SHORT COMMUNICATION

Is haemodialysis the most feasible dialysis modality for Pakistan?

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Abstract

Chronic kidney disease (CKD) has shown a rising trend in the last two decades. It is one of the most devastating diseases which has an enormous psychosocial and economic burden. The treatment available includes haemodialysis, peritoneal dialysis and kidney transplantation. All treatment options have their pros and cons, needs and preferences, though haemodialysis is one of the most available entity in Pakistan. There are a few intrinsic problems associated with haemodialysis which has significant environmental as well as economic impact. One of the most important is the need of huge quantity of water to carry out the haemodialysis procedure along with production of solid waste in the form of disposables and electricity consumption. Peritoneal dialysis on the other hand is more environment-friendly and cost-effective and it should be one of the preferred options for our CKD patients.

Keywords: Pakistan, haemodialysis, peritoneal dialysis, chronic kidney disease.

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Introduction

Chronic kidney disease (CKD) was ranked 27th in the list of causes of total worldwide deaths in 1990, but rose to 18th rank in 2010. The prevalence of End Stage Renal Disease(ESRD) in Pakistan is reported to have increased from 5% to 31% in different studies,[1] but recently in a population-based study, it was reported to be around 100 per one million population.[2] With the population of 220 million, this translates into 22,000 new patients requiring dialysis every year. It not only has serious cost implications but also an impact on natural resources such as water and electricity consumption, and also production of solid wastes in the form of disposables. The CKD epidemiology and the risk factors associated with it have not been studied thoroughly in Pakistan, as very few hospital-based studies have been performed in the past. These studies manifested that diabetes mellitus (DM) and hypertension (HTN) are the major causes of CKD in urban areas, while CKD of unknown aetiology, glomerulonephritis and kidney stones were prevalent in the rural areas.[3] In this article, we would like to review all the four major implications of haemodialysis facilities.

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Each dialysis machine can cater to six patients on a thrice weekly schedule with three patients a day. The high prevalence of ESRD requires more and more dialysis machines and increasing dialysis facilities every year in a country where healthcare still has to be paid by the patients themselves and the government is unable to spend even 1% of the GDP on healthcare. Even in developed countries such as North America, although the cost is not borne by the patients the overall cost of dialysis consumes a big chunk of the health budget. For example, in 2013 it was 28% of the medical budget which consumed around $42 billion in that year.[4] In Pakistan, a single session of haemodialysis costs around Rs3,000 to 8,000, resulting in an average cost of Rs 550,000-700,000 per year, while the reported average annual income in Pakistan is around Rs 320,000.[5] Similarly, the annual cost incurred by a 100-stationed haemodialysis facility, doing three dialysis a day will be around Rs 470 million (Table).

Dialysis registry in Pakistan has not still been established appropriately. According to the last published data by The Kidney Foundation of Pakistan in 2014, there were 5,935 patients on haemodialysis with 891 machines in the country, but this data is quite limited with large dialysis facilities not contributing their data to the foundation. Therefore, considering the prevalence reported above, the annual cost of haemodialysis for 22,000 new patients every year will be around Rs12-15 billion, which certainly the government cannot afford, at least in the recent years to come. The cost of capital expenditure to establish and equip these dialysis centres is in addition to this operating cost.

Other than the cost, there are other intrinsic problems of haemodialysis that need to be acknowledged with respect to natural resources of our country. Pakistan is facing water and electricity shortage and increasing environmental pollution due to improper solid waste management. Dialysis not only consumes huge amount of water and contaminate the existing water resources, but also consumes electricity and produces enormous amount of solid waste as dialysis disposables.

In 1951, Pakistan had per capita water availability of 5,000 cubic metres which sharply declined to around 1,038 cubic metres per capita today. The per capita storage capacity in

Table: Showing calculation of different domains of haemodialysis, transplantation and peritoneal dialysis utilized annually.

S.No	Modality	Calculation for one year (313 days), 100 machines and 3 sessions per day.	Peritoneal dialysis Cost
1	Cost in Rupees (PKR). 3000 to 8000 per session average cost 5000	5000x3x100x313=469,500,000 PKRs Per month cost per person. 4500x 12=54,000	30,000 to 35,000 / month
2	Water consumption. 350 litre in one session	500x3x100x313=32,865,000 litre or 8,682,014 gallons	
3	Electricity consumption. 480 Kw per hour for 12 hrs.	480x12x100x313= 180,288,000 Kilo Watt or 180,288 Mega Watt or 180 Giga Watt	
4	Solid waste production. 2.7 Kg in one session	2.7x3x100x313=253,530 kg	
5	CO_2 production. 66.44 pounds per Kw electricity generation.	480x12x100x66.44x313= 11,978,334,720 pounds	

the United States stands at 6,150 cubic metres, in Australia 5,000 cubic metres, but in Pakistan it is just 132 cubic metres, which shows how vulnerable 220 million Pakistanis are in terms of water availability. To carry out haemodialysis, the water should be free from solutes and germs, and its hardness is measured in terms of Total Dissolved Solids (TDS). Usually, the supplied water or "Feed water" from various sources in our country has hardness range from 700–2000 mg/L.[6] To get the required solute and germ free water of less than 10 TDS from this high TDS water, 60-80% of the feed water needs to be rejected and thrown away. The "rejected water", after extraction of "pure water", has higher concentration of solutes and higher TDS and is usually discarded into sewerage lines. On the other hand, the pure water after mixing with dialysis concentrates and passing through the dialysis machines, undergoes the process of diffusion with blood on the other side of the dialyzer, and on exit from the dialysis setup, contains waste products of the body which is also discarded. One four-hour session of haemodialysis requires at least 120 litres of pure water (consumption around 500 to 800 ml/min). With a rate of 60% rejection, around 300 litres of feed water is required to generate this amount of pure water with recommended hardness of less than 10 TDS.[7] This means that around 180 litres of feed water with high concentration of solutes is discarded before the dialysis, while 120 litres of water containing body waste products is drained after dialysis. The utility of both types of water is questionable and there are no clear recommendations for use in gardening, flush tanks, etc. due to high concentration of solutes. The rejected water in RO unit cannot be subjected to recirculation through RO as this will increase the hardness of pre-treatment feed water and will have negative impact on RO membranes, shortening their life-span.

Water wastage is further enhanced by use of reprocessing machines for dialyzers reuse. Although dialyzer manufacturers recommend 'single use', re-use is widely accepted if reprocessing is done under standardised practice guidelines like those delineated by American Association of Medical Instrumentation (AAMI). The developing countries have to rely much on this reprocessing to mitigate the cost, provided dialyzers with biocompatible membranes are used. The mechanism of reprocessing also requires around 25 litres of pure water per dialyzer, and if the raw water required to generate this pure water is also included, the total quantity of water required is around 65 litres per dialyzer for its cleaning and disinfection. Subsequently, the calculated requirement and thereafter wastage of water per dialysis session including reprocessing of the dialyzer is around 350 litres per dialysis session. If we calculate the annual consumption of water used in four-hour session thrice weekly on hundred dialysis machines, it will be around 33 million litres or 8.6 million gallons. (Table).

The entire dialysis process requires electricity: for haemodialysis machines, for RO and for dialyzer reprocessing. If we look at the total capacity of electricity and sources of production of electricity in Pakistan we will note that we are unable to cope with the demand, and most parts of our country already face hours of load-shedding. Total existing installed power capacity as of March, 2019 was 34,282 MW, although electricity generation varies according to availability of inputs and other constraints, the generation increased to 84,680 GW/h this year. Around 68.4% of this electricity is generated from thermal energy, i.e. by burning coal, which is a large source of CO2 which causes global warming[8] (each KW of electricity produces 16.44 pound of CO_2). Total electricity consumption in a dialysis facility per hour is around 480 kw (Booster pump 90 kw/h, multistage pump 132 kw/h, repressurise pump 90 kw/h, dialysis machine 120 kw/h, dialyzer reprocesser 7.4 kw/h). Similarly, if we extrapolate this 480 Kw/h into annual consumption of four-hour session three times a day, it will be 180 Gigawatt Megawatt. (Table no 1). Total CO_2 production in running a dialysis facility for one hour is 31,891 pounds (480x66.44) (Table).

Solid waste production is around 2.7 kg per dialysis session, depending if dialyzer reuse facility is present or not, translating into 253,530 kg of solid waste produced by 100 machines if used for three sessions a day.

Peritoneal dialysis (PD) on the other hand, is a home-based treatment, the efficacy of which is equal to haemodialysis and rather has more advantages in terms of solute clearance, water and energy consumption and waste production as compared to haemodialysis. Based on a simpler technique of infusing dialysate into the peritoneal cavity through a tunnelled cuffed catheter, and using peritoneal membrane as natural dialyzer, the cost of PD is significantly low as compared with HD, so it should be highly recommended for resource-constrained countries of the developing world. In his cross sectional study, Atapour et al compared the financial burden of the two groups of HD and PD in various parameters, such as cost of dialysis session, diagnostic test, drugs, hospitalisation, physician visit, dialysis centre visit, intravenous iron and Erythropoietin and number of staff needed to carry out the procedure. He found that PD is significantly low cost as compared to HD.[9]

The better quality of life is the goal of all treatments. Health-related quality of life (HRQL) was assessed prospectively in 989 patients who underwent HD or PD in a nationwide Chinese population by Jung and Jeon. They analysed the patients at 3, 12 and 24 months. They concluded a better HRQL for PD in the initial period with the effect lasting for two years.[9] There is no electricity consumption for continuous ambulatory peritoneal dialysis (CAPD), and water consumption is not more than 10 to 12 litres in a day, with four bags as disposables. Even if a cycler is used to infuse and drain fluid — a process called Automated Peritoneal Dialysis (APD) or Chronic Cycler Peritoneal Dialysis (CCPD) — the cost of cycler is too little as compared to haemodialysis machine. Moreover, electricity consumption by the cycler is also negligible.

Therefore, we conclude that for a developing country like ours, with resource constraints and where healthcare has to be paid mostly by the public and not by the government, the options for peritoneal dialysis must be explored on a national level. With appropriate planning and availability of required consumables, similar or even better outcomes can be expected with peritoneal dialysis at a lower cost and less utilisation of natural resources.

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