of all medications and treatments.

In overall, the findings of the present study showed the positive effects of computer-assisted education on the clinical parameters of patients receiving hemodialysis. Given the availability of personal computers in almost all families, the HEC application can be used for improving the quality and facilitating the process of education to eligible patients. This application provides information in small, simple, understandable, and objective multimedia units which can be easily managed by users. While navigating the application, patients can acquire self-care information and abilities step by step. This application was developed by using the principles for designing multimedia learning programs and focuses on patients' main problems and hence, it can facilitate the process of patient education and promote patients' learning. As nurse-patient human interaction is the essence of nursing practice, traditional face-to-face methods for patient education should not be completely replaced with computer-assisted education. Rather, computer-assisted methods are better to be used as complementary to other methods.

Study Limitations

In this study, we included only literate patients who had acceptable cognitive and physical health status and were able to use computer. Therefore, the findings are difficult to be generalized to other patients receiving hemodialysis. Moreover, we provided educations to the patients in different working shifts including morning, evening, and night. Such practice might have affected the study findings. However, given the small size of the study sample, provision of hemodialysis services in different working shifts, and the rotation of some patients in different working shifts, we could not manage the confounding effects of this factor.

Conclusion

The findings of this study showed that computer-assisted education by using the HEC application was as effective as the traditional face-to-face lecture method in decreasing systolic and diastolic blood pressures, itching, and serum level of urea among patients receiving hemodialysis. Moreover, it was more effective than traditional method in decreasing interdialytic weight gain. Accordingly, using this educational application can facilitate patient education and improve care quality.

Ethical Considerations

The authors of this study attempted to adhere to the principles of the Declaration of Helsinki and the contents of the ethical approval provided by the Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran.

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