**Discussion on the cost analysis of hemodialysis and renal transplantation**

The researchers conducted a comparative analysis in order to determine the maintenance costs of performing hemodialysis versus renal transplantation at the Georgetown Public Hospital Incorporated.

Figure 3.6 demonstrated that over a month period, the maintenance cost for one hemodialysis patient was significantly higher than that for a renal transplantation patient. The costs taken into consideration includes, daily medication, requisite medical supplies and laboratory fees. The estimated total cost per month for hemodialysis medication is GYD $85, 386 (US $422), while renal replacement therapy was GYD$47,820.00 (US $237). This revealed that maintenance hemodialysis drugs are 1.8 times more expensive than the maintenance drugs for renal transplantation (figure 4.4). The hemodialysis maintenance drugs that were taken into consideration included; Amlodipine, Atenolol, Ramipril, Atorvastatin, Omeprazole, Lasix, pre-dialysis medication; heparin and prophylactic antibiotic; vancomycin. However, in the event of an infection, severe anaemia or electrolyte abnormalities, which are complications frequently seen in ESRD patients, these prices are expected to further increase. In comparison, the commonly used maintenance drugs for renal transplantation included Mycophenolate, Tacrolimus, Prednisolone, Ranitidine and Septrin.

In addition, there was a huge variance in the monthly laboratory fees between hemodialysis and renal transplantation patients. Despite the fact that transplant patients’ samples are tested in Miami, Florida, United States of America, where the patient is required to incur shipping fees, the laboratory maintenance cost was two times less than hemodialysis patients (figure 4.4). This is as a direct result of transplant patients requiring less frequent blood sample monitoring of every three months in comparison to hemodialysis patients bi-weekly, tri-weekly or weekly monitoring depending on the severity of illness of the patient.

Furthermore, the cumulated cost for the monthly supply needed for the maintenance of a hemodialysis patient was estimated to be GYD $61,086.96 (US S302) This cost is inclusive of a dialyzer, sodium bicarbonate solution, acid concentrate solution, infusion line, syringes, sterile gloves, non- sterile examination gloves, adhesive tape, disposable face mask, disposable gown, iodine and cotton wool. In comparison, there was no additional cost to the hospital for patients who had renal transplant done.

A study conducted by Perović S et al (2009) revealed that costs of ESRD patient treatment by hemodialysis was almost three and a half times more than that by kidney transplantation. This was supported by our research which revealed that the total cost for hemodialysis was found to be $11,548,377.60 (US $57,170) while the total cost of maintenance treatment for transplant patients over the same five (5) year period was found to be $3,730,920.00 (US $184,699), a ratio of 3.2 times more. These figures showed that at the first month mark, first year mark and at the five-year mark, hemodialysis was more expensive than renal transplantation. A relative increase was seen in the ratios at each increment of 2.7, 3.0 and 3.1 respectively. (Figure 3.9).

Finances spent on personnel for one (1) month of hemodialysis mounted up to 1.4 times of that spent on transplant ($1,661,390.00: $1,149,702.00). (US $8307: $ 5691). This is because hemodialysis patients require more personnel such as consultant, medical doctor, registered nurse, cleaning staff and biomedical technician. On the other hand, a renal transplantation patient only require consultant and a medical doctor for their routine medical visits unless other complications arise.

Figure 4.5 and Figure 4.6 show the distribution of monthly cost for maintenance treatment for renal transplantation and hemodialysis respectively. The data revealed that both groups spent the majority on medication, with renal transplantation spending 68% and hemodialysis spending 44%. This was followed by supplies being the next major contributor for hemodialysis (32%) and then lab fees (24%).

**Discussion for Quality of Life of hemodialysis and renal transplantation patients**

 The results of the study showed that most patients who underwent RRT were East Indian males. 55% of hemodialysis patients were males, while 53% of renal transplant patients were also males; 46.8% of HD patients were East Indians while 60% of renal transplant patients were also East Indian. The significant difference lies in the age range, as 46.4% of HD patients were between 51 and 70 years, while 66.7% of renal transplant patients were between 17 and 30 years. A study conducted by Edmund Huang et al., stated that patient survival tends to be lower in older versus younger kidney recipients as immunologic, physiologic and psychosocial factors influence transplant outcomes **13**. Other contributing factors may include a stringent selection criterion, a perception among healthcare providers of limited utility of kidney transplantation in the elderly and a decreased interest in kidney transplantation in the elderly. **13** It is important to note that older patients tend to have more co-morbid conditions at the time of renal transplantation, which increases the chance of postoperative mortality, when compared to younger patients. In Guyana, donor shortage may be one of the most influential reasons for age discrepancy between the hemodialysis and renal transplant groups.

 Based on the results of the 2012 Population and Housing Census, 311 563 persons (41.7%) of the country’s 746 955 reported persons, resided in Region 4. Therefore, it is not surprising that 69% of hemodialysis patients and 80% of transplant patients were from Region 4. It was observed that no hemodialysis patient resided in regions 8 and 9 whereas no renal transplant patients resided in regions 1, 2, 7, 8, 9, and 10. There is no data to justify this discrepancy.

 56.3% of hemodialysis patients reported having hypertension, 56.4% reported diabetes mellitus and 21.9% reported hypercholesterolemia. In an article written by Yilmaz et al, cardiovascular diseases are a leading cause of morbidity and mortality in ESRD patients. **14** The exact etiopathogenic cause is unknown, and there is uncertainty whether the hypertension was as a result of the ESRD or the ESRD resulted from the hypertension. As previously mentioned, older patients tend to have more co-morbid conditions than younger patients and so this further emphasizes why most hemodialysis patients are older patients. Of the patients in the transplant group, 50% had hypertension pre-transplant, while there were no reported cases of diabetes mellitus. Of note, 28.6% and 14.3% of transplant patients, reported having Nephrotic Syndrome and Polycystic Kidney Disease respectively pre-transplant. It is important to note that in the study population, older patients who made up the majority of the dialysis group, had more age-related cardiovascular risk co-morbidities compared to the transplant group who were younger with kidney-related diseases.

 The most common intradialytic complication was fluid overload, which affected 35.3% of patients on dialysis. It should be noted that although 35.3% of patients were affected by fluid overload, only 8.9% and 3.7% of patients were affected by pulmonary edema and congestive cardiac failure respectively. Fluid overload is a known common complication in HD patients **14**; in the setting of the Georgetown Public Hospital Corporation is determined by clinical signs such as an increase in body weight, hypertension along with edema and or anasarca. Yilmaz et al., states that this approach to determining fluid overload in hemodialysis patients may lead to an inaccurate clinical judgment, and as such multifrequency bioelectrical impedance analysis (BIA) should be used. **14** Multifrequency BIA is the criterion standard method for measuring fluid status in hemodialysis patients. Previous studies show that there is a relationship between fluid overload and pulmonary arterial hypertension (PAH) in hemodialysis patients. In the cross-sectional study of Agarwal et al.**14**, PAH was detected in 38% of HD patients. Yigla et al.**14**, found that the prevalence of PAH was found in 39.7% of HD patients and a study by Etemadi et al.**14**, found PAH in 41.1% of HD patients. **14** Despite the fact that PAH is a common complication found in HD patients, there were no reported cases in our study. The hypertensive patients in our study, reported hypertension prior to receiving HD. Our study showed that 19% of patients had anemia while 14.9% and 14.5% had electrolyte imbalance and sepsis respectively. Hypervolemia leads to hemodilution, which results in what is not ‘true’ anemia, where there is a reduced hemoglobin concentration due to a decrease in red cell volume. However, patients with kidney disease may have a decrease in erythropoietin production, which leads to ‘true’ anemia, and may be the reason anemia is common among HD patients. It is this anemia that is the cause of HD symptoms such as fatigue, shortness of breath and reduced exercise tolerance. **15**. No complication was reported post-transplant in the renal transplantation group.

 The KDQOL of the study group was assessed using a short form questionnaire that consisted of questions that focused on general health, kidney disease and the effects of the kidney disease on the lives of the individuals. This questionnaire assessed 49 HD patients and 15 renal transplant patients, chosen at random, who underwent RTT between 2015-2018. Generally, most patients on RRT received up to a secondary school education level; 31.4% of the HD sample group being the main financial earner within their home while 42.9% of renal transplant patients reported that their parents were the main financial earners within the home. Of the HD group, 42.9% of the monthly income ranged from $51 000- $100 000 while most transplant patients were unable to report a monthly income. This may be as a result of the parents carrying the financial constraints and not disclosing that information to the transplant recipients.

 It is important to note that 25% and 57.1%, of HD patients and renal transplant patients respectively, reported a history of alcohol consumption. The questionnaire did not take into consideration length of time of consumption nor number of years of cessation prior to diagnosis of ESRD. Excessive alcohol consumption is associated with hypertension, which is a contributing factor of chronic kidney disease (CKD). 16 However there are conflicting studies on the reported risk of renal damage in CKD and ESRD patients. In the American population, high alcohol consumption of more than 2 drinks per day was shown to increase the risk of ESRD. **16** However, a meta- analysis conducted by Cheungpasitporn et al., found an inverse association of high alcohol consumption and CKD in adult males; the analysis did not demonstrate a significant association between high alcohol consumption and ESRD **16** 11.4% and 35.7% of HD and transplant recipients respectively, reported a history of smoking. Again, the questionnaire did not take into consideration the number of pack years or whether or not there was cessation prior to diagnosis of ESRD. A study conducted by Staplin et at., showed that smoking increases the risk of atherosclerotic and nonatherosclerotic vascular disease, but it was not associated with a rapid progression to kidney disease. **17**

 In terms of general health, 45.7% of HD patients described their health while on HD as fair, while 35.7% of renal transplant patients described their overall health as good. It is important to note that these responses are subjective. When asked whether or not the kidney disease affected their ability to do basic tasks such as bathing and dressing themselves, 57.1% and 92.9% of HD patients and post-transplant patients, stated that this activity was not limited. On the contrary, 65.7% of HD patients stated that their ability to climb one flight of stairs was limited. As previously mentioned, dyspnea is common in HD patients as a result of fluid overload, which may or may not lead to PAH, and this may affect an individual’s ability to climb stairs. HD patients also experience fatigue, as a result of their anemia, which is common in HD patients. Therefore, this finding is not surprising among this group. 78.6% of post-post-transplant patients were not limited in their ability to climb one flight of stairs.

 Fifty-one point five per cent of HD patients stated that they find that they do not get sick easier compared to anyone else they may know, while 78.6% of post-transplant patients also share this perspective.

 Fifty-seven point one per cent of HD patients reported reduced work hours in the past 4 weeks of this questionnaire being administered because of HD. This is not surprising because these individuals have to take time off work in order to attend dialysis sessions three times per week; HD patients tend to be weak after each session and so they cannot return to work after sessions end. These individuals have to also commute to and from these sessions, which also takes away from their time at work. On the other hand, 64.3% of post-transplant patients reported not having reduced work hours in the past 4 weeks. 51.4% of HD patients attributed a reduction in work hours because of depression, whereas 78.6% of post-transplant patients denied reduced work hours resulted from depression. A study conducted by Yi-Nan Li et al., showed that a decreased QOL, as well as anxiety, and depression was common in HD patients. **18**

 Thirty-four point three per cent and 78.6% of HD and post-transplant patients respectively, denied pain as an inhibitory factor when conducting daily activities. However, 65.8% of HD patients reported pain, whether mild, moderate, or severe in nature; 21.4% of post-transplant patients reported pain. It is important to note that these subjective responses to pain may or may not be as a result of HD or post-transplantation. Older patients may or may not have pain due to co-morbid conditions such as Arthritis, which causes joint pain. With regards to muscle soreness, 54.4% of HD patients reported having muscle soreness, whereas 85.7% of post-transplant patients denied having muscle soreness at all. 68.6% of HD patients reported having cramps, whereas 78.6% of post-transplant patients denied having cramps.

 Forty-eight point six per cent of HD patients reported having bouts of shortness of breath while on dialysis. This is not surprising because 35.3% of the total HD population in the study, experienced fluid overload. As stated prior, fluid overload is a common finding in HD patients. Despite this, it is uncertain whether the shortness of breath was as a result of the fluid overload, because only 8.9% of the total HD population in the study experienced pulmonary edema.

 Sixty-five point seven per cent of HD patients reported having numbness in the hands and feet, whereas 92.9% of post-transplant patients denied this claim. It is not uncommon for HD patients to have neuropathy. An increase in uremia in the blood, may lead to uremic neuropathy, which may be the culprit in these patients. Uremic neuropathy is a distal sensorimotor polyneuropathy caused by the uremia toxins; the severity of the neuropathy is associated with the severity of renal insufficiency. **19** Early observational studies showed improvements of uremic neuropathy with dialysis and transplantation. These studies demonstrated a reduction in the prevalence of neuropathy with either an increase in frequency or dose of dialysis. **20** Renal transplantations are the preferred therapeutic option to provide a ‘cure’ for the severity of uremic neuropathy. **20**

 Sixty-four point three per cent and 28.6%, of HD patients and post-transplant patients respectively, denied having excellent health. Overall KDQOL showed that patients experiencing HD have a lower QOL compared to their post-transplant counterparts. This is not surprising because as the number of years on dialysis increases the KDQOL is expected to decrease.