

Renal replacement therapy (RRT) in Rwanda: benefits, challenges and recommendations.

Authors: G. Chironda^{1,2}; F. Ngendahayo¹; G. Mudumbwa¹; V. Dushimiyimana¹; M. Jeanne Tuyisenge¹; J. Kayitesi¹; J. Nibagwire¹; O. Gashumba¹; L. Rajeswaran^{1,2}; D. Mukamana¹; M. Mukeshimana¹; G. Katende^{1,2}.

Affiliations: ¹University of Rwanda, College of Medicine and Health Sciences, School of Nursing and Midwifery, Kigali, Rwanda; ²New York University, Rory Meyers College of Nursing, New York, USA, Human Resources for Health.

ABSTRACT:

Worldwide, non-communicable diseases (NCDs) are a global health problem as they contribute to approximately 60% of deaths. There is limited data on the management of NCDs including kidney diseases at all levels of health care delivery in Rwanda. Yet renal replacement therapy (RRT), which seems to be the only option to provide an acceptable quality of life to patients with end stage renal disease (ERSD), is yet to be well established in Rwanda. Although there are policies and guidelines on renal replacement modalities in Rwanda, inadequate human and financial resources in the area of nephrology care remains a challenge. The purpose of the paper is to document an overview of kidney diseases and Renal Replacement Therapy (RRT) in Rwanda and highlight the benefits, challenges and recommendations to provide future directions for nephrology care. Improved knowledge about renal conditions and their risk factors is the initial step to create major interventions for improved kidney quality of life (KQoL) among patients with end stage renal disease. Notwithstanding, the Government of Rwanda has established several dialysis centers intended to provide services and for maintenance of the health status of patients with renal conditions. Further studies are necessary to provide evidence on the outcomes of RRT.

Keywords (MeSH): Renal replacement therapy; standards; organization and administration; supply and distribution

INTRODUCTION

Globally, there is a significant interregional and intraregional variability in kidney care [1]. Studies have also shown a wide variation in the country's readiness, capacity and response to service delivery including financing, workforce, information system as well as leadership and governance [1]. In 2015, data showed that the total population of Rwanda was projected to grow up to 11,274,221 with approximately 84 percent of people living in rural areas [2]. Moreover, the statistics from the World Health Organization (WHO) shows a double burden of both non-communicable diseases (NCDs) and communicable diseases (CDs) to be the cause of deaths in Rwanda. NCDs are estimated to account for 44% of all deaths, while communicable, maternal, perinatal and nutritional conditions account for 42% of deaths in Rwanda [3]. Therefore, the projected increased population and the double burden of diseases will translate into increased deaths related to both acute kidney injury (AKI) and chronic kidney diseases (CKD).

In Rwanda, the current GDP is 9.1 US\$ billion and the GDP per capita is 746 US\$, with the poverty rate estimated at 81.1% compared to 59.5 % for International poverty rate [1]. According to World Bank, low-income economies are defined as those with a Gross National Income (GNI) per capita of \$995 or less, lower middle-income with a GNI per capita between \$996 and \$3,895, upper middle-income between \$3,896 and \$12,055 and high-income with a GNI per capita of \$12,056 or more. Therefore, Rwanda falls in the low-income economies with GNI of 720 USD per capita [4].

With the projected population growth in Rwanda and the GNI per capita, meeting the sustainable development goals (SDGs) target of reducing premature mortality related to Communicable Diseases (CDs) and Noncommunicable Diseases (NCDs) will require concerted efforts of government of Rwanda to implement actions that are aimed at reducing risk factors for kidney diseases. These risk factors include but not limited to; malaria, HIV hepatitis B, diabetes, hypertension, traditional medicines unhealthy diet, physical inactivity and harmful use of alcohol to mention but a few [5]. Addressing the risk factors has become a cornerstone in the Health Sector Strategic Plan III of 2012-2018, where they are

Corresponding author: Dr Geldine Chironda. Phone number: +250789924956. Email: gc88@nyu.edu, New York University, University of Rwanda, College of Medicine and Health Sciences, Kigali, Rwanda.
Potential Conflicts of Interest (Col): All authors: no potential conflicts of interest disclosed; **Funding:** All authors: no funding was disclosed. **Academic Integrity.** All authors confirm that they have made substantial academic contributions to this manuscript as defined by the ICMJE; **Ethics of human subject participation:** The study was approved by the local Institutional Review Board. Informed consent was sought and gained where applicable; **Originality:** All authors: this manuscript is original has not been published elsewhere; This study was presented as a poster at ASCO Annual Meeting June 4, 2018.
Review: This manuscript was peer-reviewed by three reviewers in a double-blind review process;
Received: 3rd January 2019; **Initial decision given:** 13th February 2019; **Revised manuscript received:** 25th February 2019 **Accepted:** 16th April 2019
Copyright: © The Author(s). This is an Open Access article distributed under the terms of the [Creative Commons Attribution License \(CC BY-NC-ND\)](https://creativecommons.org/licenses/by-nc-nd/4.0/) ([click here](#)), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. **Publisher:** Rwanda Biomedical Centre (RBC)/Rwanda Health Communication Center, P.O.Box 4586, Kigali.
ISSN: 2079-097X (print); 2410-8626 (online)
Citation for this article: G. Chironda; F. Ngendahayo; G. Mudumbwa et al.: Renal replacement therapy (RRT) in Rwanda: benefits, challenges and recommendations. *Rwanda Medical Journal*, Vol 76, no 3, pp 1-6, 2019

listed in the National Research Agenda (NHRA) 2014-2018 highlighting NCDs and CDs as national priorities [6]. The aforementioned factors if well managed through the National Research Agenda will substantially reduce the burden of patients requiring Renal Replacement Therapy (RRT) [7].

Although the Government of Rwanda has made several efforts to address the burden of kidney diseases through the NHRA prioritization, implementing these strategies is still a challenge [8]. Therefore, this paper is intended to document and analyze the current situation of kidney diseases and RRT in Rwanda, discuss the benefits and challenges and lastly, to formulate recommendations and future directions for kidney disease programs in Rwanda.

KIDNEY DISEASE: SITUATION IN RWANDA

In Rwanda, like in most of other African countries, there is limited data management system on the prevalence of kidney diseases. A survey done in 2012 revealed an overall prevalence of 10.5% of people with positive urine albumin. Moreover, the prevalence of positive albumin was higher in rural areas (12%) compared to semi urban and urban areas with the Eastern (13%) and Northern (14.9%) provinces showing a higher prevalence compared to the other provinces [9]. However, the majority of the literature highlight diabetes and hypertension as being the major causes of Chronic Kidney Disease, which is progressive loss of kidney function, occurring for months to years and associated with increased morbidity and mortality [10]. In contrast, malaria, being the most prevalent disease among the Rwandan population [2], has been explicated as the infectious comorbid associated with Acute Kidney Injury [8, 11] which, with poor management can also further progress to CKD.

It is also documented that when glomerular filtration rate (GFR) falls below 10 ml /minute/1.73m², End Stage Renal Disease (ESRD) or CKD stage 5 is considered as the level of kidney dysfunction requiring dialysis treatment or transplantation [12]. In low income and middle-income countries, including Rwanda, CKD mostly affects young people [13]. Yet CKD affects 10 to 16 % of the adult population [14]. With a double burden of communicable diseases such as HIV and hepatitis coupled with increased prevalence of non-communicable diseases and their risk factors [15, 16], there is need for governments to invest in strategic interventions that are aimed at preventing kidney diseases or else invest greatly in health care and health care financing.

RENAL REPLACEMENT THERAPY SITUATIONAL ANALYSIS

Globally, the prevalence rates of renal replacement therapy (RRT) for CKD stage 5, end-stage renal disease (ESRD) vary significantly [2]. Over 50,000,000 patients have been documented to present with acute kidney injury (AKI) which requires renal replacement therapies like hemodialysis and peritoneal dialysis [8]. Moreover, it is predicted that over 1.4 million people globally will undergo renal replacement therapy (RRT) to prolong their lives [17]. Unfortunately, in Africa, little is known about the statistics of patients requiring RRT nor the RRT Registry, although estimates

suggest patients requiring RRT are more frequently present in developing countries [18].

In Rwanda, there is limited data as regards to RRT. Currently the dialysis centers in Rwanda are located in University Teaching Kigali Hospital (CHUK), University Teaching Butare Hospital (CHUB), and King Faisal Hospital, Rwanda Military hospital and in the private centers outside Kigali namely Kimihurura, Gisenyi and Cyangugu [19], but the number of human resources for the management of renal diseases is still inadequate. In spite of the highlighted centers for RRT, only one center at King Faisal Hospital conducts peritoneal dialysis making hemodialysis the most available treatment of renal failure patients in Rwanda hemodialysis tends to be the mostly used treatment because of costs and logistics although the services tend to be located in larger cities, often paid for out of pocket [20]. Nevertheless, hemodialysis is just a temporary measure ideally meant for those patients being planned for renal transplantation. Three times weekly sessions of 4 hours duration each does not guarantee adequate quality of life for patients, especially for patients with CKD, hence preventive measures are to be re-emphasized.

Peritoneal dialysis is advantageous because of less infrastructure needed and can even be cheaper with availability of PD fluids locally [20] hence the use of the procedure in countries like Tanzania, Sudan and Nigeria. In Rwanda, peritoneal dialysis (PD) is conducted in one health center. However, this procedure is common in pediatric population [20] and most likely, the fact that it requires a surgeon to insert the catheter and feared for risk of peritonitis [21], it is not commonly done in the majority of the health centers. Additionally, once peritonitis has been identified, patient will be set to be on hemodialysis and hence its unpopularity in Rwanda.

BENEFITS OF RENAL REPLACEMENT THERAPY IN RWANDA

Renal replacement therapy is a procedure that entails removal of uremic toxins, including urea, creatinine, excess fluid and restores normal electrolyte and acid base metabolism : a function that is normally performed by normal kidneys [22]. There are three [3] types of RRT: hemodialysis, peritoneal dialysis and kidney transplantation [23]. Improved kidney quality of life (KQOL) is highlighted as the benefit of RRT. Providing RRT in Rwanda and considering regular dialysis session to patients in needs will improve patients' kidney quality of life and improve patient survival without renal recovery [24]. This means that patients treated with RRT may continue to support themselves, their families and communities to some extent although the majority may continue to face other difficulties related to treatment such as fatigue, or work related problems such as absenteeism leading to being fired at work place [25] . When the patients can no longer support themselves, families and societies then begin to support these individuals for survival.

Additionally, the increased survival rate means that there will be decreased mortality and morbidity rates related to ESRD [26]. Patients surviving from ESRD and those undergoing the RRT are more likely to get kidney transplantation which has shown improved survival rate compared to maintained kidney dialysis

[27]. So far, kidney transplantation is not developed in Rwanda and for those patients who will require the procedure, they are being taken out of the country such as India for the procedure. Resident programs in form of internships in medicine and nursing should focus on increasing capacity in the area of kidney transplantation for improved quality kidney care.

CHALLENGES OF RRT IN RWANDA

There are a number of challenges to renal replacement therapy in Rwanda. Most of these are related to policies and guidelines, accessibility, nutritional management and community education among other factors. Inadequate of trained health care providers, limited accessibility and of integration of renal services in usual care, high costs related to RRT, make early detection and management of kidney disease complex [8]. Additionally, in Rwanda, like in most other African countries, there is a limited data management system for kidney diseases, at all levels of health care delivery [8]. Below, we will provide a detailed discussion of these challenges.

Policies and guidelines

Despite the great efforts to promote quality of life among patients on RRT in Rwanda, there are some challenges to policies and guidelines. Firstly, there is increased NCD burden [2, 8]. Even with other communicable diseases such as HIV/AIDS and other diseases that end up with severe renal damage, RRT will not be adequately conducted for all patients. The lack of clear policies and guidelines specific to the treatment of kidney diseases as well as inadequate funds to mitigate the challenges related to kidney disease management at the national level complicate the situation further [8]. Policies and guidelines related to treatment of Acute and End stage renal diseases are not yet fully developed. One of the components of RRT, Hemodialysis, was introduced in Rwanda at certain health facilities but with limited machines and renewables. Moreover, its accessibility is quite problematic by patients in need as this procedure is not fully covered by the community-based health insurance (CBHI), Mutuelle de Sante, and this is the only health insurance that assists most of the population - around 80 % [28]. There is limited expansion of coverage of medical procedures related to RRT as, for example, patients with AKI have only 6 weeks of acute high dependence (HD) to benefit from it by using government-run community-based health insurance scheme [11, 29]. On contrary, patients on FARG do have full coverage including kidney transplantation. The only challenge may be related to the kidney donor.

Accessibility

Accessibility is still a big challenge to RRT. The majority of Rwanda's population is in a rural setting and these are or will be affected by distances as the dialysis centers are situated in the cities. Those that are situated in the rural center may face other issues such as inadequate trained personnel and patients' inability to pay for the services since they are predominantly private. The available dialysis centers may not be adequate enough to cover the affected population. Additionally, there is a shortage of both nephrologists and nephrology nurses to

adequately cover the growing population suffering from CK. Yet, there is no specific pediatric hemodialysis center in Rwanda to address the burden of renal diseases secondary to malarial manifestations in children. Continuous Ambulatory Peritoneal dialysis is provided to the pediatric population even though only one health care center offers this type of RRT modality. Moreover, malaria associated renal diseases are found in adult population as well. Hence the need to expand the available PD services in all dialysis centers to be able to manage both the pediatric and adult population being affected.

The challenge with patients to be referred to this health center is related to financial burden, therefore causing a delay in treatment of AKI in this population. There is evidence that shows that patients treated with acute PD have good prognosis [20]. Moreover, financing the complete treatment regimen is still a major challenge in which the majority of the patients will be required to pay out of pocket when the mandatory sessions are completed [30, 31]. Therefore, attrition is common and patients may end up with more complications related to missed or inadequate therapy.

Nutritional management

It is imperative to note that patients at risk of AKI and those undergoing RRT are advised to take special diets. These special diets are neither present nor affordable by the majority of the patients in Rwanda. The majority of the hospitals or dialysis center ask patients to prepare their own diets from the available, affordable and accessible foods in the community. The literatures highlight nutritional impact of being treated by dialysis options, where both macro nutrients and micro nutrients lost then results in delay of renal recovery and patient survival especially in patients with AKI [32]. Patients with AKI are most likely to suffer from diseases related to malnutrition [33]. Obviously, patients on RRT need to be managed by nutritional specialists for the purpose of balancing input and output and maintain patient's wellbeing. In Rwanda, these patients and their next of kin get such information, but due to financial constraint most of them use only what is available from their local community.

Community education

There is still limited knowledge in the majority of the Rwandan community about risk factors, treatment, and prevention of renal diseases. This significantly contribute to inadequate intake of the required special diets, and drug noncompliance is common. Also, for patients who have undergone renal transplants, renal rejection is very common due to lack of education. However, there could be other problems that may led to inadequate recovery after renal transplant such as post-transplant infections like TB, nocardiosis and many others that the communities need to be aware of and may require urgent attention if they occur or present. With reference to Rwanda's Health Management Information Systems (HMIS), NCDs including kidney diseases were responsible of 51.86% of all District Hospital outpatients' consultations and 22.3% of all District Hospital hospitalization [8]. These numbers are alarming to the extent that at each health care level they are a means to prevent, diagnose, refer and follow up

of NCDs. On the other hand, there are steps to continue with such as keep training nurses and doctors at all health sector levels, avail medications and other consumables and search for appropriate health sector budgets so that services become more affordable to Rwandans [8].

RECOMMENDATIONS AND FUTURE DIRECTIONS FOR RENAL DISEASES IN RWANDA

Although the majority of the patients on the community-based insurance have the mandatory 6 weeks treatment regimen, It is imperative that the six week policy of RRT on acute cases in Rwanda be strictly followed depending on the etiology and severity of the diagnosis but also, this policy may require amendment to include chronic patients that may not have plans for renal transplant. The policy therefore needs to be disseminated widely to practitioners to facilitate in the implementation of a successful RRT program. Integrating these developed guidelines into the usual care for all patients at risk is significant [34]. Moreover, policies should specify early identification and management of renal diseases considering the national health financing insurances in the country. Whereas the NCD policy 2015 has less kidney disease, a review of this policy should be undertaken to include kidney diseases as a national strategy to improve care of this population.

Empowering and equipping the existing health care settings with dialysis units with adequate supplies and human resources will be the imperative. This will help in making accessibility of RRT affordable thus reducing the mortality and morbidity rates. Similarly, adequate supplies and human resources will help in identification, prevention and treatment of renal conditions [35]. The inadequate number of nephrologists in Rwanda makes the situation more complex. The University of Rwanda has tried to address the inadequate human resources for renal diseases by initiating and implementing a master program in Nephrology nursing to support the management of patients with kidney diseases [36]. Additional efforts are related to the authorization of a private clinic located at Kimihurura which inaugurated its branch in the Western Province exactly in Gisenyi Hospital to lower the long traveling of patients from Western and Northern Province.

At hospital level, the Quality Management (QM) and Quality Assurance (QA) team that ensures that the necessary materials for use in renal replacement therapy needs to be formulated for improved quality care for patients with renal conditions [12]. This will require a systematic approach in which all major stakeholders are involved to advocate for funding [12]. Establishing a continuous and professional development program for health care providers in renal replacement therapy is imperative [36]. Health professional councils involved in the licensing of health professionals should develop and establish a framework to accredit professional development programs in renal replacement therapy. This will help in the update and sustainability of renal therapy programs in Rwanda [12].

Efforts should be made to make the communities in Rwanda aware of renal risk factors and the treatment modalities [37].

Primary prevention of renal diseases, infectious and Non-Communicable Diseases is paramount. Community acquired AKI are caused by infectious agents such as leptospirosis, malaria, sepsis and noninfectious agents which includes nephrotoxic herbal medicines [38]. Therefore, community education will impact on healthy lifestyle changes, thus consequently reducing global societal costs and promoting a healthy, active, and long-lived population [31]. Additionally, early identification and prevention of major non-communicable diseases must be intensified through the creation and development of prevention disease programs [39].

Currently, the university of Rwanda, school of nursing with African Health care network, Rwanda biomedical center and Rwanda kidney organization have been involved in community outreach programs relating to screening of hypertension and diabetes mellitus as well as identification of kidney disease to different communities in Rwanda. This has been coupled with World Kidney day commemorations. However, health care programs that are aimed at reducing the burden of all NCDs and CDs need to be evaluated for their contribution of reducing morbidities and mortalities related to kidney diseases. This will also help in designing strategies that improve patients' self-care and improved kidney quality of life.

IMPLICATIONS TO NURSING PRACTICE, NURSING EDUCATION, FUTURE RESEARCH

Specifically, nephrology nursing practice practices are being offered at the Referral Hospitals and other few specialized private centers. Considering the extent to which RRT technology is new for Rwandans, nurses are appointed in these unities after an intensive training in order to be able to handle patients and the materials in use. As Rwanda is always struggling for the wellbeing of its population, there are good examples such as in maternal and child health, malaria, HIV, tuberculosis among others, this effort is to be kept as well to fight against NCDs, as they are the main cause of renal diseases. The community is now getting information to prevent NCDs in different ways like during car free day, health education during community outreaches, and from media. They will need to highlight renal diseases among other NCDs and make the population aware on the prevention and treatment modalities including kidney transplant.

The alarming status of renal diseases in Rwanda has been considered at a point of training specialists (nurses and doctors) in the field of Nephrology. The aim is to educate pre-service health candidates on renal conditions so that in their working place they will be able to take the right decision on time. Although there are still very few such specialists and mostly located in the referral hospitals where renal units have been inaugurated, they are well equipped to manage cases of kidney conditions. The field of research should be based on available lived experience and go for improvement as well as replying to its customer demands. Although nephrology nursing is a recently growing entity, there is a will to connect to regional and international nephrology professionals so that we exchange experience and adapt feasible evidence-based practice to our context.

CONCLUSIONS

Renal diseases are an important determinant of poor health outcomes for major non-communicable diseases. Rwanda is faced with the burden of both communicable and non-communicable diseases and this needs to be addressed simultaneously. Renal Replacement therapy is one way to address the morbidity of ESRD. Improved knowledge about renal conditions and their risk factors is the initial step to create major gains of improved kidney quality of life. There are several benefits of RRT but compromised by the major challenges to a successful RRT program. The government of Rwanda should put more emphasis on sustainable programs to maintain the health status of patients with renal conditions.

ETHICAL CONSIDERATIONS AND DECLARATIONS

Acknowledgements: We acknowledge the support from the University of Rwanda, School of Medicine and Health Sciences, School of Nursing and Midwifery and the Human Resources for Health (HRH) programme, Ministry of Health.

Potential Conflicts of Interest: All authors declare no potential conflicts of interest

Funding: All authors declare no funding.

Academic Integrity: All authors confirmed that they have made substantial academic contributions to this manuscript as defined by the ICMJE.

Originality: All authors confirmed that this manuscript is original and has not been published elsewhere

REFERENCES

- Bello A, Levin A, Tonelli M, et al (2017) Assessment of global kidney health care status. *Jama* 317:1864–82
- NISR (2015) Rwanda Demographic and Health Survey 2014-15. Natl. Inst. Stat. Rwanda
- World Health Organisation (2016). https://www.who.int/nmh/countries/rwa_en.pdf. Accessed 22 february 2019.
- World Bank, 2019. <https://data.worldbank.org/indicator/ny.gnp.pcap.pp.cd>. Accessed 22 february 2019.
- Webster AC, Nagler EV, Morton RL, Masson P. Chronic kidney disease. *The Lancet*. 2017 Mar 25;389(10075):1238-52.
- Ministry of Health (2014) The National Health Research Agenda 2014-2018. http://www.moh.gov.rw/fileadmin/templates/cdc/NATIONAL_HEALTH_RESEAR%09CH_AGENDA_2014-2018.pdf. Accessed 1 Mar 2017
- Nyaaba G, Stronks K, Aikins A, Kengne A, Agyemang C (2017) Tracing Africa's progress towards implementing the Non-Communicable Diseases Global action plan 2013–2020: a synthesis of WHO country profile reports. *BMC Public Health* 17:297
- Ministry of Health (2015) NON COMMUNICABLE DISEASES POLICY. In: MoH. www.moh.gov.rw/fileadmin/templates/policies/NCDs_Policy.2015.pdf. Accessed 28 Feb 2017
- Rwanda Ministry of Health (2015) Rwanda Non-communicable Diseases Risk Factors Report, 2015. Accessed 22 february 2019.
- CG Geldine, Bhengu B, Manwere A (2017) Adherence of adult Chronic Kidney Disease patients with regard to their dialysis , medication , dietary and fluid restriction Adhésion de patients adultes atteints de maladie rénale chronique en ce qui concerne leur dialyse , leurs médicaments , leur régi. *Res J Heal Sci* 5:3–17
- Nsengiyumva V, Igiraneza G, Lameire N (2018) Definition and epidemiology of acute kidney injury. *Rwanda Med J* 75:17–23
- Teerawattananon Y, Luz A, Pilsant S, Tangsathitkulchai S, Chootipongchaivat S, Tritasavit N, Yamabhai I, Tantivess S (2016) How to meet the demand for good quality renal dialysis as part of universal health coverage in resource-limited settings? *Heal Res Policy Syst* 14:21
- Seck S, Doupa D, Gueye L, Dia C (2014) Prevalence of Chronic Kidney Disease and Associated Factors in Senegalese Populations: A Community-Based Study in Saint-Louis. *Nephro Urol Mon* 10:1–12
- Stanifer JW, Maro V, Egger J, Karia F, Thielman N, Turner EL, Shimbi D, Kilaweh H, Matemu O, Patel UD (2015) The epidemiology of chronic kidney disease in Northern Tanzania: A population-based survey. *PLoS One* 10:1–12
- Kidney Health Australia (2017) Chronic Kidney Disease (CKD): Management in General Practice. 44
- Teixeira FIR, Lopes MLH, Silva GA dos S, Santos RF (2015) Survival of hemodialysis patients at a university hospital. *J Bras Nefrol* 37:64–71
- Stanifer JW, Muiru A, Jafar TH, Patel UD (2016) Chronic kidney disease in low- and middle-income countries. *Nephrol Dial Transplant* 31:868–874
- Ashuntantang G, Osafo C, Olowu WA, Arogundade F, Niang A, Porter J, Naicker S, Luyckx VA (2017) Outcomes in adults and children with end-stage kidney disease requiring dialysis in sub-Saharan Africa: a systematic review. *Lancet Glob Heal* 5:e408–e417
- Mukakarangwa MC, Chironda G, Bhengu B, Katende G (2018) Adherence to Hemodialysis and Associated Factors among End Stage Renal Disease Patients at Selected Nephrology

- Units in Rwanda : A Descriptive Cross-Sectional Study. *Nurs Res Pract* 2018;1–8
20. Niang A, Iyengar A, Luyckx VA. Hemodialysis versus peritoneal dialysis in resource-limited settings. Current opinion in nephrology and hypertension. 2018 Nov 1;27(6):463-71.
 21. Kennard A, Johnson DW, Hawley CM. Complications of Peritoneal Dialysis. In *Core Concepts in Dialysis and Continuous Therapies* 2016 (pp. 121-133). Springer, Boston, MA.
 22. Sutherland SM, Alexander SR (2012) Continuous renal replacement therapy in children. *Pediatr Nephrol* 27:2007–2016
 23. Van Amstel SP, Noordzij M, Warady BA, Cano F, Craig JC, Groothoff JW, Ishikura K, Neu A, Safouh H, Xu H, Jager KJ. Renal replacement therapy for children throughout the world: the need for a global registry. *Pediatric Nephrology*. 2018 May 1;33(5):863-71.
 24. Robert Faulhaber-Walter, Sebastian Scholz, Herrmann Haller, Jan T Kielstein, Carsten Hafer (2016) Health status, renal function, and quality of life after multiorgan failure and acute kidney injury requiring renal replacement therapy. *Int J Nephrol Renovasc Dis* 119–128
 25. Chironda G, Bhengu B. Perceptions of caregivers regarding engagement with integrated management of chronic kidney disease patients in selected public hospitals of KwaZulu-Natal region, South Africa. *Health SA Gesondheid*. 2018;23(1).
 26. Sanchez-de-Toledo J, Perez-Ortiz A, Gil L, Baust T, Linés-Palazón M, Perez-Hoyos S, Gran F, Abella RF (2016) Early Initiation of Renal Replacement Therapy in Pediatric Heart Surgery Is Associated with Lower Mortality. *Pediatr Cardiol* 37:623–628
 - 27 Wang JH, Skeans MA, Israni AK (2016) Current Status of Kidney Transplant Outcomes: Dying to Survive. *Adv Chronic Kidney Dis* 23:281–286
 28. Rwanda Ministry of Health Fourth health sector strategic plan. July 2018 – June 2024. www.moh.gov.rw/fileadmin/templates/Docs/FINALH_2-1.pdf. Accessed 23 Aug 2017
 29. Igiraneza G, Ndayishimiye B, Nkeshimana M, Dusabejambo V, Ogbuagu O (2018) Clinical Profile and Outcome of Patients with Acute Kidney Injury Requiring Hemodialysis: Two Years' Experience at a Tertiary Hospital in Rwanda. *Biomed Res Int*. doi: 10.1155/2018/1716420
 30. Obrador GT, Rubilar X, Agazzi E, Estefan J (2016) The challenge of providing renal replacement therapy in developing countries: The Latin American perspective. *Am J Kidney Dis* 67:499–506
 31. Vanholder R, Annemans L, Brown E, et al (2017) Reducing the costs of chronic kidney disease while delivering quality health care: A call to action. *Nat Rev Nephrol* 13:393–409
 32. Kritmetapak K, Peerapornratana S, Srisawat N, et al (2016) The impact of macro-and micronutrients on predicting outcomes of critically ill patients requiring continuous renal replacement therapy. *PLoS One* 11:1–12
 33. Oh WC, Gardner DS, Devonald MAJ (2015) Micronutrient and amino acid losses in acute renal replacement therapy. *Curr Opin Clin Nutr Metab Care* 18:593–598
 34. Jha V, Arici M, Collins AJ, et al (2016) Understanding kidney care needs and implementation strategies in low- and middle-income countries: conclusions from a “Kidney Disease: Improving Global Outcomes” (KDIGO) Controversies Conference. *Kidney Int* 90:1164–1174
 36. Lunyera J, Kilonzo K, Lewington A, Yeates K, Finkelstein FO (2016) Acute kidney injury in low-resource settings: Barriers to diagnosis, awareness, and treatment and strategies to overcome these barriers. *Am J Kidney Dis* 67:834–840
 36. Cancedda C, Cotton P, Shema J, et al (2018) Health Professional Training and Capacity Strengthening Through International Academic Partnerships: The First Five Years of the Human Resources for Health Program in Rwanda. *Int J Heal Policy Manag* 7:1024–1039
 37. Lopez-Vargas PA, Tong A, Howell M, Phoon RKS, Chadban SJ, Shen Y, Craig JC (2017) Patient awareness and beliefs about the risk factors and comorbidities associated with chronic kidney disease : A mixed-methods study. *Nephrology* 22:374–381
 38. Tupper H. Confronting the growing burden of kidney disease: the sub-Saharan landscape (Doctoral dissertation). 2016.
 39. Perico N, Remuzzi G (2016) Prevention programs for chronic kidney disease in low-income countries. *Intern Emerg Med* 11:385–389