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Impact of Patient Education and Knowledge on Medication Adherence in Chronic Kidney Disease Patients

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Abstract

Background: There are limited number of studies looking at the reasons of and interventions for non-adherence to chronic kidney disease (CKD) management in India. Medication adherence is an important public health consideration, affecting health outcomes and overall healthcare burden. Hence the aim of this study was to explore knowledge among CKD patients and evaluate the impact of basic education of disease on knowledge and adherence to treatment by using MKAQ and MMSA-8 questionnaire.

Material and methods: The study was conducted on 100 adult patients of CKD selected from K and D clinic PGIMS, Rohtak. All the patients underwent detailed socio-economic, clinical, biochemical and radiological examination. Patients were assessed for basic knowledge and adherence to medication by using MKAQ and MMSA-8 on each visit and basic education regarding their disease and treatment was given.

Results: Out of total 100 patients, 62 were male and 38 were female. The study results revealed, the post-total mean knowledge scores 2.94 ± 1.17 of the study subject increased significantly ($p < 0.001$) in subsequently follow-up visit times as compared to pre-program 1.17 ± 0.78 with educational intervention. The post-total and sub-total adherence scores of the study subjects is also increased significantly ($p < 0.001$). Patients who belonged to higher socio-economical status and higher basic education had more knowledge about their disease and management as well as had more adherence to prescribed treatment. Most common reason for non-adherence in our study was high cost of drugs.

Conclusion: Poor adherence and poor medication knowledge remain a major obstacle in the effective treatment of CKD patients. There is need for comprehensive approach to make effective tools that eliminate or minimize the contributory factors to non-adherence in CKD patients.

Key words: Chronic kidney disease, treatment adherence, medication knowledge.

Introduction

Chronic kidney disease (CKD) is an emerging public health problem that affects 5% to 10% of the world population with increasing prevalence and adverse outcomes, including progressive loss of kidney function, cardiovascular disease and premature death[1,2]. Diabetes and hypertension account for over 2/3rd of the cases of CKD globally[3]. Similarly, in India hypertension and diabetes account for 40 - 60% cases of CKD[4]. The number of CKD patients is continuously rising over time. The major goal of drug therapy in CKD patients is to halt the progression of disease along with ameliorating the associated co-morbidities.

Patients of chronic kidney disease are required to follow oppressive management that is complex and difficult to understand. Comprehensive management of CKD patients includes dietary modification, fluid management, appropriate medication and renal replacement therapy (RRT). This comprehensive patient care is pivotal in slowing the progression and complications of CKD[5]. Consequently, these patients have a large pill burden, on an average of 8 - 10 tablets/day[6].

In developing countries where health facilities are scarce and hard to access, the clinic valid approach for detection, prevention and timely management of early stages of CKD needs adequate patient knowledge. Various studies have reported that patient education can retard the progression of renal disease and improve survival[7-9]. Lack of knowledge about seriousness of their disease was found to be an important factor in CKD patients. Various studies have shown that many patients with advanced stages of renal disease do not have enough knowledge for managing their fluid and diet[10].

Chronic diseases patients do not adhere to their prescribed treatment and it has been reported, that many patients modify their drug dosage as well as frequency of drugs. These decisions are usually made because of poor understanding of schedule and fear of adverse reaction to taking multiple drugs simultaneously[11]. This imposes a high personal and monetary burden on patients and their families

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and a significant proportion of CKD patients are found to deviate from prescribed management causing ongoing challenges for the healthcare system[12]. Various studies reflect that educational programes carried-out by healthcare providers improve management of CKD patients and patients feel more satisfaction, increase self-care and overcome various misconceptions regarding diet, medication and dialysis[13]. Hence, knowledge and adherence to treatment are a major intervention to slow down the progression of CKD as well as prevent the complications of CKD.

Adherence is defined as the extent to which individuals follow instructions they are given for prescribed treatments[14]. Non-adherence has been shown to vary depending on diseases and characteristics of medicines prescribed. Non-adherence to chronic drug therapy is known to significantly increase the disease burden in developing economies. The major predictors of poor adherence include cost of medication, missed appointments, side-effects of medication, psychological problems, treatment complexity, asymptomatic disease, inadequate follow-up, poor patient provider relationship, patients' lack of insight in illness, patients' lack of belief in benefit of treatment and barrier to access the healthcare facilities. Pill burden is one of the most common reasons for medication non-adherence in patients of CKD. Wide variability in rates of non-adherence are reported in various studies depending on the type of instrument used[15-17]. Non-adherence rates among CKD patients found in previous studies range from 2% to 98%[18]. Hence, it is necessary to understand non-adherence to medications in a particular disease and study the factors affecting it.

Measurement of medication adherence is challenging because it depends on individual patient behavior. Various subjective and objective modalities have been used to assess adherence. Subjective measurements are obtained by using various questionnaires like Brief medication questionnaire (BMQ), Morisky medication adherence questionnaire (MMAQ) and End-stage renal disease adherence questionnaire (ESRD-AQ). Objective measurements can be obtained by counting pills, examining pharmacy refill records or using electronic medication event monitoring systems. Biochemical measurements can be obtained by adding a non-toxic marker to the medication and detecting its presence in blood or urine. Morisky medication adherence questionnaire (MMAQ) includes MMAS-4 and MMAS-8 scores based on number of questions asked to the patient. Adherence is graded as high, medium or low. Higher score indicates low adherence[19].

Assessment of patient medication knowledge can be done by different questionnaires described and validated in various studies and one of them was medication knowledge assessment questionnaire which consists of 5 questions, out of them 4 questions score is calculated on the basis of recalling the name of medication, indication, dose and side-effects of medication[20].

Therefore, patient's education regarding knowledge and adherence to prescribed treatment regimen is important for dealing with the complexities of chronic disease and their management. Several studies showed that patient education can retard the progression of chronic renal disease and improve survival, improve illness related understanding, and boost quality of life[14-16]. Hence, the present study was planned to assess the impact of education in improving medication knowledge and adherence to medication therapy in CKD patients.

Material and methods

The study was conducted among 18 - 75 years adult patients of CKD, undergoing treatment as outpatient in the Kidney and Dialysis clinic, PGIMS, Rohtak and consenting to participate in the study. Patients with any psychiatric illness, multiple organ system failure, having altered sensorium and memory impairment were excluded from the study. Patients who were unable to speak/write/understand English and Hindi (local language) were also not included in the study. Study was approved from the institutional ethics committee.

Data including patient demographics age, sex, occupation, marital status, level of education, employment status and income status as per Kuppuswamy's scale was collected[21]. Past medical and medication history, duration of treatment, medications prescribed (name, dose, frequency, route, duration of the drug) were obtained by direct patient history interview and review of the patient medical records and documented in the data collection forms specially designed for the study. Patients were counseled verbally (15 - 30 min/patient) on their regular OPD visit days regarding their disease, dialysis procedure, drugs, diet and fluid restrictions. Patient education leaflets were prepared in English and Hindi and distributed to the patients on the first counselling.

Patients' medication knowledge was assessed using a validated interviewer administered medication knowledge assessment questionnaire (MKAQ)[20]. The questionnaire consists of 5 questions and two columns named as 'actual' and 'patient' for each question. The 'actual' column contains the current actual list of the medications taken by the patient. This column was filled by the interviewer before interviewing the patient by referring to patients' case records and OPD card. An interview was conducted for each patient in a single session of 20 - 30

minutes to assess the parameters like ability of each patient to recall the names of his/her medications, the purpose of use (indication), dose/strength, the number of doses to be taken each time and side-effects of their medications and the responses were used to score questions 1 to 4 separately in the corresponding "patient" column. If the patient recalled only one of the parameter without recalling the other three parameters it was considered as true knowledge. Thus minimum score was '0' which indicated poor medication knowledge and maximum score '4' indicated higher knowledge. Question number five does not have a scoring system hence it was not scored.

The medication adherence pattern of the patients was assessed by using Morisky medication adherence questionnaire-8 (MMSA-8)[19]. To assess the reported medication adherence behaviour of the study subjects. MMSA-8 consists of total 8 questions, out of them first 7 questions have two options "YES" and "NO" and the last question has 5 options and a total score graded as low (0), medium (1 - 2) and high (≥ 3). Higher score was indicative of poor adherence and decreasing score after education was indicative of improving in adherence to treatment. Both the questionnaires were administered at baseline, on the sixth week and twelfth week.The responses obtained from the patients were scored as stated in the questionnaires and were subjected to statistical analysis.

Statistical analysis

The association between patient education, reported medication adherence pattern and patients' knowledge about the medications was examined using the two tailed independent paired t-test. The correlation between patients' medication knowledge and medication adherence was assessed using Pearson's correlation co-efficient. A p value of < 0.05 was considered statistically significant.

Result

A total of 100 patients were selected according to inclusion and exclusion criteria and interviewed for this study. Out of 100 patients, 62 were male and 38 were female. There was a male predominance in this study. The most common aetiology of kidney disease was hypertension (29%) followed by diabetes mellitus (24%) and chronic glomerulonephritis (19%). Most of the patients were from lower and middle family income class. The most common educational status was primary school (32%) followed by 26% of higher secondary. Baseline demographic characteristics of study group are enumerated in Table I.

Table I: Demographic characteristics of study sample (N = 100).

Variables	N
Sex	
• Male	62
• Female	38
Age	
• < 20 years	4
• 21 - 30 years	14
• 31 - 40 years	13
• 41 - 50 years	20
• 51 - 60 years	22
• 61 - 70 years	24
• > 70 years	3
Marital status	
• Married	90
• Unmarried	10
Kuppuswamy score {income scale} (rupees per month)	
• Score-1 (< 2,091)	0
• Score-2 (2,092 - 6,213)	39
• Score-3 (6,214 - 10,356)	12
• Score-4 (10,357 - 15,356)	15
• Score-6 (15,536 - 20,714)	10
• Score-10 (20,715 - 41,429)	20
• Score-12 (> 41,430)	4
Residency	
• Urban	36
• Rural	64
Level of education	
• Primary	28
• Middle	12
• Secondary	16
• Higher secondary	26
• Graduation	18
Employment status	
• Employed	37
• Unemployed	50
• Retired	13
Co-morbid conditions	
• Hypertension	20
• Diabetes	23
• Hypertension and diabetes	14
• Cardiac diseases	12

In this study, the average age of patients was 48.02 ± 15.40 years. Out of 100 patients, 51% were below age 50 years. 42% patients belonged to lower middle class on the Kuppuswamy's scale. Most patients were from rural background. Over half of the patients had associated co-morbidity in this study, diabetes and hypertension. Most

patients were in advanced stages of CKD and 51% of the patients were on haemodialysis. Renal function of patients on each visit is summarised in Table II. Mean serum creatinine in study group was 6.9 ± 3.72 mg/dl, 5.9 ± 3.44 mg/dl and 6.8 ± 3.41 mg/dl, respectively at each visit.

Table II: Renal function of patients at each visit

Basic investigation	Mean ± SD		
	First visit	Second visit	Third visit
Haemoglobin (g/dl)	8.38 ± 1.63	8.29 ± 1.63	7.97 ± 1.88
Total leucocyte count/ cumm	8,481 ± 2,459.93	8373 ± 2292.71	8037.66 ± 2825.01
Absolute platelet count lakhs/cumm	2.65 ± 1.08	2.69 ± 1.24	2.86 ± 1.09
Blood sugar (mg/dl)	107.49 ± 33.6	107.51 ± 28.34	108.66 ± 34.02
Blood urea (mg/dl)	157.95 ± 68.5	159.17 ± 58.44	160.67 ± 68.41
Serum uric acid (mg/dl)	9.44 ± 2.56	8.36 ± 2.46	7.64 ± 2.68
Serum sodium (meq/l)	138.78 ± 5.68	136.78 ± 4.61	138.74 ± 6.14
Serum potassium (meq/l)	5.44 ± 0.76	4.56 ± 0.86	4.46 ± 0.86
Serum creatinine (mg/dl)	6.9 ± 3.72	5.9 ± 3.44	6.8 ± 3.41
Serum calcium (mg/dl)	8.36 ± 1.42	8.49 ± 1.44	8.44 ± 1.44
Serum phosphate (mg/dl)	8.49 ± 3.54	7.28 ± 3.06	6.78 ± 2.68
Serum protein (g/dl)	6.37 ± 0.9	5.87 ± 0.9	6.16 ± 0.95
A:G ratio	0.99 ± .21	0.89 ± 0.22	0.99 ± 0.22
GFR (ml/min)	16.57 ± 10.96	16.57 ± 10.96	16.26 ± 10.4

Table III: Paired t-test comparing total knowledge (MKAQ) score (N = 100).

MKAQ score	Pre-program	At 6th week	At 12th week	P - value
Mean ± SD	1.17 ± 0.78	2.19 ± 0.97	2.94 ± 1.17	< 0.0001

In this study we found significant improvement in total and subtotal knowledge score in subsequent visits after medical education.The mean MKAQ score before initiation of patient medical education was found to be 1.17 ± 0.78, on sixth week of education was 2.19 ± 0.97 and on twelfth week was 2.94 ± 1.17. On comparison of pre-program with 6th weeks, 12th weeks mean MKAQ score and after 6th weeks with 12th weeks mean MKAQ score that was comparable and was statistically significant ((< 0.0001), (Table III and IV).

There was a statistically significant (< 0.005) correlation observed between residential status and total knowledge and this was consistent with medical education on 6th and 12th weeks. In this study basic income of patients also had positive correlation (< 0.0001) with total knowledge and was consistent with medical education as higher monthly income patients had a higher degree of knowledge than lower income. It was also observed that level of education also had positive correlation (< 0.0001) with total knowledge score. It was also apparent that employment status also had positive correlation ((< 0.0001) with total knowledge. In this study we also found significant drop in total and subtotal MMSA-8 score in subsequent visits with medical education which signify increased adherence after educational intervention (Table VI and VII). In this study basic income of patients also had statistically significant correlation (< 0.0001) with adherence and was consistent with medical education as higher monthly income patients had a higher degree of adherence than lower income. It was also observed that level of education also had statistically significant correlation (< 0.0001) with adherence. It was also apparent that employment status also had statistically significant correlation (< 0.0001) with adherence.We also found that patients' knowledge regarding renal diet, fluid control, basic investigation, medication and dialysis, improved with educational intervention which results in improved adherence and management of their disease.

In this study we found that the most common reasons for non-adherence were high cost (58%) followed by complex dosing schedule (49%), forgetfulness (45%) and fear of adverse reaction (43%). In this study more than half (58%) of the patients reported that the main reason for not taking treatment as prescribed was high cost of treatment which also correlates with patient income status as patients with higher economic status were more adherent to their prescribed treatment. In this study we also observed that knowledge and adherence had positive correlation with subsequent visit.

Table IV: Progress of knowledge before and after intervention.

Area of knowledge assessment		Pre-program			After 6 weeks			After 12 weeks			P - value
		Poor ('0' score)	Average ('1 - 2' score)	Good ('3 - 4' score)	Poor ('0' score)	Average ('1 - 2' score)	Good ('3 - 4' score)	Poor ('0' score)	Average ('1 - 2' score)	Good ('3 - 4' score)	
Fluid	N	50	34	16	37	22	41	10	16	74	< 0.001
Diet	N	60	20	20	35	23	42	12	14	74	< 0.001
Medication	N	52	28	20	36	24	41	8	16	76	< 0.001
Basic renal parameter	N	57	24	19	37	21	42	21	15	64	< 0.005
Total knowledge	N	55	26	19	36	22	42	13	15	72	< 0.001

Table V: Correlation between socio-demographic characteristics and total knowledge (MKAQ score).

Variables	Pre-program		After 6th week		After 12th week	
	Mean ± SD	P - value	Mean ± SD	P - value	Mean ± SD	P - value
Sex						
• Male	1.19 ± 0.76	> 0.05	2.15 ± 0.94	> 0.05	2.89 ± 1.22	> 0.05
• Female	1.13 ± 0.81		2.26 ± 1.03		3.03 ± 1.1	
Age						
• < 20 years	1.75 ± 0.5	> 0.05	2.75 ± 1.26	> 0.05	3 ± 1.15	> 0.05
• 21 - 30 years	1.14 ± 0.95		2.36 ± 1.08		3.21 ± 1.05	
• 31 - 40 years	1.08 ± 0.64		2.08 ± 0.86		3.08 ± 0.95	
• 41 - 50 years	1.05 ± 0.83		2.05 ± 1		2.85 ± 1.35	
• 51 - 60 years	1.23 ± 0.81		2 ± 0.93		2.82 ±1.22	
• 61 - 70 years	1.13 ± 0.74		2.33 ± 0.96		2.92 ± 1.1	
• > 70 years	1.67 ± 0.58		2.33 ± 1.15		2.67 ± 2.31	
Marital status						
• Married	1.17 ± 0.77	> 0.05	2.17 ± 0.93	> 0.05	2.96 ± 1.16	> 0.05
• Unmarried	1.2 ± 0.92		2.4 ± 1.35	>0.05	2.8 ± 1.32	
Income score (per month)						
• 2	0.58 ± 0.64	< 0.001	1.45 ± 0.72	< 0.001	2.08 ± 0.94	< 0.001
• 3	1.43 ± 0.53		1.86 ± 1.07		3 ± 1.29	
• 4	1.5 ± 0.82		2.69 ± 0.7		3.31 ± .95	
• 6	1.75 ± 0.46		3 ± 0.76		3.63 ± 1.06	
• 10	1.52 ± 0.58		2.7 ± 0.78		3.59 ± 0.93	
• 12	1.5 ± 0.58		2.75 ± 0.5		3.75 ± 0.5	
Residency						
• Urban	1.53 ± 0.65	< 0.0004	2.75 ± 0.84	< 0.001	3.17 ± 1.06	< 0.005
• Rural	0.97 ± 0.78		1.88 ± 0.9		2.18 ± 1.22	
Level of education						
• Primary	0.62 ± 0.68	< 0.0001	1.41 ± .73	< 0.0001	2.17 ± .04	< 0.0001
• Middle	0.67 ± 0.65		1.58 ± 0.79		2.08 ± 1	
• Secondary	1.56 ± 0.73		2.56 ± .73		2.94 ± .18	
• Higher secondary	1.42 ± 0.64		2.5 8 ± 0.86		3.58 ± 0.86	
• Graduation	1.71 ± 0.47		3 ± 0.61		3.88 ± 0.49	
Employment status						
• Employed	1.58 ± 0.55	< 0.0001	2.82 ± 0.73	< 0.0001	3.66 ± 0.67	< 0.0001
• Unemployed	0.8 ± 0.79		1.63 ± 0.83		2.35 ± 1.13	
• Retired	1.38 ± 0.65		2.46 ± 0.88		3.08 ± 1.32	

Table VI: Paired t-test comparing total adherence (MMSA-8) score.

Assessment time	Mean ± SD	Median	Comparison	P - value
Pre-program	5.34 ± 1.62	6	Pre-program with After 6 weeks	< 0.0001
After 6 weeks	2.51 ± 0.1.53	2	Pre-program with after 12 weeks	< 0.0001
After12 weeks	1.7 ± 1.6	1	After 6 weeks with after 12 weeks	< 0.0001

Discussion

Chronic kidney disease (CKD) is an emerging health problem in both developed and developing countries. Most CKD patients tend to progress, and with declining renal function various complications such as anaemia, hypertension, inflammation, malnutrition, metabolic and mineral-bone disorders gradually develop. ESRD patients on maintenance haemodialysis, tend to develop co-morbidities that require complex management which lead to poor adherence. The challenge for the treating team is to better understand the factors that limit patient education, so that patients'

Table VII: Total and sub-total adherence (MMSA-8) before and after intervention.

Area of adherence assessment		Pre-program			After 6 week			After 12 week			P - value
		Low (score ≥ '3')	Medium (score '1 - 2')	High (score '0')	Low (score ≥ '3')	Medium (score '1 - 2')	High (Score '0')	Low (score ≥ '3')	Medium (score '1 - 2')	High (score '0')	
Fluid	N	86	9	5	38	32	30	24	28	47	< 0.001
Diet	N	84	10	6	36	35	29	24	27	48	< 0.001
Medication	N	74	14	12	29	36	35	19	31	50	< 0.001
Basic renal parameter	N	88	8	4	40	43	27	33	22	45	< 0.005
Total adherence	N	83	10	7	36	37	27	25	27	48	< 0.001

Table VIII: Correlation between socio-demographic characteristics and total adherence (MMSA-8 score).

Variables	Pre-program		After 6th week		After 12th week	
	Mean ± SD	P - value	Mean ± SD	P - value	Mean ± SD	P - value
Sex						
• Male	5.37 ± .55	> 0.05	2.76 ± 1.51	0.037	1.69 ± 1.42	> 0.05
• Female	5.29 ± .74		2.11 ± 1.48		1.71 ± 1.89	
Age						
• < 20 years	4.75 ± 2.22	> 0.05	2 ± 2	> 0.05	1.5 ± 1.73	> 0.05
• 21 - 30 years	5.57 ± 1.5		2.64 ± 1.74		1.36 ± 1.5	
• 31 - 40 years	5.38 ± 1.76		2.08 ± 1.44		0.92 ± .61	
• 41 - 50 years	5.2 ± 1.99		2.45 ± 1.7		1.85 ± .39	
• 51 - 60 years	5.41 ± 1.56		3 ± 1.35		2.27 ± 1.8	
• 61 - 70 years	5.46 ± .25		2.46 ± 1.41		1.83 ± .61	
• > 70 years	4.33 ± .08		1.67 ± 1.53		0.67 ± .58	
Marital status						
• Married	5.37 ± 1.59	> 0.05	2.48 ± 1.49	> 0.05	2.48 ± 1.49	> 0.05
• Unmarried	5.1 ± 1.91		2.8 ± 1.93		2.8 ± 1.93	
Income scale (per month)						
• 2	5.92 ± 0.97	0.001	3.03 ± 1.5	0.008	2.32 ± 1.44	0.008
• 3	5.86 ± 1.07		3.14 ± 1.35		2.71 ± 2.69	
• 4	5.81 ± 0.98		2.63 ± 1.59		1.81 ± 1.6	
• 6	5.13 ± 2.03		2.5 ± 1.93		0.75 ± 0.71	
• 10	4.26 ± 1.97		1.7 ± 1.17		1 ± 1.27	
• 12	4.75 ± 2.63		1.5 ± 1		0.25 ± 0.5	
Residency						
• Urban	4.81 ± 1.98	> 0.05	1.81 ± 1.28	0.0002	1.81 ± 2.08	> 0.05
• Rural	5.64 ± 1.29		2.91 ± 1.52		1.64 ± 1.28	
Level of education						
• Primary	5.86 ± 1.09	< 0.0001	3 ± 1.56	< 0.001	2.34 ± 1.42	< 0.001
• Middle	5.67 ± 1.07		3 ± 1.48		2.5 ± 1.78	
• Secondary	5.56 ± 1.15		3.06 ± 1.18		1.63 ± 0.89	
• Higher secondary	5.58 ± 1.65		2.15 ± 1.38		1.46 ± 1.92	
• Graduation	3.65 ± 2		1.35 ± 1.37		0.47 ± 0.87	
Employment status						
• Employed	4.55 ± 2.05	< 0.0003	1.89 ± 1.47	0.001	0.95 ± 1.21	< 0.0002
• Unemployed	5.92 ± 0.95		3.08 ± 1.44		2.33 ± 1.64	
• Retired	5.46 ± 1.27		2.15 ± 1.28		1.54 ± 1.61	

knowledge and understanding of their kidney disease may be improved.The burden of chronic disease on healthcare services is growing worldwide and the increased development of educational interventions which help patients to better manage their conditions is evident internationally.

Table IX: Reasons for non-adherence.

Reasons for non-adherence	No. of patients
High cost for medicine	58
Complex dosing schedule	49
Forgetfulness	45
Fear of adverse effects	43
Difficult to take large number of pills	32
Unaware about seriousness of the condition to be treated	25
Unaware about the need/usefulness of the condition to be treated	19
Others	16

Table X: Correlation of mean MKAQ and mean MMSA-8.

Variables	Pre-program		After 6th week		After 12th week	
	Correlation co-efficient	P-value	Correlation co-efficient	P-value	Correlation co-efficient	P-value
Questionnaires						
● MKAQ	-0.311	<0.001	-0.325	<0.001	-0.305s	<0.005
● MMSA-8						

Patient education is an essential part of patient care. Patient education is not only an important aid by which patients can better understand their questions, concerns, and needs regarding kidney disease care addressed, but also a crucial pathway to make sure patient participation in self-management of CKD risks. Patient education can help with better patient outcomes but a large number of barriers intercept universal implementation of comprehensive education for people with chronic kidney disease. Among most patients, barriers to education include the complex nature of kidney disease information, low baseline awareness, limited health literacy and numeracy, limited availability of CKD information, and lack of readiness to learn.

World Health Organisation estimated that only half of the people with chronic diseases take their medications consistently as prescribed[22]. In CKD patients, non-adherence may be a cause of uncontrolled hypertension, dialysis, increased medication and hospitalisation-related costs.Thus, non-adherence reduces health benefits of treatment and hastens advancement of CKD to end-stage renal disease. Poor medication adherence has multifactorial causes that need to be understood before interventions can be designed to improve medication adherence[23]. There are many factors which cause poor medication adherence, which according to WHO are classified into five categories : socio-economic factors, therapy-related factors, patients-related factors, disease-related factors, and health system/ healthcare provider related factors[24]. A proper intervention can be customised individually to improve the adherence to treatment of each patient with an understanding of factors affecting non-adherence and identify type of adherence whether it is primary or secondary.

Measuring adherence is, therefore, equally important to both researchers and clinicians. Inaccurate estimation of medication adherence can lead to several problems which are potentially costly and dangerous in both settings. Effective treatments may be judged as ineffective, expensive diagnostic procedures may be ordered, and therapy may be unnecessary and dangerously intensified. Moreover, accurate estimates of medication adherence will provide better evidence on the consequences, predict risk factors, and plan to improve treatment adherence.

The MKAQ score for assessment of knowledge and MMSA score for assessment of adherence in patients with chronic illness are effective tools that have been validated for the same. In India there have been only few studies which have evaluated medication knowledge and treatment adherence and their socio-demographic correlation in different stages of CKD. The present study assessed the medication knowledge and adherence to treatment of chronic kidney disease patients, at the baseline and at the end of 6th and 12th weeks, after providing patients with structured education about their medications.

The study observed that total and subtotal knowledge for fluid management, diet, medication ($P < 0.001$) and renal parameters was significantly ($p < 0.005$) improved with education from baseline to the sixth and twelfth weeks. Various studies support our results which also showed increased knowledge after intervention in CKD patients[15,18]. In this study we observed that patient knowledge had statistically significant ($p < 0.0001$) association with residence, education, employment and income status of patients. However in this study most of CKD patients had very poor knowledge in the pre-program because of poor socio-economic status and rural background of most of the study population.

In the present study, according to MMSA-8 there was significant improvement in total and subtotal adherence from pre-program to subsequent visits at 6 weeks and 12 weeks after education. Total adherence significantly improved after 3 months of education, declining non-adherence for treatment from 80% to 25% . There was

statistically significant (P < 0.001) improvement in adherence to fluid, diet, medication and renal parameters. Total MMSA-8 score also had significant correlation with demographic parameters. viz., education, employment and income status of patients. Chronic kidney disease patients with higher income, higher education and employment status were more adherent to their prescribed treatment. Level of education has also been cited as a determinant in adherence behaviour in chronic illnesses such as CKD. Low education has been found to cause decreased adherence due to poor correlation with knowledge of disease and treatment. Patients with low health literacy find it difficult to follow appropriate schedule. Similar findings were reported by Hala *et al*. They found statistically significant correlation between total adherence scores and levels of education, ($f = 11.902$, $p < 0.05$)[25]. Abdulmalik *et al*, reported that there was a significant difference in adherence (P = 0.024) between participants who had lower education compared to participants with high education[26].

In this study rural patients had poor knowledge regarding their disease and available treatment compared to urban patients. The scarcity of health care resources in developing countries makes it difficult to avail of renal replacement therapy, with consequently low adherence to this therapy. In India, the majority of patients live in rural areas where they have to travel long distances to receive treatment, resulting in dialysis inadequacy and frequent disruption of work that leads to job losses and consequent non-engagement with treatment regimen. Problems of transport are one of the most common reasons for absence or late appearance at the scheduled time for dialysis sessions. Thus, availability and accessibility of treatment centers affect adherence to prescribed treatment regimen among CKD patients.

Most of the patients in present study belonged to lower socio-economic status class; affordability of treatment remains a major issue for these patients. Patients with better income status were more adherent to their prescribed treatment and had more knowledge about their illness and treatment. These results were in agreement with previous study that was conducted by Abdulmalik *et al*[26]. Another study by Alnaif and Alghanim also reported that patients of higher income status, higher baseline education and with employment had good knowledge score[27].

The most common reason for non-adherence in our study was high cost of medicine (58%), followed by complex dosing schedule (49%), forgetfulness (45%), fear of adverse effects (43%), difficult to take large number of medicines (32%), etc. Only 5% of the patients were non adherent due to depression and failure of trust in the physician. High cost of medication was found as one of the most common reasons for non-adherence to drug therapy in present study (58%). Frankenfield *et al*, has also reported that cost is a major factor for non-adherence in 23% of the ESRD patients[28]. Varleta *et al*, reported forgetfulness as the most common factor responsible for non-adherence in 67% of the patients (n = 310) using Morisky green questionnaire; the present study finds this only in 45% of the patients[29]. Sontakke *et al*, also reported that high cost (62.74%), complex dosing schedule (58.82%), and fear of adverse effects (47.05%) were the common causes of nonadherence[30]. Fear of adverse effects due to medication and aversion to consume multiple drugs at the same time were another factor due to which patients are reluctant to adhere to the medication schedule. Adverse effects, if present, can play a crucial role in deciding whether or not patients will take their medications as prescribed. Hence, health professionals can play a vital role in this regard in convincing patients that benefits of treatment outweigh risk of adverse effects.

In our study, the level of education has also been reproduced as a determinant in adherence behaviour. Knowledge becomes the chief facilitator of positive adherence to treatment. Low level of patient's education has been implicated to cause low adherence due to poor correlation with knowledge of disease and treatment. Low health literacy has been reported in CKD patients and this factor, combined with other factors, may contribute to non-adherence. Those who had low levels of health literacy were found to have difficulty to follow instructions on how to care for themselves or to adhere to treatment regimens such as management of fluid, diet and taking their medicines. Moreover, patients with low income status and low health literacy were associated with more hospitalisations, greater use of emergency care, less adherence to treatment recommendations, worse health status, and higher mortality rates.

Most of the CKD patients seen in this study were already in the late stages of CKD. In a developing country like India most of the patients approach a nephrologist at an advanced stage of disease thus, there has already been delayed referral to the nephrologist and delayed initiation of treatment to retard the progression of renal disease. As it is obvious poor health literacy along with poor socio-economic status, complex medication schedule and poor approach of RRT centers contributes to non-adherence; hence health professionals can play an active role in overcoming this barrier to adherence. Education programmes have the purpose of increasing patient awareness about their condition and its outcome so that lifestyle modifications can be initiated that might delay the progression of renal disease. It could at the same time prepare the patient for Renal replacement therapy (RRT) or pre-emptive renal transplantation in the future. An early diagnosis of CKD

would aid in the appropriate management of its complications and move patients gradually into RRT. The morbidity and higher cost associated with delayed initiation of dialysis or the need for emergency dialysis may be avoided with educational opportunities and longer pre-dialysis period might be afforded.

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