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Original Research

Sociodemographic and Economic Correlates of Dialysis Vintage in a Resource Challenged Setting: A Four-Year Prospective Study in Southwest Nigeria

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Abstract

Background: Dialysis vintage is largely dependent on the effectiveness of the delivered dose coupled with the extent of patient compliance with the prescribed treatment regimen. This study assessed the determinants and correlates of dialysis vintage.
Methodology: This was a 4-year prospective, observational study. The data was collected from the dialysis and medical records, both had the contacts of patients and relatives.
Results: A total of 314 participants (males 67.20%) with a mean age of 47.91±8.81 years underwent 2265 maintenance haemodialysis sessions. The females were older and had more hospital admissions; (P=0.07). Approximately 32.17% of the participants traveled at least fifty kilometers to access dialysis treatment**.** In a month, only 23.57% of the participants received the minimum prescribed twelve sessions, and 24.84% received the required erythropoietin dose. The mean dialysis vintage for all population was 9.13 ± 3.15 months, it was shorter for participants with hospitalization, (p<0.001), dialysis termination (p<0.001), intradialytic hypotension (p<0.001), and hypertension (p<0.001), Approximately, 14.2% of the participants had health insurance coverage, more so with the men After dialysis initiation, 6.69% of the participants were alive to the fourth year. The predictors of dialysis vintage were income (OR-4.62, 95% CI-2.88-6.24), health insurance (OR-8.11, 95% CI-4.82-13.35), dialysis duration (OR-6.38, 95% CI-2.40-9.55) and spKt/V (OR-4.24, 95% CI-0.48-5.91).
Conclusion: Dialysis vintage was short (9.13 ± 3.15 months), more so in females, poor funding, peridialysis complications, and without health insurance. More concerted efforts from governments, multinational donor agencies, and philanthropists are needed in health insurance coverage, particularly for kidney care to increase the dialysis vintage.

Keywords: Maintenance; Haemodialysis; Resource-challenged Settings; Dialysis Vintage; Mortality; Chronic Kidney Disease; Cardiovascular Function.

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Introduction:

Dialysis vintage is defined as the time from the initiation of maintenance haemodialysis (MHD) to renal transplantation, or to death, or to an event such as data collection or necessitating the termination of dialysis.[1,2] It is known to vary widely across the various regions of the world due to several factors including socioeconomic development, availability or otherwise of health insurance, infrastructural and manpower availability, and patients compliance with prescribed dialysis regimen.[2] End-stage renal disease (ESRD) progresses to death if effective renal replacement therapy (RRT), coupled with good compliance, is not instituted.[3] Chronic kidney disease (CKD) in end-stage has become one of the most common cause of death worldwide.[4,5] The annual cost of managing end-stage kidney disease with haemodialysis (HD)for a patient has continued to increase over the past years, and these amounts are incomparable to the meagre resources allocated for the same purpose in many resource-challenged nations(RCNs). In Nigeria, a maximum of six HD sessions are paid for by the Federal Government-owned National Health Insurance Scheme (NHIS), similar to the practice in Laos.[6,7] The cost of a session of HD in Nigeria ranges from thirty-five dollars to a hundred and seventy dollars ($35-$170), the privately-owned centers being more expensive than those owned by governments and religious bodies.[8,9] These amount to a monthly dialysis bill ranging from two hundred and eighty dollars to one thousand three hundred and sixty dollars ($280-$1360) for patients on twice weekly sessions and four hundred and twenty dollars to two thousand and forty dollars for patients on thrice weekly sessions ($420-$2040).[8,9] The least amounts of these HD sessions in Nigeria is far larger than the monthly national minimum wage of twenty three dollars ($23).[8-10] In the developed nations, governments and cooperate bodies fund healthcare delivery but dialysis costs in most developing nations have remained a great burden to patients and their families particularly in sub-Saharan Africa, the low and middle-income nations in Asia and South America.[9,11] The very low enrollment on the health insurance scheme has necessitated out-of-pocket payments for 80-90% of dialysis patients in Nigeria.[9] The absence of adequate manpower and financial resources further heightens the financial burden of dialysis in these settings.[7,13-14] Added to the burden of dialysis in low-income settings are high illiteracy rates, particularly in women, unemployed, underemployed, and gender-based cultural biases.[15] Poor road networks, unreliable power supply, and dialysis non-availability in many villages have also limited effective dialysis delivery in sub-Sahara Africa (SSA).[16] The recent sharp increase in the relocation of health workers from SSA to Western, European, and some Asian countries has further worsened the challenges in dialysis delivery due to manpower shortages.[8] Moreover, the overall morale of the health professionals still working in these settings has been dampened by the incomparable differences in remunerations in the two settings..[8,9]

The combined effect of these challenges in low-income settings is a high proportion of inadequate dialysis, which can lead to suboptimal blood pressure control, fluid and anemia control, poor management of chronic kidney disease mineral bone disease (CKD-MBD), increased morbidity and early death during maintenance hemodialysis (MHD)[9,13-14] Rich et al[17] reported that for dialysis-dependent patients, the median time to death after stopping dialysis treatment is seven days. The mean dialysis dose, which is dependent on the frequency of erythropoietin administration, dialysis sessions and fluid and blood pressure control, among other factors is a major determinant of health-related quality of life (hrQOL) and dialysis vintage.[4, 5,11] Good family support often goes a long way in alleviating the burdens of MHD patients, however, an effective support system may be compromised in patients of low socioeconomic status.[9,16] Intradialytic and interdialytic events and death tend to be more common in RCNs than in developed nations.[12-14] Dialysis vintage is often related to cardiovascular (CVS)function which has remained the most common determinant of death in MHD patients.[17]

Concerted efforts by national, regional, and global nephrology bodies, coupled with contributions by donor agencies, governments, and multinational agencies to augment kidney care have largely remained insufficient.[18-19] This leaves most dialysis patients and their relatives hopeless from the time the diagnosis of end-stage kidney disease is made, only looking forward to their eventual premature death. Despite the relatively poor dialysis outcome in RCNs, literature related to dialysis vintage is still under-reported. We studied dialysis vintage and assessed its socio-demographic and economic correlates in Nigeria,

Materials and Methods

Study design:
This study was conducted at the dialysis suite of Babcock University Teaching Hospital (BUTH), Ilishan-Remo, between August 2018 and July 2022. Each patient was followed up from the commencement of maintenance hemodialysis to death.

Study population
The study involved 314 patients who had CKD (according to the 2015 KDOQI Clinical Practice Guidelines)[20] and had 2265 MHD sessions. All participants were on bicarbonate supplementation, antiplatelet agent, and an angiotensin-converting enzyme inhibitor (ACEI) or an angiotensin receptor blocker (ARB), except when contraindicated. The correction factor for the dose of darbepoetin to epoetin was 250.

Dialysis Schedule
After three months of dialysis treatment, patients who were found to have fairly regular thrice weekly visits were grouped into Mondays, Wednesdays, Fridays, or Tuesdays, Thursdays, and Saturday's schedules. Patients regular on twice weekly visits were grouped into the Mondays, Thursdays, or Tuesdays, Fridays schedule. Participants on weekly schedule were advised to visit Wednesdays or Sundays. All patients were strictly informed that they were to come for dialysis anytime outside their routine schedules, whenever the need arises.

Sample size
This was estimated using the dialysis vintage of 35 months in a previous study conducted in a resource-challenged nation, with a power of 80% and a margin of error of 5%, which yielded a sample size of 119.[21]

Inclusion and exclusion criteria
Participants were 18 years or older and had MHD at the dialysis suite in BUTH, Ilishan-Remo. Exclusion criteria included: kidney transplantation, loss to follow-up, not receiving antiplatelet and antilipid agents, and an interdialytic duration greater than one month (very wide or irregular interdialytic intervals).

Data collection
Participant demographics, health insurance status, sponsorship, educational attainment, estimated monthly income, sponsors, and distance traveled to access treatment were collected using an interviewer-administered questionnaire. The contacts of patients and their caregivers were documented. Patients case notes, dialysis charts, and medical records (from where CKD aetiology, frequency of dialysis and erythropoietin administration, date of first MHD session, and length of MHD treatment were retrieved. Also retrieved were the pre dialysis and post dialysis blood pressure (BP), renal biochemistry, the dialysis dose (urea reduction ratio (URR) and spKt/V), dialysis base, heparin dose, blood flow rate (BFR), dialysis duration, ultrafiltration volume (UFV) and dialyzer flux type and area.

The height (m) and weight (kg) were measured using standardized protocols and the BMI (kg/m^2) was calculated. The pre dialysis BP was measured manually while the patients were in the sitting position, while the intra dialysis and post dialysis BP were machine derived. The mean of each variable for each participant was used for data analysis.

The phone numbers of each patient and two close relatives (next of kin/caregivers) were documented. The date, timing, and nature of the death of each participant were documented after this was confirmed by at least two documented relatives.

Sample collection
After ensuring patency of the internal jugular access by withdrawing 1ml of blood, pre dialysis samples were taken, and then arterial and venous blood lines were flushed with heparinized saline. Blood samples from the femoral catheters were taken immediately after fresh accesses were obtained. Sample from participants with arteriovenous fistulas (AVF) were taken from a peripheral vein in the contralateral arm. The stop dialysate flow method was used in post dialysis blood sampling. At dialysis time zero, the dialysate flow was stopped and the blood pump flow continued. After five minutes, blood was first taken from the arterial portal for biochemical analysis (minimizes access recirculation); and then the hematocrit. The urea-based dialysis doses (URR and spKt/V) were calculated using the Daugirdas second-generation logarithmic estimation of a single pool.[22]
The dialysate buffer was bicarbonate and unfractionated heparin 5000 IU was used for all sessions. With altered heparin dose (increased risk of bleeding or thrombosis), the average was documented. Whenever the BFR was altered, the average for the session was documented. All sessions were conducted with a dialysate flow rate (DFR) of 500ml/min.

Definition of terms
The study variables were defined as described and following the cited references. **Dialysis vintage**: Time from MHD initiation to death,[3, 23]; **Hospitalization**: hospital admission lasting for at least 24 hours.[24] ; **IDH-**intradialytic hypotension.[25] ; **IDHT-**intradialytic hypertension.[25] ; **Dialysis termination:** sessions less than four hours due to intradialytic event(s).[26] **Health insurance**: Full sponsorship of MHD treatment.[27] **Cardiovascular events**: Any heart or blood vessel-related event requiring intervention or leading to death.[28]

Ethical considerations: This study was approved by the Babcock University Health Research Ethics Committee (BUHREC/723/19, NHREC/24/01/2018). All participants provided written informed consent.

Statistical analysis: Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows, version 22.0. Continuous variables (means with standard deviation) were compared using paired Student's t-test. Categorical variables (proportions with frequencies) were compared using the chi-square test or Fisher's exact test. A P value <0.05indicated statistical significance. Multiple regression analysis was used to determine associations with dialysis vintage.

Results
Three hundred and fourteen participants (211 males and 103 females) with 2265 sessions were studied. The mean age of the population was 47.90± 8.81 years, the females were older (48.81 ± 8.52 as against 47.50±7.02 years). A greater proportion (44.27%) of the participants were middle-aged and received the highest (46.05%) dialysis sessions (Table 1). A greater proportion of the participants had secondary education, received less than thirty dollars monthly, and had no health insurance (42.04%), (35.35%), (85.99%) respectively. Of the 286 (91.08%) participants who had an electrocardiogram (ECG), 220 (76.92%) had left ventricular hypertrophy (LVH). Forty-five (14.33%) of the participants had an

echocardiogram prior to the commencement of MHD, 42 (93.33%) had LVH, and 12 (26.67%) had heart failure with reduced ejection fraction (HFrEF). The mean length of MHD (in months) for all participants was 9.13 ± 3.15 (Table 2); it was longer in males than in females (P=0.01). The dialysis vintage was longest in the young and shortest in the elderly group, (P=0.03). Dialysis vintage was longer in participants with health insurance than in the uninsured group, ($p<0.001$), and was positively related to educational status, monthly income, dialysis frequency, and erythropoietin frequency, ($p<0.001$, $p<0.001$, $p<0.001$ and $p<0.001$), respectively.

There was a positive correlation between the dialysis vintage and blood flow rate (p=0.02), the use of an arteriovenous fistula ($p<0.001$), and the duration of dialysis, p=0.03 (Table 3). It was also positively related to the frequency of the dialysis sessions, the use of erythropoietin, and the delivered dialysis doses, ($p<0.001$, $p<0.001$, $p<0.001$, and $p<0.001$, respectively).

One hundred and sixteen (36.94%) patients had at least one hospitalization, 57 (18.1%) had at least an episode of IDH, 64 (20.38%) participants had an episode of IDHT and 11 (3.50%) had at least an episode of dialysis termination. The dialysis vintage for patients who had at least an episode of hospitalisation, intradialytic hypotension, intradialytic hypertension, and dialysis terminations were 7.71 ± 2.23 months ($p<0.001$), 7.96 ± 1.98 months ($p<0.001$), 8.72 ± 2.87 months ($p<0.001$) and, 7.88 ± 2.63 months ($p<0.001$) respectively.

Of the 314 participants who commenced maintenance hemodialysis, 308 (97.77%) were alive into the fourth month, 166 (52.86%) were alive into the second year, 80 (25.48%) were alive into the third year, and only 21 (6.69%) lived into the fourth year (Table 4). Females, the elderly, diabetic patients, and the non-health-insured were more likely to have died before their fourth year on maintenance hemodialysis. Participants who had hypoalbuminemia and a very low GFR prior to MHD initiation were also more likely to die before their fourth year on MHD.

According to the multivariate Cox regression analysis (Table 5), the absence of health insurance, hypoalbuminemia at dialysis initiation, monthly dialysis duration and erythropoietin dose, and delivered dialysis dose independently predicted death before the fourth year of maintenance hemodialysis treatment.

Discussion

The dialysis vintage, as found in this study in a resource-challenged setting, is rather short considering that, of all the participants who commenced MHD, only 6.69% were alive into the fourth year of maintenance hemodialysis treatment. The mean duration of MHD of 273 days in this study is greater than the187 (34-754) days reported by Haile et al[12] in Cameroon, a resource-challenged neighboring country. Despite the longer mean dialysis vintage, only 52.86% of the participants were alive at the end of the first year of MHD compared to the 73.2% reported from the study in Cameroon. The findings in these two African studies are higher than the 45.5% reported in an elderly population in the United States (US).[28] The differences could be attributable to the higher prevalence of multiple comorbidities in an aged population. The exclusion of patients who eventually underwent kidney transplantation in our study most likely accounted for the greater death rate than that reported by Haile et al[21], as patients opting for kidney transplantation are often more financially empowered. They tend to present earlier than the general MHD population. The dialysis vintage in this study and that from Cameroon is shorter than that reported from Egypt (a more socioeconomically developed African nation), with an annual mortality rate of 7.44%/year among the MHD population).[29]

The impact of national or regional socioeconomic status on dialysis vintage is evident from the findings in Dubai (a socioeconomically advanced population) where 3.16% and 27.3% of the MHD population died at one and five years of initiating MHD respectively. This is incomparably lower than the 47.14% one-year mortality in this study[30] Considering that only 6.69% of the maintenance dialysis population in this study lived into the fourth year, it is very unlikely that any MHD survivor would have been alive after 5 years of MHD in this study, which is in agreement with findings from another African nation where the longest dialysis vintage was 754 days (under three years).[21] The shorter dialysis vintage in African nations compared with the developed nations despite the larger elderly population (who commonly have multiple comorbidities) in the later; underscores the very significant impact of socioeconomics and health insurance coverage on the dialysis vintage.[7, 9, 31]

The impact of poor funding of renal care on dialysis vintage is expected to be similar in many RCNs, particularly in Asia, sub-Saharan Africa, and South America (Table 7), where the average national monthly income for a sizeable part of the working population is in most cases less than a tenth (10%) of the monthly cost of dialysis sessions.[8,32-34] The fact that the health insurance coverage of many of these nations is not extensive, or unavailable to the majority of citizens further compounds the challenges associated with poor funding of renal care.[13, 35-37]

Dialysis prescription has remained a significant pathway to the delivery of an adequate dialysis dose and entails an optimized prescription regimen that encompasses higher blood flow rates, longer dialysis durations, and higher ultrafiltration volumes. Despite the benefits of this routine prescription, it could be associated with higher incidences of intradialytic hypotension and dialysis termination, events that have been documented to worsen the morbidity and mortality profile of dialysis patients.[38, 39]The younger age at initiation of maintenance hemodialysis in resource-challenged settings (compared to developed nations) could partly be attributed to the greater prevalence of infectious causes of CKD such as post-streptococcal glomerulonephritis and pyelonephritis which can lead to chronic glomerulonephritis in low-income settings unlike in developed nations where CKD often complicates long-standing diabetes and hypertension.[40]

The negative relationship between dialysis vintage and hypoalbuminemia and, metabolic acidosis mirrors findings from the United States that reported a dialysis vintage of 30 ± 3.2 months, much longer than that found in this study.[39] The fact that most patients pay out of pocket could have negatively impacted the dialysis vintage, as evidenced by the very low health insurance coverage (14.01%) among participants, and more so, the 5% reported by Kalyesubula et al[36] in Uganda. The younger age at initiation of MHD agrees with findings from African nations of 47.90±1.81 years (index case) and 46.3 ± 14.7 years in Cameroon.[21] However, this pattern is significantly different from findings from developed nations where MHD was reported to be initiated at a mean age of 59.38 ± 13.5 years (Dubai),61.5 ± 12.7 years (China),70.05 ± 7.40 years (China), 65.5 ± 14.5 years (Holland) and 72.10 ± 10 years (South Korea).[30, 4144]

The male predominance in this dialysis population agrees with previous findings and this can partly be attributed to the higher CKD incidence in males and partly to socioeconomic, educational, and cultural biases against women that tend to limit the health-seeking ability of females.[15] The fact that a greater proportion of middle-aged and young actively productive individuals are affected further worsens the CKD burden and negatively impacts the economy in low-income nations.[35,36] The predominance of hypertension as a cause of CKD is in agreement with previous findings in Uganda and many African nations but is at odds with findings from Asia and Western nations where diabetes has remained the most common cause of CKD.[30,36,43] A Western diet with a higher fat content coupled with industrialization-associated sedentary lifestyle could also play contributing roles.[26]

The longer dialysis vintage in males could be attributed to their younger age coupled with more prevalent CVS dysfunction in postmenopausal women from the loss of estrogen-mediated cardiorenal protection.[23,28, 45]

The limitations of this study included the single-center design; and the inability to conduct an echocardiogram for most of the patients as it was difficult to precisely define a CVD/event as a cause of death. The acute (secondary) causes, particularly interdialytic death were largely unknown to the patients' relatives. Some episodes of hospitalization outside our facility could have been missed, and/or were not documented for patients who received non-dialysis-based treatment outside our facility. The residual renal function and dry weight of the participants were not assessed, just as the blood pH (the best modality for assessing metabolic acidosis) was not assessed in our facility because of cost.

Conclusion

The dialysis vintage in maintenance haemodialysis of the study population in Nigeria is short (9.13 ± 3.15 months), and similar to that in other resource-challenged nations but significantly shorter than those reported from the developed nations. It was longer in males, with health insurance and higher income and was positively related to the dialysis dose, dialysis frequency, and the dose of erythropoietin. Participants with hypoalbuminemia; or metabolic acidosis, at dialysis initiation and those without health insurance coverage were less likely to live into the fourth year of maintenance hemodialysis treatment. A greater involvement of governments, multinational bodies, donor agencies, and philanthropists) is needed in health insurance coverage particularly for kidney care to lengthen the dialysis vintage.

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