

## Effect of Micro-learning strategy on caregivers' Knowledge and Reported Practices of Children undergoing Hemodialysis

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**Abstract:** Renal Failure among children has the potential for not only devastating a child's health but can also place a burden on the whole family. Micro-learning is an easy learning strategy which improves knowledge about adherence to treatment, overcoming complication and decreasing morbidity. The purpose of this study was to evaluate the effect of micro-learning strategy on caregivers' knowledge and practices of children undergoing hemodialysis. A quasi –experimental design (one group pre & posttest) was utilized for this study. It was conducted at the Pediatric Hemodialysis Unit, Menoufia University Hospital – Shebin El-Kom city. Sample: A convenience sample of all caregivers who have children undergoing hemodialysis (n=36) was included. Two instruments for data collection were used; structured interviewing questionnaire. Instrument two; included caregivers' reported practice checklist. The results of this study showed that there were highly statistical significant differences between caregivers' knowledge on post and follow up test compared to pretest (95.20% & 90.20% Vs. 3.50%). Also, there were highly statistical significant differences between caregivers' reported practices on post and follow up test compared to pretest (94.00% & 93.00% Vs. 15.0 %). The study concluded that the caregivers had satisfactory knowledge and reported practices after implementation of micro-learning strategy. Therefore, this study recommended that continuous micro-learning sessions should be scheduled regularly for caregivers in the Pediatric Hemodialysis Units to increase caregivers' knowledge and improve their practice. So, quality of care and children's outcomes will improve.

**Key words:** Caregivers, Children, Hemodialysis, Knowledge, Micro-learning, Reported practices.

## **Introduction**

Renal failure accounts for more than 67,000 annual fatalities, which is a substantial amount of morbidity and death worldwide. Because of the poor and low socio-economic standards, its prevalence is still rising. In Egypt, nearly 1.36% of all hospitalized children are between the ages of newborn and 15 years old who have chronic renal failure (CRF) (Mohammed et al., 2023). Also, 3:5 children out of every million in the USA get CRF each year (Centers for Disease Control and prevention (CDC), 2019). Chronic renal failure is a clinical syndrome characterized by a gradual irreversible loss of kidney function that can further progress to end stage kidney disease (ESKD) (Amanullah et al., 2022).

Hemodialysis (HD) is a widely used kidney replacement therapy for children with ESKD. HD is based on diffusive transport of solutes across a semipermeable membrane and is effective in removing small uremic retention solutes such as urea, correcting electrolyte abnormalities and restoring fluid balance. Despite technical advances, children on dialysis continue to experience high rates of morbidity and mortality compared to the general pediatric population (Shroff et al., 2022). A special food and fluid regimen are required for HD, which is a lengthy and expensive treatment that also necessitates lifestyle adjustments. In addition, physical and psychological pressures that children experience include loss of security, social

isolation, anemia, hypertension and lack of appetite (Liu et al., 2022).

Although dialysis is the most effective method to eliminate toxins from the body and improve a child's quality of life, this process may aggravate the situation on its own due to its negative effects. Children under hemodialysis have an elevated risk of cardiovascular complications such as hypertension, hyperlipidemia, increased coagulability, anemia, increased arterial calcification, problems related to nutrition, gastrointestinal, hepatic, endocrine systems, complications of arterio-venous fistula (AVF), infections, nervous system & sleep disorders and neurocognitive/neurodevelopmental delay (Osman et al., 2023).

Hemodialysis is establishing by creating arterio-venous fistula (AFV), it recommended by the Dialysis Outcomes Quality Initiative (DOQI) guidelines. It is created by a surgical procedure where an artery is connected to a vein under the skin, which results in venous engorgement and enlargement, allowing large-bore needles to be cannulated for HD. The fistula is susceptible to several complications such as edema in the hand, thrombosis, aneurysm, infection, ischemia and cardiovascular diseases which may lead to fistula failure (Natti Krishna et al., 2024).

Childhood CRF presents clinical features such as growth failure and psychosocial issues that significantly impact on child quality of life (QoL). Cardiovascular complications secondary to CRF lead to morbidity in

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young adulthood (Amanullah et al., 2022). Children are physically, mentally and developmentally dependent by their nature; so, their family members play a great deal of responsibility

to take care of them. Children receiving HD have a physical and psychosocial strain on their family caregivers. Caregivers are the main cornerstone of care, directly dealing with the health centers, social and community services. So, their awareness as well as their attitudes and practices toward the ESRD children influence their quality of care (Al-agamy et al., 2022).

Family caregivers play a substantial role in children's lives not only they assist in meeting domestic needs such as preparing meals, performing housework, doing laundry, providing transportation and purchasing supplies, but they also help with more complicated tasks. These tasks include management of burdensome physical and psychological symptoms, diet management, medication administration, monitoring side effects and complications, navigating the healthcare system, interacting and exchanging information with health care providers and making health care decisions (Abed et al., 2020). The caregivers require adequate knowledge about the process of the disease, treatment, diet and the control of this disease. As a result, they will be able to provide better care for their children considering all difficulties (Eidivandi et al., 2020).

There are different educational methods that have been used to

broaden caregivers' knowledge and increase their awareness about patients care. Micro-learning is one of these methods, which is a small piece of content centered on a goal that presented on electronic tools in any media format. Short video as a medium for micro-learning is believed to remove barriers to learning related to its accessibility and ability to download in short time. So, the information needed will be available at anytime and anywhere (Khah et al., 2023).

**Definitions of variables:**

▪ **Micro-learning:** is an educational strategy that breaks complex topics into short-form, stand-alone units of study that can be viewed as many times as necessary, whenever and wherever the learner needs. The materials can be provided in various formats, such as text, images, videos, podcasts, animations, dialogue simulations, and quizzes (Aldaghi et al., 2022). While in the current study, it is operationally defined as a series of small recorded videos provided in multiple sessions to a small group of caregivers in a short period of time (5-8/min) that contain about all knowledge and practices about chronic kidney disease, hemodialysis, its complication and home care.

▪ **Caregivers Knowledge:** is theoretically defined as data and/or information that have been organized and processed to convey understanding, experience, accumulated learning, and expertise as they apply to a current problem or

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activity (Petrushenko & Vorontsova, 2020). While in the current study, it is operationally defined as a knowledge that caregivers have regarding general knowledge about chronic renal failure, hemodialysis, fistula complication, fistula care and fluid and dietary management. It will be assessed through the interviewing questionnaire part two about caregiver's knowledge (Instrument one).

- **Reported practice** is theoretically defined as the actual application or use of an idea, belief, or method, as opposed to theories relating to it, which helps to develop skills (Benner et al., 2019). While in the current study, it is operationally defined as caregiver action, which includes measures regarding fistula care, exercise and hand washing. It will be assessed through caregiver's reported practice checklist (instrument two).

## **Methods**

### **The purpose of the study:**

To evaluate the effect of micro-learning strategy on caregivers knowledge and reported practices of children undergoing hemodialysis.

### **Research Hypotheses:-**

- 1) Caregivers' knowledge about hemodialysis will be higher after implementation of micro-learning strategy than before.
- 2) Caregivers' health care related practices regarding hemodialysis will be more satisfactory after implementation of micro-learning strategy than before

### **Research Design:**

A quasi-experimental design (pre/posttest) was utilized.

### **Setting:**

This study was conducted at the Pediatric Hemodialysis Unit, Menoufia University Hospital – Shebin El-Kom city.

### **Sampling:**

Convenience sample of all caregivers who have children undergoing hemodialysis (n=36) in the previous mentioned setting.

### **Instruments:**

There two instruments were used:

#### **Instrument one: a structured interviewing questionnaire:**

It will be created by the researcher in Arabic guided by Ajarmeh et al., (2018) & El-Awady & Mohamed, (2021). It will consist of two parts, as the following:

- **Part 1:** Social characteristics of caregivers and children medical history. It was used to assess social characteristics of caregivers (including 7 items) such as age, employment, economic status, educational level, marital status, No. of children. Also, children medical history related to renal disease (including 8 items) such as dialysis, arterio-venous fistula (AVF), duration of HD, number of sessions per week, duration of AVF, history of previous AVF, regular medication used, adverse effect of medication and special nutritional program used.

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- **Part 2:** Caregivers' knowledge about renal failure. It was used to assess knowledge of caregivers about renal failure. It included 34 questions (6 questions about general knowledge about renal failure, 2 questions about hemodialysis, 4 questions about fistula complication, 6 questions about care of vascular access & 16 questions about fluid and dietary management).

**Scoring system:**

Items	Score
Complete and correct knowledge	2
Incomplete and correct knowledge	1
Incorrect and don't know	0

All scores were converted into percentages scores as the following:

Items	Score
Good knowledge	$\geq 75\%$
Average knowledge	$50\% - <75\%$
Poor knowledge	$< 50\%$

**Instrument two: Caregiver's Reported Practice checklist:**

It was developed by the researcher in English form guided by Ajarmeh et al., (2018); El-Awady & Mohamed (2021) to assess caregivers' reported practice. It included 3 items such as daily activities precautions to prevent AVF failure (postoperative immediate care 7 items & postoperative long term care 10 items), hand washing 10 items and fistula exercise (ball squeeze, fingertip touches, clothes peg grasp & bicep curl).

**Scoring system:**

Items	Score
Done	1
Not done	0

All scores were converted into percentages scores as the following:

Items	Score
Satisfactory	$60\% - \geq 75\%$
Unsatisfactory	$< 60\%$

**Ethical consideration:**

An initial approval was obtained from the Research Ethics Committee of the Faculty of Nursing, Menoufia University. A written consent was obtained from caregivers of children undergoing hemodialysis who participated in the study. An initial interview was done to inform the caregivers about the purpose and benefits of the study. Also, they were told that the study was voluntary, harmless and they can withdraw from the study at any time without penalty. Caregivers were assured that confidentiality and anonymity were respected through coding all data and putting it in a closed cabinet.

**Procedure:**

**Assessment phase**

An official permission to carry out the study was obtained from the director of the setting after submitting an official letter from the Dean of the Faculty of Nursing explaining the purpose of the study and the method of data collection. Data collection took five months, started from beginning of May 2023 to the end of September 2023 Data collection took five months, started from beginning of May 2023 to

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the end of September 2023 The study conducted two days per week for 15-20 minutes. At the beginning of the study, the researcher introduced herself and explained the purpose and nature of the study to the caregivers to gain their cooperation to share in the study. Characteristics of caregivers was assessed at the beginning of the study using instrument one, part one (pretest). Children medical history was assessed using instrument one, part one (pretest).

Assessment of caregivers knowledge about chronic renal failure, general knowledge about hemodialysis, fistula complication, fluid and dietary management, was assessed at the beginning of the study using instrument one, part two (pretest). Caregiver's reported practices about daily activities life precautions to prevent AVF failure, hand washing and fistula exercise was assessed using instrument two (pretest).

### **Planning phase**

Area of knowledge and practice deficit about home care of children undergoing hemodialysis was identified to be considered while preparing the micro-learning videos. The sessions started by the researcher to all caregivers who have children undergoing hemodialysis. The researcher met the caregivers two times per week for 15-20 minute. Micro learning videos was prepared by the researcher and specialist to compile their contents to appear in best possible light which contained the knowledge and illustrative pictures and recorded by the voice of the researcher.

The videos were provided in five sessions, one topic in each video and each video took about 5-8 minutes. Caregivers were divided into small groups nine in each group. The researcher took the caregivers phone numbers during the data collection, a WhatsApp group was created to send the videos to them as a reference. The caregivers who didn't have phones received explanatory booklets.

The prepared videos was designed based on review of related literature to improve caregivers' knowledge and practice regarding chronic renal failure, general knowledge about hemodialysis, fistula complication, fluid and dietary management, daily activities life precautions to prevent AVF failure, hand washing and fistula exercise.

### **Implementation phase:**

The researcher started to implement the micro-learning sessions through the following videos:

The first video included the anatomy of the renal system, kidney functions, definition, causes and common signs of CRF, as well as complications and CRF management. The second video discussed hemodialysis concepts, methods of action, duration, different types of vascular access connections, importance of adjusting to hemodialysis sessions. The third video focused on the complication of hemodialysis and how to manage, warning signs and its home care. The fourth video focused on daily activities life precautions to prevent AVF failure. The fifth video focused on fistula exercise, hand washing, the diet and

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fluid management (adhering to a dietary regimen for renal disease, the sorts of foods to eat, the dangers of not adhering to the kidney dietary regimen and fluid therapy). The researcher provided summery about knowledge provided at the end of each session. All caregivers received five videos; the video took 5-8 minutes. It was displayed using the researcher laptop and supported by oral clarifications and discussions, feedback questions, direct reinforcement for caregivers in form of material rewards and teaching assisting tools such booklet containing theoretical and practical videos data.

**Evaluation phase:**

Reassessment of caregivers knowledge and reporting practices was done immediately post application of micro-learning sessions using instrument one & two (posttest). Follow up test was done three months later to reassess caregiver knowledge and reported practices using the same instrument one and two (follow up test).

**Data Analysis:-**

Data was coded and transformed into specially designed form to be suitable for computer entry process. Data was entered and analyzed by using SPSS (Statistical Package for Social Science) statistical package version 23. Graphics were done using Excel program. Quantitative data were expressed as mean and standard deviation ( $\bar{X} \pm SD$ ) and analyzed by applying t-test and ANOVA test for comparison of means. Qualitative data were presented as number and percentage and compared utilizing chi-square test ( $\chi^2$ ). A statistical

significant difference was considered if  $P$  value  $< 0.05$ .

**Results**

**Table 1** shows characteristics of studied caregivers. It was obvious that more than one third of the studied caregivers (38.9%) were between 40-50 years old. Regarding relationship to the child, more than three quarters were mothers and were married (83.3% & 91.6% respectively). While 80.6% of them were not working and had middle income (61.1%). Moreover less than half (41.6%) of studied caregivers had three children only.

**Table 2** displays mean total scores of caregivers' knowledge about chronic renal failure, vascular access, care of vascular access, fluid and dietary management on pre, post and follow-up tests. The findings revealed that mean and standard deviation of total knowledge on pretest were  $11.47 \pm 3.88$  compared to  $41.58 \pm 2.88$  on posttest. Therefore, there were highly statistical significant differences between pretest and posttest ( $P < 0.0001$ ). Also, mean and standard deviation of total knowledge on pretest were  $11.47 \pm 3.88$  compared to  $36.83 \pm 2.75$  on follow up test. Therefore, there were highly statistical significant differences between pretest and follow up test. However, mean and standard deviation of total knowledge on posttest were  $41.58 \pm 2.88$  compared to  $36.83 \pm 2.75$  on follow up test. So, there were no statistical significant differences between posttest and follow up test ( $P > 0.05$ ).

**Figure 1** shows caregivers' level of knowledge about chronic renal failure,

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vascular access, care of vascular access, fluid and dietary management on pre, post and follow-up tests. The findings revealed that 95.20% & 90.20% had good knowledge on posttest and follow up test compared to 3.50% on pretest. Therefore, there were high statistically significant differences between pretest, posttest and follow up test ( $P < 0.0001$ ).

**Table 3** shows mean total scores of caregivers' reported practices regarding hand washing; immediate and long term postoperative care to prevent arterio-venous fistula failure and exercises of upper and lower arm fistula on pre, post and follow-up tests. The findings revealed that mean and standard deviation of total reported practices on pretest were  $9.08 \pm 3.19$  compared to  $32.77 \pm 2.98$  on posttest. Therefore, there were highly statistical significant differences between mean total scores of pretest and posttest ( $P < 0.0001$ ). Also, mean and standard deviation of total scores of reported practices on pretest were  $9.08 \pm 3.19$  compared to  $29.13 \pm 3.61$  on follow up test. Therefore, there were highly

statistical significant differences between mean total scores of reported practices on pretest and follow up test. However, mean and standard deviation of total reported practices on posttest were  $32.77 \pm 2.98$  compared to  $29.13 \pm 3.61$  on follow up test. So there were no statistical significant differences between posttest and follow up test ( $P > 0.05$ ).

**Figure 2** shows caregivers' level of reported practices on pre, post and follow-up tests. The findings displayed that caregivers had satisfactory reported practices on posttest and follow up test compared to pretest (94.00%, 93.00% & 15.0 % respectively). Therefore, there were highly statistical significant differences between caregivers' reported practices on pretest, posttest and follow up test ( $P < 0.0001$ ).

**Table 4** shows correlation between caregivers' educational level and their total knowledge and practices. There was a significant correlation between caregivers' educational level and their total knowledge and practices.



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**Table (1): Characteristics of Studied Caregivers (n=36)**

Characteristics of caregivers	No. (n=36)	%
Age		
20-less than 30 years	9	25.0
30- less than 40 years	13	36.1
More than 40 years	14	38.9
Relationship to the child		
Father	4	11.1
Mother	30	83.3
Brother	1	2.8
Grandmother	1	2.8
Marital status		
Married	33	91.7
Divorced	2	5.5
Single	1	2.8
Occupation		
Working	7	19.4
Not working	29	80.6
Family economic status		
Low	14	38.9
Middle	22	61.1
Number of children		
One	1	2.7
Two	10	27.8
Three	15	41.7
Four or more	10	27.8

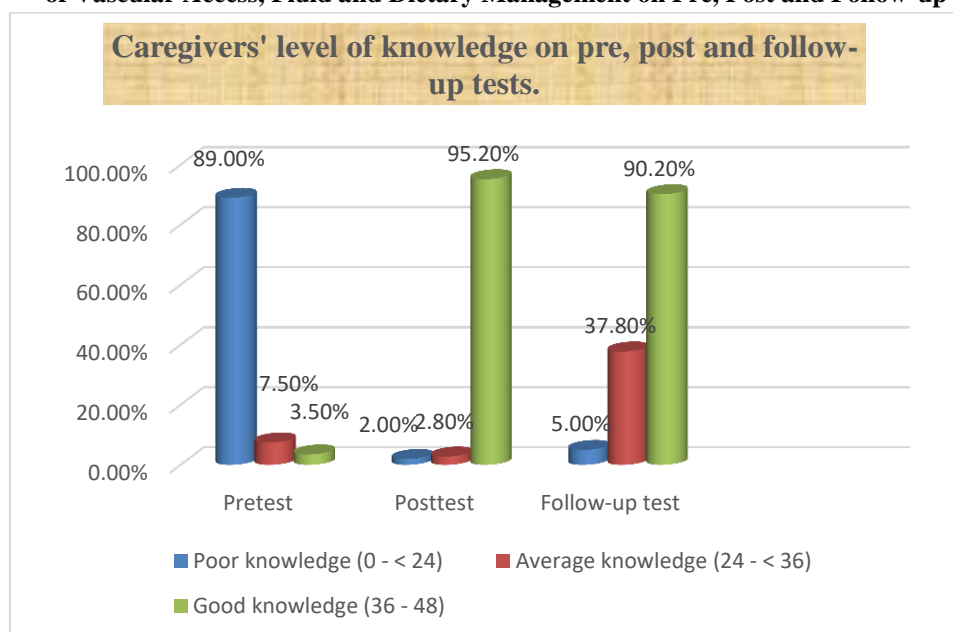
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**Table (2): Mean of Total Scores of Caregivers' Knowledge about Chronic Renal Failure, Vascular Access, Care of Vascular Access, Fluid and Dietary Management on Pre, Post and Follow-up Tests**

Caregivers' knowledge	Pretest (M±SD)	Posttest (M±SD)	Follow-up test (M±SD)	ANOVA Test	P- value
Chronic renal failure	3.83 ± 2.74	13.72 ± 1.59	11.72 ± 1.75	224.914 <sup>HS</sup>	.0001
Vascular access	1.80 ± 1.52	7.02 ± 1.05	6.25 ± 1.48	152.039 <sup>HS</sup>	.0001
Care of vascular access	2.50 ± 1.69	10.72 ± 1.25	9.86 ± 1.57	318.295 <sup>HS</sup>	.0001
Fluid and dietary management	3.33 ± 1.72	10.11 ± 1.93	9.00 ± 2.43	112.610 <sup>HS</sup>	.0001
Total scores	11.47 ± 3.88	41.58 ± 2.88	36.83 ± 2.75	913.256 <sup>HS</sup>	.0001

Note: (HS): High significant (p<0.001)

**Figure (1): Caregivers' Level of Knowledge about Chronic Renal Failure, Vascular Access, Care of Vascular Access, Fluid and Dietary Management on Pre, Post and Follow-up Test.**



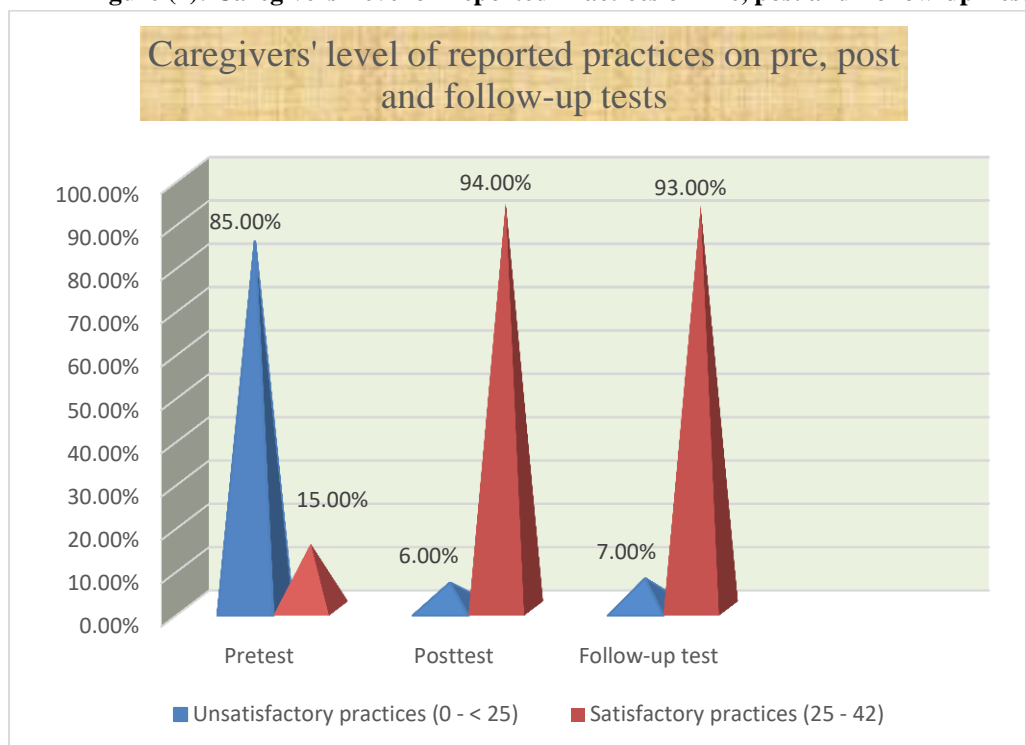
**Table (3): Mean Total Scores of Caregivers' Reported Practices on Pre, Post and Follow-up Tests**

Caregivers reported practices about	Pretest (M±SD)	Posttest (M±SD)	Follow-up test (M±SD)	ANOVA test	P- value
Hand washing	3.72 ± 2.53	9.72 ± 1.71	8.77 ± 1.72	90.933 <sup>HS</sup>	.000
Immediate postoperative care to prevent arterio-venous fistula failure	1.19 ± 1.09	5.63 ± 1.12	5.13 ± 0.99	186.311 <sup>HS</sup>	.000
Long term postoperative care to prevent arterio-venous fistula failure	2.97 ± 1.31	7.69 ± 1.09	7.00 ± 1.37	145.737 <sup>HS</sup>	.000
Exercises of upper and lower arm fistula	1.19 ± 0.98	9.72 ± 1.42	8.22 ± 1.80	357.620 <sup>HS</sup>	.000
Total scores	9.08 ± 3.19	32.77 ± 2.98	29.13 ± 3.61	545.955 <sup>HS</sup>	.000

Note: (HS): High significant (p<0.001)

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**Figure (2): Caregivers Level of Reported Practices on Pre, post and Follow-up Tests**



**Table (4): Correlation between Caregivers' Educational Level and Their Total Knowledge and Reported Practices**

Items	Educational level	
	R	P- value
Total knowledge	.348*	.038
Total reported practices	.929**	.000

\* Correlation is significant at 0.05 level (2- tailed)

\*\* Correlation is significant at 0.01 level (2- tailed)

### **Discussion**

Chronic renal failure is a condition characterized by abnormalities in the structure and function of the kidneys which lasts for more than 3 months, along with a decrease in GFR to less than 60 ml/min/ 1.73 m<sup>2</sup>, this is considered a challenge to public health and the prevalence rate of this disease has always increased annually (Surani, 2021). So, Children with CRF rely on dialysis to mechanically remove fluid,

electrolytes and waste products from the blood. For the most effective hemodialysis, the pediatric patients need good vascular access with an arteriovenous (AV) fistula or an AV graft that provides adequate blood flow (Irum, 2023). Long term HD places a huge burden on children, family caregivers and the health-care system (Mohammed et al., 2023). Therefore, Application of micro-learning strategy

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significantly improves caregivers' knowledge and practices.

The current study hypothesized that caregivers' knowledge about hemodialysis would be higher after implementation of micro-learning strategy on posttest than pretest. Also, caregivers' health care related practices regarding hemodialysis would be more satisfactory after implementation of micro-learning strategy on posttest than pretest.

The current study showed that mean total score of caregivers' knowledge about CRF on pretest was  $3.83 \pm 2.74$  compared to  $13.72 \pm 1.59$  &  $11.72 \pm 1.75$  on post and follow up test respectively. So, there were highly statistically significant differences between mothers' knowledge about CRF before and after implementation of the educational program based on micro-learning strategy. The researcher may justify this to the use of micro-learning strategy in improving caregivers' efficiency and achieving satisfactory teaching effects. This result was in the same line with El Nagar et al., (2020) who showed that mean total score of mothers' knowledge about CRF on pretest was  $20.14 \pm 6.02$  compared to  $33.98 \pm 6.92$  on posttest. So, there were statistically significant differences between mothers' knowledge about CRR before and after implementation of the empowerment program.

Moreover, the finding was consistent with Ajarmeh et al., (2018) who concluded that more parental education and greater awareness of childhood kidney disease were needed for more effective early diagnosis, better

management, improving family care and adherence to treatment regimen

In the same line, Khah et al., (2023) who found that treatment adherence in the mobile health group was significantly higher than the face-to-face training group ( $1018.57 \pm 129.66$  compared to  $914.29 \pm 126.06$  respectively). From researcher perspectives, the learning via brief, focused learning units may have a significantly greater impact on immediate knowledge recall.

In addition, this result showed that the caregivers had good knowledge on posttest (95.20%) compared to pretest (3.50%). This could be attributed to the application of micro-learning which is effective in recalling the information. This finding was agreement with Tharwat et al., (2023) who revealed that 69.6% of the studied adolescents had good level of knowledge scores on posttest compared to 0.0% on pretest. Therefore, there was a statistically significant difference between total knowledge scores of the studied adolescents on pre and post-test respectively ( $P=0.001$ ).

Regarding care of vascular access the current study showed that mean and standard deviation of care of vascular access on pretest was  $2.50 \pm 1.69$  compared to  $10.72 \pm 1.25$  on posttest. From the researcher perspectives, this may indicate that micro-learning sessions are more flexible and easily stimulate the learning interest. In the same context, there was a decrease in knowledge score on follow up test than posttest; this might be attributed to knowledge retention. Therefore, there were highly statistical significant

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differences between pre and posttest ( $P < 0.0001$ ). This result came in agreement with Mohammed et al., (2023) who found that mean and standard deviation of vascular access care was  $5.9 \pm 2.1$  on pretest compared to  $11.90 \pm 1.43$  on posttest. Therefore, there were highly statistical significant differences between pre and posttest ( $P < 0.0001$ ).

In relation to hypothesis two: the present study illustrated caregivers' reported practices on pre, post and follow up tests. The study revealed that the highest level of caregivers' reported practices was on post and follow up test. From the researcher perspectives, this could be attributed to the positive effect of micro-learning implementation which characterized by its flexibility and easily to recall and understood.

Regarding caregivers' reported practice of hand washing and fistula exercises, the current study showed that caregivers had higher level of reported practice regarding all items of hand washing on posttest and follow up test than pretest. Also, the caregivers had higher score regarding fistula exercise on posttest and follow up test than pretest. Therefore, there were highly statistical significant differences between caregivers' reported practice regarding hand washing and fistula exercise on posttest and follow up test than pretest ( $P < 0.0001$ ). This may be due to using micro-learning strategy which based on illustrated videos that deliver information quickly and easily. the finding agreed with Hassan & Mahmoud (2019) who stated that the

mean of hand washing practice post empowerment program was more than the pre-empowerment program ( $11.16 \pm 0.874$  &  $5.66 \pm 0.958$  respectively); also the mean of fistula exercise practice post empowerment program was more than the pre-empowerment program ( $6.83 \pm 0.379$  &  $0.066 \pm 0.253$  respectively). Therefore, there were highly statistical significant differences between pre and post-tests ( $p < .0001$ ).

In addition, this result consistent with El-Awady & Mohamed (2021) who revealed the participant mother's reported practice regarding fistula exercise markedly increased from 28% before implementation of the educational program compared to 82% immediately after the study intervention. Therefore, there were highly statistical significant differences between pre implementation and post implementation program ( $p < .0001$ ).

Regarding caregivers' reported practice about immediate postoperative fistula care and long term care, there was an improvement in immediate post-operative care on post and follow up test ( $5.63 \pm 1.12$  &  $5.13 \pm 0.99$  respectively) after application of micro learning compared to pretest ( $1.19 \pm 1.09$ ). Also, there was an improvement in long term postoperative care on posttest and follow up test ( $7.69 \pm 1.09$  &  $7.00 \pm 1.37$  respectively) after application of micro learning compared to pretest ( $2.97 \pm 1.31$ ). This might be attributed to micro-learning application that can broaden caregivers' knowledge and increase their awareness about patients care. This result was consistent with

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Mohammed et al., (2023) who found that there was increase in mean and standard deviation regarding immediate postoperative fistula care and long term care on posttest ( $2.97 \pm 0.84$  &  $11.90 \pm 1.43$  respectively) after empowerment program compared to pretest ( $1.1 \pm 0.823$  &  $5.9 \pm 2.1$  respectively). Therefore, there were highly statistical significant differences between pretest and posttest ( $P < 0.0001$ ).

**Conclusion:**

Based on the findings of the present study, the following is concluded:

Caregivers who attended micro-learning sessions about hemodialysis had higher level of knowledge after implementation of micro-learning strategy than before. Also, they had more satisfactory level of their reported practices after implementation of micro-learning strategy than before.

**Recommendations**

In the light of findings obtained from current study and its conclusion, the following recommendations are suggested:

**Recommendations for caregivers:**

Continuous micro-learning sessions should be applied for all caregivers of children in HD to increase their information and improve their skill. Prepared videos should be available for caregivers and their children in HD to improve their awareness. Written and chronic renal failure to increase and sustain caregivers' verbal information should be available in the pediatric units based on the new trends on knowledge, attitudes and improve their

children care. Booklets with illustrated pictures should be available for home management and prevention of complication of CRF and hemodialysis. The caregivers should follow guidelines of fistula care to prevent its complications. Ongoing assessment of mothers' reported practices to detect any deficit regarding their children home care.

**Recommendations for Research:**

Application of the present study on a large sample size and for a long period of time to ensure the generalization of the results.

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