UNIVERSITY OF KWAZULU-NATAL

Dialysis until the Last Drop: Testing the Resilience of Private Haemodialysis Centres in Kwazulu-Natal during Prolonged Water Interruptions (Case Study)

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ABSTRACT

Healthcare facilities play a pivotal role in supporting the community when they are at their most vulnerable. As the provision of healthcare is heavily reliant on consistent supply of electricity and water, the impact of municipal interruptions of these services, has societal impacts and causes which considerably affects the healthcare sector. The province of KwaZulu-Natal encountered drought and various water crises over the past decade resulting in water interruptions being reported frequently in some areas of the province. Chronic Haemodialysis is a lifesaving therapy for patients' dependant on the dialysis treatment. The process is heavily dependent on high volumes of quality water that is used for the process. The purpose of this case study is to measure the resilience of Chronic Haemodialysis Centers in the presence of prolonged water outages. This will generally be defined as the impact of prolonged municipal water interruptions as determined in four scenarios of water outage duration. These durations are <12, 12 - 48 and 24 - 48 and >48 hours. A resilience survey was distributed to 12 National Renal Care owned and operated Chronic Haemodialysis units in the KwaZulu-Natal area which were sampled by purposive sampling method. The surveys were completed and analysed using descriptive and inferential statistics. The feedback from the study showed that between 2016 and 2017, the majority of water interruptions which were reported in 9 centres were less than 12 hours. As a result, it was difficult to demonstrate whether the haemodialysis units at various centres were resilient and vulnerable, as the impact of the water interruptions was not as high as expected. Most of the interruptions from each of the units recorded a total average of 6.7 hours. It was recommended that future studies be carried out in other parts of South Africa to test the resilience of other units operated by National Renal Care, other dialysis companies and that South African Public Hospitals providing dialysis are also included. It was also recommended that centres should begin to explore other alternative water sources in an effort to ensure efficient and consistent services to chronic kidney patients during water crisis periods. Therefore, most of these centres were encouraged to embark on water sustainability projects in order to minimise waste streams. This can be achieved by recycling appropriate parts of processed water back into processes which rely on water but do not require the use of potable drinking water for their applications. In addition, it was clearly recommended that the

development of minimum standards which include minimum water availability must be developed by the Health Professions Council of South Africa (HPCSA) as this will help to promote resilience in haemodialysis units servicing the patients in South Africa.

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List of Acronyms

EWSP	Emergency Water Supply Plan
HPCSA	Health Professions Council of South Africa
KZN	KwaZulu-Natal
NRC	National Renal Care
RO	Reverse Osmosis
SA	South Africa

CHAPTER 1
INTRODUCTION AND BACKGROUND

1.0 INTRODUCTION

Healthcare facilities play a pivotal role in supporting the community when they are at their most vulnerable condition. As the provision of Healthcare is heavily reliant on consistent supply of electricity and water, the impact of municipal interruptions of these services, has a societal impact and causes considerable impact to the healthcare sector (Krishna, 2017). All systems are subject to an acceptable level of failure which are caused by numerous factors, for example, by environmental disturbances such as storms, floods and other natural phenomenon. Imbalanced supply and demand can place utilities under undue stress and lead to system failure especially if routine maintenance is not up to date (EPA, 2018). Mitigating the risk of adverse impacts effectively requires an acceptance of the pending interruption which includes having a disaster plan in place in other to help to reduce vulnerability. This increases resilience that allows business continuity. Prolonged interruptions can have catastrophic effect for patients and can as well drive operational costs of the facility upward. Therefore, the aim of this study is to test the resilience of private haemodialysis centres in KwaZulu-Natal during prolonged water interruptions.

1.1 MOTIVATION OF THE STUDY

Prolonged interruptions can have catastrophic effect for patients as well as drive operational costs of the facility upward. Data extrapolated from (John, 2012) study describes the global dialysis population of approximately 2 million patients. The study goes on to describe that 156 billion litres of water is needed to service this population. According to Davids, Singh, Marais, and Jacobs (2016), an alarming approximation of two-third of the quantity of water used is discarded during reverse osmosis processes commonly used in haemodialysis, despite the grey water being high grade potable water. South Africa has close to 56 million people across 9 provinces. In 2014 the South African (SA) Renal Registry annual report noted 9591 patients were receiving renal replacement therapy. (Davids, et al., 2016) At this stage the population size was 54 million and the treatment rate was extrapolated as 178 patients per million population.

According to media publications released in 2014, South Africans are using more water than available (Thelwell, 2014). Available supply of water which is current at about 98% and waste water treatment of about 40% is rated as being in a “critical state”, while about 37% of our fresh drinkable water is being lost via ineffective ways of utilising water such as worn out pipes that leak, taps that drip water (Thelwell, 2014). Furthermore, the Department of Water and Sanitation was quoted as saying that the demand for water had already overtaken supply of water in 60% of South Africa’s Municipal water management systems (Dippnall, 2016). The KwaZulu-Natal (KZN) region has been hard hit with drought conditions over the past couple of years. In response to growing demand on diminishing supply, the province has established processes to be used in managing demand for water. These processes are achieved by improving facilities, increasing capacity to store water and developing a network of linked catchment areas (AECOM, 2016). During 2016, a call for immediate reduction of water consumption (50% for Agriculture and 15% for Domestic / Commercial / Industrial) through water restriction took place (AECOM, 2016). Even though water restrictions provided a short-term resolution of the drought situation in KZN, the fact remains that health services level need to ensure sustainable utilisation of Haemodialysis unit in servicing kidney related patients as it is expected not to drop. As a result of these water restrictions, it became pertinent to understand the resilience of private haemodialysis centres in KZN during prolonged water interruptions, as it is important to maintain minimal water interruption in other to maintain the life of patients in the KZN Province.

1.2 FOCUS OF THE STUDY

Everyday operations and services for patient care in Healthcare facilities are dependent on basic services such as water and electricity. In the case of prolonged interruptions, a disaster management plan is essential to mitigate patients being negatively affected by delaying treatment. In the case of Chronic Haemodialysis patients, dialysis dosage, time on treatment and treatment intervals are essential for quality of life (Department of Health, 2013). Thus, there is a need to develop an emergency plan in other to ensure continuity of treatment during prolonged water outages. This study will define prolonged outages by looking at the number of hours the unit is interrupted due to water unavailability. This will be estimated against scenarios of water outage durations like <12, 12 to 24, 24 to 48 and >48 hours. Understanding the health sectors legislation determining how facilities are built, the likelihood of prolonged water interruptions and the Chronic Haemodialysis units' resilience in essentially formulating an effective emergency plan (Etheredge & Fabian, 2017). Through highlighting the tangible risk of prolonged water interruptions, collaborative and cost-effective strategies can be created with the aim of reducing the vulnerability of Chronic Haemodialysis units while increasing the health sectors resilience.

1.3 PROBLEM STATEMENT

Frequent water supply disruptions to hospitals throughout KZN have meant that doctors and nurses are usually unable to provide continuous and adequate treatment for patients. This has led to extended interruptions in healthcare and has resulted in increased stress for patients, healthcare providers, as well as placed a huge burden on the Healthcare system. Chronic Haemodialysis is a lifesaving therapy for patients' dependant on proper kidney treatment (Hoenick & Ward, 2019). The process is heavily dependent on high volumes of quality water being made available (John, 2012). As the industry is partially regulated, service providers are not required to provide a minimum amount of water for emergency supply. In KZN, private Chronic Dialysis Centres can be attached to large hospital groups or stand-alone units. Centres that are attached to large Healthcare facilities benefit from industry regulated emergency preparedness. However, according to the Healthcare facilities guidelines and building code R158, Chronic Haemodialysis Centres are not listed as essential services and therefore do not receive preferential electrical and water supply in the case of delayed interruptions (Department of Health, 2016). There is more complication if the centre is not attached to a hospital, as the current standards for private dialysis facilities do not make provision for mandatory emergency water supplies or set a minimum limit of water storage to ensure continuity of dialysis therapy (Department of Health, 2016). While the industry regularly allows for back up water supplies, there is no definite minimum standard as this is generally governed by operational demand and affordability which is mostly determined by the respective service provider.

1.4 AIM OF THE STUDY

The purpose of this will be to test the resilience of a private Healthcare Facility known as National Renal Care (NRC) Chronic Haemodialysis in the KZN region. This facility specialises in Organ Support Therapies in the presence of prolonged water outage. The phenomenon being studied will generally be defined as the impact of prolonged municipal water interruptions as determined for four scenarios of water outage duration which are less than twelve hours (<12 hours), twelve hours to forty eight hours (12 – 48 hours) and twenty four to forty eight hours (24 – 48 hours) and greater than forty eight hours (>48 hours).

1.5 OBJECTIVES OF THE STUDY

The study was guided by the objectives below;

1. To understand the vulnerability of Chronic Haemodialysis units and patients in the KZN region in terms of prolonged water outages.
2. To determine the resilience of the service provider when experiencing prolonged water outages.
3. To ascertain standards and norms of the industry for the possibility of improving industry standards and containing cost.
4. To identify environmentally friendly responsible actions which are being taken by the chronic dialysis units.

1.6 RESEARCH QUESTIONS

In other to realise the objectives of the research, the study aimed to answer the following questions:

1. How vulnerable are Chronic Haemodialysis units and patients in the KZN region with regards to prolonged water outages?

2. Is their resilience established by service providers towards coping with prolonged water outages?
3. What are the standards and norms in the industry which are applied when facing prolonged water outages?
4. What environmentally focused and responsible actions are the service providers taking?

1.7 RESEARCH METHODOLOGY

The positivism method was utilised in the study as the view denotes that mainly true knowledge gathered through observation should be trusted (Cooper & Schindler, 2011). The positivism (also known as the quantitative approach) encourages the researcher to assess the outcomes without individual conclusions (Creswell & Creswell , 2018). This approach was used in evaluating the view of the researcher and helped in contributing to an improved understanding of the study objectives. The purposive sampling was used for the study, as there are specific units, operated by NRC that needed to be investigated. Hence the study focused on the 12 NRC units that are in KZN.

The survey form was manually distributed to the participating centres. The data was analysed using the Microsoft Excel Data Analysis Tools. The outcome of the data was presented using both descriptive and inferential statistics. The survey focused on a retrospective analysis of reported water outages in the form of adverse event reports. The phenomenon being studied was generally defined as the impact of prolonged municipal water interruptions as determined for four scenarios of water outage duration which are, twelve hours (<12 hours), twelve hours to twenty four hours (12 – 24 hours) and twenty four to forty eight hours (24 – 48 hours) and greater than forty eight hours (>48 hours).

The researcher ensured that ethical considerations were applied during the study, as great care was exercised in ensuring the suitability of wordings. Gate keeper's letter was obtained from NRC Human Resources Manager and the researcher further obtained ethical clearance from the UKZN ethical committee. This clearance ensured that all necessary protocols were met in accordance with the guideline of the University. The renal units under investigation was represented by “units” in order to retain the confidentiality of these unit.

1.8 LIMITATIONS OF THE STUDY

The study was limited to the NRC centres in KZN province and did not consider other provinces. The researcher did not evaluate other haemodialysis units that are operated by other companies or competitors, hence beyond NRC, the findings of this study may not be applied to other renal haemodialysis units.

1.9 LAYOUT OF CHAPTER

Chapter 1 – Introduction

This chapter presents the introduction, background, motivation, research problem and the background of the study. This chapter also covered study aim, specific objectives, research questions, significance and limitations of the study.

Chapter 2 – Literature Review

The literature survey was reviewed in this chapter. It outlines a wide-ranging summary of the literature sources that were consulted, key definitions, overview and trends on various topics relating to the study. Other general subjects that are relevant to the study was discussed in detail and gaps on the existing topic were also identified.

Chapter 3 – Research Methodology

This chapter outlines the methodology of the research. It presents a summary of the models and ideals surrounding the research methodology. It reviews the general methods of research accessible to researchers, the suitability of these methods and their implication. It reviews some of the aspects like research design, target population, sampling strategy, research instrument, data analysis, validity, reliability, bias elimination and ethical considerations.

Chapter 4 – Presentation of results, Discussion and Interpretation of Results

Chapter four presents the results from the study and the direct interpretation of the results. This chapter describes the general pattern observed from the data. It also shows the statistical methods used for data analysis and presentation of the results.

Chapter 5 – Discussion of Results

Chapter five presents the discussion of the results. It reviews the literature related to the study in relation to the study objectives.

Chapter 6 – Conclusion and recommendations

This chapter covers the research conclusion and recommendations extracted from the study to the organisation. This chapter also suggested some scope for future study.

1.10 CONCLUSION

This chapter outlined the overview of the entire study which was intended to evaluate the pace for the study, that is, to test the resilience of private haemodialysis centres in KZN region during prolonged water interruptions. This chapter presented the study's overview, background, objectives, research limitations and research methodology. The next chapter expounds on the literature review.

CHAPTER 2
REVIEW OF LITERATURE

2.0 INTRODUCTION

The earlier chapter outlined the introduction to the study. This chapter presents the literature surrounding the study. It provides overview on global and South Africa (SA) water issues, as well as current water crises in the KZN province. It also provides an overview on haemodialysis procedure, dependence on water and other water conservation approaches. This chapter also reviews resilience and the plans government or public sector can put in place to address water outages. Those suggested plans will minimize interruptions that can jeopardize services in the health sector.

2.1 THE IMPORTANCE OF WATER TO HEALTHCARE FACILITIES

More than half of South Africans are using more water than what is presently available (Thelwell, 2014). A study showed that over 37% of clean and drinkable water is lost through inefficient ways of water use such as dripping taps, and leaking pipes due to weak infrastructure. Healthcare facilities play a pivotal role in supporting the community when they are at their most vulnerable condition. As the Healthcare is heavily dependent on reliable supply of water, the impact of municipal interruptions of water services has a societal impact and causes considerable impact on the Healthcare sector (Lauer, 2016). According to Bartram, Cronk, Montgomery, Gordon, Neira, Kelley, and Velleman (2015), a report by the World Health Organisation and the United Nations Children's Fund (UNICEF) highlighted the condition of water in Healthcare facilities. This report showed that where water is available, there is no guarantee that it will be safe for use or for consumption (Bartram, et al., 2015). Many of the water systems are subject to an acceptable level of failure which are caused by numerous factors, such as storms, floods and other phenomenon (Lauer, 2016).

Imbalanced supply and demand can place utilities under undue stress and lead to system failure especially if routine maintenance is not up to date. Mitigating the risk of adverse impacts effectively requires an acceptance of the pending interruption which is cubed by having a disaster plan in place which reduces vulnerability and increase in resilience, in other to allow business continuity (Krishna, 2017). Prolonged water interruptions can have catastrophic effect for patients as well as drive operational costs of any health facility. For instance, a water interruption situation at Ugu District Municipality resulted in stage four cancer patient at Murchison Hospital services not bathing for three days, coupled with the inability to meet necessary needs at the hospital (Krishna, 2017). According to Agar (2012), some of the examples of very crucial usage of water in a Healthcare facility that can be affected by interruption of water. These are;

a. Drinking water at fountains and faucets
b. Water for preparation of food, toilet flushing and bathing of patients
c. Water for general laundry and other services like cleaning or sterilization of surgical instruments and other equipment or accessories used on patients
d. Water for haemodialysis, hydrotherapy and other medical use
e. Sprinkler system for radiology
f. Air-conditioning and ventilation water supply

2.2 GLOBAL ENVIRONMENTAL ISSUES AND CHALLENGES AROUND WATER SUPPLY

The global society and ecosystem require water for many reasons. People rely on a reliable, clean supply of drinking water in order to sustain their health. Water is needed for agriculture, the production of energy, navigation, manufacturing, recreation and in the health industries (EPA, 2018). These uses create pressures and demand on water resources, which could be multiplied by increasing global issues related to climate change (EPA, 2015). The results of climate change ranges from warming temperatures, variations in precipitations, extreme weather events and rising sea levels. These affect the health of humans by influencing the food people eat and the water they drink. The criticality of diverse health issues rely on the capability of health and public services to manage or respond to these growing challenging threats (EPA, 2015). One of the most susceptible group of people that face health risks are individuals from developing countries, even though these changes in the climate lead to substantial dangers to health in industrialised countries like the United States and United Kingdom.

The impact of water scarcity is currently felt in all continents, as almost 1.2 billion or close to 20 percent of the global population are resident in localities of dire scarcity. Even so, almost more than half a billion people are reaching such scarcity situation. The scarcity of water is defined as the level or degree when the cumulative effect of consumers of waters affect the supply or water quality under prevalent established provisions, to the degree that the request by all industries are more than what can be met (UNESCO, 2012). The Figure 2-1 below shows the global physical and economic water scarcity according to World Water Development Report.

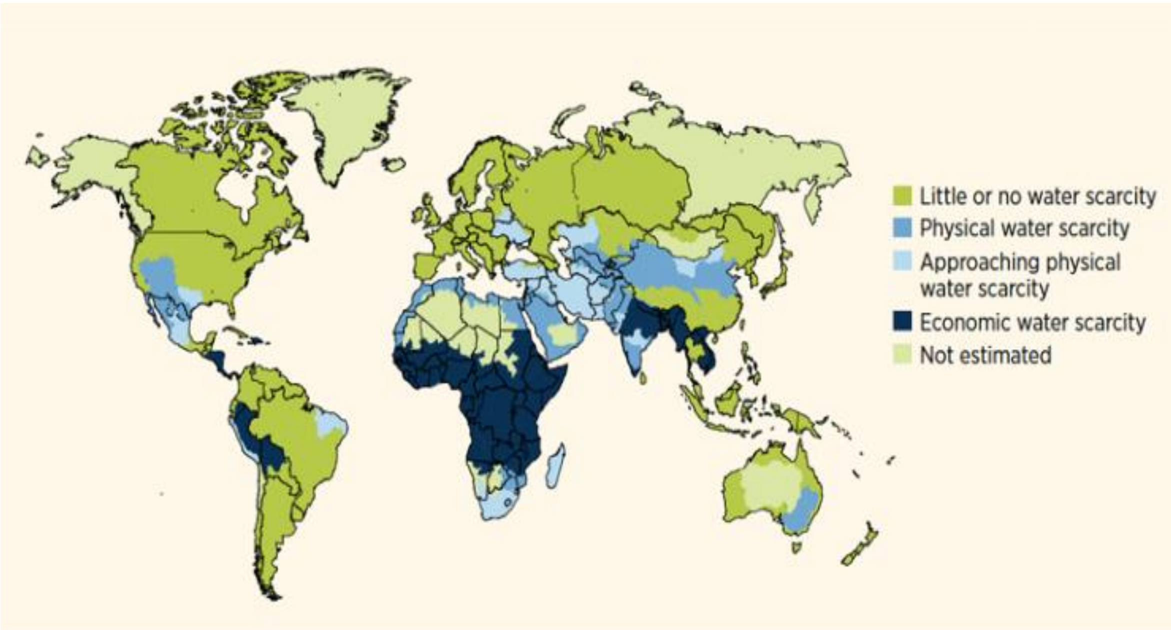


Figure 2-1: Global Physical and Economic Water Scarcity (Source: World Water Development Report 4, 2012)

From Figure 2-1 above, the biggest water-affected nation in any region is the Sub-Saharan Africa. In addition, SA as shown is approaching physical water scarcity. In the last couple of years, Cape Town was hit by serious water crisis that required series of intervention from the Government and private water based companies (Leahy, 2018). The city of Sáo Paulo in Brazil, with a population of about 20 million, was challenged in 2015 when they reached what was known as "Day Zero". As a result, water supply was shut for 12 hours a day, which forced many companies and industries to go offline (Leahy, 2018). Over 10 years ago, Barcelona Spain had to import tankers of fresh water from France (Leahy, 2018).

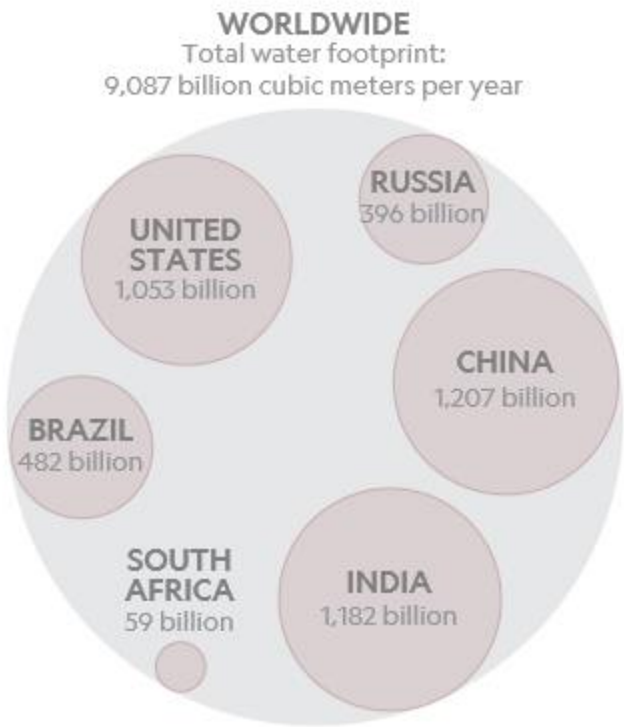


Figure 2- 2: The Total Water Footprint (Source: Leahy, 2018)

The Figure 2-2 above shows the total water footprint of the top five nations that add to humankind's overall water footprint. This is in addition to SA where Cape Town faced an emergency shortage of water level that broke in 2018 (Palm, 2019). The total water footprint of national production can be defined as the total volume consumed or polluted within a country. The issue of water scarcity and flood related problems are basically as a result of accelerated growth, cumulative susceptibility, and inadequate preparation (Leahy, 2018).

2.3 WATER SITUATION IN KWAZULU-NATAL PROVINCE AND DAM LEVELS

As a nation, SA has 7 million residents that lack access to water. The KZN region was hit with drought conditions over the past years, between 2014 and 2016 (Corke & Whittles, 2015). This was cited by a writer who indicated that the then drought which gripped parts of the province was the worst since 1982 with some areas bond dry (Corke & Whittles, 2015). KZN suffered this crippling drought throughout 2015 and 2016, leaving many farms and rural areas with JoJo tanks as their only source of water. As at then, the water levels of Midmar Dam dropped to its lowest since 1982 even though the dam is now at 94% (Pieterse, 2019). As at 7th December 2016, the dam levels in 2016 versus 2015 with variance is shown in the Table 2-1 below;

Table 2-1: Dam Levels 7th December (Adapted from Umgeni Water, 2016)

Dam Description	**2015 (%)**	**2016 (%)**	**Variance (%)**
Midmar	50	53	6%
Mearns Weir	62	63	2%
Spring Grove	80	46	-68%
Nagle	67	65	-4%
Albert Falls	42	27	-30%
Inanda	82	66	-32%

In view of the Table 2-1 above, water restrictions were put in place as an approach to avoid potential disaster of the dams at Midmar and Albert Falls. The disaster of these water dams could have affected the Pietermaritzburg and Durban economies. A water dam is said to be in a Failure State when it dries up, leaving only mud on it (Harichunder, 2016). During this situation, restrictions had to be applied as the dams at Midmar and Albert Falls were required to reach 70% levels respectively as minimum levels before they can be deemed to be adequate, and able to address the demands of uMgungundlovu District Municipality, Msunduzi Local Municipality and eThekwini Metro (Harichunder, 2016).

In response to the growing demand on diminishing supply, the province established various task teams in other to address the growing demand for water. This they did by improving facilities, increasing capacity to store water and developing a network of linked catchment areas which can be controlled according to the need (Motsai, 2018). Interventions for the Umgeni Water Supply System Operations Forum (SOF) was established in other to focus on improving system operation and the management of water restrictions in the event of a drought. During 2016, a call for immediate reduction of water consumption (50% for Agriculture and 15% for

Domestic, Commercial, and Industrial) restriction took place (AECOM, 2016). Media houses were enlisted to drive water wise campaigns and create awareness to the public about the water shortages. Such campaign was aimed at managing the situation and preparing for future drought conditions. While water restrictions provided a short term resolution of the drought situation in KZN, long term ongoing planning and implementation of the Reconciliation Strategy is critical to managing the possible impact of similar future water scarcity situations (AECOM, 2016). The task team estimated water restrictions being unavoidable and particularly the next 8 years, even though it is seen as part of the strategy to manage periods of prevalent over compromised water availability. To explain further, whilst water restrictions are noted as undesirable, they are carefully considered a necessary tool needed to manage water availability challenges (AECOM, 2016).

2.4 SOME CAUSES OF WATER SHORTAGE

In SA, the department of Water and Sanitation is responsible for ensuring that SA's water resources are managed sustainably and equitably for everyone's benefit (Toxopeús, 2019) . It is vital to mention that the issue of water shortage beyond natural effects is driven by severe institutional and governance challenges that compromise its capability to function efficiently (Toxopeús, 2019). According to Toxopeús (2019), some of the issues include;

- Poor financial management
- Instability and leadership structures
- Human resource management
- Failure to decentralise water resource management
- Water use authorisations: Unsustainable practices
- Failing infrastructures
- Rising population
- Water conservation and demand management
- Water resource quality

Amongst above mentioned reasons, there is also the impact of illegal water connections to be blamed. According to Cullinan, Mukwevho, Motaung, Mojela, Dalana and Maseko (2019), vandalism and illegal water connections on the major water line supply have been recorded to lead to shortages of water in villages such as Maphambu, Dumela, Muswani and Dakari under the Collins Chabane municipality. This resulted in the community leaders holding meetings with stakeholders to deal with issues of vandalisation (Cullinan, et al., 2019).

2.5 DIALYSIS PROCEDURE AND DEMAND FOR WATER

2.5.1 Haemodialysis Procedure

Haemodialysis is a remedial process for sick people that are experiencing momentarily or perpetually lost kidney function, because of renal or kidney failure (Hoenich, et al., 2016). This procedure is done using a haemodialysis unit. The Figure 2-3 is an adapted picture of the Haemodialysis Unit.

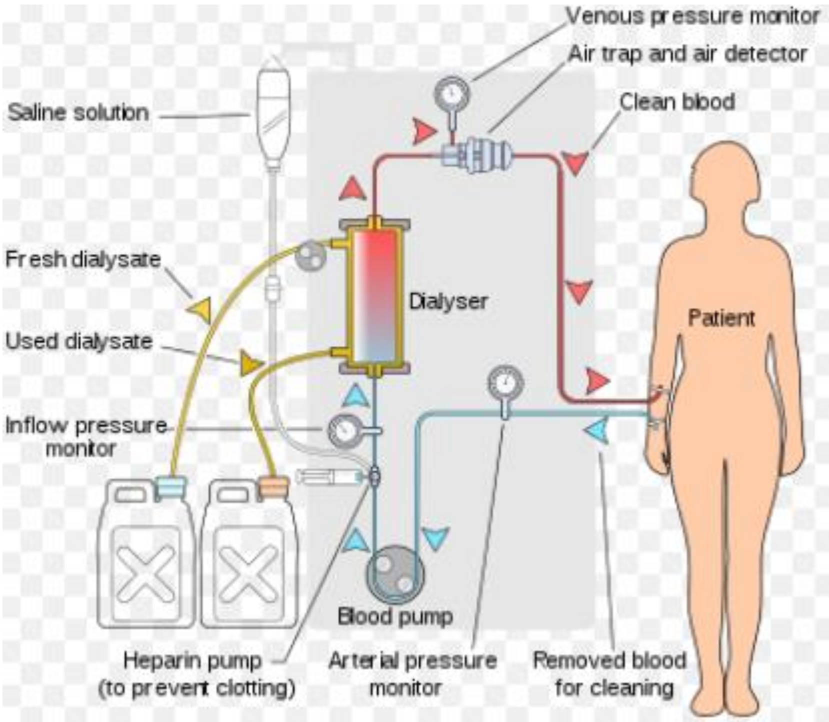


Figure 2- 3: Haemodialysis Unit (Adapted from Tarrass et al., 2010)

The kidneys make up the very essential body parts of the human body, because they play essential roles in elimination of unwanted products from the body, hormones excretion, and assists in keeping the equilibrium of body fluids via pH control and human blood pressure (Centres for Diesease Control and Prevention, 2016). This process does not provide a holistic solution to kidney replacement function as it cannot discharge hormones, instead it helps the body to remove waste and maintain body fluids balance (Centres for Diesease Control and Prevention, 2016). In haemodialysis procedure as shown in Figure 2-3 above, blood travels from the body by one side of a selectively permeable membrane while the dialysate, the fluid in the dialysis unit travels by the reverse side of the membrane. According to Tarrass, Benjelloun, Benjelloun and Bensaha (2010), through this process, unwanted waste in the blood runs into the dialysate, while bicarbonate (required for the balance of pH) travels from the dialysate into the patient's blood. In that manner, the cleaned blood is transported back to the body, thereby eliminating the detrimental waste and additional salt. Also, the fluid in the dialysis unit assists in controlling the blood pressure, pH balance of the body, and plasma volume (Tarrass, et al., 2010).

2.5.2 Haemodialysis Unit and Importance of Water

Dialysis unit is a robust equipment that is a life-saving and life-sustaining therapy from which millions of patients have benefited (Tarrass, et al., 2010). The efficiency of the dialysis unit is to provide ultra-clean water to the patient. Above other compound, water is critical in supplying safe and effective haemodialysis procedure to the patient. Water is used for the dialysis process and for the safety and health of the patients. It is also essential to make sure that the water is safe and clean (Centres for Diesease Control and Prevention, 2016). This unit requires continuous water and special water treatment process. This process helps to avoid negative outcomes from patient's dialysis therapy that usually emanates from improper origination of dialysate with water, as it contains increased levels of some chemical or biological pollutants (Centres for Diesease Control and Prevention, 2016). During a single dialysis session, a patient is exposed to 120 to 200L of dialysis solution. This is because, in the case of absence of renal excretion, any low molecular weight contaminant in the solution may enter the blood unhindered and this will accrue in the body. Therefore, it is important for the dialysis solution to maintain a chemical and microbiologic purity, as it assists in preventing injury.

Previous research uncovered that typical dialysis sick people encounter about 2 cubic metre of water over a period of 30 days. This denotes the importance of ensuring that the supply water to the dialysis unit is void of metals, impurities or microorganisms. This is because even small quantities of such particulates or contaminants can enter the bloodstream (Hoenick & Ward, 2019). It is said that every kidney doctor understands that the water room is the most crucial part of the unit, as without proper water treatment, the unit will not function optimally (Desai, 2015). In course of the dialysis process, the blood of the patient encounters the water based solution carrying salts (dialysate). This dialysate passes via a unique type of filter. However, the water can carry substances that could travel into the patient's blood if not properly treated and can culminate into a critical risk to the patient's health (National Renal Care, 2019).

No municipal water can be considered safe for use in haemodialysis in the absence of water treatment system (National Renal Care, 2019). Renal care in South Africa is aligned with the International Organisation for Standardization (ISO) which has established least criteria or standard for water in other to make dialysis solution and the cleanliness of the last dialysis solution (National Renal Care, 2019). The purpose of treating water for haemodialysis is to achieve high quality and safe haemodialysis water and dialysate.

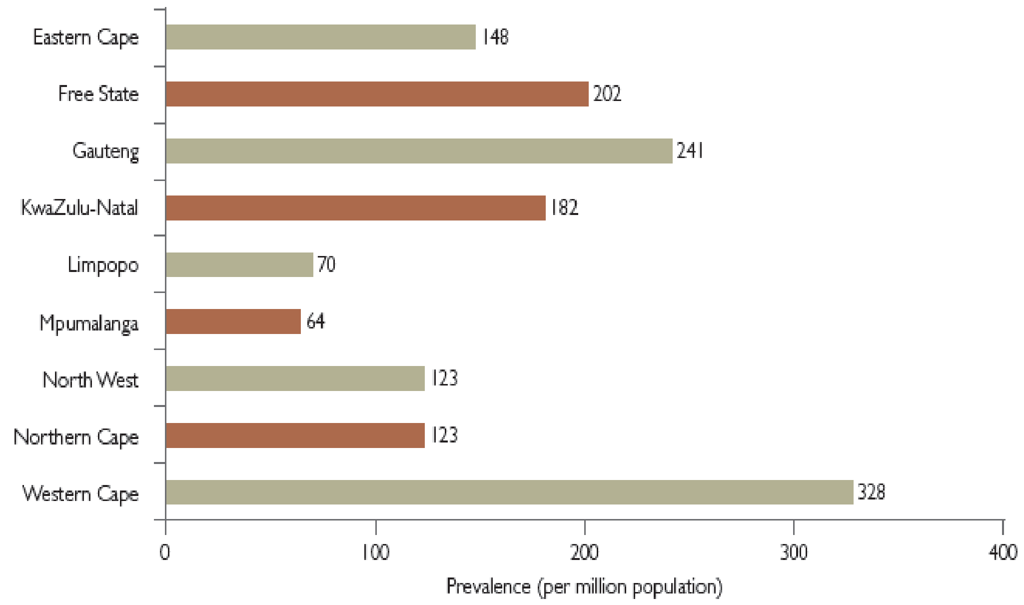
2.5.3 Prevalence of Renal Replacement Therapy

The total number of patients on Renal Replacement Therapy (RRT) as at 31 December 2016 in SA was 10257. This is a prevalence of 183 per million population (per million population – pmp). The Table below is a summary of the existing centres by province and sector.

Table 2- 2: Number of Centres by Province and Sector (Source: Davids et al, 2016)

Sector	EC	FS	GT	KZN	LP	MP	NW	NC	WC	All
Public	3	6	7	5	0	0	3	1	5	30
Private	18	13	67	61	13	11	11	4	32	230
Total	21	19	74	66	13	11	14	5	37	260

The figure below shows the prevalence of RRT by province and sector.



Province	EC	FS	GT	KZN	LP	MP	NW	NC	WC	All
Patients	1 045	577	3 255	2 022	409	275	465	146	2 063	10 257

Figure 2- 4: Prevalence of RRT by Province and Sector (Source: David et al, 2016)

From Figure 2-4 above, the province with the greatest patient numbers remains Gauteng, followed by the Western Cape and then KZN. There were 472 who started the RRT as at 2016. Many of these patients (86%) received RRT in private centres.

2.6 HOSPITAL EXPERIENCES WITH WATER OUTAGES AND SOLUTION

SA hospitals are not new to water outages that increases the potential of impacting hospital patients adversely. Recently, an emergency water interruption affected several Germiston suburbs. During the supply interruption, water tankers provided water to the Bertha Gxowa Hospital to ensure that the water levels in the hospital's storage tank were kept below 75%. This was done in other to give water to internal wards networks and accommodate any possible emergency incidents (Hodgson, 2019). The impact of water outages to hospitals can result in the cancellation of operations and prolonged outages that can affect dialysis procedure. At the notification of water interruption to a healthcare facility, management is expected to evaluate the nature of the problem. The agility of response is usually dependent on the prolonged period of the outage before the water is returned to normal (Tarrass, et al., 2010). Experience showed that a time frame of about 8 hours is often the breakpoint between a significant water supply interruption and non-significant scenarios that can be handled quickly (Tarrass, et al., 2010).

To maintain daily operations and efficient patient care services, Healthcare facilities are required to develop an Emergency Water Supply Plan (EWSP). This EWSP will help the hospital prepare for, respond to and also recover from a total of partial interruptions of the healthcare facilities of usual water supply in case of water interruption (Centre for Disease Control, 2012).

2.7 CONSUMPTION OF WATER IN HEAMODIALYSIS AND PROJECTED POTENTIAL NEEDS

The growth of the present global population is increasing and is also simultaneous with the demand to sustain the population of dialysis patient. It is expected that the population of the dialysis patients will increase to about 6% and can easily lead to about 4 million patients by the year of 2025. This growth in the population of these patients also affect the resources that are required to maintain the dialysis facilities (Centre for Disease Control, 2012). As at 2007 in the United States, about 5000 clinics (managing over 325,000 patients) carry out over 50 million dialysis procedure every year, which leads to about a consumption of 5 trillion litres of fresh water yearly

(Calson, 2008). This equates to about 26% population of the global dialysis market. About 400 000 cubic metre volume of water goes down the drain annually from swimming pool systems.

Another study also showed that the consumption of water is more than 190 000 cubic metre of fresh water annually at a haemodialysis unit (Centre for Disease Control, 2012). As a result, these huge consumptions of water at dialysis facilities demands that centres for dialysis should be focussed on water conservation initiatives, as an innovative way of conserving water.

2.8 MEASURES OF WATER CONSERVATION IN HAEAMODIALYSIS

There are different approaches that can be explored for the configuration of conventional water treatment equipment. These can vary from water reuse, water reduction and also can depend on the setup or design of the installed RO water system and the quantity of water processed by the RO system (Guenther & Balbus, 2014). For instance, some water conservation systems may be made up of simple RO system selection or a re-design of reject water by RO or even other complex technologies like waste spent dialysate recycling (Guenther & Balbus, 2014).

2.8.1 System Selection for Reverse Osmosis

Accurate Reverse Osmosis (RO) system design, choice of membrane and appropriate pre-treatment is essential in the optimal benefit of any water treatment system. The quantity of water wasted differs from the system configuration. An over-designed RO system can lead to extreme treated water waste and reject RO water (Garcia, 2013). Such over-designed RO membrane system require high output and demands correspondingly higher reject flow. As a result, it is essential to consider these parameters when setting up water treatment equipment (Agar, 2012). The composition of the feed water as well as temperature also affects the efficiency of an RO system. This is because temperature creates an inverse effect on the product flow via the membrane and increases product flow while reduced temperature lowers the flow of product (Favero, 2012). This can be reduced using a double-pass structure in which the rejected water flows via the RO process, prior to being thrown away as waste (Garcia, 2013). Additionally, modern RO systems are generally more efficient and rejects less water to drain, (Favero, 2012).

A regulation device that controls the system flow is fitted into the distribution loop. This used to control the water flow in order to fit the actual usage (Favero, 2012). Hence, less water is consumed, and the reject is less reject is sent to the sewer through the RO system. In haemodialysis, there is no continuous demand of fluid in machine, as it varies with the cyclic flow of the equipment (Agar, 2012). This leads to allowing flow regulators like the valve to be used in regulating the water flow rate in line with the consumption by machines (Garcia, 2013). The RO module decreases wastage of water by similarly altering the production of water. This leads to a good benefit of using this technology in minimising waste from RO systems (Favero, 2012). For example, a facility operating with 20 machines on 2 sessions four (4) hours each) daily, six (6) days per week, and on a half capacity three (3) times per week, the reject RO water could be estimated at 1,373 cubic metre annually. However, when using a motorized three-way valve, the reject RO water reduced to 917 cubic metre annually, which leads to a direct annual water savings of 4562 cubic metres (Laurence, 2010).

2.8.2 Recycling Spent Dialysate

Dry countries produce effluents that are too valuable to be wasted. The effluent from dialysate is consistently sent to the sewer by many dialysis centres globally. A study evaluated the practicability of utilising membrane technology to generate recycled haemodialysis wastewater appropriate for irrigation (Tarrass, et al., 2010). It was uncovered that dialysate effluent is known for its high conductivity content. The chemical content and bacterial biomass meets the criteria put in place by the World Health Organization and the United Nations Food and Agriculture Organization for the type of water applied in irrigation system (Favero, 2012). To obtain low levels of the required conductivity, utilising membranes (i.e RO and ultra-filtration) in treating haemodialysis effluents for reuse looks very feasible. This type of process are presently utilised in treating diverse kinds of wastewaters and are efficient in the removal of trace organic compounds, bacteria and viruses (Favero, 2012). The cost-benefit analysis of this technology appears promising.

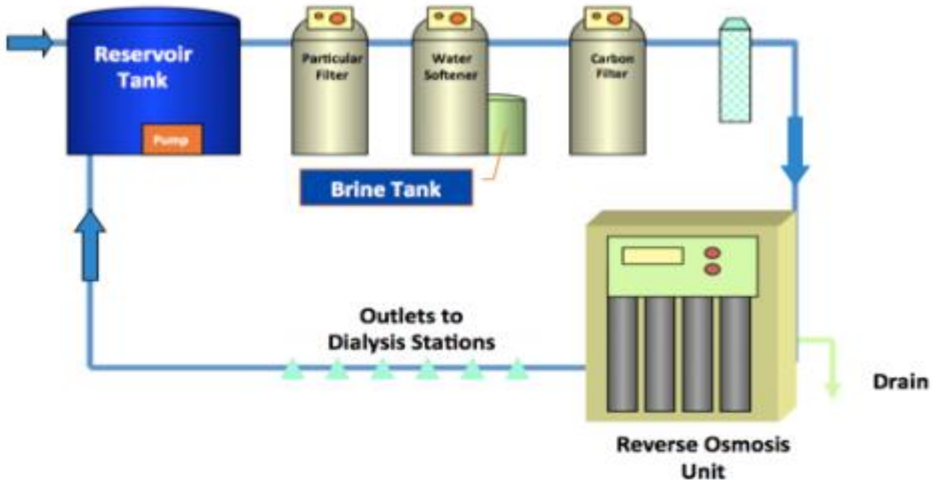


Figure 2- 5: Schematic Representation of a Typical Dialysis Water Treatment Circuit (Source: Dheda, Van Eps, Hawley and Johnson, 2015)

According to Dheda et al., (2015), the Figure 2-5 above is a diagram illustration of a typical dialysis water treatment circuit. This is typically used in centres that supply multiple dialysis machines and are utilised more than three times a day. Such centres require large amount of water, hence the need for more filtration systems (Dheda, et al., 2015).

2.9 BENEFITS OF SALVAGING WATER IN HAEMODIALYSIS AND WATER CONSERVATION MEASURES IN HEAMODIALYSIS

Some of the benefits of saving water from haemodialysis include;

- Financial savings – dialysis facilities are substantial consumer of water and reducing water can result in significant water savings.
- Environmental impact – Waste water generated from dialysis process may have a significant impact on the environment due to its high conductivity and salinity.

Other substitute water sources that may be accessible in a crisis situation mostly fall into one of the categories: Portable Water, Ground water and Tanker Water.

2.9.1 Potable Water

Another operative public water resource with sufficient capability to provide potable water to the Healthcare facility is often the most likely substitute source of water in times of water interruption situation. In order to utilise this substitute supply, the management of Healthcare facility must organise with another public water supply to get potable water and also to determine the amount of potable water that the other public water supply can be provided. They also need to ascertain whether the quantity of drinkable water provided is enough to cater for the entire facility, the critical areas, or some part of the facility's vital areas. Therefore, in other to utilise any water that is available, supplies must be made to bring the water to the building and the suitable critical areas (Fuentes, 2010).

2.9.2 Groundwater

According to Foster, Tuinhof and van Steenbergen (2011), groundwater is the critical essential resource for human existence and economic development in broad drought-prone areas across Sub-Saharan Africa. Presently, the reliance of rural water-supply by communities on groundwater is unarguable. The increased presence of successful water well is efficiently supporting the smooth running of clinics, markets, schools and for farming (Foster, et al., 2012). Many healthcare facilities can receive dependable alternate source of water if there is a set-up of emergency power supply (City of Cape Town Report, 2017). It is the duty of the management of the facility to establish if any of the wells available or at the nearby properties could be utilised for emergency water supply (City of Cape Town Report, 2017). In some cases, some of such alternative wells belong to a private home or may have been built to provide portable water, irrigation water or water for industrial processes (Cosgrave & Loucks, 2015). In a situation where the facility decides to explore the development of their own reserve or alternative water, it is vital to liaise with the state water agency so as to establish if any permit limitations or other criteria are necessary (City of Cape Town Report, 2017).

2.9.3 Tanker Water

Water in a water-supply emergency, amenities may need to depend on a water transporter to convey water to the facility (City of Cape Town Report, 2017). Preparation for the utilisation of tanker-transported water comprises the following steps: It is necessary to establish if the water source utilised in filling the tanker trucks is harmless and from a permitted source, (City of Cape Town Report, 2017). It is also important to establish if the water truck utilised to transport the water is proper for the transportation of the potable water. If all these checks are done and meets the required specification, then tank water should be considered as alternatives for hospital services, especially haemodialysis.

2.10 SUSTAINABILITY AND RESILIENCY PLANNING FOR WATER SHORTAGES FOR HEALTHCARE PROVIDERS

Variations in climate, disasters and rapid growth in the urban areas of many cities pose a serious risk to the provision of urban water services like safe drinking water, sanitation, water supply to health services and safe drainage (Johannessen & Wamsler, 2017). The growth of the population of any city increases the danger of disasters, as such growth usually limits drainage capacity and increases pressure on urban water systems, thereby affecting the poor (Johannessen & Wamsler, 2017). Prior to discussing the concept of resiliency, a broader framework of sustainability needs to be in place. Sustainability is defined as those physical and official practices that fulfil the necessities of the present without compromising the meeting of citizens need in the future (Leigh & Lee, 2019). The goal of any government should be to design systems that are responsive and sustainable, i.e. systems that are resilient (Leigh & Lee, 2019). Recently, the term “urban resilience” is becoming a popular idea used in minimising the increase of risk in the society. Resilience can be seen as the capability of a system or society that are faced with threats to resist, absorb, accommodate to and recuperate from the efforts of such hazards in a timely and inefficient manner (Johannessen & Wamsler, 2017). A resilient system can bear a high degree of turbulences and may even have more capacities to reorganise itself in other to adapt and still maintain essential functions (Leigh & Lee, 2019). The Figure 2-3 below shows three levels of perceived resilience in city water management.

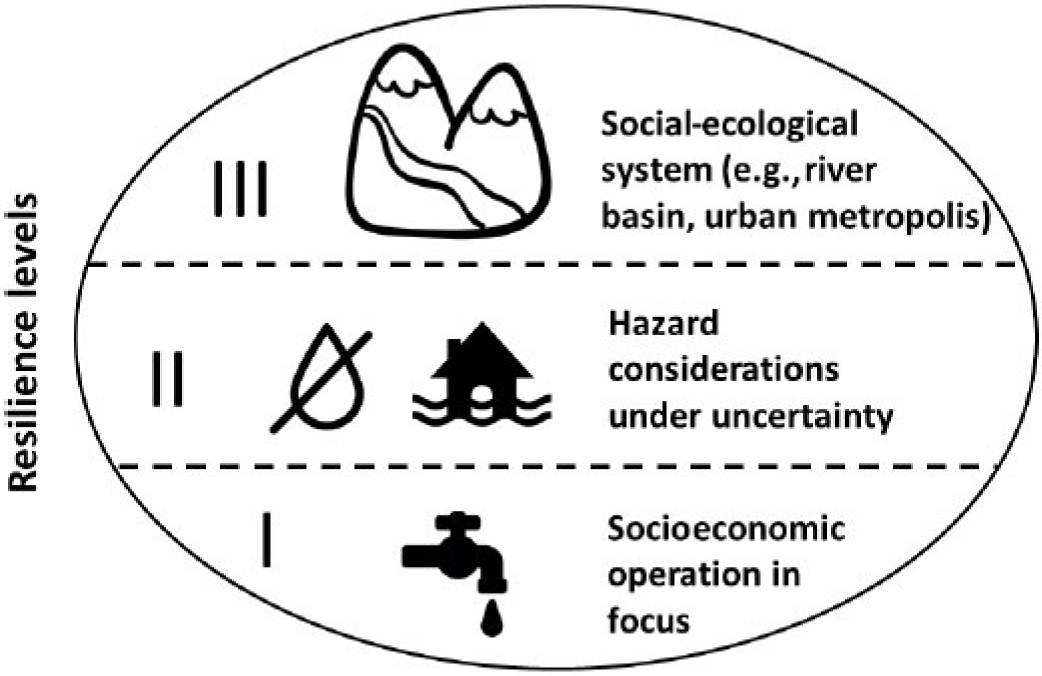


Figure 2-6: Three Levels of Perceived Resilience in the Urban Water (Source: Johannessen and Wamsler, 2017)

According to Figure 2-3 above, there are three (3) levels of resilience with regards to urban water service.

Level 1 deals with Socioeconomic Resilience: Under this stage, a certain level of sufficient water supply that satisfied human needs can be seen. This level demands a certain level of management of the water system.

Level 2 deals with External Hazards Resilience: This level talks about the degree/ patterns of (perceived) climate change related to floods and its perceived impact on the society.

Level 3 deals with Socio-ecological Resilience: This shows the extent of drought and its supposed future consequence on the society. It also highlights the extent of water scarcity, pollution and its impact on society.

For the Haemodialysis to maintain resilience, the hospital or renal unit must make provisions for alternative sources of water. Such centres must not rely on municipal water only, as other sources of water needs to be provided. Water and wastewater systems should be built for resilience and sustainability of operations during water shortage, emergencies, events or other circumstances that could potentially interrupt services to healthcare providers.

2.11 RISK ASSESSMENTS AND PLANNING OF PROLONGED WATER SHORTAGES

Managing water shortage and interruption risk is not new to the water industry as the climate is always changing. However, the Healthcare providers are expected to mitigate these risks in several ways (Lee, 2013). The engineering and operations team in Healthcare providers must assess all aspects of the facility and regional water availability, in order to put together a capital plan, as well as the degree of investment required on a set five-year planning cycle. This will enable them to be prepared for the future infrastructural need. It also involves a 15 year overview that comprises of estimates of population growth, the city growth rates, and other driving factors (Lee, 2013). There is also a need to continue and develop emergency healthcare response plans, in order to increase the readiness and their versatility in addressing prolonged water shortages incidences. In addition, it is also essential to include the capital plan if there is no adequate detail on how the changes in physical climate influences the particular geographic zones within the 15 year plan (Etheredge & Fabian, 2017).

Adequate planning studies should include the following;

1. Historic water variability records and shortages.
2. Regional urbanisation trends.
3. Local and regional per capital use of water for Healthcare providers.
4. Regional availability of water supply

Proper risk assessment and planning for prolonged water shortages may include:

a. To help resolve periodic severe water scarcity challenges, Healthcare facilities may jointly establish water treatment plants to assist in ensuring suitable supply of water to the respective healthcare providers (Lee, 2013).
b. Accessibility and utilisation of substitute or dispersed water supplies. For instance, recharge of groundwater, retention of storm water and treatment,

re-evaluation of technologies that facilitate these water opportunities (Stone, 2013).

c. Incorporated analysis of engineering, economic, and ecological costs.
d. Recognising and management of risk, as well as uncertainty. This involves a growing guide on essential matters such as the likely impacts of climate change.
e. Inspiring organisation of planning between water and wastewater utilities, environmental agencies, nongovernmental organizations, land use planners, transportation planning, and others in specific regions, (Lee, 2013).

A supply chain consists of three essential resources. It is very necessary to deal with each individual resource and speculate on possible vulnerabilities. External risks are made up of demand supply risk, supply risk and environmental risk. Internal Risks are made up of Process Risk and Organisation Control Risk. Managing these risks and creating early detection systems, allows the organisation to provide continuity and maintain service levels at all times. (Avery, 2014) When discussing vulnerabilities of the supply chain of these resources, we will assume that internal risks are well controlled.

The service provided to assist renal failure patients is life saving and cannot be delayed or substituted for longer than a 24 to 48 hour period, depending on the patients' circumstances (Etheredge & Fabian, 2017). The environment in which the services are provided varies from patients who are not admitted into the hospital and an acute service provided for critically ill patients who are admitted into the hospital. Therefore, it is urgent and needful for prolonged water interruptions to be managed within a short space of time. If interruptions continue, service providers can be subjected to excessive cost in other to subsidise a basic service such as water supply. This additional cost is due to the absolute need to provide treatment as shown by the cost responsiveness efficient frontier (Chopra & Meindl, 2016).

2.12 DISASTER MANAGEMENT DURING WATER INTERRUPTION

As a result of the high drought potential, NRC has implemented a disaster plan, in other to ensure the continued operation of dialysis treatment facilities. The disaster plan includes 3 options on the anticipated length of water outages as well as four key concepts as shown by Table 2-3 and Figure 2-7 below.

Table 2-3: NRC Disaster Plan Option (Source: National Renal Care 2019)

Option 1	Option 2	Option 3
Temporary interruption in water supply	Day 0, Temporary interruption in water supply	Day 0, Total disruption in water supply
One unit affected < 12hrs no change > 12hrs Water tanker from either municipality / private if unsuccessful redirected to alternative unit	All units continue to dialyse in units. One unit temporarily interrupted refer to plan A	All Units interrupted and all patients redirected to disaster units
Conservation mode if unit running of buffer tanks	Conservation mode	Conservation mode

The Table 2-3 above represents different options to address disaster management. The Figure 2-7 below further summarizes different disaster plan key concepts.

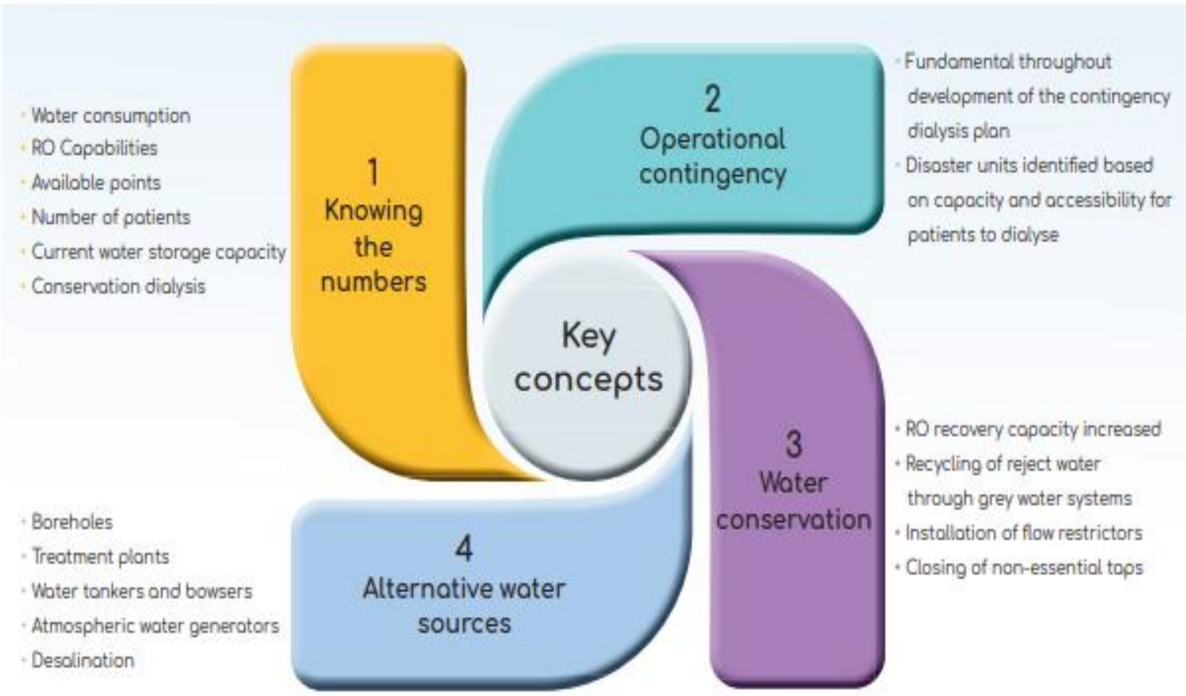


Figure 2-7: NRC Disaster Plan Key Concepts (National Renal Care 2019)

From Figure 2-7 above, various concepts on managing disaster to maintain sustainable renal care through haemodialysis is shown. For instance, concept 3 shows that water conservation should be priority in adequate disaster plan. Options like improving RO capacity should be explored and recycling of reject water. Again, concept 4 shows that alternative water sources initiative should be pursued which includes; exploring, boreholes, treatment plants, water tankers and bowsers, desalination and atmospheric water generators (National Renal Care, 2019).

2.13 REGULATIONS AND GUIDELINES FOR DIALYSIS IN SOUTH AFRICA – WATER ALTERNATIVES

There are existing guidelines for the optimal care of patients on chronic dialysis in SA. According to Moosa, Naicker, Naiker, Pascoe and van Rensberg (2006), these guidelines are there to guarantee that overall best practices are upheld; this is to certify that similar consistency and fairness regarding treatment is upheld in the country. This is also to ensure that patients are not unreasonably advantaged over others due to limited resources (Moosa, et al., 2006). Implementation of these rules should lead to an overall enhancement in the standard of patient care.

The current guidelines highlight that pure water is the basic form of treated water that is recommended for conventional haemodialysis units. Purified water can also be used and is realised from a purification system that comprises of pre-treatments like; softener, activated carbon, downsizing micro filters and an RO unit that is implemented in series (Moosa, et al., 2006). However, this guideline does not stipulate the minimum requirement for each renal unit centres which should assist in providing alternatives of water supply, in order to ensure a non-interrupted sustainable operation and services to patients. The impact of water shortage or interruption can affect the Haemodialysis unit if water challenges increases in the country. It is expected that this study will provide this as a recommendation.

2.14 SUMMARY

According to Molle, López-Gunn and van Steenbergen (2018), healthcare facilities Provide important assistance and help to the community. They provide help during natural disasters, incidence or even during acts of terrorism. As a result, it is essential to prepare health care facilities to possible water interruptions of water just like these facilities are prepared for a loss of electrical power (Molle, et al., 2018). It should not be a question of whether the water supply will ever be interrupted, but rather if it occurs and for how long such interruptions will last. The Centre for Medicare and Medicaid Services (CMS) Conditions for Participation/Conditions for Coverage also requires that Healthcare amenities make room in their preparation plans for scenarios in which utility water interruptions may occur (Etheredge & Fabian, 2017). A vital approach in preparation is establishing each incidence and coming up with the necessary response time needed for water interruptions and outages. If the water interruptions is scheduled to stay for 8 hours or shorter, the alternative supply of water is much easier. When the potential water outage is much more than 8 hours, the alternative water supply option becomes more difficult. For a large healthcare facility, unifying water supply substitutes is likely important for extended water interruptions and outages. The development using EWSP is dependent on each site and is likely dependent on the prevailing conditions. Before finalising a EWSP, it is crucial for facilities or amenities manager to evaluate all these essential options. The first part in the entire process is the development of a documented EWSP and such written plans should be used instead of just being filed away. The EWSP should be a working document in the entire emergence response plan of the facility, it should be tested and reviewed periodically to ensure that new deviations in the facility management is incorporated into the document. These practices can range from easy table exercise with the staff to a more functional actions that might involve other outside agencies.

2.15 CONCLUSION

A vital aspect of any haemodialysis process is water which serves as a core resource. A conservative approach in the utilisation of water for haemodialysis units will improve the management of water in healthcare facilities. Creating a campaign awareness on water conservation among nephrologists where they oversee dialysis units or other external centres, where renal technicians oversee these units is a vital step in improving water management. The HPCSA and other regulatory authorities can also assist in the driving of water conservation campaigns in health care facilities nationally. This chapter reviewed the literature related to the study. The next chapter presents the research methodology for the study.

CHAPTER 3
RESEARCH METHODOLOGY

3.0 INTRODUCTION

The previous chapter outlined the literature review. This chapter presents the general research methodology and philosophy that was employed in understanding the study objectives. Aspects like research design, strategy, population, sample size, questionnaire design, data analysis, reliability, validity and ethical considerations will be reviewed in this chapter. This chapter is vital as the research methodology is an approach of finding out the result of a particular problem or the focus of an investigation.

3.1 OBJECTIVES OF THE STUDY

The objectives of the research are as follows:

a. To understand the vulnerability of Chronic Haemodialysis units and patients in the region in terms of prolonged water outages.
b. To determine the resilience of the service provider when experiencing prolonged water outages.
c. To ascertain standards and norms of the industry for the possibility of improving industry standards and containing cost.
d. To identify environmentally friendly responsible actions which are being taken by the chronic dialysis units.

3.2 RESEARCH PARADIGM

Paradigms are important as they provide beliefs and dictates for the scholar in a particular discipline what should be studied and how the results of the study should be evaluated (Kivunja & Kuyini, 2017). The research paradigm denotes the scholar's rational view as it affects the substantial decision that will be made during the research process, including choice of methods and methodology (Kivunja & Kuyini, 2017). The research paradigm also informs the researcher of how the information or meaning from the data will be constructed from the data that will be collected based on an individual's experience. Research paradigm comprises of elements like epistemology, ontology, methodology and axiology (Kivunja & Kuyini, 2017). According to Chetty (2016), there are two main paradigms which are positivist and interpretivist. This study utilised the positivist paradigm as it is based on what is known in research method as the scientific method of investigation (Chetty, 2016). The elements of the positivist paradigm seems most suitable for the study as it revolves around testing the resiliency of the Haemodialysis units.

3.3 RESEARCH DESIGN

The aim of this study is to test the resilience of Private Haemodialysis Centres in KwaZulu-Natal during prolonged water interruptions. The design method that will be used is quantitative study as it will enable us to test the haemodialysis system resilience during water interruptions or outages. Quantitative design is used for this study as it is essential for the researcher to have a statistical conclusion, in other to gather actionable insights (Bhat, 2018).

3.4 RESEARCH STRATEGY

Research strategy can be defined as a step wise action plan that provides direction to the researcher's effort. It also enables the researcher to conduct research systematically in other to generate quality results and proper reporting (Dinnen, 2014). A good research strategy helps the researcher to stay focused, maximise time and resources. The strategy for research explains the rational of the research and the trials to be done to accomplish the desired goals (Dinnen, 2014). The strategy for a research can take the nature of a qualitative or a quantitative approach. Both methods were evaluated for appropriateness and to provide safeguard in ensuring that the study provides good results. The qualitative approach makes use of the interpretivism method, which deals with explaining an occurrence and extracting information that makes sense regarding the key topic (Creswell & Creswell , 2018). The quantitative approach scrutinises the link between variables through statistical measurement and is always carried out through survey forms or questionnaires (Sekaran & Bougie, 2013). A quantitative approach was used for this study and the study is testing the resilience of private haemodialysis units during water interruptions. The study also checks the variance on each unit in comparism to other units.

3.5 LOCATION OF STUDY

The research was conducted in KZN region with focus on the twelve (12) NRC owned and operated Chronic Haemodialysis Units in the area. The area of focus for the study is shown by Figure 3-1 below;

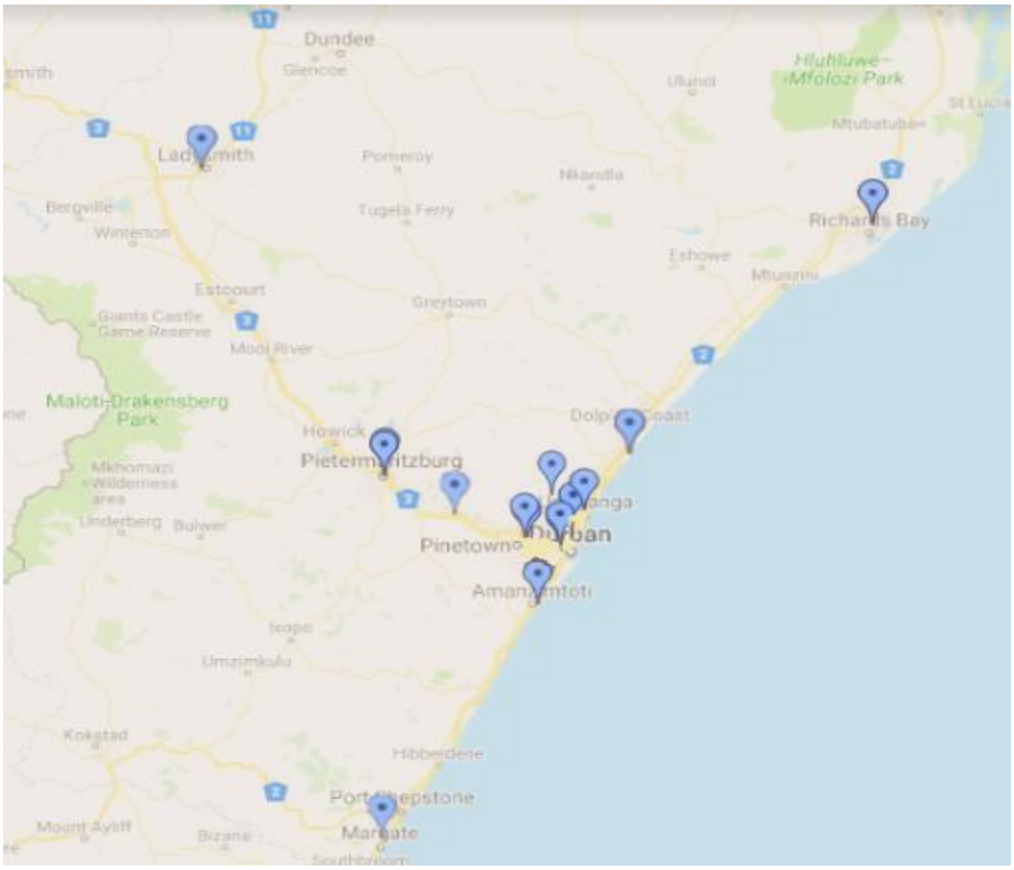


Figure 3-1: Study Location of NRC Haemodialysis Units in KZN

3.6 TARGET POPULATION AND SAMPLING

Population can be defined as the total group of people or subjects that the researcher intends to investigate (Sekaran & Bougie, 2013). The marked or focus population should be different with regards to elements, geographical boundaries or time (Sekaran & Bougie, 2013). The target population for the study includes all the twelve (12) NRC units.

There are two main kinds of sampling strategy which are probability and non-probability sampling. In probability sampling strategy, the elements in the population have some defined and non-zero chance of being selected, while the non-probability sampling do not have a recognised or prearranged possibility of being selected as subjects (Sekaran & Bougie, 2013). The sub-types of probability sampling include simple random or unrestricted sampling, restricted or complex probability sampling (e.g. systematic sampling and stratified random sampling) and cluster sampling. Non-probability sampling techniques includes convenience sampling and purposive sampling. According to Sekaran and Bougie (2013), a purposive sampling method is restricted to a specific type of objects or subjects that can offer the anticipated information, either because they are the only ones that have it or they comply with some requirements by the scholar. Hence, purposive sampling was used in selecting the sample for this study, which are all the 12 NRC haemodialysis units in KZN.

3.7 RESEARCH INSTRUMENT

This study was carried out using the survey method. According to Saunders, Lewis and Thornhill (2015), this type of method encourages the gathering of standardised data from samples and is suitable for data analysis. However, the offline survey approach was utilised as the haemodialysis centres were required to capture the data using the provided forms.

3.7.1 Survey Instrument Design

A manual survey form was created for the purpose of gathering data for the study. Because of the nature of the survey, the survey form was divided into six sections with close ended questions as shown below;

a. Have you experienced water interruptions during the time period?
b. How many hours did each water interruptions generally last for?
c. How long can the unit you work on provide service for without water being restored?
d. Is the therapy provided at the same efficacy, length and does it provide similar outcomes during prolonged water interruptions?
e. What standards does the unit use to determine how much water to store for emergency purposes?

f. Does the unit participate in any sustainability initiatives?

Details and contents of the survey form is provided on the appendix section.

3.7.2 Data Collection

The manual survey form was disturbed to all the 12 NRC centres for data collection over the 2016 to 2017 period, which was the expected drought season. Information on water interruptions which were also collected was ranged from dates and duration (hours) of the water interruption. Other sections of the manual survey forms were also completed.

3.8 DATA ANALYSIS

The first approach in data analysis was to capture the data from the manual form into Microsoft Excel sheet to arrange it properly. The data was then reviewed and tabulated in readiness for data analysis. The descriptive analysis tool on the Microsoft Excel data analysis was used first on the data per survey form. The next step in the data analysis was to develop an analysis of variance for the sets of data which were covered by inferential statistics.

3.8.1 Analysis of Variance

The analysis of variance (ANOVA) is a statistical tool used to detect differences between experimental group means (Sawyer, 2009). ANOVA evaluates differences in group means in a round-about fashion and it comprises of parameters like variances, sum of variances, sum of squares between groups, sum of squares within groups, total sum of squares, degrees of freedom and F score (Sawyer, 2009). If the P-value is less than the alpha (0.05), then the test has found a statistically significant difference between two or more groups and if it is not significant, then the P-value is more than 0.05.

3.9 VALIDITY

The degree to which the research design and instrument effectively measures the aspect of a study is known as validity. For a study to be deemed valid, the research instrument and style of study is expected to match the concepts that are to be tested (Creswell & Creswell , 2018). Validity also shows how well an instrument that is set up, measures the correct concept it is intended to measure (Sekaran & Bougie, 2013). A good research is expected to be valid as it will produce high quality results. According to Sekaran and Bougie (2013), validity testing is grouped under three types of validity, which are content validity, criterion-related validity, and construct validity.

The content validity makes sure that the measures encompasses an acceptable and appropriate set of items that explains the concept. The content validity is a function of how well the dimensions and elements of a concept have been described (Sekaran & Bougie, 2013). The criterion-related validity is established when the measure distinguishes individuals on a condition it is anticipated to forecast. The construct validity attests to how well the results collected from the use of the measures, suits the model around which the test is planned (Creswell & Creswell , 2018).

3.10 RELIABILITY

Reliability is a test of how steadily a measuring instrument tests the information it is measuring or intends to measure. According to Saunders, Lewis and Thornhill (2015), the reliability of a measure shows the ability of a measuring instrument to produce the similar results under different conditions. Hence, a measuring instrument is deemed reliable when it is consistent and stable at how it measures the concept (Saunders, et al., 2015). The measuring instrument used for this study was checked to ensure that it is reliable.

3.11 BIAS ELIMINATION

There is usually a vulnerability of bias in quantitative studies and this can take many forms. Bias involves asking the wrong question which can lead to a discrepancy between the study objectives and the results (Saunders, et al., 2015). The questions on this study were not adapted from previous studies, hence the researcher ensured that there was no bias in the structure of the questions. The study also ensured that no misleading questions that confused the participants was asked. For instance, the researcher eliminated sample bias such that they were not selected based on a perceived knowledge.

3.12 ETHICAL CONSIDERATIONS

According to Cooper and Schindler (2011), ethics can be seen as a norm or nature of behaviour that regulates the moral decisions regarding a behaviour and connection with others. The ethics of the research design has significant consequences for the negotiation of contact with objects, people, organisations and the gathering of data (Saunders, et al., 2015). The aim of ethics in a study is to guarantee that no one is injured or hurt adversely resulting from the research activities (Bawa, 2014). Unethical events are wrong and involve violating non-disclosure agreements, going against respondents' privacy, misrepresenting results, deceiving people and avoiding legal liabilities (Cooper & Schindler, 2011). As a start, the researcher submitted the research proposal to the University's Ethics Committee in line with university requirement in other to obtain approval. The researcher continued with the study after obtaining ethical approval from the committee. The researcher obtained gate keeper's approval from NRC, in other to be allowed to study these units, knowing the confidential nature of their services on patients. To maintain the confidentiality of this this study, the haemodialysis was represented with "UNITS" in the study instead of stating their physical locations.

3.13 CONCLUSION

The applicable research methodology to the study was reviewed in this chapter. The chapter assessed the applicable research design, methodology, study location, population and sample selection. The data analysis approach and ethical considerations that applied to this study was also reviewed. The next chapter shows the presentation of the results.

CHAPTER 4

PRESENTATION OF RESULTS AND DISCUSSON OF FINDINGS

4.0 INTRODUCTION

The foregoing chapter outlined the research methodology applicable to the study. This chapter presents the outcomes and results from the study which emanates from the data information that was provided. The data analysis was done both from a descriptive and inferential point of view. These outcomes are presented using a pie chart, histogram, bar chart and tables. The chapter also covered the discussions that relates to the study objectives which was done by evaluating these objectives in line with the objectives. The charts in this chapter showed the individual duration of interruption for each of the NRC units. The description and inferential statistics from the data analysis were also presented. This chapter further reviews the findings from the study through post literature review.

4.1 SUMMARY OF THE CENTRES

The Table 4-1 below shows the twelve (12) NRC centres that were reviewed for the study.

Table 4- 1: Investigated NRC Centres

Renal Centre	KZN - Area
Centre 1	Unit 1
Centre 2	Unit 2
Centre 3	Unit 3
Centre 4	Unit 4
Centre 5	Unit 5
Centre 6	Unit 6
Centre 7	Unit 7
Centre 8	Unit 8
Centre 9	Unit 9
Centre 10	Unit 10
Centre 11	Unit 11
Centre 12	Unit 12

Out of the 12 centres selected for the study, only 9 of them experienced water interruption. The presentation of results in this chapter will be focused on the NINE centres which are identified as Unit 1 to 9.

4.2 SECTION A – DATES AND DURATIONS OF INTERRUPTIONS

This section provides a summary of the period month and the duration in hours per centre where water interruption occurred.

4.2.1 Unit 1

The Figure 4-1 below presents the summary data for water interruptions in the Renal Unit in Centre 1.

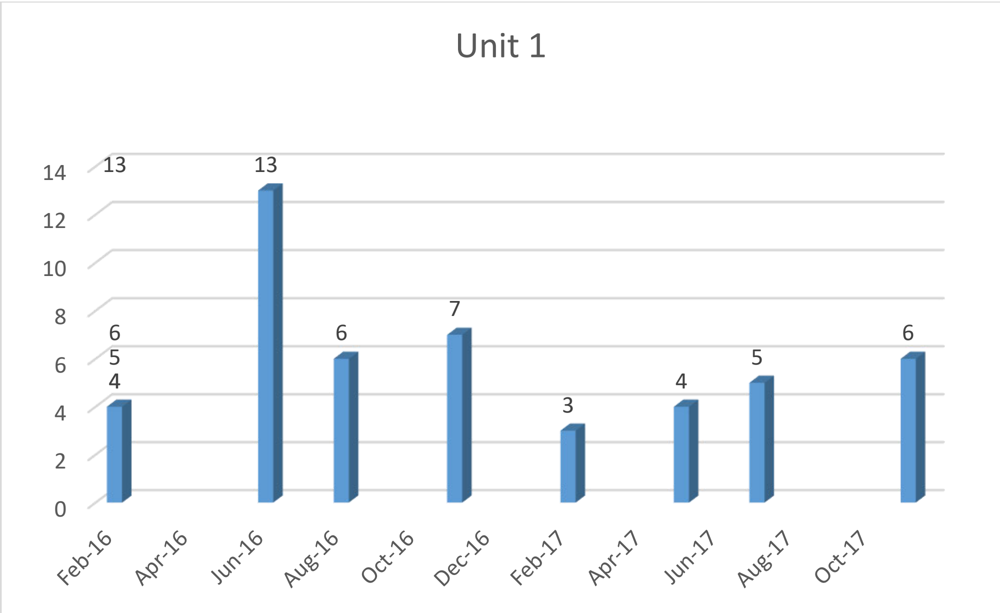


Figure 4-1: Duration of Water Interruption – Unit 1

The Figure 4-1 outlines the duration of water interruptions between the 2016 and 2017. All the recorded water interruptions were less than 12 hours except for one interruption in June 2016.

4.2.2 Unit 2

The Figure 4-2 below presents the summary data for water interruptions in the Renal Unit in the Centre 2.

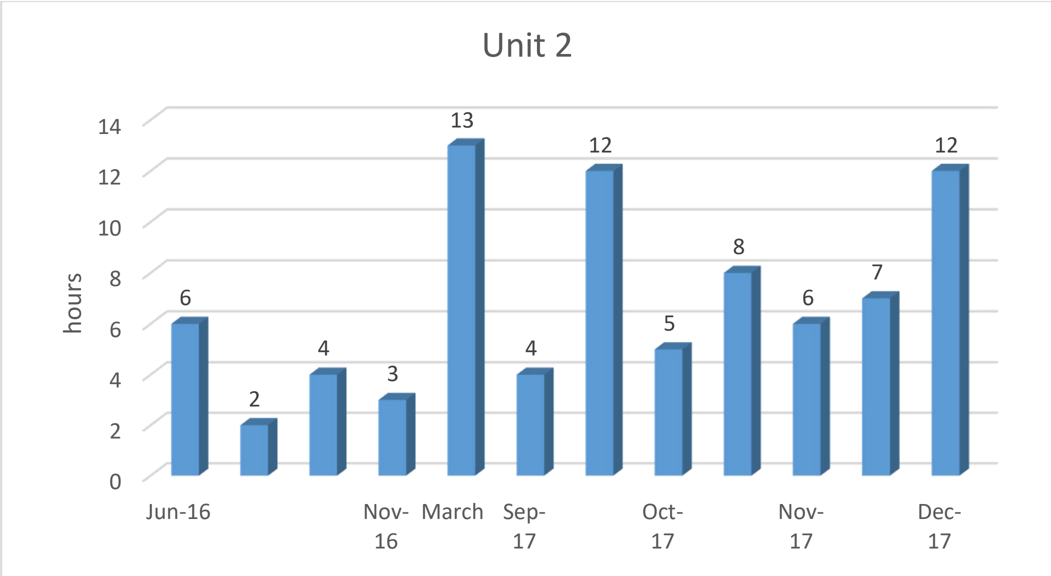


Figure 4-2: Duration of Water Interruption – Unit 2

Figure 4-2 highlights the duration of water interruptions between the 2016 and 2017. Three out of the twelve recorded total number interruptions were more than 12 hours.

4.2.3 Unit 3

The Figure 4-3 below presents the summary data for water interruptions in the Renal Unit in the Centre 3.

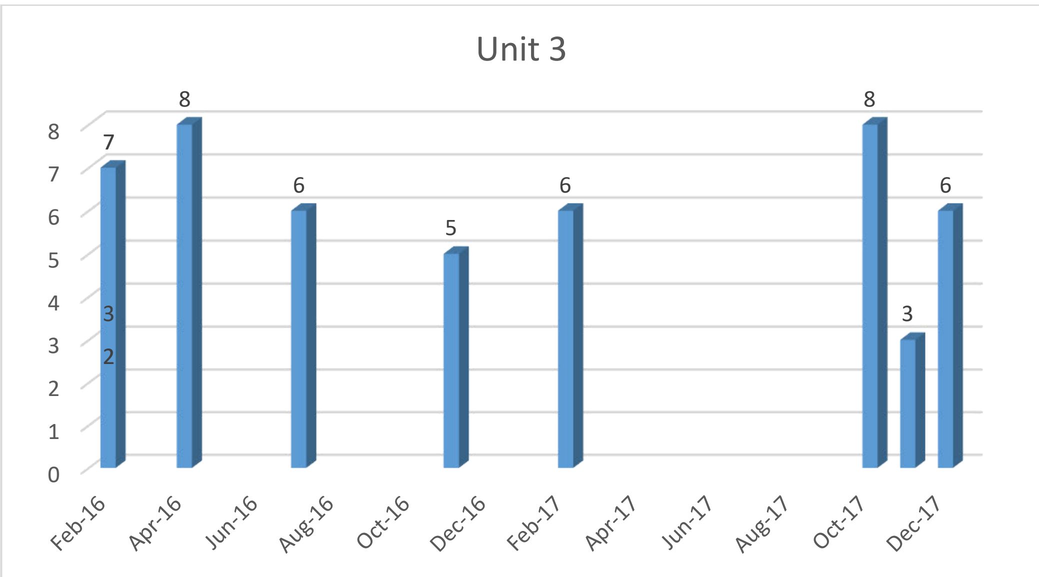


Figure 4-3: Duration of Water Interruption – Unit 3

The Figure 4-3 above outlines the period of water interruptions between the 2016 and 2017. All the recorded water interruptions were less than 12 hours.

4.2.4 Unit 4

The Figure 4-4 below presents the summary data for water interruptions in the Renal Unit in the Centre 4.

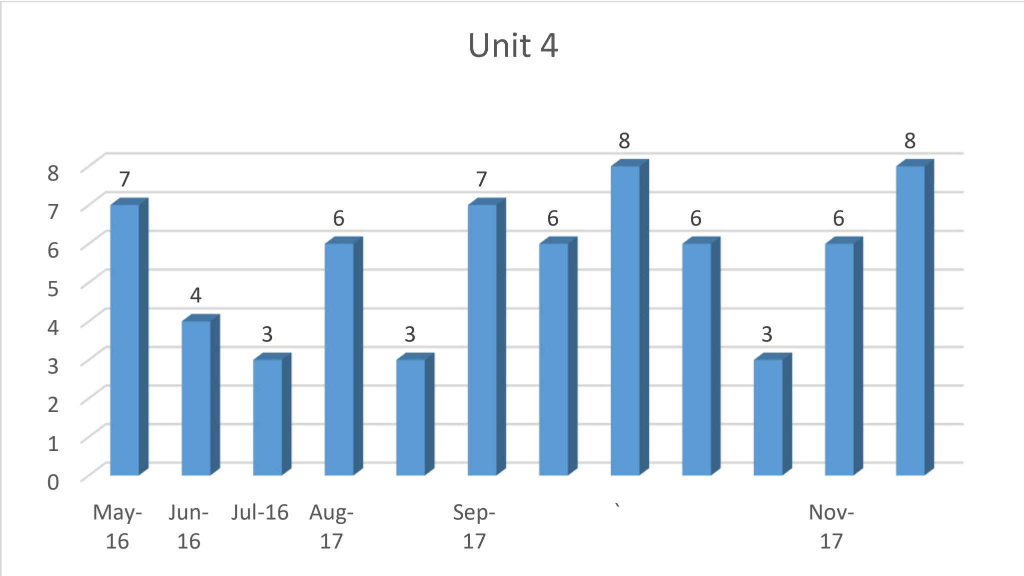


Figure 4-4: Duration of Water Interruption – Unit 4

The Figure 4-4 above outlines the length of time of water interruptions between the 2016 and 2017 in the centre 4 area. All the 14 recorded water interruptions were less than 12 hours.

4.2.5 Unit 5

The Figure 4-5 below presents the summary data for water interruptions in the Renal Unit in the Centre 5.

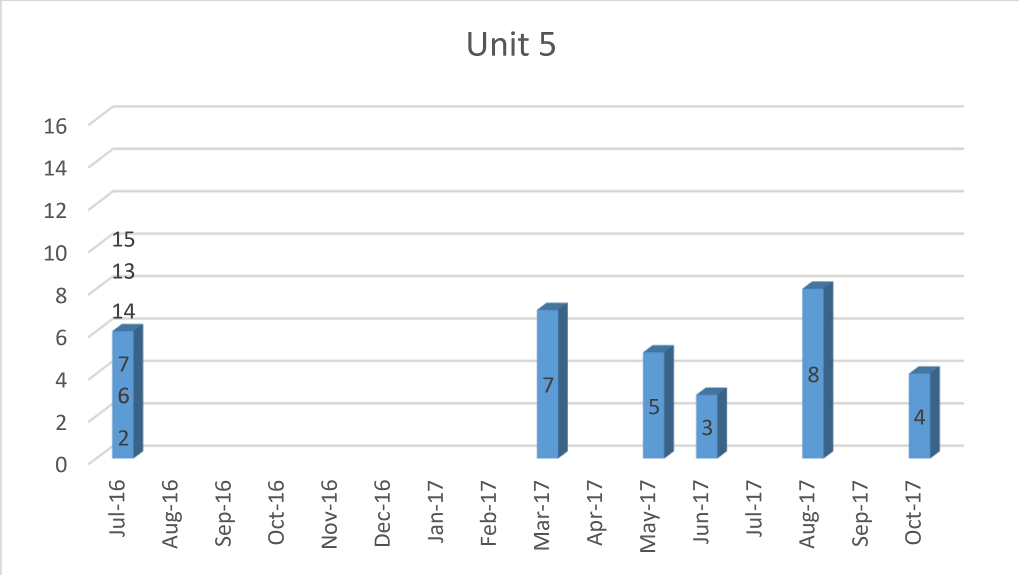


Figure 4-5: Duration of Water Interruption – Unit 5

The Figure 4-5 above shows the duration of water interruptions between the 2016 and 2017 in the Centre 5 area. There were three (3) incidences of water interruptions that were above 12 hours whereas the rest were less than 12 hours.

4.2.6 Unit 6

The Figure 4-6 below presents the summary data for water interruptions in the Renal Unit in the Centre 6 area.

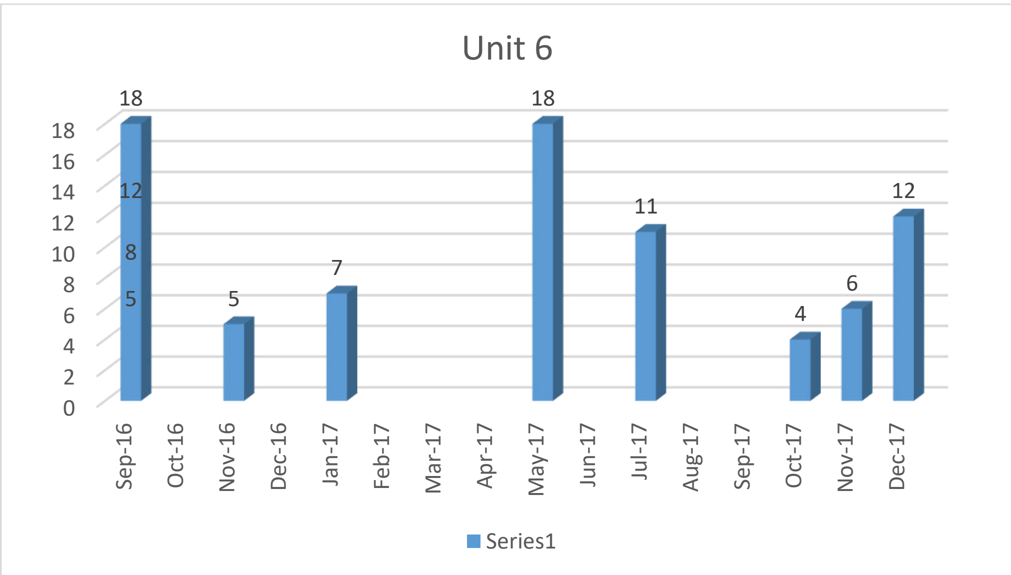


Figure 4-6: Duration of Water Interruption – Unit 6

The Figure 4-6 above shows the duration of water interruptions between the 2016 and 2017 in the centre 6 area. There were four (4) incidences of water interruptions that were above and equal to 12 hours where the rest were less than 12 hours.

4.2.7 Unit 7

The Figure 4-7 below presents the summary data for water interruptions in the Renal Unit in the Unit 7.

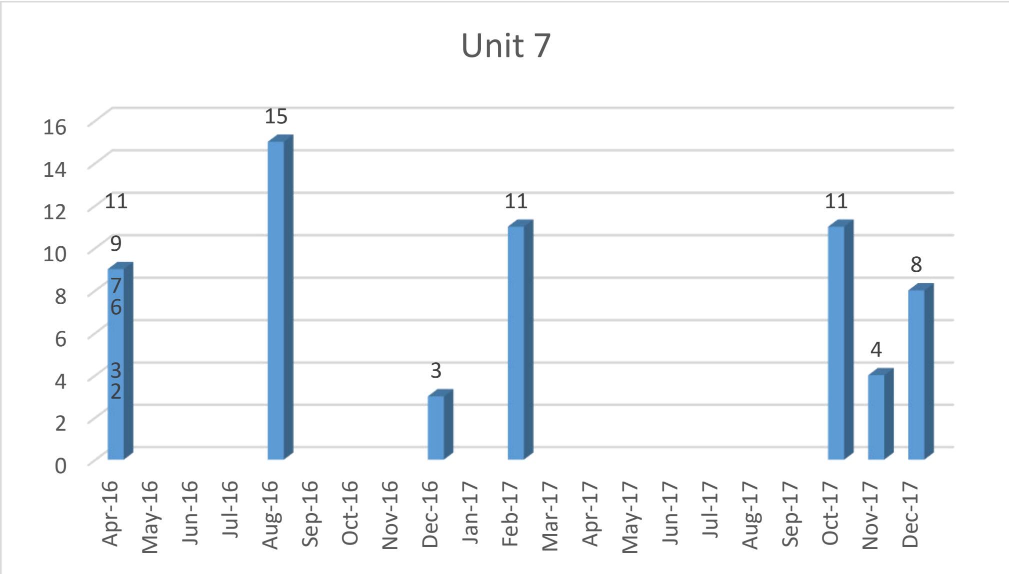


Figure 4-7: Duration of Water Interruption – Unit 7

The Figure 4-7 above presents the duration of water interruptions between the 2016 and 2017 in the Centre 7 area. Only one (1) interruption above 12 hours occurred for the entire period while the rest were less than 12 hours.

4.2.8 Unit 8

The Figure 4-8 below presents the summary data for water interruptions in the Renal Unit in the Centre 8 area.

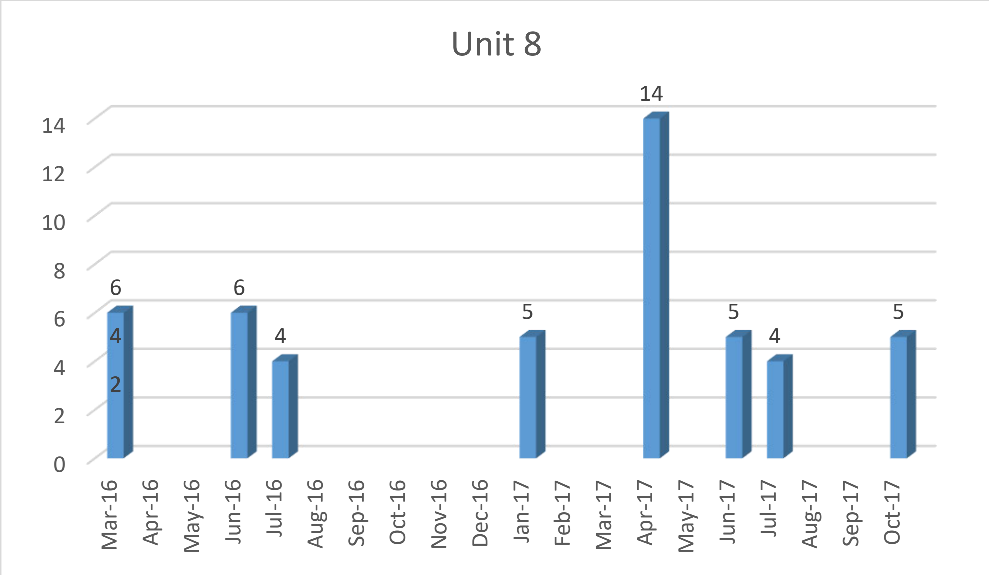


Figure 4-8: Duration of Water Interruption – Unit 8

The Figure 4-8 above presents the period of water interruptions between the 2016 and 2017 in the Centre 8 area. Only one (1) interruption above 12 hours occurred for the entire period while the rest were less than 12 hours.

4.2.9 Unit 9

The Figure 4-9 below presents the summary data for water interruptions in the Renal Unit in the Centre 9 area.

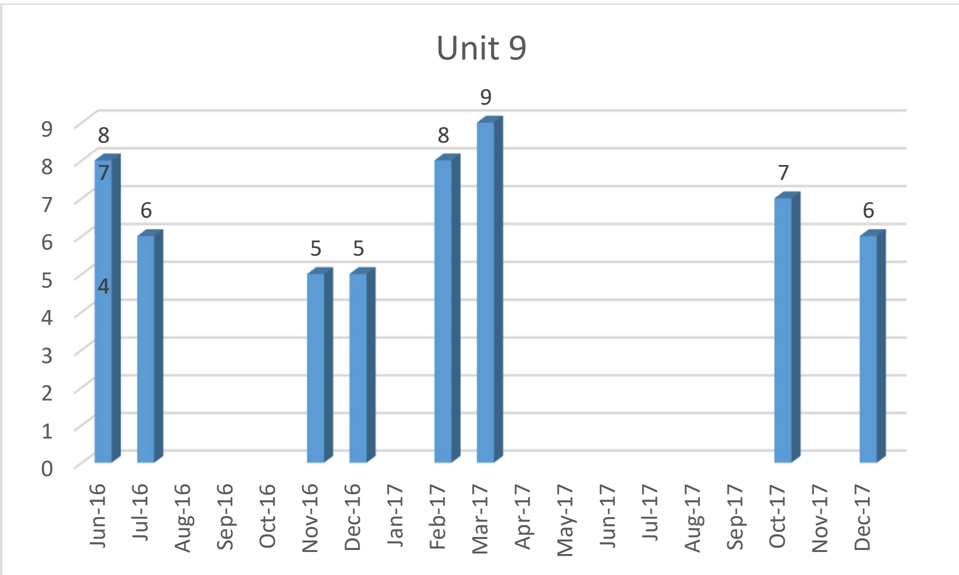


Figure 4-9: Duration of Water Interruption – Unit 9

The Figure 4-9 above outlines the period of water interruptions between the 2016 and 2017 in the Centre 9 area. There was no interruption that lasted more than 12 hours that occurred during the entire period.

4.3 SECTION B - DESCRIPTIVE STATISTICS

Descriptive statistics is an aspect of statistical analysis that aims to describe and state several features of data typically involved in a study. The aim of descriptive statistical analysis is to supply a summary of the samples and evaluating measures utilized in a specific study. The descriptive statistical analysis comprise a major part of almost all the quantitative data analysis. In descriptive analysis, it is usually about describing the data shown and is used in outlining a quantitative data analysis in a much simpler way. Hence, this type of statistical analysis is used to break these numerous amounts of data into an easier format.

The Figure 4-10 below shows a descriptive statistics summary of the NRC centers where water interruption occurred. The Figure 4-10 below shows details of the mean, standard error, median, mode, standard deviation and variance of each of the group.

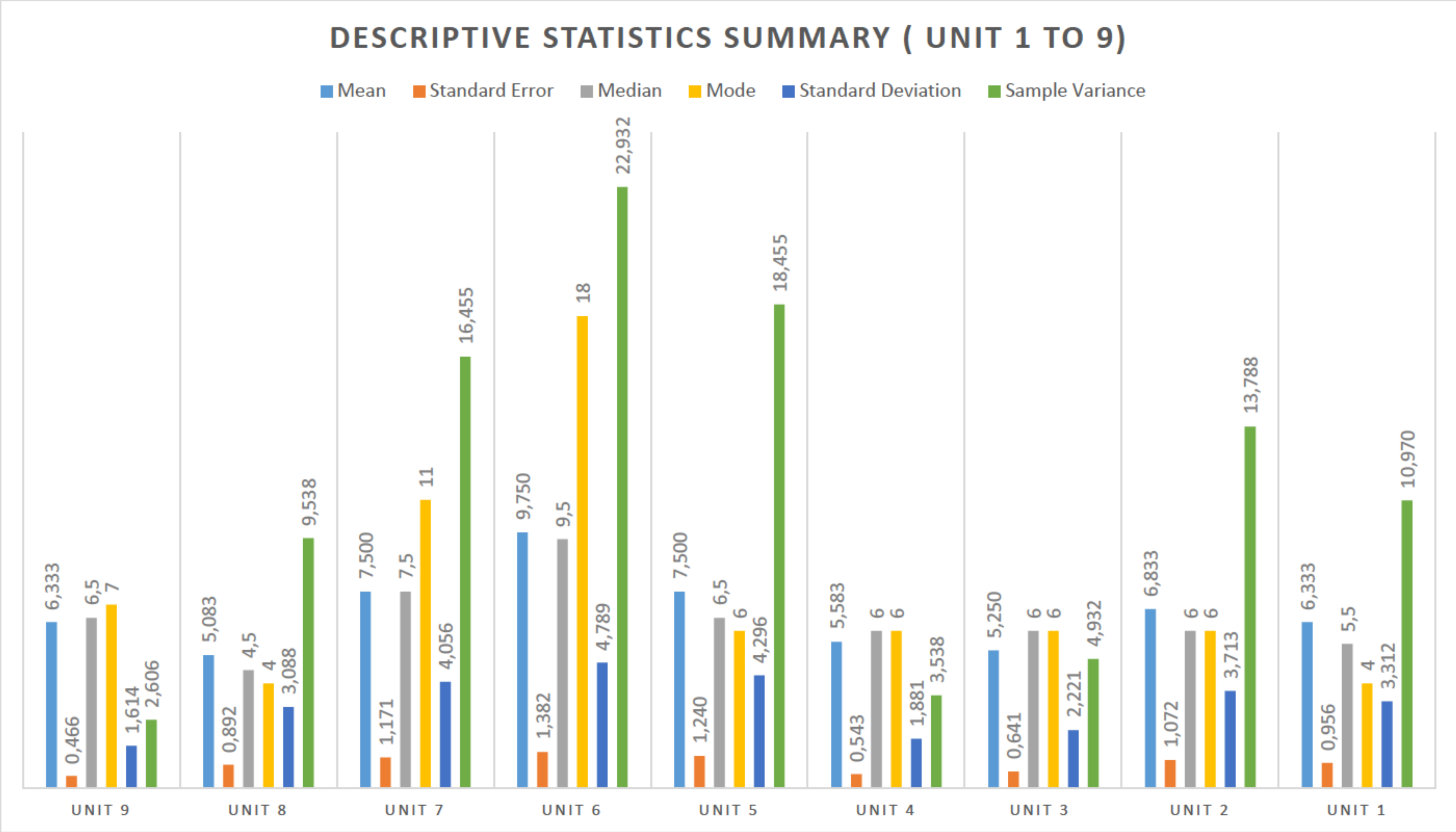


Figure 4-10: Descriptive Statistics Summary of All Identified Area

From Figure 4-10 above, all the mean of the units were less than 12 hours which shows that there was no prolonged interruption of water in the area monitored. The highest in occurrence (mode) seems to be in Centre 6. This is because the highest interruption was in that area. The mean values obtained from the descriptive analysis also shows that there is a significant difference between the groups, which implies that there is significant difference between the water interruptions from one renal center to the other. In addition, the deviation from one group (renal center) to other was quite distinct. This shows that the level and severity of outages was not consistent at each of the renal centers.

4.4 SECTION C – INFERENTIAL STATISTICS (ANOVA)

Inferential statistics are used to provide a sign of the view from the population with respect to the sample. It is also used to assess the likelihood of something happening as a result of the behavior of the sample data taken for the study. Hence, inferential statistical analysis are used to provide inference based on the sample data that was available for conclusions. The Table 4-2 below shows the summary of the ANOVA analysis.

Table 4-2: ANOVA Analysis

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Unit 1	12	76	6,333	10,970		
Unit 2	12	82	6,833	13,788		
Unit 3	12	63	5,250	4,932		
Unit 4	12	67	5,583	3,538		
Unit 5	12	90	7,5	18,4545		
Unit 6	12	117	9,75	22,9318		
Unit 7	12	90	7,5	16,4545		
Unit 8	12	61	5,083	9,538		
Unit 9	12	76	6,333	2,606		
			6,685			
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	201,96	8	25,245	2,2014	0,0335	2,0333
Within Groups	1135,3	99	11,468			
Total	1337,3	107				

The Table 4-2 above shows the one-way ANOVA analysis for the data, indicating the duration of water interruptions for different hemodialysis units that were evaluated. From the table above, the group means are 6.333, 6.833, 5.250, 5.583, 7.500, 9.750, 7.500, 5.083, and 6.333. These group means are distributed around the overall mean for all 108 observations. If the group means are grouped closer to the total mean, their discrepancy is low. However, if the group means are quite far from the overall mean, then their variance is high. In general, the group means in comparism to the overall mean shows a high variance.

In addition, the ANOVA statistics will be considered significant if the P-value is less than 0.05. From Table 4-2 above, the P-value is less than the alpha (0.05) which implies that there is a statistically significant difference between the groups. Therefore, the test indicates that there is a significant statistical difference between the water interruption durations at different NRC renal centers in KZN. However, in relation to the degree of interruption, they are overall less than 12 hours.

This further shows that the water crisis had improved around the time this investigation took place as majority were less than 12 hours. Hence, the monitoring could not routinely show water interruptions that were between 12 to 24 hours, 24 to 48 hours or more than 48 hours.

4.5 DISCUSSION OF FINDINGS

The objectives for the study are;

a. To understand the vulnerability of Chronic Haemodialysis units and patients in the region in terms of prolonged water outages.
b. To determine the resilience of the service provider when experiencing prolonged water outages.
c. To ascertain standards and norms of the industry for the possibility of improving industry standards and containing cost.
d. To identify environmentally friendly responsible actions which are being taken by the chronic dialysis units.

4.6 PROBABILITIES OF WATER INTERRUPTION: VULNERABILITY

Objective 1:

To understand the vulnerability of Chronic Haemodialysis units and patients in the region in terms of prolonged water shortages.

The feedback from the investigation showed that the vulnerability level or potential for the water interruptions to affect these chronic haemodialysis units and ultimately affect patients are low. Majority of the units had water interruptions that were less than 12 hours, except for Centre 6 (Unit 6) which showed two (2) 18 hour interruptions and two (2) 12 hour interruptions. According to National Renal Care Report (2019), the present disaster management plan of less than <12 hours does not lead to a huge impact as the units can still operate under such circumstance, which shows that the units are still not vulnerable. As highlighted in the literature section, managing water shortage and interruption risk is not new to the water industry, as the climate is always changing due to varying natural reasons (Lee, 2013). The zone of vulnerability increases once the interruption moves over into the zone of 12 to 24 hours and becomes even worse for the zone of 24 to 48 hours period (Etheredge & Fabian, 2017). According to Agar, Perkins and Heaf (2015), typical water consumption for a haemodialysis unit varies from 500 to 1500 mL per minute depending on the flow rate of dialysate and the percentage of water rejected during the RO process. Hence, an intermittent shortage of water for less than 12 hours did not immediately increase the vulnerability of the haemodialysis procedure to the degree that a patient will be affected (Agar, et al., 2015). The water interruption recorded in this study does not increase the vulnerability of the units but will become a challenge when the interruptions starts moving into 12 to 24 hours, 24 to 48 hours and greater than 48 hours.

4.7 RESILIENCE: THE IMPORTANTCE OF CONTINUITY OF CARE IN CRISIS

Objective 2:

To determine the resilience of the service provider when experiencing prolonged water outages.

According to Johannessen and Wamsler (2017), resilience is defined as the capability of systems that are faced with hazards to timely resist, absorb, accommodate and recover from the efforts of such hazards in an inefficient manner. A system that is resilient can bear a high degree of turbulence and still maintain essential functions (Johannessen & Wamsler, 2017). According to Murakami, Siktel, Lucido, Winchester and Harbord (2015), a previous study on disaster preparedness and awareness showed that an individual dialysis specific disaster readiness contributed to fewer missed dialysis sessions, indicating that a good preparedness is vital in the continuity of patient care in the health sector. Crisis period usually create lots of unsteadiness and can result in the patient fatality where the hospital has not provided a proper alternative care (Murakami, et al., 2015). However, it is essential for continuity in adequate healthcare services to be maintained so that the services to the patients are not reduced in any way. The feedback from the study shows that the KZN renal centres under investigation were not in a crisis mode, even though the period of investigation was aligned to the season where there was water crisis in the province. A good resilient system in the context of this study should be able to withstand variations in water interruptions without endangering the lives of the patients. Unfortunately, the various water interruption data collected from the study was not enough to test the resilience of the haemodialysis units, even though the collected data showed different variability at different units. To prepare for better resilient services, the engineering and operations team of the Healthcare sector must examine every facility and regional water availability, in other to develop a critical plan to remain resilient (Lee, 2013).

4.8 UNIFORMITY OF FACILITIES: DO PATIENTS RECEIVE THE SAME SERVICE GUARANTEES ACROSS THE PROVINCE

Objective 3:

To ascertain standards and norms of the industry for the possibility of improving industry standards and containing cost.

As previously highlighted in the literature section, there are existing guidelines for the optimal care of patients on chronic dialysis in SA, although these guidelines mainly guarantee that overall best practices are upheld (Moosa, et al., 2006). These guidelines and regulations ensure that there is fairness and consistency in regards to the treatments that are applied in the country. These guidelines also emphasise the minimum quality of the water that is required for dialysis but does not cater for the quantity of water and other availabilities in case of shortage through interruptions. The survey forms tested each of the units on the following comments and is represented by Table 5-1 below.

- Is the therapy provided at the same efficacy, length and does it provide similar outcomes during prolonged water interruptions?
- What standards does the unit use to determine how much water to store for emergency purposes?
- Are there sustainability initiatives?

Table 4-3: Additional Survey Feedback

KZN - Area	Is the therapy provided at the same efficacy, length and provides similar outcomes during prolonged water interruptions	What Standards does the unit use to determine how much water to store for emergency purposes	Sustainability Initiatives
Unit 1	No water interruptions experienced, but if we did have interruption, we would reduce patients time to 3 hours to accommodate more than one session	Estimated amount of water to provide 1 session	No
Unit 2	-	-	-
Unit 3	Dialysis flow rates are decreased including time on dialysis and frequency	Estimated amount of water to provide for more than 3 sessions	Yes (Recycling of grey water)
Unit 4	Dialysis flow rates are decreased including time on dialysis and frequency	Estimated amount of water to provide for more than 3 sessions	Yes (water tankers available)
Unit 5	Dialysis flow rates are decreased including time on dialysis and frequency	Estimated amount of water to provide for more than 3 sessions	No
Unit 6	Dialysis flow rates are decreased including time on dialysis and frequency	Estimated amount of water to provide for more than 3 sessions	No
Unit 7	Dialysis flow rates are decreased including time on dialysis and frequency	Estimated amount of water to provide for more than 3 sessions	No
Unit 8	Dialysis flow rates are decreased including time on dialysis and frequency	Estimated amount of water to provide for more than 3 sessions	No
Unit 9	Dialysis flow rates are decreased including time on dialysis and frequency	Estimated amount of water to provide 1 session	Yes (Recycling of grey water)

The third row from the table above shows that similar standards are majorly used to establish how much water to store up for emergency purposes. In essence, the study shows that similar nature of services are used across the province.

4.9 SUSTAINABILITY: CONSERVING WATER TO GUARANTEE LONGETIVITY

Objective 4:

To identify environmentally friendly responsible actions which are being taken by the chronic dialysis units.

An environmentally friendly responsible actions that can be taken by the chronic dialysis units is usually followed by sustainability initiatives. A good sustainability follows practices that satisfy the necessities of the present and does not compromise the needs of the future (Leigh & Lee, 2019). According to Cole, Bailey, Cullis and New (2018), water is critical to the well-being of humans and growth of many economies. Measuring how water adds to a sustainable development is a vital aspect of many United Nations initiatives in recent times (Cole, et al., 2018). Efficient urban water management is one of the ways of improving water sustainability of any city. The idea of sustainability has been described as a vision of the future as it encourages the industrial sector to consistently apply available and innovative ways in managing water for longevity (Carden & Armitage, 2013). The majority of the feedback from Table 5-1 above showed that there are no sustainable initiatives currently applied to the dialysis centres water management. Only two out of the investigated renal centres are involved in initiatives that recycle water, which are also used in other parts of the hospital facility. Just like the government in the Western Cape embarked on desalination plants and other initiatives to address water crisis, it is essential for renal centres to be set up in such a way that sustainability initiatives are applied in the entire water management.

4.10 CONCLUSION

This chapter outlined the results from the data analysis and the individual observations on the renal haemodialysis units that were investigated. Descriptive and inferential statistics approach was used to present the outcome of the study. The next chapter presents the discussion on findings. This chapter further reviewed the objectives of the study in comparism to the literatures and the findings from the study. A review of the study findings in relation to vulnerability of the dialysis units and resilience was reviewed. This chapter also assessed if a uniform approach is used in all facilities and also checked if these units are aiming for sustainability measures for the future. The next chapter presents the conclusions and recommendations of the study.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.0 INTRODUCTION

The previous chapter outlined the discussions in comparism to the findings observed from this study. This study reviews the conclusions gathered from the study and recommendations for future study. It also points out potential scope for future study.

5.1 STUDY CONCLUSIONS

The following deductions can be drawn from the study. These include;

- Unit 1 to 9 from the 12 units located at various centres showed water interruptions during the review period.
- Majority of the interruptions were less than 12 hours except for the few times Unit 6 encountered higher water interruptions more than 12 hours.
- Although the recorded water interruptions were small, the study showed that most of the centres still reduced the dialysis flow rate and frequency.
- The feedback from the data analysis showed that the units were not very vulnerable, as the water interruptions were not major.
- Since the interruptions were low, it was difficult to properly test the resilience of these units.
- The units were resilient enough with the current water interruptions results.
- The study showed that there is some form of uniformity on the facilities even though they differed in terms of sustainability initiatives.
- The study showed that some of the units were already doing sustainability initiatives. This was in other to conserve water to be utilised in other parts of the health facility even though a higher number of the units at other centres were still behind.

5.2 STUDY RECOMMENDATIONS

From the conclusions recorded from the study, below are the researcher's recommendations.

a. Although the water interruptions were not severe as seen from the study, it is highly recommended that the centres should come up with contingency plans for water supply in the entire management of these facilities.
b. It is recommended for each health provider to come up with a contingency or back up plan in other to ensure variability in the supply of water used at a haemodialysis facility. This will show that as a unit, they are well prepared for all conditions, thereby increasing the resilience of the dialysis units.
c. It is recommended that the Health Professions Council of South Africa (HPCSA) should develop definitive guidelines that can be included in the health regulations. This guideline will be applicable not just on water quality which is currently in place, but also on the minimum requirement for water availability at any haemodialysis centre.
d. It is therefore recommended that such a guideline should become a rule before any renal services provider is allowed to set up a dialysis whether it is for a private centre or within a hospital. This will also ensure that chronic dialysis patients receive good Healthcare that is the same in all provinces.
e. It is also recommended that all such guidelines should be applicable in all the provinces in the country, as this will ensure uniformity of facilities.
f. It is also highly recommended that each centre should set up water sustainability projects that is aimed at providing water conservation in each facility. One of the best ways to decrease their water consumption is to simply set a direction such that the staff adheres to it, including the reasons why. Healthcare facility administrators should inspire the staff to evaluate their daily routines and explore possible ways to conserve water. Also, the desalination plant will use groundwater that is currently pumped out on a daily basis from the basement of that facility on the foreshore, which is known to be in a reclaimed land that reaches approximately 10 meters below ground level. The desalination plant will produce sufficient water for the facility.
g. One of the most significant steps medical facilities can take to save water is to modify their refrigeration systems so that the water used for cooling is

"close looped" and recirculated; many systems use a "once through" water cooling system where the water is drained after use.

5.3 LIMITATION OF THE STUDY

The research was limited to only NRC facilities in the KZN province and did not cover other provinces. Hence, the findings from this study cannot be applied to other provinces in SA. The improvement of water in the province during the period of investigation did not allow for the researcher to properly test the resiliency of these units at various centres.

5.4 SCOPE FOR FURTHER STUDY

It is recommended that the study should be applied to other haemodialysis units in other provinces of South Africa and possibly, the rest of Africa.

5.5 CONCLUSION

This chapter outlined the conclusions, recommendations, limitations of the study and scope for further study. Haemodialysis unit is vital for the survival and recovery of chronic kidney patients. As a result, it is a very sensitive procedure that the lives of chronic kidney patients are dependent on. Hence, it is vital to ensure that all the service components that affects the functionality of the equipment is always in place. It is also vital for the haemodialysis unit to be resilient and sustainable as it relates to its operation and functionality. Therefore, it is essential that health providers make adequate and robust provision for consistent water supply without interruption for haemodialysis units. Further study should explore resiliencies of many other units in the other provinces of South Africa and in the rest of Africa. The researcher believes that the study was a fruitful study and should further be explored. He believes that haemodialysis units should be operated in a resilient manner such that they remain stable in the face of possible potential water supply and availability issues.

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APPENDIX A

Questionnaire

Dear Colleague July 2018

This questionnaire forms part of a research study being performed to measure the resilience of a private Healthcare Facility who specializes in Organ Support Therapies in the presence of prolonged water outages. The research is approved by the company and will be performed under all necessary ethical and confidentiality standards.

The research will be submitted to the University of KwaZulu-Natal to achieve a master's in business administration.

The phenomenon being studied will generally be defined as the impact of prolonged municipal water interruptions as determined for four scenarios of water outage duration, <12, 12 - 48 and 24 - 48 and >48 hours.

This resilience survey will be distributed to 12 National Renal Care owned and operated Chronic Hemodialysis units in the KwaZulu-Natal area. The unit manager for each dialysis unit will be asked to respond to the survey, where they are not available the assistant unit manager will be asked.

Specific Objectives:

1. Understand the vulnerability of Chronic Hemodialysis units and patients in the region in terms of prolonged water outages.
2. Determine the resilience of the service provider when experiencing prolonged water outages.
3. Ascertain standards and Norms of the industry for the possibility of improving industry standards and containing cost.
4. Identify environmentally responsible actions which are being taken by the chronic units.

Your participation in the study will be confidential and the data will be reported only in aggregate. Your information will be coded and kept confidential throughout. If at any time you have a query towards the research please contact the researcher on the email address below.

Please complete the questionnaire before 20 August 2018 and return a copy to Brendon.hill@nrc.co.za.

Thank you for your participation, please see the questionnaire on page 2.

Resilience Survey to determine the impact of prolonged municipal water interruptions on Chronic Hemodialysis Units as determined for four scenarios of water outage duration, <12, 12 - 48 and 24 - 48 and >48 hours.

Unit name: ____________________________________Respondent Name:_________________

Questions related to the period 1 January 2016 to 31 Dec 2017.

SECTION A: VULNERABILITY

1. Have you experienced water interruptions during the time period? Please provide dates of the interruptions.

Yes	No

2. How many hours did each water interruptions generally last for?

<12 hrs.	12 – 48 hrs.	24 – 48 hrs.	>48 hours
Please make use of the attached excel sheet to document the date and duration of municipal water interruptions.			

SECTION B: RESILIENCE

3. How long can the unit you work in provide service for without water being restored?

<12 hrs.	12 – 48 hrs.	24 – 48 hrs.	>48 hours

SECTION C: INDUSTRY STANDARDS AND NORMS

4. Is the therapy provided at the same efficacy, length and provides similar outcomes during prolonged water interruptions?

Yes	No

If no, please explain the material differences?

5. What standards does the unit use to determine how much water to store for emergency purposes? Please tick the correct box.

Estimate amount of water to provide 1 section	
Estimated amount of water to provide 2 sessions	
Estimated amount of water to provide >3 sessions	
No standards are in place	

SECTION D: ENVIRONMENTAL RESPONSIBLE INITIATIVES

6. Does the unit participate in any sustainability initiatives?

Yes	No

If yes, please comment:

Example answer: Yes, we recycle grey water / No.

Thank you for your participation, should you wish to add any information you are welcome to contact the researcher at any time.

BRENDON HILL
National Acute Therapies Manager
Funder Relations

NATIONAL RENAL CARE

Tel: +27 11 049 3830
Cell: +27 72 282 7488
Fax: +27 86 599 0860
Email: Brendon.Hill@nrc.co.za
www.nrc.co.za

APPENDIX B

Gatekeeper's Letter

RENAL CARE

Reg No: 1995 / 006721 / 07

03 August 2017

Brandon Hill

RE: PERMISSION TO CONDUCT RESEARCH IN THE WORKPLACE

This letter serves to confirm that the management of National Renal Care has granted you permission to conduct research (provided that the research policy has been signed and are complied with) in the workplace and to have controlled access to NRC's resources and patients in terms of the research policy.

Please read and initial each page of the attached policy and sign last page on space provided and return to Human Resources Department.

Conditional approval subject to ethics approval.

Should provisions of the research policy not be complied with, this privilege may be withdrawn.

Yours sincerely,

[redacted]

HR DIRECTOR

APPENDIX C

Ethical Clearance Approval

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

04 October 2017

Mr Brendon James Hill (215077184)
Graduate School of Business & Leadership
Westville Campus

Dear Mr Hill,

Protocol reference number: HSS/1709/017M
Project title: Dialysis until the last drop: Testing the resilience of Private Haemodialysis Centres in KwaZulu-Natal during prolonged water interruptions

Approval Notification – Expedited Approval

In response to your application received on 14 September 2017, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Dr Muhammad Hoque
Cc Academic Leader Research: Dr Emmanuel Mutambara
Cc School Administrator: Ms Zarina Bullyraj

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** [illegible] / [illegible] / [illegible]
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APPENDIX D

Turnitin Report

Dissertation 215077184 Brendon Hill 17 June

ORIGINALITY REPORT

8%	6%	4%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Faissal Tarrass, Meryem Benjelloun, Omar Benjelloun, Tarik Bensaha. "Water Conservation: An Emerging but Vital Issue in Hemodialysis Therapy", Blood Purification, 2010 Publication	1%
2	www.cdc.gov Internet Source	1%
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