

End stage chronic kidney disease in Saudi Arabia

A rapidly changing scene

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ABSTRACT

رافقت العقود الثلاثة الماضية زيادة واضحة في نسبة الحالات المصابة بمرض الفشل الكلوي المزمن في مرحلته النهائية بالمملكة العربية السعودية، وقد فاقَت هذه النسبة تلك النسب التي نُشرت في البلدان الأخرى. وقد أثر على زيادة نسبة انتشار المرض كلاً من العوامل التالية: تغير نمط الحياة، ونمو التعداد السكاني، وارتفاع معدل العمر المتوقع للأفراد، وانتقال الناس للعيش في المدن الكبيرة، وكانت زيادة نسبة الإصابة بمرض السكري الكلوي، والتغير الملحوظ في عامل العمر من أكثر هذه العوامل تأثيراً على المرض ومدى انتشاره.

There have been a marked rise in the prevalence and incidence of end stage chronic kidney disease (CKD) in Saudi Arabia over the last 3 decades. This rise exceeds those reported from many countries. The enormous and rapid changes in lifestyle, high population growth, and fast increase in life expectancy, and massive urbanization that has occurred over the last 3 decades combined to make the current CKD status different to what it was. The 2 major factors that influence the CKD status are the very high rate of diabetic nephropathy and shift in age demographics.

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with functioning kidney grafts.¹ There have been remarkable changes in the characteristics, etiology, and demographics of patients with chronic kidney disease (CKD) in Saudi Arabia as well as in healthcare delivery, including renal replacement therapy modalities, given to these patients.¹ In this article, we review the status of adult end stage chronic kidney disease (ESRD) in the Kingdom of Saudi Arabia. Unless otherwise stated, the information given in this article is based on the latest primary data (2008) available from the Saudi Centre of Organ Transplantation registry.¹ The purpose of this review is to describe the present status of CKD in Saudi Arabia, the CKD disease burden, the changes that occurred over the years and speculate on future trends.

Incidence and prevalence. Of the 10,203 patients on hemodialysis in the Kingdom, 65.9% were treated by the Ministry of Health (MOH) hospitals, 17.7% by non-MOH governmental hospitals, and 16.4% from the private sector (Table 1). Of all the patients receiving dialysis, only 8.7% were on peritoneal dialysis (PD). Of these, two-thirds are on automatic PD and one-third on continuous ambulatory peritoneal dialysis (CAPD). The mortality rate among patients on PD is similar to those on hemodialysis. Approximately 54.8% were males and 88.3% were Saudis. Of all the patients on dialysis, 66.2% were over >45 years of age (Table 1). Of the current patients on hemodialysis, 42.5% were diabetic (Table 2). The prevalence of renal replacement therapy (RRT) has increased from 361 per million population (PMP) in 1995 to 874 PMP in 2008. Over the same period, the dialysis patient prevalence has increased from 187 to 463 PMP (an increase of 162%)² (Table 3) and renal transplant prevalence from 168 to 371 PMP (an increase of 121%). The discrepancy between the 2 prevalence figures reflects that the transplant activity did not rise equally with the rise in the dialysis activity over that period. The prevalence of ESRD in the USA increased from 1150 PMP in 1995 to 1698 PMP in 2007 and in dialysis from 710 to 1076 PMP.² This reflects a 47.7% rise in ESRD prevalence, and a 51.5%

The first dialysis session in Saudi Arabia took place in 1971 and the first renal transplant in 1979.¹ By the end of 2008, there were 10,203 patients on hemodialysis, 966 on peritoneal dialysis, and 7836

Table 1 - Renal replacement therapy in Saudi Arabia and age distribution (2008).¹

Renal replacement therapy	Percentage
On hemodialysis	53.7
On peritoneal dialysis	5.1
With renal graft	41.2
Male	54.8
Ministry of Health	65.9
Non-Ministry of Health	17.7
Private	16.3
Saudi	88.3
Mean age (years)	55.6
Age distribution (years)	Percentage
<15	1.6
16-25	7.3
26-45	24.9
46-55	22.1
56-65	23.4
>66	20.7

Table 2 - Extrapolated age-related prevalences and incidences of end stage chronic kidney disease.

Age (years)	Prevalence (PMP)	Incidence (PMP)	Incidence (%)	Prevalence (%)	New patients (%)
≤15	16.40	4.76	0.0005	0.0016	1.6
16-25	325.22	94.46	0.0094	0.0325	7.3
26-45	396.41	115.79	0.0116	0.0396	24.9
46-55	1877.50	548.08	0.0548	0.1878	22.1
56-65	3407.14	994.83	0.0995	0.3407	23.4
≥66	3022.86	880.05	0.0880	0.3023	20.7
Total	479.01	139.72	0.0140	0.0479	100

PMP - per million population

Table 3 - Change in the prevalences (PMP) of ESRD and dialysis in Saudi Arabia and United States of America (USA) (1995 and 2008).^{1,2}

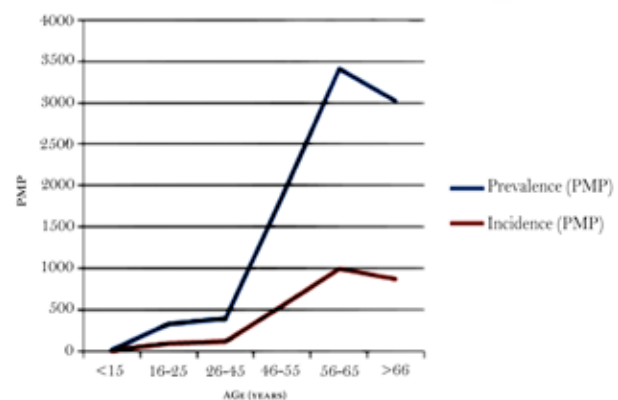
Treatment	1995	2008	% change
ESRD			
Saudi Arabia	361	874	142
USA	1150	1698	47.7
Dialysis			
Saudi Arabia	187	463	161
USA	710	1076	51.5

PMP - per million population, ESRD - end stage chronic kidney disease

rise in dialysis prevalence (Table 3). The larger changes seen in KSA compared to the USA reflects the facts that the annual increase of ESRD has plateaued in the USA and even decreased for diabetes, caused by ESRD,³ while it continues to increase in Saudi Arabia. The main reasons being related to shift in age demographics and dynamics towards an older age and the increasing incidence of diabetes. It was anticipated that the Saudi population aged >66 years will rise up to 3.5 folds over the next 20 years. Probably, this will cause a rise in new cases in that age group from 1198 in 2008, to 4109 in 2029. This would represent an increase in the incidence rate from 138 PMP to 176 PMP (27.9%).

In 2008, 2976 new patients were added to the hemodialysis program pool. This represents 29.2% of the total of 10203 patients. However, during the same year (2008), 7% of the dialysis population was transplanted and 12% died. This will make a net annual increase in the Saudi dialysis population of 10.2%, which is roughly 4 times the Saudi national population growth rate. This rate is also higher than the reported global annual dialysis population increase of 7%. In the USA, the latest annual increase rate in the dialysis population was 3.97%,³ with a 10.2% net increase in the dialysis population in Saudi Arabia and these calculations could provide an estimate of 17,488 in 2015. The non-MOH governmental medical sectors considered 17.7% of the total dialysis population, and 59% of the transplant population. Of the total RRT patients in Saudi Arabia, 35.8% was being cared for by the non-MOH governmental medical sectors.

Age, mortality, and ESRD. The prevalence and incidence of ESRD in Saudi Arabia increase sharply with age (Figure 1 & Table 2). As the number of elderly Saudis increases, as expected, one could infer that ESRD incidence and prevalence would increase in Saudi Arabia in the future, which is not the case in developed countries in which these rates have declined or stabilized recently.^{4,5} Half of all adult patients starting RRT in the

**Figure 1** - Dialysis incidence and prevalence in Saudi Arabia by age groups.¹ PMP - per million population

UK are >65 years old, although this group recorded 25% of the adult population.⁶ Similarly, in KSA, 21% of our incident patients were >65 years old, although this group was recorded as 3.2% of the adult Saudi population. This amounts to an incidence of 893.7 PMP/year in this age group currently. In 20 years time, the population over the age of 65 years is expected to increase up to 13% in Saudi Arabia. This means that the number of ESRD in this age group will quadruple by 2030. Of the current total dialysis population, patients over 45 years account for 66.2%, which is 13.6% of the total Saudi population. The overall incidence in this age group is 757.7 PMP. There are no data published to inform us of the prevalence of pre-dialysis CKD among the Saudi population, and this is important for planning healthcare delivery policy. In a number of countries, the prevalence of glomerular filtration rate (GFR) <60 mls/minute was reported between 5.7-11%. The age adjusted risk of death is 4.7 times in patients with GFR >60 mls/minute compared with those with GFR <60 mls/minute.⁷

The overall death rate in Saudi Arabia was 2.47/1000⁸ and in our study we recorded 12% (Table 1). From these figures, one could calculate that deaths from ESRD were 2.21% annually. Of those 12% dying with CKD in Saudi Arabia annually, we estimated that two thirds were diabetics.⁹ Since the prevalence of diabetic nephropathy (DN) among ESRD patients was 42.5% (Table 2), it follows that the mortality rates among diabetic ESRD patients was 18.6% and non-diabetic was 6.9%.

Implications on required manpower by the year 2015. In MOH hospitals, there is one doctor for each 17.7 patients on dialysis. This compares to 13.7 for non-MOH governmental hospitals. This discrepancy is clearly more obvious when we look at patient/consultant ratio (122.3 for MOH hospitals and 29.6 for non-MOH governmental hospitals) (Table 4). On the other hand, the ratio of transplanted patients followed up to nephrologists was 16.0 for MOH hospitals and 41.3 for non-MOH governmental hospitals (Table 4). Thus, the current MOH complement of healthcare providers for dialysis falls well below those in non-MOH government hospitals. To bring their number to the minimally optimal ratio of 75 patients to one consultant, there would be a

need of 31 additional consultants in the MOH dialysis services, and an additional 54 consultants by the year 2015. This would reflect 4.7 consultant nephrologists PMP compared with 53 consultant nephrologists PMP in Taiwan.¹⁰

In this study, we calculated the prevalence of ESRD in Saudi Arabia to become 1100 PMP by the year 2015. Thus, the suggested number of consultants will mean that each consultant will be looking after 234 ESRD patients. This does not include other renal conditions he/she will be required to look after. The British Renal Association recommendation is that for every 75 ESRD patients' there should be one consultant.¹¹ By the year 2015, the MOH dialysis nurses workforce will need an additional 1746. Currently, the estimated Saudi dialysis nurse is at <10%.

The improving story of HCV and HBV. The overall prevalence of HBV among our dialysis patients in 2008 was 4.6%. This is down from 10.8% in the early 1980s.⁹ It is now rare to have HBV seroconversion to positivity on dialysis. This is largely due to the aggressive vaccination program against HBV carried out in the dialysis patients. In the early 1980's, we noted a massive prevalence of liver disease with high mortality among our dialysis population, which we attributed then to non-A, non-B hepatitis.¹² With the advent of HCV testing, it became quickly apparent that this was due to HCV infection. The overall prevalence of HCV infection was 68% in 1995.¹³ Now it has decreased to 33% (Table 5) (using RIBA test). The sero-conversion rate in the late 1990's was reported to be 5-9%.^{14,15} The drop in HCV prevalence is due to improved application of strict universal precautions by nurses. Some units in the Kingdom use geographical or temporal isolation of HCV positive patients. Nevertheless, there are still pockets of high prevalence of HCV particularly in the Western and Southern region, but even in these pockets there has been a major reduction in HCV prevalence, by around a third (Table 5). A high HCV rate of seroconversion in patients travelling for holiday and being dialyzed in certain dialysis units with high HCV prevalence has been reported.¹⁶

Reports comparing nursing practices in high HCV prevalence units to those with low prevalence units in the Western and Eastern regions of Saudi Arabia concluded

Table 4 - Manpower ratios for dialysis and transplant patients.

Medical sector	HD patient/consultant	HD patients/specialist	HD patient/GP	HD patient/nurse	Transplant patients/nephrologist
MOH	122.3	46.7	37.0	3.7	16.0
Non-MOH	29.6	33.5	106.4	2.8	41.3
Total	65.0	43.4	48.1	3.6	20.8
MOH - Ministry of Health, HD - hemodialysis					

that improving the nurse/patient relationship results in a better control of HCV transmission in dialysis units.^{15,17}

The worsening story of diabetic nephropathy. Twenty-five years ago, the prevalence of diabetic nephropathy among the dialysis patients in Saudi Arabia was reported to be 4%.^{9,12} Now the prevalence is 42.5% (an increase of 162%) (Tables 1 & 2). In 1999 we reported that diabetic nephropathy accounted for 40.5% of incident ESRD;⁹ now it is approaching a horrendous 50% with 60.5% of the annual deaths among dialysis patients occurring in patients with diabetic nephropathy.⁹ The incidence of diabetic nephropathy among all new cases in Saudi Arabia is one of the highest in the world (Table 6).

The few reports available, suggest that diabetic nephropathy occurs more commonly among Saudi diabetics than reported elsewhere, even in ethnic groups known to have such propensity (namely British Asians or Native Americans).¹⁸ We also found that disturbingly, Saudis with diabetic nephropathy progress to ESRD faster than any other ethnic groups including Pima Indians and African Americans. In this study, we found that 50% of patients with histologically proven diabetic nephropathy progress to ESRD or double their serum creatinine in less than 2 years.¹⁹ It is interesting

that the progress to ESRD in white Americans with diabetic nephropathy was reported to be much faster than in their Norwegians counterparts, although the prevalence and degree of control of hypertension were similar in the 2 groups. The incidence of DN-related ESRD in Norway was 9 PMP, and among American Whites was 92 PMP. The authors speculate that this might be due to the much higher rate of morbid obesity among white Americans compared to Norwegians (4% versus 0.7%).²⁰ In a study in primary care attendants in Riyadh, morbid obesity was seen in 8.9%.²¹ In another study, the prevalence of overweight was found to be 30.7% for males and 28.4% for females, and obesity prevalence was 14.2-16% in males and 23.6-24% in females.²² Overweight was detected early in life with 23.1% of males and 30.5% of females aged 18-21 years being overweight.^{21,22} The obesity prevalence among Saudis (23.6% in females and 14.2% in males) is higher than that seen in USA, Sweden, Italy, and Australia.²² The Kingdom of Saudi Arabia has one of the highest prevalences of diabetes mellitus in the World (23.7% in those over 30 years of age) and is expected to rise to approximately 40-50% by 2030. This is largely associated with the high prevalence of obesity among the Saudi population, including the children. The vast majority (96%) of diabetic nephropathy occurs in type 2 diabetes mellitus. The overall incidence of ESRD among Saudi diabetics over the age of 45 years is 1515.⁴ PMP, which is 3 times that in the non-diabetic group (505.1 PMP). The incidence among non-diabetics and diabetics in this age group was 0.05% and 0.15% (Table 7). This high incidence of ESRD among Saudi diabetics is even higher than that seen in the Canary Islands, which is quoted as having one of the highest incidences of DM-ESRD (1477.3 pmp) among all the Spanish regions in which the incidences range from 177.3 to 984.9 pmp.²³

Diabetes and kidney donation. A view from Saudi Arabia. Since diabetic nephropathy is the most common cause of ESRD in Saudi Arabia, one would expect many instances of donors coming forward to donate to relatives with DN. The question then arises as to the risk of Saudi diabetic donor developing ESRD. This question could be approached in 2 ways at least: The accumulative incidence in the Saudi general population over 50 years is $135 \times 50 = 6750 / \text{PMP} = 0.675\%$. In other words, a 20-year-old Saudi has a 6.75 in 1000 chance of developing ESRD when he is 70 years old. On the other hand, for a Saudi diabetic, the cumulative incidence over a 50-year period is $287.8 \times 50 = 14390.7 / \text{PMP} = 1.44\%$. In other words, a 20-year-old Saudi diabetic has a 14.1 in 1000 chance of developing ESRD when he is 70 years old. Thus, being a diabetic increases the risk of

Table 5 - Prevalence rates of HBV and HCV in different areas and hospitals in the Kingdom.¹

Country	HBV %	HCV %
Central	4.7	29.0
West	4.2	38.5
East	4.1	22.0
North	4.4	24.1
South	7.2	36.6
Overall prevalence	5.0	33.0
HBV - hepatitis B virus, HCV - hepatitis C virus		

Table 6 - Manpower ratios for dialysis and transplant patients.

Country	Percentage of incident of ESRD due to diabetic nephropathy
Netherlands	14.6
Australia	22.0
Iran	25.2
Sweden	25.0
Germany	36.1
Italy	15.9
USA	45.2
Saudi Arabia	50.0
ESRD - end stage chronic kidney disease	

Table 7 - Incidence of diabetic and non-diabetic end stage chronic kidney disease among Saudis over 45 years of age.

Variables	Incidence
Number of new cases (>45 years)	1970.0
Number of new cases due to DN	985.0
Incidence/PMP in >45 years	757.7
Incidence/PMP among diabetics >45 years	1515.4
Incidence/PMP among non-diabetics >45 years	505.1
Percentage incidence in diabetics >45 years	0.15
Percentage incidence in non- diabetics >45 years	0.15
DN - diabetic nephropathy, PMP - per million population	

developing ESRD by 0.76% (RR=2.1).

However, this assumes that the donor is a diabetic at the time of donation. It has been shown that the offspring of a non-insulin-dependent diabetic mother is twice more likely to develop DM than the offspring of a diabetic father (Europeans, 21.7% versus 9.9%; Maori, 17.6 versus 11.4%; Pacific Islands, 15.7 versus 5.3%).²⁴ Thus, assuming that the donor is giving a kidney to his mother with DN, his chance of developing diabetes is 21%. Repeating the calculation above with this additional factor in mind, one could calculate that his chances of developing ESRD to have now been reduced to 8.3 in 1000 (RR=1.23). However, the fact of the matter is that such a donor-compared to other siblings-would be sure to have DM excluded in him and be sure to be counseled to avoid weight gain and to have regular checks. As such, theoretically, he should have a somewhat less chance of developing diabetes or its complication than his siblings. The Minnesota study found, compared to the general population, an approximate one-third reduction in ESRD in former donors.²⁵ This means that his chances of developing ESRD will drop from 8.3 in 1000 to 5.6 in 1000. One should always remember that when DN develops, it does so whether the patient has one or 2 kidneys. There has been no evidence showing that having one kidney is associated with faster deterioration of diabetic nephropathy.²⁶

Saudi Arabian place in the World League of RRT Provision. The overall incidence for ESRD in Saudi Arabia is 135 per PMP/year. The prevalence of ESRD (dialysis and transplantation) is 874 PMP, and the dialysis treatment prevalence is 486 PMP. The reported prevalences of RRT in different parts of the world are as shown in Table 8. As can be seen, the Kingdom's provision for renal replacement therapy is good. Indeed, it is the current policy in Saudi Arabia to provide dialysis to all citizens free of charge whenever required. Renal replacement therapy is an expensive form of therapy. The prevalence of ESRD in a given country

is related to its GDP, which suggests that low GDP imposes restrictions on ESRD treatment provision. It was found that there is a significant correlation between ESRD prevalence and GDP per capita when the GDP is below \$10000. Above \$10000, there is no such clear correlation, which suggests that following attainment of a certain economic wealth, factors other than economy dominate in determining incidence and prevalence of ESRD treatment providing.⁴ Based on current estimated cost of dialysis session as well as manpower and overhead and utility costs, we estimate that the current total direct cost for looking after RRT patients in the Kingdom is \$506,723,847 annually, which amounts to 3.8% of the Ministry of Health's budget, although ESRD patients comprise only 0.08% of the total population. In the UK, 1-2% of the total British NHS budget goes towards RRT provision, although ESRD patients constitute only 0.05% of the total population.⁶ In 2006, RRT costs in USA reached nearly \$23 billion, 6% of the Medicare budget, although the ESRD patients comprised only 0.18% of the total US population.⁵

Income and educational level, and their impact on burden of ESRD in KSA. It has been well established that patients with ESRD tend to be in the lower income bracket. This has been reported from different parts of the world.²⁷⁻²⁹ We also found that most of our patients are of low socioeconomic status. At least half of the dialysis patients earn less than 40% of the average national monthly income, and 25% earn less than 20% of the average national monthly income.³⁰⁻³² In a USA study,²⁹ the association between low socioeconomic status was found to be particularly strong in patients with diabetic nephropathy. This may be related to reduced access to measures that would prevent progression of CKD in the poorer patients. There are no available data in Saudi Arabia to assess if the same relationship exists. In a Swedish study,²⁷ it was found that ESRD is 60-110% more prevalent in unskilled compared to professional individuals, and 30% higher in non-university compared to university graduates. In another study in the USA,²⁸ it was found that progressive CKD is 60% more likely to occur in the lowest socioeconomic status quartile compared with the highest quartile. The relative risk among whites in USA of developing ESRD is 1.21 in those earning up to \$10,000 annually, and only 0.77 in those earning more than \$25,000 annually.²⁹ In a study from Jordan,³³ 86.8% of the patients were unemployed, and 92% were poor.

Poverty is associated with lower educational levels. Our studies also show a similar pattern. We found in one study that 54% of our patients hardly completed primary level schooling.³⁰ In another study covering 4 dialysis units in 3 Saudi cities, we found that 57.1% of the patients had <4 years of education.³³ In a third

study,³⁰ we found that 41.5% were illiterate. Homrany³¹ found that 70.4% of the dialysis patients he studied were illiterate. These figures compare to a general KSA population illiteracy rate of 21.2%, with 94% of those starting grade I expected to finish 6 years of education.³⁴ Poverty is also associated with low birth weight, which is in turn associated with higher incidence of CKD. The odds ratio (OR) for ESRD in low birth weight was reported to be 1.58; (95% CI, 1.33-1.88).³⁵ The prevalence of low birth weight in Saudi Arabia is 12% compared to 8% in the UK and USA.³⁶ This may be related to suboptimal dietary intake during pregnancies. In a study from Riyadh, it was found that the average energy intake among pregnant Saudi women was only 65.7% of the recommended level. In this group, 7.9% of the pregnancies ended with low birth weight babies. The mean birth weight was slightly higher among mothers with an intake above 85% of the recommended, compared to those with an intake below 85%.³⁷ We do not have figures of birth weights of Saudi patients with CKD. We also do not have details of the relationship between birth weights and socioeconomic status in Saudi Arabia.

Satisfaction, awareness expectation, and quality of life. Better quality of life (QOL) scores among dialysis patients are associated with a significant reduction in the frequency of hospitalization and in mortality.³⁸ End stage renal disease has been reported to negatively impact health (44%), work (70%), finance (55%), and psychological status (25%).⁴⁰ In our own study, we found the worst affected QOL domains in Saudi patients to be “sexual life” and “exercise” and the least affected to be “family and social lives” and “religious duties.” This can be explained partly due to the priority our patients give to their religious duties, and partly because Islam teaching eases up the rigorousness of religious obligations as the disease symptoms worsen, and functional capacity diminishes.³³ We also found that a lower level of education was associated with a greater effect on stress, overall health, mood, sexual life, energy, hobbies, and exercise ability.³⁴

Like reports from other countries,⁴⁰ Saudi patients on dialysis suffer from a high prevalence of depression, with 40.7% being clinically depressed.³³ This is associated with a very high prevalence of insomnia among our patients (60.8%).⁴¹ In a study comparing satisfaction/expectation among Saudi and Austrian dialysis patients, we observed higher satisfaction coefficients among Saudi patients and higher dissatisfaction coefficients among Austrian patients. These were not related to age or duration on dialysis, but were related to literacy rate.⁴²

We evaluated dialysis patients’ knowledge and health awareness in 5 areas, causes of renal failure, biology of

the kidneys, symptoms of kidney disease, therapeutic options available, and existing national kidney patients support facilities. We found that 60% of the patients had less than secondary education. The average mark for correct responses for all patients was 45.9% with a highest (58%) for the category on “biology of the kidney” and lowest (36.8%) for “national kidney patients support facilities.” Thus, the level of our patients’ health awareness is lower than satisfactory. The level of education seems to be a contributory factor.⁴³ Most of our patients have limited awareness of cardiopulmonary resuscitation, mechanical ventilation, and disease outcomes.⁴⁴ Most of the patients said that they trust their physicians to decide on the futility of resuscitation.⁴⁵

We can, thus, conclude that our dialysis patients suffer from similar psychosocial problems as do other dialysis patients in other countries. They suffer from depression, they have problems with physical, and sexual function, and they have problems with finances, work, and lack of vitality. What is strikingly different among our patients is the especially good social/familial support they have, and the correspondingly low level of feelings of being a burden to the family. Another striking difference we observed in our patients was the high level of satisfaction as perceived by them. All this seems to be linked to low levels of expectation. There is also a tendency to respond in a way to support the status quo rather than being critical of it. In contrast to this placid survey-related behavior, in real life situations impacting them personally, they can be very critical and demanding.⁴² Concomitant with the rise in CKD disease burden witnessed in Saudi Arabia in the last 3 decades, there has been a concomitant rise in the dialysis services provided in all areas of the country, such that all citizens requiring dialysis often get it very near to their abode.¹ One recent vital development is the increasingly important services being provided for renal failure patients by the Prince Fahd Bin Salman Kidney Patients Society. Although kidney transplant activity is also on the rise, this has plateaued and is nowhere near enough to catch the rising demands.¹ To that end, a system of ethically regulated unrelated donor transplantation has started recently.⁴⁶ Although this is likely to face societal resistance, we need to explore the introduction of non heart beating donation, and the “presumed consent” strategies.

Preventive measures are of paramount importance. As shown in this review, a main reason for the rise of CKD in Saudi Arabia is diabetic nephropathy. A major preventive measure should, therefore, aim at reducing the incidence of diabetes in the population by introducing vigorous lifestyle alteration advice media campaigns. Another important preventive measure is

to establish a strategy of early referral of patients with CKD to the nephrologist, as this has been shown to slow or even prevent progression of CKD.⁴⁷

In conclusion, the prevalence, and incidence of endstage CKD in Saudi Arabia exceed those seen in many other countries, and has shown a rapid rise over the last 3 decades. The enormous and rapid changes in life style, high population growth, fast increase in life expectancy, and massive urbanization that occurred over the last 3 decades have combined to make the CKD status different to what it was. The 2 major factors that influence the CKD status are the very high rate of diabetic nephropathy and shift in age demographics.

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