Fatal outcomes among patients on maintenance haemodialysis in sub-Saharan Africa: a 10-year audit from the Douala General Hospital in Cameroon

Marie Patrice Halle1,2*, Gloria Ashuntantang3, Francois Folefack Kaze3, Christian Takongue2 and Andre-Pascal Kengne4*

Abstract

Background: End-Stage Renal disease (ESRD) is associated with increased morbidity and mortality. We assessed the occurrence, time-trend and determinants of fatal outcomes of haemodialysis-treated ESRD patients over a 10-year period in a major referral hospital in Cameroon.

Methods: Medical records of ESRD patients who started chronic haemodialysis at the Douala General Hospital between 2002 and 2012 were reviewed. Baseline characteristics and fatal outcomes on dialysis were recorded. Accelerated-failure time and logistic regression models were used to investigate the determinants of death.

Results: A total of 661 patients with 436 (66 %) being men were included in the study. Mean age at dialysis initiation was 46.3 ± 14.7 years. The median [25th–75th percentiles] duration on dialysis was 187 [34–754] days. A total of 297 (44.9 %) deaths were recorded during follow-up with statistical difference over the years (\(p\) < 0.0001 for year by year variation) but not in a linear fashion (\(p\) = 0.508 for linear trend), similarly in men and women (\(p\) = 0.212 for gender*year interaction). The death rate at 12 months of follow-up was 26.8 % (\(n\) = 177), with again similar variations across years (\(p\) < 0.0001). In all, 34 % of deaths occurred within the first 120 days. Year of study and background nephropathies were the main determinants of mortality, with the combination of diabetes and hypertension conveying a 127 % (95 % CI: 40–267 %) higher risk of mortality, relative to hypertension alone.

Conclusion: Mortality in dialysis is excessively high in this setting. Because most of these premature deaths are potentially preventable, additional efforts are needed to offset the risk and maximise the benefits from the ongoing investments of the government to defray the cost of haemodialysis. Potential actions include sensitisation of the population and healthcare practitioners, early detection and referral of individuals with CKD; and additional subsidies to support the cost of managing co-morbidities in patients with CKD in general.

Keywords: ESRD, Outcome, Haemodialysis, Cameroon, Sub-Saharan Africa
Background

Chronic kidney disease (CKD) is a major public health problem and was ranked as the 18th cause of death worldwide in 2010, with most of these deaths occurring in patients with End-Stage Renal Disease (ESRD) [1, 2]. It has been projected that by 2030 more than 70 % of patients with ESRD will originate from low- and middle income countries, such as those in sub-Saharan Africa [3]. ESRD requiring renal replacement therapy (RRT) is the common final pathway for CKD. The population of patients on RRT has doubled in the last two decades. Globally, the number of patients receiving RRT was estimated to be over 1.8 million in 2004, with less than 5 % of this population residing in sub-Saharan Africa (SSA) [4].

Maintenance dialysis therapy is the commonest mode of RRT and demand for this service is increasing with the ESRD population. Although dialysis prevents death from uraemia, patients’ survival remains an important issue. Patients on dialysis have a 3–8 times higher mortality rate than the general population, essentially from increased cardiovascular morbidities [5–7]. There are suggestions that major developments in the management of ESRD patients worldwide have not benefited patients in low- and middle income countries where access to RRT and outcomes of care remain very poor [8–10]. As a result, the mortality rate within 90 days of commencing RRT in SSA countries is as high as 90 %, compared with European countries where it is about 3 % [10, 11]. However existing data from African countries is very patchy and do not reflect the contemporary profile of ESRD patients and patterns of care in this setting.

Dialysis was introduced in Cameroon in the early 1980s and included both peritoneal and haemodialysis, although for over 20 years now haemodialysis has been the only modality of RRT available in the country [12]. For many years however, access to dialysis services in the country has been restricted to few centres (at most three) in the two main cities of the country (Yaoundé and Douala). It is only within the last eight years that the government has expanded haemodialysis services in terms of geographic coverage and capacity to cope with increasing demand. Nevertheless, data regarding the outcome of patients on RRT in Cameroon is inexistent, a situation which is shared by most countries in SSA. The aim of this study was to report on the occurrence, time-trend and determinants of major outcomes of haemodialysis-treated ESRD over a 10 years period in a referral tertiary hospital in Cameroon.

Methods

Study setting and clinical pathway of patients with ESRD

This prospective study was carried out in the renal unit of the Douala general hospital (DGH) in Cameroon, and covered the period from 2002 to 2012. DGH is a 320 bedded public institution, which serves as referral hospital for kidney diseases for the Littoral region of the country (approximately 3 million population in 2012) and beyond. The haemodialysis unit of DGH including the staff, equipment and pathway of patients with ESRD, has been described in details previously [13]. At the end of the year 2012, the unit was operating with one nephrologist, two general practitioners and 12 nurses and was equipped with 17 hemodialysis Fresenius’ 4008S generators (Fresenius Medical Care, Hamburg, Germany), synthetic polysulfone dialysis membrane, and bicarbonate dialysate was used. Patients in this unit received two weekly sessions of 4 h haemodialysis. Each patient with ESRD has at initiation of dialysis a clinical assessment and laboratory investigations. The register of patients with ESRD starting RRT in the DGH served as basis for patients’ recruitment. This study received administrative authorization from the DGH and was approved by the ethic committee of the Douala University, Cameroon.

The total population in Cameroon was estimated to be about 21.7 million in 2012, with 16.5 % aged less than five years. The total health expenditure was equivalent to 4.3 % of the gross domestic product (GDP), and the general government health expenditures represented about 24.6 % of the total health expenditure and 5.5 % of the general government expenditure [14]. Therefore, in the absence of social security system in Cameroon, out-of-pocket spending represent an important proportion of the health expenditure. However, access to haemodialysis in public health facilities is highly subsidized by the government since 2002, with the co-contribution of patients representing about 5 % of dialysis session cost [13]. In 2012, the country had a total of five nephrologists (two in Douala), eight haemodialysis centres with two in Douala including the study centre and a private haemodialysis centre. The eight centres were providing care to about 500 patients on chronic dialysis, with 30 % (140) of them being managed at the study centre [13].

Data collection

This study included a total of 661 patients with ESRD on regular haemodialysis at the DGH in Cameroon and was done in the period from the 1st January to 30 June 2013. The case records of all patients with ESRD on RRT over a 10-year period (2002–2012) were retrieved. Data were extracted for each patient on age, sex, major comorbidities (hypertension, diabetes, HIV, gout, history of stroke), the presumed aetiology of ESRD, key parameters at dialysis initiation and the vital status at the last contact with the service.
Operational definitions
The diagnosis of ESRD was based on the following: estimated glomerular filtration rate using the Cockcroft and Gault formula (from 2002 to 2010) or the four-variable Modification of Diet in Renal Disease (MDRD) formula (from 2010 and beyond) [15, 16] (eGFR) less than 15 ml/min/1.73 m², bilateral shrunken kidneys on ultrasound and presence CKD risk factors and any clinical or biological signs of uraemia. Hypertension, diabetes and HIV were based on documented history, ongoing drug treatments or a documented systolic blood pressure (BP) >140 mmHg and/or diastolic BP >90 mmHg for hypertension or fasting blood glucose >126 mg/dl, or a positive test for HIV.

The background nephropathy was based on clinical arguments in the absence of renal histology data. Chronic glomerulonephritis was based either on a documented history of glomerular disease or the presence of a glomerular syndrome (proteinuria and/or haematuria, hypertension in the absence of identifiable secondary causes). Background nephropathy was ascribed to HIV in the presence of a glomerular syndrome in an HIV positive patient with hyperechogenic and normal size kidneys on ultrasound. Diabetic nephropathy was defined by the presence of hypertension in a diabetic patient associated with glomerular proteinuria, diabetic retinopathy and normal size kidney on ultrasound in the absence of any other cause. CKD was attributed to hypertension in patients with longstanding history of hypertension, and normal urine sediment in the presence of other target organ damages such as left heart hypertrophy, hypertensive retinopathy, and bilateral shrunken kidneys. The etiology was mixed (diabetes and hypertension) in case of longstanding history of diabetes and hypertension in a patient with clinical sign of both nephropathy. The Charlson comorbidity score was estimated by adding up the scores assigned to existing comorbidities based on the risk of death associated with each of them. The following comorbidities were considered: congestive heart failure, coronary disease, diabetes mellitus, malignancies, stroke, peripheral vascular disease, chronic obstructive pulmonary disease, HIV/AIDS, chronic liver disease and connective tissue disease [17].

Unplanned dialysis was defined as dialysis initiation without preparation, indicated for a life threatening situations using a temporary vascular access (non-tunneled polyurethane double lumen central venous catheter). Patient’s outcome in this study refers to their status at the last dialysis session – dead or alive. Deaths in the first 120 days of initiation of dialysis were considered as early mortality.

Statistical analysis
Data were analyzed with the use of SAS/STAT® v 9.1 for Windows (SAS Institute Inc., Cary, NC, USA). We have presented the results as count and percentages, mean and standard deviation (SD) or median and 25th–75th percentiles. Differences between men and women and across years of study were investigated via chi square tests and equivalents for qualitative variables, and linearity in the trend across years assessed with the Cochran-Armitage trend test, while the analysis of the variance (ANOVA) and equivalents were used for quantitative variables. The Kaplan-Meier estimator and accelerated failure time models, implemented with the use of LIFETEST and LIFEREG procedures of SAS were used to investigate the baseline characteristics associated with mortality during follow-up. Basic regression models were adjusted for age, sex and year of study, while the extended multivariable models also comprised significant predictors in basic models, based on a threshold for significance of \( p \leq 0.10 \). To test the robustness of our findings, determinants were also investigated via logistic regression models, both accounting for the entire duration of follow-up and after restriction of the outcomes to those recorded within the first 12 months of starting the dialysis. To maximize the stability of the estimates across years of study, participants were grouped by clusters of two consecutive years of observations. A \( p \)-value <0.05 was used to characterize statistically significant results.

Results
Sex and age distribution on dialysis overall and by year of study
A total of 661 patients, with 436 (66 %) being men, started RRT during the study period. The proportion of men ranged from 69.2 % in 2002–2004 to 63.6 % in 2011–2012, with a nadir at 61.5 % in 2009–2010, and no significant difference (\( p = 0.575 \)), nor a linear trend (\( p = 0.187 \) for linearity) across years of study. The mean age was 46.3 (SD = 14.7) years overall and ranged from 46.9 (15.7) years in 2002–2004 to 46.1 (14.5) years in 2011–2012 again with no significant difference, nor a linear trend across years of the study (both \( p \geq 0.133 \)), and similarly among men and women (\( p = 0.840 \) for gender*year interaction).

Profile for chronic kidney disease overall and across years of study
The distribution of the background nephropathy is described in Table 1. Major identified etiologies were hypertension (28.3 %), chronic glomerulonephritis (17.5 %), diabetes mellitus (13.9 %), hypertension and diabetes (7.3 %), HIV (6.7 %), other aetiologies (9.4 %); while no aetiology was identified in 16.9 % of the
Table 1 Profile of patients on dialysis and case-fatality overall and across years of the study

| Variables | Overall | 2002–2004 | 2005–2006 | 2007–2008 | 2009–2010 | 2011–2012 | p-value<sup>1</sup> | p-trend<sup>2</sup> | p year*gender<sup>3</sup> |
|-----------|---------|-----------|-----------|-----------|-----------|-----------|----------------|----------------|-------------------|
| N (%)     | 661 (100) | 120 (18.1) | 153 (23.1) | 111 (16.8) | 156 (23.6) | 121 (18.3) | 0.575 | 0.187 | NA |
| Men, n (%)| 436 (66.0) | 83 (69.2) | 103 (67.3) | 77 (69.4) | 96 (61.5) | 77 (63.6) | 0.282 | 0.133 | 0.840 |
| Mean age, years (SD) | 46.3 (14.7) | 46.9 (15.7) | 48.3 (13.5) | 44.9 (16.4) | 45.2 (14.0) | 46.1 (14.5) | 0.240 | 0.521 | 0.649 |
| Mean hemoglobin, g/dl (SD) | 7.7 (2.0) | 7.4 (2.3) | 7.6 (1.9) | 7.9 (1.8) | 7.5 (1.9) | 7.9 (1.9) | 0.009 | 0.003 | 0.661 |
| Mean Urea, g/l (SD) | 2.60 (1.16) | 2.28 (0.96) | 2.48 (1.17) | 2.67 (1.20) | 2.74 (1.91) | 2.8 (1.1) | 0.031 | 0.007 | 0.518 |
| Mean creatinine, mg/l (SD) | 184.3 (88.9) | 168.5 (87.5) | 191.7 (104.8) | 188.9 (87.3) | 184.2 (82.2) | 185.1 (75.1) | 0.044 | 0.007 | 0.751 |
| Mean corrected calcium, mg/l (SD) | 802.13.7) | 79.6 (14.0) | 80.9 (13.7) | 82.0 (11.4) | 80.9 (13.2) | 77.6 (15.6) | 0.411 | 0.523 | 0.829 |
| Mean phosphate, mg/l (SD) | 726 (35.2) | 85.4 (55.2) | 66.0 (30.1) | 75.6 (28.0) | 66.4 (31.1) | 78.2 (33.7) | 0.020 | 0.037 | 0.270 |
| Planned dialysis start, n (%) | 74 (11.2) | 8 (6.7) | 16 (10.5) | 7 (6.3) | 23 (14.8) | 20 (16.5) | 0.622 | NA | 0.328 |
| Median dialysis duration, days (Q1–Q3) | 187 [37–754] | 15 [6–298] | 197 [44–836] | 218 [57–855] | 580 [119–977] | 179 [62–357] | <0.0001 | 0.630 | 0.173 |
| Background nephropathy, n (%) | | | | | | | | |
| Hypertension | 187 (28.3) | 35 (29.2) | 40 (26.1) | 37 (33.3) | 40 (25.6) | 35 (28.9) | 0.044 | 0.007 | 0.751 |
| Diabetes | 92 (13.9) | 16 (13.3) | 19 (12.4) | 18 (16.2) | 21 (13.5) | 18 (14.9) | 0.009 | 0.003 | 0.661 |
| Hypertension and diabetes | 48 (7.3) | 10 (8.3) | 11 (7.2) | 8 (7.2) | 10 (6.4) | 9 (7.4) | 0.020 | 0.037 | 0.270 |
| Chronic glomerulonephritis | 116 (17.5) | 13 (10.8) | 27 (17.6) | 25 (22.5) | 34 (21.8) | 17 (14.0) | 0.031 | 0.007 | 0.518 |
| HIV | 44 (6.7) | 8 (6.7) | 11 (7.2) | 5 (4.5) | 10 (6.4) | 10 (8.3) | 0.020 | 0.037 | 0.270 |
| Others | 62 (9.4) | 9 (7.5) | 18 (12.4) | 8 (7.2) | 16 (10.3) | 11 (9.1) | 0.009 | 0.003 | 0.661 |
| Unknown | 112 (16.9) | 29 (21.2) | 27 (17.6) | 10 (9.0) | 25 (16.0) | 21 (17.4) | 0.009 | NA | 0.475 |
| Median Charlson Score (Q1–Q3) | 1 [1–2] | 1 [1–2] | 1 [1–2] | 1 [1–1] | 1 [1–1] | 1 [1–2] | 0.044 | 0.007 | 0.751 |
| Death overall, n (%) | 297 (44.9) | 27 (22.5) | 98 (64.0) | 55 (49.5) | 68 (43.6) | 49 (40.5) | <0.0001 | 0.508 | 0.212 |
| Death at 12 month, n (%) | 177 (26.8) | 9 (7.5) | 57 (37.2) | 33 (29.7) | 34 (21.8) | 44 (36.4) | <0.0001 | 0.004 | 0.138 |
| Death by follow-up duration | | | | | | | | | |
| < 120 days | 101 (15.3) | 8 (6.7) | 32 (20.9) | 20 (18.0) | 20 (12.8) | 21 (17.4) | 0.020 | 0.037 | 0.270 |
| 120–365 | 76 (11.5) | 1 (0.8) | 25 (16.4) | 13 (11.7) | 14 (9.0) | 23 (19.0) | 0.031 | 0.007 | 0.518 |
| > 365 | 120 (18.1) | 18 (15.0) | 41 (26.8) | 22 (19.8) | 34 (21.8) | 5 (4.1) | 0.009 | NA | 0.475 |

<sup>1</sup> p-value for year-by-year variation
<sup>2</sup> p-trend, p-value for the linear trend in the changes across years
<sup>3</sup> p year*gender, p-value for the interaction effect of gender and year of enrolment on the level of attributes of interest
The distribution of the background nephropathy was similar across years \( (p = 0.622) \) and in a non-differential way between men and women \( (p = 0.328 \) for gender*year interaction). The baseline biological profile of patients is also shown in Table 1 indicating the expected high serum urea and creatinine, low hemoglobin and calcium levels, which with the exception of serum urea did not vary across years of study overall \( (all \ p \geq 0.240) \) and by gender \( (all \ p \geq 0.649 \) for gender*year interaction) and did not display a linear trend \( (all \ p \geq 0.133 \) for linearity). Serum urea varied significantly across years \( (p = 0.009) \) and in a linear fashion \( (p = 0.003 \) for linearity) from 2.28 g/l in 2002–2004 to 2.80 g/l in 2011–2012. The Median Charlson score was generally around one point score, with suggestion however of significant variations across years \( (p = 0.044 \) in a linear fashion \( (p = 0.007) \), but not in a differential way among men and women \( (p = 0.751 \) for gender*year interaction).

**Dialysis start and follow-up**

In all, the start of dialysis was planned in 74 (11.2 %) participants. This proportion varied from 6.7 % in 2002–2004 to 16.5 % in 2011–2012 \( (p = 0.031) \). The pattern across years was linear \( (p = 0.007) \) with no evidence of heterogeneity between men and women \( (p = 0.518 \) for gender*year interaction). The median duration [25th–75th percentiles] on dialysis was 187 [34–754] days overall and varied from 15 [6–298] days in 2002–2004 to 179 [62–357] days in 2011–2012, with a pic of 580 [119–977] in 2009–2010. Variations across years were statistically significant \( (p < 0.0001) \) but not in a linear fashion \( (p = 0.630) \), nor in differential ways between men and women \( (p = 0.173 \) for gender*year interaction), Table 1.

**Mortality and determinants during follow-up**

A total of 297 (44.9 %) deaths were recorded during follow-up. This proportion rose from 22.5 % in 2002–2004 to 64.0 % in 2005–2006 and steadily decreased thereafter down to 40.5 % in 2011–2012 \( (p < 0.0001 \) for year by year variation, and \( p = 0.508 \) for linear trend), similarly in men and women \( (p = 0.212 \) for gender*year interaction). The death rate at 12 months of follow-up was 26.8 % \( (n = 177) \), with again similar variations across years \( (p < 0.0001) \). Overall, 101 (34 %) deaths occurred within 120 days of starting dialysis; 76 (25.6 %) within 120–365 days and 120 (40.4 %) beyond 365 days, Table 1. The survival probability from the Kaplan-Meier estimator for all-cause mortality is illustrated in Fig. 1.

In sex and age adjusted Weibull regression analyses, year of study \( (p < 0.0001) \) and background nephropathy \( (p = 0.0001) \) were significant predictors of mortality while baseline Charlson score \( (p = 0.118) \) was borderline \( (Table 2) \). In further multivariable models adjusted for these factors, year of study and background nephropathy \( (both \ p < 0.0001) \) remained the main predictors of mortality during follow-up. Compared with the year
2002–2004, all other years of study were associated with higher risk of mortality with magnitude ranging from 73 to 229 % (Table 2). Using hypertension alone as a referent background nephropathy, diabetes alone was associated with 83 % (26–166 %) higher risk mortality while diabetes combined with hypertension was associated with 127 % (40–267 %) higher risk of mortality. Furthermore ESRD of unknown etiology was associated with 99 % (36–191 %) higher risk of mortality, while with reference to a Charlson score of 1 point, a score of 4 was associated with 111 % (10–307 %) higher risk. The latter however was based on small numbers as indicated by the wide confidence intervals. The pattern was mostly similar, but the magnitude of the association differed (being much higher) when the logistic regression models were applied to investigate the predictors of mortality both for the entire duration of follow-up (Table 3) and after restriction to the first 12 months of follow-up (Data not shown). Furthermore, there was a linear trend in the association of mortality risk with increasing Charlson score (all p < 0.07 for linear trend).

**Discussion**

In this study based on a large sample of patients started on renal replacement therapy for ESRD, we have for the first time in Cameroon and to some extent in SSA, carefully characterised the mortality pattern and determinants over time, using data from a referral dialysis centre. Death rate among patients starting RRT in this setting is unacceptably high, with over a quarter of patients dying within the first year of starting dialysis, and half of those deaths occurring within the first six months. The baseline background nephropathy appears to be a major determinant of mortality, with the combination of diabetes and hypertension conveying an excess risk. Our year-by-year analyses further suggested an improvement over time in

| Variable                      | Basic models      | Multivariable models |
|-------------------------------|-------------------|----------------------|
|                               | HR (95 % CI)      | P-value   | HR (95 % CI)      | P-value   |
| Age, per year                 | 0.99 (0.99–1.00)  | 0.412     | 0.99 (0.98–1.00)  | 0.517     |
| Sex (men)                     | 0.90 (0.71–1.15)  | 0.246     | 0.92 (0.72–1.18)  | 0.182     |
| Year                          | <0.0001           |           | <0.0001           |           |
| 2002–2004                     | 1 (reference)     |           | 1 (reference)     |           |
| 2005–2006                     | 2.55 (1.62–3.99)  | 2.95 (1.85–4.67) |
| 2007–2008                     | 2.02 (1.24–3.27)  | 2.40 (1.44–3.98) |
| 2009–2010                     | 1.49 (0.93–2.39)  | 1.73 (1.06–2.82) |
| 2011–2012                     | 2.82 (1.70–4.67)  | 3.29 (1.94–5.58) |
| Background nephropathy        | 0.0001            |           | <0.0001           |           |
| Hypertension                  | 1 (reference)     |           | 1 (reference)     |           |
| Diabetes                      | 1.80 (1.24–2.62)  | 1.83 (1.26–2.66) |
| Hypertension and diabetes     | 2.31 (1.44–3.72)  | 2.27 (1.40–3.67) |
| Chronic glomerulonephrities   | 1.08 (0.72–1.62)  | 1.08 (0.72–1.64) |
| HIV                           | 1.63 (0.99–2.69)  | 1.17 (0.64–2.16) |
| Others                        | 1.03 (0.66–1.61)  | 0.99 (0.63–1.56) |
| Unknown                       | 1.97 (1.35–2.87)  | 1.99 (1.36–2.91) |
| Charlson score                | 0.118             |           | 0.124             |           |
| 1                             | 1 (reference)     |           | 1 (reference)     |           |
| 2                             | 1.09 (0.73–1.63)  | 1.02 (0.67–1.54) |
| 3                             | 1.23 (0.83–1.82)  | 1.39 (0.85–2.26) |
| 4                             | 2.07 (1.10–3.88)  | 2.11 (1.10–4.07) |
| Planned dialysis start        | 0.86 (0.60–1.23)  | 0.422     | -                 |
| Haemoglobin, per g/dl         | 0.99 (0.92–1.06)  | 0.702     | -                 |
| Serum creatinine, per 10 mg/l | 1.00 (0.98–1.02)  | 0.884     | -                 |
| Calcium, per 10 mg/l          | 0.96 (0.85–1.08)  | 0.532     | -                 |
| Phosphate, per 10 mg/l        | 1.01 (0.96–1.07)  | 0.633     | -                 |

95 % CI, 95 % confidence interval, HR hazard ratio
the proportion of patients starting RRT following a planned program, but the overall proportion of patients in the category remained unacceptably low.

Mortality in patients commencing or receiving dialysis has been reported in few previous studies in SSA. In a study of 40 incident dialysis cases in Ghana, 32 % of patients died within 90 days of starting dialysis [18]. In a similar study in 91 incident dialysis in Ethiopia, the death rate was 23 % at 90 days, and only 42 % of patients were still alive after 1 year [19]. In a series of 760 ESRD patients managed over a 19-year period (including 565 via dialysis) at a referral hospital in the South-East of Nigeria, 87 % of patients died within the first month of treatment, and at 3 months only 6.8 % of patients receiving haemodialysis were still alive [11]. The 1-year mortality rate was 7.4 % in a cohort of 242 prevalent haemodialysis cases in Sudan [20]. Late presentation (or referral) with CKD and affordability are often cited as major drivers of the high early mortality among patients starting chronic dialysis in SSA.

Differences in dialysis-related medical care influence early dialysis mortality. Interventions identified as important include timely access to pre-ESRD nephrology care, ESRD education and support services, treatment of biochemical abnormalities in advanced CKD, and timely placement of a permanent vascular access. The high early dialysis mortality rate in our study is likely attributable in part to poor quality of care prior to referral, financial constraint, the lack of a national screening and management programs for CKD, the limited number of nephrologists in the country, the high number of late referral [21] and the lack of preparation for dialysis as well.

| Variable                  | Basic models |                  | p-value | Multivariable models | p-value |
|---------------------------|--------------|------------------|---------|----------------------|---------|
|                          | OR (95 % CI) | p-value          | OR (95 % CI) | p-value          |
| Age, per year             | 1.00 (0.99–1.01) | 0.844     | 0.99 (0.97–1.01) | 0.282     |
| Sex (men)                 | 0.90 (0.64–1.26) | 0.530     | 0.86 (0.61–1.22) | 0.400     |
| Year                      | <0.0001       |                | <0.0001       |              |
| 2002–2004                 | 1 (reference) |                | 1 (reference) |              |
| 2005–2006                 | 6.14 (3.57–10.56) | 7.25 (4.13–12.75) |              |
| 2007–2008                 | 3.38 (1.91–5.96) | 3.86 (2.13–7.00) |              |
| 2009–2010                 | 2.64 (1.55–4.49) | 2.91 (1.67–5.08) |              |
| 2011–2012                 | 2.33 (1.22–4.09) | 2.72 (1.52–4.88) |              |
| P for linear trend        | 0.548         |                | 0.451       |
| Background nephropathy    | 0.108         | 0.056          |
| Hypertension              | 1 (reference) |                | 1 (reference) |              |
| Diabetes                  | 1.94 (1.14–3.30) | 2.00 (1.17–3.43) |              |
| Hypertension and diabetes | 2.00 (1.02–3.92) | 1.99 (1.00–3.95) |              |
| Chronic glomerulonephritis| 1.10 (0.63–1.92) | 1.08 (0.61–1.92) |              |
| HIV                       | 1.64 (0.81–3.32) | 0.81 (0.31–2.14) |              |
| Others                    | 1.19 (0.64–2.18) | 1.03 (0.54–1.95) |              |
| Unknown                   | 1.67 (1.00–2.80) | 1.76 (1.04–2.99) |              |
| Charlson Score            | 0.071         | 0.045          |
| 1                         | 1 (reference) |                | 1 (reference) |              |
| 2                         | 1.13 (0.66–1.98) | 1.12 (0.63–1.98) |              |
| 3                         | 1.58 (0.89–2.79) | 2.13 (0.96–4.75) |              |
| 4                         | 4.03 (1.18–13.79) | 5.15 (1.39–18.99) |              |
| P for linear trend        | 0.013         | 0.013          |
| Planned dialysis start    | 1.27 (0.76–2.11) | 0.355     |              |
| Haemoglobin, per g/dl     | 1.00 (0.91–1.10) | 0.950     |              |
| Creatinine, per 10 mg/l   | 1.00 (0.98–1.02) | 0.959     |              |
| Calcium, per 10 mg/l      | 1.03 (0.87–1.22) | 0.711     |              |
| Phosphate, per 10 mg/l    | 1.01 (0.94–1.08) | 0.804     |              |

95 % CI, 95 % confidence interval, OR odd ratio
as exceptionally high number of unplanned start of dialysis and twice weekly dialysis schedule could explain this situation in our setting [22, 23]. Some other causes of poor outcomes of patients on haemodialysis in Cameroon may include low socioeconomic status of haemodialysis patients, low social support, non-adherence to diet and treatments. Since the year 2002, dialysis is highly subsidized in public health facilities. While, these subsidies cover nearly 95 % of cost of dialysis session, patients and family still have to pay for the costs of all concurrent treatments, laboratory investigations and incident hospitalisations; which for the majority of patients, are unaffordable [13]. Studies elsewhere have highlighted catheter use and late or absent pre-ESRD nephrology care, as well as malnutrition as captured by hypoalbuminemia, as major ‘reversible’ determinants of early dialysis mortality [24, 25].

Although some existing studies from Africa have collected data across years, none has presented sufficiently time-trend data for comparisons. The largest study is from Arogundade et al. in Nigeria [11], and has covered a 19-year period (1989–2007). In this study, the background nephropathy appeared to be similar across time periods; in line with our findings of no significant variation in background nephropathies across years. We however observed significant variations in mortality rates across years, not explained by varying lengths of exposure to dialysis, and other study characteristics. The apparent low mortality rate in the first years of study likely reflect incomplete follow-up. This is reflected by the very short duration of follow-up on dialysis, implying that patients were transferred to other centres soon after the start of the dialysis, dropped out of dialysis, or perhaps died in other settings. Between 2005 and 2010, death rate mostly declined, likely reflecting the better staffing of the service with initially one nephrologist, then subsequently two. Further increase in mortality rate in the last years of study are likely explained by severe shortage of consumables for dialysis experienced by the service and other centres across the country during those 2 years. Over the years covered by the study, conditions to access dialysis in public institutions have mostly remained the same. However issues with the supply chain for dialysis consumable, which occurred in differential ways across years, could be a major driver of differences in mortality across years. We also noted that an increasing proportion of patients started dialysis in planned manners across years; however their absolute number was very small to affect early mortality [26].

We found background nephropathy to be a determinant of the overall and early mortality, with the combination of diabetes and hypertension conferring very high risk, followed by diabetes alone, unknown aetiologies and glomerulonephritis. In general, people with diabetes tend to have many co-morbidities, are at high risk of fatal infections on temporary vascular access, cardiovascular and all-cause mortality. In general, the poor survival in dialysis of patients with diabetes is well documented [27, 28]. Patients with ESRD of unknown aetiology are also more likely to carry a high burden of co-morbidities, some of which on their own (like undiagnosed cancers) are highly fatal regardless of RRT. Across existing studies from Africa, advanced uraemia, cardiovascular diseases and infections have variably been reported as causes of death in patients starting dialysis [11, 19, 22, 23].

Strengths and limitations
Our study has some limitations. Analyses are based on data found in records, therefore precluding the investigation of the broad spectrum of predictors of mortality in dialysis, as well as the whereabouts of the defaulters. Furthermore, we completely lacked data on causes of death which were not assessed in this study. Data were collected from a single centre, which could raise issues regarding the generalizability to the entire country. However, the study centre is the only public institution to provide sufficient data for the range of time covered in the current study. The background nephropathy in these patients mostly reporting with advanced CKD was essentially based on clinical arguments. Such an approach is not all accurate considering for instance that the differentiation between hypertension causing ESRD and hypertension resulting from or co-occurring with ESRD may not be possible from a cross-sectional analysis. Our study also has major strengths including the large sample size and the long period of data collection. Our study is one of the largest to provide time-trend on the outcomes of contemporary patients commencing hemodialysis in SSA, and using robust analytic methods.

Conclusion
In conclusion, mortality in patients with ESRD commencing dialysis in our setting is very high, with about 15 % of patients dying within the first 120 days of starting haemodialysis. In spite of some improvement over times, the overall and early mortality rates have remained acceptably high in these patients, and far above rates reported in developed countries. Because most of these premature deaths are potentially preventable, additional efforts are needed in this setting to offset the risk and maximise the benefits from the ongoing investments of the government to defray the cost of haemodialysis. Potential actions include intensive sensitisation of the population and healthcare practitioners, in order to improve early detection and referral of individuals with CKD; and additional subsidies to support the cost of managing co-morbidities in patients with CKD in general.
Abbreviations
AIDS: Acquired immunodeficiency syndrome; ANOVA: Analysis of the variance; CKD: Chronic kidney disease; DGH: Douala General Hospital; ERSD: End-stage renal disease; HIV: Human immunodeficiency virus; MDRD: Modification of Diet in Renal Disease; RRT: Renal replacement therapy; SD: Standard deviation; SSA: Sub-Saharan Africa.

Acknowledgment
The authors are grateful to the nurses, medical doctors and medical students, who over the years have contributed to the follow-up, and therefore maintaining the medical files of patients used as the basis of data collection for the current study.

Funding
No funding was received for this study.

Availability of data and material
The corresponding authors can be contacted for further details regarding the data used for this study is possible. Ethics approval for the study did not make provision for data sharing, and accordingly there is no data or material to share relating to the study.

Authors’ contributions
MPH: Conception and design of the study, writing of manuscript. GA: Study design and revising of the manuscript; FFK: study design and revising of the manuscript; TC: Data collection and revision of manuscript; APK: Data analysis and co-drafting the manuscript. All authors read and approved the final version of the manuscript.

Competing interests
The authors declare that they have no competing interests.

Ethics approval and consent to participate
This study received administrative authorization from the DGH and was approved by the ethic committee of the Douala University, Cameroon. The study used clinical registries and files, and therefore no opportunity of consenting patients individually.

Author details
1Department of clinical sciences, Faculty of medicine and pharmaceutical science, University of Douala, Douala, Cameroon. 2Department of internal medicine, Douala General Hospital, Douala, Cameroon. 3Department of internal medicine and specialties, Faculty of medicine and biomedical sciences, University of Yaounde I, Yaounde, Cameroon. 4South African Medical Research Council and University of Cape Town, Cape Town, South Africa.

Received: 22 April 2016 Accepted: 26 October 2016
Published online: 03 November 2016

References
1. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, Abraham J, Adair T, Aggarwal R, Ahn SY, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2095–128.
2. Coreij J, Selvin E, Stevens LA, Mand J, Kusek JW, Eggers P, Van Lente F, Levey AS. Prevalence of chronic kidney disease in the United States. JAMA. 2007;298(17):2038–47.
3. Naicker S. Burden of end-stage renal disease in sub-Saharan Africa. Clin Nephrol. 2010;74 Suppl 1:513–6.
4. Grassmann A, Giebregz S, Maellor S, Brown G. ESRD patients in 2004: global overview of patient numbers, treatment modalities and associated trends. Nephrol Dial Transplant. 2005;20(12):2587–93.
5. Sehgal AR, Dor A, Tsi AC. Morbidity and costs implications of inadequate hemodialysis. Am J Kidney Dis. 2001;37(6):1223–31.
6. Go AS, Chertow GM, Fan D, McCulloch CE, Hsu CY. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. N Engl J Med. 2004;351(13):1296–305.
7. Gansevoort RT, Correa-Rotter R, Hemmelgarn BR, Jafar TH, Heerspink HJ, Mann JF, Matsushita K, Wen CP. Chronic kidney disease and cardiovascular risk: epidemiology, mechanisms, and prevention. Lancet. 2013;382(9889):339–52.
8. Barsoum RS. Chronic kidney disease in the developing world. N Engl J Med. 2006;354(10):997–9.
9. Naicker S. End-stage renal disease in sub-Saharan Africa. Ethn Dis. 2009;19(1 Suppl 1):S13–15.
10. ERA-EDTA Registry. ERA-EDTA Registry Annual Report 2014. Amsterdam: Academic Medical Center, Department of Medical Informatics; 2016.
11. Arogundade FA, Sanusi AA, Hassan MO, Akinsola A. The pattern, clinical characteristics and outcome of ESRD in Ilé-Ife, Nigeria: is there a change in trend? Afr Health Sci. 2011;11(4):594–601.
12. Kaze FF, Kengne AP, Choukem SP, et al. Dialysis in Cameroon. Am J Kidney Dis. 2008;51:1072–4.
13. Halle MP, Takongue C, Kengne AP, Kaze FF, Ngui KB. Epidemiological profile of patients with end stage renal disease in a referral hospital in Cameroon. BMC Nephrol. 2015;16:59.
14. World Health Organization. Global Health Expenditure Database. Available at http://apps.who.int/nha/database/ViewData/Indicators/en. Accessed 16 July 2016.
15. Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Kidney Int. 2013;Suppl 3:1–150.
16. Levey AS, Coresh J, Greene T, Stevens LA, Zhang YL, Hendriksen S, Kusek JW, Van Lente F. Using standardized serum creatinine values in the modification of diet in renal disease study equation for estimating glomerular filtration rate. Ann Intern Med. 2006;145(4):247–54.
17. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373–83.
18. Eghani BA, Amoako-Atta K, Kankam CA, Nish-A sare A. Survival pattern of hemodialysis patients in Kumasi, Ghana: a summary of forty patients initiated on hemodialysis at a new hemodialysis unit. Hemodial Int. 2009;13(4):467–71.
19. Shibiru T, Gudina EK, Hable B, Derbew A, Agonafer T. Survival pattern of patients on maintenance hemodialysis for end stage renal disease in Ethiopia: summary of 91 cases. BMC Nephrol. 2013;14:127.
20. Elsharif ME. Mortality rate of patients with end stage renal disease on regular hemodialysis: a single center study. Saudi J Kidney Dis Transpl. 2011;22(3):594–6.
21. Halle MP, Kengne AP, Ashuntantang G. Referral of patients with kidney impairment for specialist care in a developing country of Sub-Saharan Africa. Ren Fail. 2009;31(5):341–8.
22. Kaze FF, Ashuntantang G, Halle MP, Kengne AP. Outcomes of non-tunnelled non-cuffed hemodialysis catheters in patients on chronic haemodialysis in a resource limited Sub-Saharan Africa setting. Ther Apher Dial. 2014;18(5):455–60.
23. Kaze FF, Ashuntantang G, Kengne AP, Hassan A, Halle MP, Muna W. Acute haemodialysis complications in end-stage renal disease patients: the burden and implications for the under-resourced Sub-Saharan African health systems. Hemodial Int. 2012;16(4):526–31.
24. Bradbury BD, Fissell RB, Albert JM, Anthony MS, Critchlow CW, Pisoni RL, Port FK, Gillespie BW. Predictors of early mortality among incident US hemodialysis patients in the Dialysis Outcomes and Practice Patterns Study (DOPPS). Clin J Am Soc Nephrol. 2007;2(1):89–99.
25. Astor BC, Eustace JA, Powe NR, Klag MJ, Fink NE, Coresh J, Choice Study. Type of vascular access and survival among incident hemodialysis patients: the Choices for Healthy Outcomes in Caring for ESRD (CHOICE) Study. J Am Soc Nephrol. 2005;16(5):1449–55.
26. Gorriz JL, Sancho A, Pallardo LM, Amoedo ML, Martin M, Sanz P, Baril G, Selgas R, Salgueira M, Palma A, et al. Prognostic significance of programmed dialysis in patients who initiate renal substitutive treatment. Multicenter study in Spain. Nefrologia. 2002;22(1):49–59.
27. Beladi Moussav SS, Hayati F, Alemzadeh Ansari M, Valavi E, Cheraghian B, Shahbazi H, Golzar K, Ghobari A, Rashidi H, Payami P, et al. Survival at 1, 3, and 5 years in diabetic and nondiabetic patients on hemodialysis. Iran J Kidney Dis. 2010;4(1):74–7.
28. Nishimura R, Dorman JS, Bosnyak Z, Tajima N, Becker DJ, Orchard TJ, Diabetes Epidemiology Research International Mortality Study, Allegheny County Registry. Incidence of ESRD and survival after renal replacement therapy in patients with type 1 diabetes: a report from the Allegheny County Registry. Am J Kidney Dis. 2003;42(1):117–24.