Health Systems Readiness to Manage the Hypertension Epidemic in the Primary Health Care Facilities in the Western Cape, South Africa

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Abstract

Background. Developing countries are undergoing a process of epidemiological transition from infectious to non-communicable diseases, described by the United Nations Secretary General Ban Ki-Moon as "a public health emergency in slow motion". One of the most prevalent of these diseases, in sub-Saharan Africa, is hypertension, which is a complex chronic condition often referred to as the "silent killer" and a key contributor to the development of cardiovascular and cerebrovascular diseases. Hypertensive patients in this setting are estimated to increase from 74.7 million in 2008 to 125.5 million in 2025, a 68% increase. There is however an important gap between emerging high-level policies and recommendations, and the near-absence of practical guidance and experience delivering long-term medical care for non-communicable diseases within resources-limited health systems. To address this gap, our study consisted of field investigations to determine the minimum health systems requirements necessary to ensure successful delivery of anti-hypertensive medications when scaling-up interventions.

Methods/Design. A cross-sectional analytic study was conducted in the Western Cape Province of South Africa using a mixed method approach with two sets of semi-structured interviews and simulation modeling. One set of interviews was conducted with health professionals involved in the care of hypertensive patients within nine community health centers (five urban and four rural) to understand the challenges associated with their care. The other set was used to map and assess the current supply chain management system of antihypertensive medications and involved key informants at different levels of the process. Finally, modeling and simulation tools with ARENA Software were used to estimate minimum numbers of health workers required to ensure successful delivery of medications when scaling up interventions.

Results. The study found numerous challenges affecting the care of hypertensive patients in primary health care facilities and categorized these into five interconnected dimensions: Management of the visits within the PHC facility, Adequacy of human resources, Standardization of patients' care, Infrastructure limitations, and Patients' responsibilities. Potential solutions to overcome these challenges were explored in order to improve the care of the hypertensive patients in the PHC facilities. Mapping of the drug supply chain management system highlighted the complexity of the system. In fact many of the issues reported fell outside of the control of the provincial health department. The need for a more single comprehensive computer system to handle most of the functions of the drug supply management system was heavily emphasized. The modeling and simulation tool with ARENA Software estimated the type and number of health care professionals needed to provide appropriate services to a certain patient population based on the set targets. The sample data used showed how one can test the impact of various changes in the processes and staffing levels to minimize waiting times while increasing the daily patients' intake at the facility. We found that with few additional nursing staff, that are more affordable and quicker to train than medical doctors and pharmacists, one can considerably improve the performance of the facilities in the care of hypertensive patients.

Discussion. This investigation has highlighted the detailed processes in place for the care of hypertensive patients in primary health care facilities, identifying the challenges in providing such care. The potential solutions suggested by the study results, if implemented, should help

improve services offered and ensure that the system remains sustainable when patients' intake increases exponentially as a result of scaled up interventions. The weaknesses of the drug supply chain management system demand immediate action. The modeling and simulation tools used in this study, if used on an ongoing basis, could create more effective planning of needed resources, although their proper utilization will require extra training for managers. Whether there is sufficient political support to ensure the resources necessary to reach the provincial health department's hypertension target remains to be seen, and would benefit with further economic studies to estimate the cost associated with tackling the hypertension epidemic.

Keywords:
Hypertension; Manage; Health System; Epidemic; Scaling-up Interventions; requirements; Supply Chain; Anti-Hypertensive; Control; Delivery;

Résumé

Contexte. Les pays en voie de développement font l'objet d'un processus de transition épidémiologique de maladies infectieuses aux maladies non transmissibles. Toutefois, ce processus est décrit par le Secrétaire général des Nations Unies, Ban Ki-Moon, comme « une urgence de santé publique en mouvement au ralenti ». L'une des plus répandues en Afrique sub-saharienne est l'hypertension, qui est une maladie chronique complexe souvent désignée comme la « tueuse silencieuse » et une des causes principales de l'émergence des maladies cardio-vasculaires et cérébro-vasculaires. Les patients hypertendus dans cette région devraient passer de 74,7 millions en 2008 à 125,5 millions en 2025, soit une augmentation de 68%. Cependant, il y a un écart important entre les politiques émergentes de haut niveau et les recommandations, cumulé à une quasi-absence de conseils pratiques et d'expérience en matière de prestation de soins médicaux à long terme pour les maladies non transmissibles dans les systèmes de santé aux ressources limitées. Pour combler cette lacune, nous avons entrepris cette étude qui a consisté à mener des enquêtes sur le terrain en vue de déterminer les exigences minimales essentielles aux systèmes de santé afin d'assurer la fourniture de médicaments contre l'hypertension, lorsque des interventions à grande échelle seront mises en place pour faire face à cette épidémie d'hypertension.

Méthodes. Une étude transversale combinant une approche mixte, et utilisant des entrevues et des outils de modélisation, a été menée dans la province du Western Cape, en Afrique du Sud. D'abord une série d'entrevues a été conduite auprès des professionnels de la santé impliqués dans la prise en charge des patients hypertendus dans neuf centres de santé communautaires (cinq en milieu urbain et quatre en milieu rural) pour comprendre les défis associés à leur pratique. Ensuite une autre série d'entrevues avec des acteurs clés impliqués à différents niveaux du processus d'approvisionnement en médicaments d'hypertension, a été menée afin de mieux comprendre et d'évaluer le système d'approvisionnement des médicaments pour traiter l'hypertension. Enfin, les outils de modélisation et de simulation avec le logiciel ARENA ont été utilisés pour estimer le nombre minimum d'agents de santé nécessaires pour assurer une bonne prise en charge des patients et une chaîne d'approvisionnement efficace des médicaments aux patients lorsque des interventions à large échelle pour faire face à cette épidémie seront déployées.

Résultats. L'étude a permis de mettre en exergue les nombreux défis qui affectent la prise en charge des patients hypertendus dans les établissements de soins de santé primaires. Ceux-ci ont été classés en cinq catégories inter reliées à savoir: gestion de la visite dans le centre de santé, adéquation des ressources humaines, standardisation de la prise en charge des patients, contraintes infrastructurelles, et responsabilité des patients. Les solutions possibles pour surmonter ces difficultés ont été explorées afin d'améliorer la prise en charge des patients hypertendus dans les établissements de soins de santé primaires. La représentation graphique du système de gestion de la chaîne d'approvisionnement en médicaments a mis en évidence la complexité du système. Plusieurs des difficultés relevées semblent hors de contrôle du ministère provincial de la santé. La nécessité d'un système informatique unique plus simple pour gérer les fonctions du système de gestion de l'approvisionnement en médicaments a été fortement soulignée. L'outil de modélisation et de simulation avec le logiciel ARENA nous a permis

d’estimer le type et le nombre de professionnels des soins de santé nécessaires pour fournir des services appropriés aux patients sur la base des objectifs fixés. Les données d’échantillon utilisées ont montré comment on peut tester l’impact de divers changements dans les processus et les niveaux de dotation en personnel pour réduire au minimum le temps d’attente, tout en augmentant le nombre de patients traités par jour. Il apparaît très clairement qu’en mettant l’emphase sur le personnel infirmier qui offre un rapport coût bénéfice plus intéressant comparé aux médecins et aux pharmaciens, il est possible d’améliorer de façon considérable la performance du système dans la prise en charge des patients hypertendus.

Discussion. Cette enquête a permis de mettre en évidence l’infrastructure en place pour la prise en charge des patients hypertendus dans les établissements de soins de santé primaires, et d’identifier les difficultés dans la prestation des soins. Les conclusions de notre étude, si elles sont mises en œuvre, devraient permettre d'améliorer les services offerts et de veiller à ce que le système demeure viable dans l’éventualité où le nombre de patients à soigner augmente de façon exponentielle suite à des interventions à grande échelle. Les faiblesses du système de gestion de la chaîne d’approvisionnement en médicaments exigent des actions immédiates. Les outils de modélisation et de simulation utilisés dans cette étude pourraient contribuer à une planification plus efficace des ressources nécessaires, bien qu’une formation des gestionnaires soit requise en vue d’un usage approprié de ces outils. La question du soutien politique reste entière car elle est essentielle afin d’assurer la disponibilité des ressources nécessaires pour l’atteinte des objectifs du ministère provincial de la santé en ce qui a trait à l’hypertension. En définitive, des recherches additionnelles en économie de la santé seraient souhaitables en vue d’une estimation du coût associé à la lutte contre l’épidémie de l’hypertension.

Mots clés:
Hypertension; Gestion; Système de santé; Épidémie; Interventions à grande échelle; Exigences; Chaîne d'approvisionnement; Antihypertenseurs; Contrôle; Fourniture;

Dedication

I dedicate this dissertation to my family, especially…..

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List of Abbreviations

ADM	Administrative staff
AIDS	Acquired Immune Deficiency Syndrome
API	Active Pharmaceutical Ingredient
ART	Antiretroviral
BEC	Bid Evaluation Committee
BMI	Body Mass Index
BP	Blood Pressure
CDU	Chronic Dispensing Unit
CHC	Community Health Center
CHD	Coronary Heart Disease
CMD	Cape Medical Depot
CNP	Clinical Nurse Practitioner
CPUT	Cape Peninsula University of Technology
CRDI	Centre de Recherches et de Développement International
CVD	Cardiovascular Disease
DDV	Direct Delivery Voucher
DOH	Department Of Health
EML	Essential Medicines List
ENA	Enrolled Nurse Assistant
GACD	Global Alliance on Chronic Diseases
GDP	Gross Domestic Product

HIV	Human Immunodeficiency Virus
IDRC	International Development Research Centre
JMIR	Journal of Medical Internet Research
KIN	Key Informant
LMIC	Low and Middle Income Countries
MDG	Millennium Development Goals
MDO	Medical Officer
MET	Metropolitan area
MGR	Manager
MOU	Maternal and Obstetric Unit
NCD	Non-Communicable Disease
NCDRU	Non-Communicable Diseases Research Unit
NDP	National Drug Policy
NGO	Non-Governmental Organization
NHI	National Health Insurance
NHRD	National Health Research Database
NMET	Non-Metropolitan area
NPO	Non-Profit Organization
OPD	Out Patients Department
OSD	Occupational Specific Dispensation
PHARM	Pharmacist
PHC	Primary Health Care

PMFA	Public Finance Management Act
REB	Research Ethics Board
SA MRC	South Africa Medical Research Council
SANHANES	South African National Health and Nutrition Examination Survey
SAPC	South African Pharmacy Council
SBP	Systolic Blood Pressure
SSA	Sub-Saharan Africa
STG	Standard Treatment Guidelines
TB	Tuberculosis
WC	Western Cape
WHO	World Health Organization
WMA	World Medical Association

CHAPTER 1:

INTRODUCTION

Introduction and Statement of the Problem

Developing countries are undergoing a process of epidemiological transition from infectious to non-communicable diseases (NCDs). The launching of the World Health Organization Action Plan on NCDs (World Health Organization, 2013), the UN General Assembly Resolution on the Prevention and Control of NCDs (United Nations, 2010), and the Global Alliance for Chronic Diseases (GACD) provides strong evidence that increasing attention is being paid to the impact of non-communicable diseases on health and development. One of the most prevalent NCDs in sub-Saharan Africa (SSA) is hypertension. Hypertension is a complex chronic condition, often referred to as the "silent killer", and a key contributor to the development of cardiovascular and cerebrovascular diseases. A recent systematic review and meta-analysis to assess the recent burden of hypertension in Sub-Saharan Africa revealed that a large proportion of the population with hypertension remains undiagnosed, untreated, or inadequately treated, contributing to the rising burden of cardiovascular diseases in the region. In effect, hypertension is a serious unrecognized epidemic in Sub-Saharan Africa (Ataklte et al., 2015). Twagirumukiza et al. (2011) reported in 2008 that the prevalence of hypertension in sub-Saharan Africa was estimated at 16.2% and that in 2025 the figure would rise to 17.4% (with a 95% confidence interval of 15.4–22.6%). The number of hypertensive patients would increase from 74.7 million in 2008 to 125.5 million in 2025 – a 68% increase. Low levels of awareness suggest that screening campaigns are largely non-existent. This is most likely because of the

generally poor health infrastructure and low number of health workers in the region. Most systems cannot afford the additional costs associated with operating a cardiovascular screening program in an already resource-limited environment (Kotwani et al., 2013). Treatment and control of high blood pressure is however a major public health goal. Yet, there is an important gap between emerging high-level policies and recommendations and the near-absence of practical guidance and experience delivering long-term medical care for NCDs within resource-limited health systems.

NCDs and hypertension in particular are affecting large volumes of the population both in developed and developing countries and are the result of multiple health determinants. They consequently require interventions at the society, community and individual level. Upstream interventions focusing on some key health determinants, such as education and physical environment, for example, might contribute greatly to prevent the occurrence of these conditions, while others will help to improve the management of patients with these chronic conditions. Health services or the health system in general is an important health determinant that we are focusing on in this study. This research explores concrete health system requirements for the proper management of high blood pressure for a large population.

Purpose of the Study and Significance

This research consists of field investigations in the Western Cape (WC) Province of South Africa to address the implementation and scale-up of drug treatment systems for hypertension. In the context of scaling up access to antihypertensive medications in health systems with limited resources, we specifically examine the development of an effective drug

supply management system. We investigate how to determine the minimum number of health workers required at each health care supply chain interval to ensure adequate care. The goal of the study is to determine the minimum health systems requirements to ensure successful delivery of antihypertensive medications when scaling-up interventions to control the hypertension epidemic in WC, South Africa. The rationale for choosing South Africa lies in the fact that it has a clearly documented hypertension epidemic and because South African medical guidance frequently informs others countries in Africa. The Western Cape Province has one of the more efficient provincial health care systems in the country. The scope of the study was limited to the Western Cape Province for practical and operational reasons, giving the limited resources and time available for the study. Affiliation with the South Africa Medical Research Council (SAMRC) was also one of the key deciding factors for selecting South Africa and the WC province for the study.

The study provides important data and analysis that can be used by health department officials to strengthen health systems, particularly the drug supply chain management system, and to inform educational programs of the projected human resources needed based on set targets. Research results will inform policy makers and health care managers in planning and implementing effective health intervention programs to manage hypertension, notably interventions that successfully reach all target populations, particularly the most vulnerable. This program of research can inform the design of strategies to control and treat hypertension. This will help to prevent complications and, more importantly, reduce the risks of cardiovascular and cerebrovascular diseases, as it is well established that hypertension is a key contributor to their development. As such, the program of research contributes to secondary prevention of hypertension by stopping it from getting worse and reducing co-morbidities associated with

hypertension. Study findings could help in developing practical guidelines for delivering long-term medical care for hypertension within the weak health systems characteristic of other resource-limited settings across sub-Saharan Africa.

Research Questions

The overarching research question is framed as follows: In scaling-up interventions to control the hypertension epidemic in the Western Cape Province of South Africa, what are the health systems requirements to ensure successful delivery of antihypertensive medications? No *a priori* hypotheses were formulated. Instead this program of research used a combination of primary, administrative, and survey data to undertake the necessary analyses to answer the following three sub-research questions: (1) What are the challenges of the South African health care system, particularly of the Western Cape Province, in the care of hypertensive patients? (2) How is the current supply chain management system of antihypertensive medications in the Western Cape Province organized? (3) Using modeling tools, what are the numbers of health workers required at each supply chain interval to ensure successful delivery of medications when scaling up interventions?

Theoretical/conceptual framework

The focus of the study is on the supply chain as a key element in system responsiveness to hypertension. Effective and well-structured procedures need to be in place to reach the maximum number of people possible, and to ensure cost-effectiveness of health interventions.

Our notion of supply chain here does not consider only the processes in place to ensure the availability of drugs but also the mechanisms to deliver the drugs to the patients at the level of the primary health care facilities. Primary health care, as a component of the broader health system, should be able to deliver services to those who need them, using available resources. In order to be sustained and expanded, the supply chain needs to be robust, agile and flexible. Systems need to be in place to account for potential reductions in annual funding, increases in drug costs, decreases in drug quality, and loss of drug products. Should any of these situations arise, the management system needs to be designed in such a way that available drugs are equitably distributed to those in the most need. Policy makers, program and supply chain managers are under intense pressure to improve healthcare supply chains in order to ensure an uninterrupted flow of drugs and related supplies at the various service delivery points. They are also under pressure to produce greater levels of responsiveness, and shorter lead and cycle times for delivery and positioning of an inventory of high-quality drugs and related commodities to meet the healthcare needs of millions of people. All these parameters make any scale up process fairly complex.

Our research examined key aspects of the scale up of health interventions through a case study of the health systems requirements needed to ensure successful delivery of medications to manage the hypertension epidemic in the primary health care facilities of the Western Cape Province in South Africa. Our study used the framework proposed by Garvin Yamey (2012) (Figure 1), as it specifically draws upon insights from interviews with scale-up "leaders", many of whom had led national or global health implementation programs. The Yamey Framework takes full advantage of the "learning and doing" concept in ways that engage key stakeholders,

use data to address constraints, and incorporate results from pilot projects. Such approaches are very relevant to the study of the issues that arise when scaling up interventions.

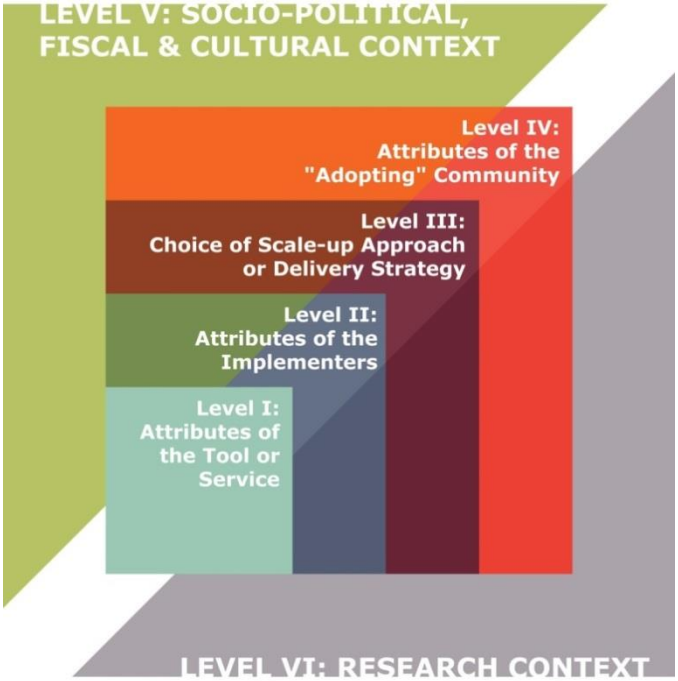

Figure 1: Framework for categorizing the study results – The Yamey Framework
Source: Yamey (2012)

The framework identifies a range of reported success factors which are organized into six categories representing different components of the scaling up process. Inspired by the works of Bergh, van Rooyen, and Pattinson (2008) and Simmons and Shiffman (2007), these categories are the following: attributes of the specific tool or service being scaled up, attributes of the implementers, the chosen delivery strategy, attributes of the "adopting" community, the socio-political context, and the research context.

Attributes of the Tool or Service Being Scaled Up:

The Yamey Framework identifies the importance of simplicity of the intervention and scientifically robust technical policies. Keeping the intervention simple is widely considered to

be an important predictor of success. Also, as stated in, Khatri and Frieden (2002), technical experts who have managed large-scale implementation argue that getting the technical policies scientifically robust before going to scale is crucial for success. Our investigations explored the characteristics of the care of hypertensive patients, which is the intervention that is being considered for future scale-up. Mechanisms in place to ensure availability of the antihypertensive drugs are considered part of such an intervention.

Attributes of the Implementers:

Strong leadership and governance, engaging local implementers and other stakeholders, and using both state and non-state actors as implementers, are the key attributes recommended by the framework for those who implement an intervention. These features were particularly relevant for us in selecting our key informants for the mapping and assessment of the current supply chain management system of antihypertensive medications in South Africa, particularly in the Western Cape region. Health care providers involved with the daily care of hypertensive patients were selected as participants in our study. This component of the Yamey Framework is mainly about health, human resources and governance, which are two of the six clearly defined health systems building blocks described by the WHO "Framework for Action" on health systems. These building blocks alone do not constitute a system, but it is the multiple relationships among the blocks that convert these blocks into a system (De Savigny & Adam, 2009).

The Chosen Delivery Strategy:

In this category, the framework recommends applying diffusion and social network theories, cascade and phased approaches to scale-up, tailoring scale-up to the local situation, decentralizing delivery, and adopting an integrated approach to scale-up. Important past lessons from the limitations of purely vertical or horizontal interventions emphasize a need for a more integrated approach. The approach to design the scale up of the care for hypertensive patients will need to consider these parameters but this activity is out of the scope of our study.

Attributes of the "Adopting" Community:

An engaged, "activated" community is needed. Binswanger (2000) suggests that the active participation of the community in planning, implementing, and monitoring interventions is a crucial factor in successful scale-up. This is important in order to avoid blind transposition of solutions from the developed to developing countries that typically do not integrate local norms. Our research was implemented in the Western Cape Province of South Africa, and the findings need to be contextualized in the event that there is interest in applying them to other provinces or countries.

Socio-Political Context:

Political will, national policies, and country leadership are key elements in the framework. Clear and easy to implement policies should be in place to ensure successful scaling up of the intervention. This aligns well with Kingdon's Multiple Streams theory, which proposes that at certain points in time, "policy windows" are created through the convergence of a problem, an appropriate solution, and a receptive political environment, and present an

opportunity for major policy change (Kingdon, 1984; Milton & Grix, 2015). The "policy window" concept is important in population health research for providing guidance for the successful implementation of interventions, that is, the timing of the proposed interventions should be compatible with the political agenda of the current policy makers. Moreover, as noted by Walt and Gilson (1994), health policy research has focused largely on the content of policy, neglecting actors, context and processes. All these four elements should be taken into consideration, in particular to note how these elements interact to shape policy-making. This component of the Yamey Framework articulates the notion of sustainability as a very important principle for effective population health intervention planning. In the context of South Africa, previous research commissioned and endorsed by the government has highlighted the high prevalence of hypertension in the population and the urgent need to develop appropriate interventions to manage the epidemic. Politically speaking, our research is, therefore, timely.

Research Context:

Incorporating research into implementation ("learning and doing") is the last feature of the Yamey Framework to be considered and one of the main reasons why we chose it in designing this study. Simmons and Shiffman (2007) argue that successful scale-up, "Requires the systematic use of evidence to guide the process and incorporate new learning". To be clear, as the scaling up process is ongoing, it is important to continually gather new knowledge and evidence that will be used to make the interventions more effective. Recommendations in our study are derived from inputs of the health care providers and key informants that are the potential implementers of the scaled-up interventions to manage the hypertension epidemic.

This introduction sets the stage for the thesis; the next chapters cover the literature review and research methods, followed by three chapters of results, and a final chapter summarizing the findings and their main implications.

CHAPTER 2:

REVIEW OF LITERATURE

Increasing attention is being paid to the impact of non-communicable diseases (NCDs) on health and development as evidenced by the launching of the World Health Organization's Global Action Plan on NCDs (World Health Organization, 2013). However, there is an important contrast between emerging high-level policies and recommendations and the near-absence of practical guidance and experience delivering long-term medical care for NCDs within the weak health systems characteristic of resource-limited settings such as in sub-Saharan Africa (Rabkin & El-Sadr, 2011).

Chronic diseases care and HIV/AIDS care

Although there is an increasing consensus about the need to address chronic disease, practical implementation approaches required to deliver secondary prevention, care and treatment services are less well developed, especially in resource-limited economies. One overlooked fact is that many low and middle income countries (LMIC) have already established examples of effective chronic disease programs in their work scaling up HIV/AIDS services over the past decades. Rabkin and Nishtar (2011) reported that although HIV and chronic disease care are often thought of as very different challenges and are administratively siloed within most health agencies, HIV programs are the first large-scale chronic disease initiatives in LMICs, and thus offer local and effective models that can be emulated, adapted and expanded. This research

project considers the usage of existing HIV/AIDS infrastructure, and lessons learned, as a gateway to access the larger hypertensive community and to target specifically high-risk hypertension patients.

Rabkin and El-Sadr (2011) found that despite recommended models by agencies such as the World Health Organization (WHO), health service delivery systems in LMICs typically provide only episodic care and are often designed for the relief of acute symptoms rather than the maintenance of well-being or the prevention and care of chronic conditions. In practice, long-term care may be unfamiliar to policy-makers and health workers who lack effective local models to draw upon. From a practical perspective, shortage of staff and infrastructure hinders the establishment of continuity services and leads patients to defer routine visits necessary for the prevention, monitoring, and treatment of chronic diseases such as hypertension. In sub-Saharan Africa, primary care systems for decades have been in a state of crisis and the HIV/AIDS epidemic has placed a further strain on systems and health workers to a breaking point (Lamptey & Dirks, 2012). Despite these formidable barriers, HIV programs have achieved remarkable success. Atun and Bataringaya (2011), for example, reported that the number of people receiving antiretroviral treatment (ART) in LMICs skyrocketed from 400,000 in 2003 to more than 5.2 million in 2009. They also pointed out that treatment costs dropped from $US10,000/patient/year to $US60/patient/year today. The findings of Rosen and Fox (2011), that less than 50% of eligible patients worldwide received antiretroviral therapy, demonstrate that although HIV scale-up remains a work in progress, the achievements have been substantial. In this context, much has also been learned about the limitations of purely ‘vertical’ programs as well as increasing ways to mitigate the potential negative impacts of disease-specific initiatives on health systems. We believe that the important lessons from HIV scale-up interventions represent the best opportunity

for rapid scale-up of hypertension infrastructure because many LMICs have already developed and scaled up AIDS programs in prevention, chronic disease management and intersectoral approaches, using local and effective models that can be emulated, adapted and expanded (Lamptey & Dirks, 2012; Rabkin & El-Sadr, 2011).

Hypertension in Sub-Saharan Africa

As affirmed by Kearney et al. (2005), hypertension is a major public health problem worldwide. It is the most common modifiable risk factor for stroke, congestive heart failure and kidney failure in the sub-Saharan African region (Kengne & Anderson, 2006). Cardiovascular disease (CVD), namely hypertension, renal disease, and heart failure, is a major global public health crisis, being responsible for 30 % of worldwide deaths in 2008 (17 million deaths worldwide from an annual total of 57 million deaths) with an alarming 80 % of these deaths occurring in low- and middle-income countries (LMICs) (World Health Organization, 2011). Hypertension is a major contributor to overall death risk in adults in the sub-Saharan African region and is more prevalent in urban population (Fezeu, Kengne, Balkau, Awah, & Mbanya, 2010). CVD mortality (including hypertension) is on a steady rise in LMICs with rates of up to 300–600 deaths attributed to CVD per 100,000 population, and is projected to increase causing preventable loss of life (World Health Organization, 2011).

In many parts of the developed world, clear identifiable risks associated with various blood pressure (BP) readings have largely been established for populations. This is not the case for LMICs, including the sub-Saharan Africa region. Long-term lowering of BP to either normal or optimal levels has several significant health benefits (Turnbull, 2003). However, Kengne and

Anderson (2006) argue that most eligible patients in sub-Sahara Africa do not have access to antihypertensive therapies either because of under-diagnosis or other barriers including access to antihypertensive medications or treatment compliance.

Addo, Smeeth, and Leon (2007) published a systematic review of the prevalence of hypertension in the general population of sub-Saharan Africa. Of the 10 countries included in the review, they found that the prevalence of hypertension ranged from 13–39%. The prevalence was generally higher in males, older individuals, and those with high body mass index (BMI). It was also higher in urban populations compared to their rural counterparts. With respect to socioeconomic factors, the prevalence was higher in socially and economically advantaged communities. In a more recent review of studies published since 2000, Dalal et al. (2011) found that the hypertension prevalence in SSA countries, using literature on NCDs in SSA and data from the World Health Organization, ranged from 6 - 48%. It should be noted that this review found few community-based studies and some countries, such as South Africa, were over-represented. The review also found that high BMI, male gender, old age, urban residence, and affluence are strongly associated with a high prevalence of hypertension.

Recent studies have revealed that a large proportion of the population with hypertension remains undiagnosed, untreated, or inadequately treated, contributing to the rising burden of cardiovascular disease in the region. A recent systematic review with meta-analysis by Ataklte et al. (2015), to assess the recent burden of hypertension in Sub-Saharan Africa, looked at studies published between 2000 and 2013. They found that predicted prevalence of hypertension at mean participant ages of 30, 40, 50, and 60 years were, respectively, 16%, 26%, 35%, and 44%, , with a pooled prevalence of 30%. Of those with hypertension, only between 7% and 56% (pooled prevalence: 27%; 95% confidence interval, 23%-31%) were aware of their hypertensive status

before the survey. Overall 18% (95% confidence interval, 14%-22%) of individuals with hypertension were receiving treatment across the studies, and only 7% (95% confidence interval, 5%-8%) had controlled blood pressure. This review found a high prevalence of hypertension, as well as low percentage of hypertension awareness, treatment, and control in Sub-Saharan Africa, highlighting the need for implementation of timely and appropriate strategies for diagnosis, control, and prevention.

The case of hypertension in South Africa:

Challenges to its health system and reforms

Health care in South Africa varies from the most basic primary health care, offered free by the state, to highly specialized, hi-tech health services available in the both the public and private sector. Ohanyan, Danielyan, Hopayian, and Mash (2015) report that while the state contributes about 40% of all expenditure to health, the public health sector is under pressure to deliver services to about 80% of the population. Public health consumes around 11% of the government's total budget, which is allocated and mostly spent by the nine provinces. How these resources are allocated, and the standard of health care delivered, varies from province to province. The private sector is run largely on commercial lines and caters to middle- and high-income earners who tend to be members of medical schemes(schemes has a bad connotation, do you mean health care plans?). It also attracts most of the country's health professionals. This two-tiered system is inequitable and inaccessible to a large portion of South Africans. The NHI, which is still in its pilot phase will try to address this issue (Naidoo, 2012; van Rensburg, 2014).

In an effort to improve the health care situation in the country, a health system with primary health care at the base has been promoted in South Africa by the government since the end of Apartheid, (Maillacheruvu & McDuff, 2014). In 2002, additional legislation was passed, in the form of the National Health Bill, with standards to provide "comprehensive primary health services" to all (Section 27.2.k), and to promote "health and healthy lifestyles" (Section 27.2.s) and "community participation in the planning, provision and evaluation of health services" (Section 27.2.t) ("National Health Bill (Section 76 Bill)," 2002). As a result, the government provides free primary care for all citizens and special cost-free community health centers for pregnant women and children under the age of six (Maillacheruvu & McDuff, 2014). This could explain why primary health care facilities are overcrowded. Recent studies further found that in the South Africa primary health care system, the number one motivation for patient visits, associated with chronic care, was for cardiovascular concerns, at nearly ten percent (Mash et al., 2012).

South Africa has one of the highest rates of hypertension in sub-Saharan Africa, where the condition has been well researched compared to other countries in the region. According to Ibrahim and Damasceno (2012), the prevalence of hypertension in the South African population is as high as 44% in adult males living in rural areas. They also found that older adults and males are more affected by hypertension in South Africa. The 2013 South African National Health and Nutrition Examination Survey (SANHANES-1) reported a hypertension rate of 68.2% among people over the age of 50 (Shisana et al., 2013). However, unlike other countries in the region, the prevalence was comparable between the rural and urban populations (Steyn et al., 2001), which is attributed by the authors to an increase in obesity caused by widespread uptake of Westernized diets throughout the country.

Because the risk for cardiovascular disease increases progressively throughout the range of blood pressure, it is important that modifiable risk factors such as diet and exercise be addressed among those with a diagnosis of hypertension, pre-hypertension and even those at what is considered to be a normal blood pressure reading. Roger et al. (2011) reported that two-thirds of the Coronary Heart Disease (CHD) risk in a US cohort was concentrated in the proportion with high-normal Systolic Blood Pressure (SBP - 120-139 mmHg) and stage 1 hypertension, rather than in the cohort with the highest blood pressures above 160 mmHg systolic. This finding justifies the need for attention to risk reduction among all patients, regardless of their blood pressure, and therefore suggests large scale interventions should target all patients along the continuum of blood pressure.

Olafiranye et al. (2011) reported that there is a current debate on whether research and infrastructure dollars should be best spent on preventing and managing hypertension in a non-drug approach versus providing antihypertensive drugs for the long term. A similar argument was put forward in the HIV/AIDS epidemic as there was great concern about funding and resistance to treatment. As we now know, effective drug treatment to manage hypertension is a possibility and should be explored. Current blood pressure drugs in sub-Saharan Africa are inexpensive, even by local standards. Gaziano, Steyn, Cohen, Weinstein, and Opie (2005) suggest, that in South Africa, the annual cost of antihypertensive medicines could be as low as $43 and even lower in some settings where they are subsidized by the government.

Fezeu et al. (2010) describe how South Africa is faced with a quadruple burden of communicable, non-communicable, perinatal and maternal, and injury-related disorders. Non-communicable diseases are emerging in both rural and urban areas, most prominently in poor people living in urban settings, and are resulting in increasing pressure on acute and chronic

health care services. They are largely preventable and yet also becoming more prevalent as a consequence of rapid industrialization, urbanization and development. In fact, the WHO assesses the disease burden resulting from NCDs in South Africa to be two to three times higher than that observed in developed countries.

To respond to these changes, in August 2011 a Green Paper (2011) on National Health Insurance (NHI) was released for debate and comments by all in the country. The proposed NHI is a step towards health care reform as espoused in the Constitution and the National Health Act and a move towards the Alma-Ata's vision of 'Health for All'(Labonte, Sanders, Packer, & Schaay, 2014; World Health Organization and United Nations Children's Fund, 1978). The seven principles of the NHI, i.e. the right to access, social solidarity, effectiveness, appropriateness, equity, affordability and efficiency, could be interpreted as the value assumptions of the proposed reforms. The objectives of the NHI are 1) To improve access to quality health services for all, 2) To pool risks and funds in order to achieve equity and social solidarity, 3) To procure services on behalf of the entire population and to efficiently mobilize and control key financial resources, and 4) To strengthen the public health sector so as to improve health systems performance.

The National Department of Health developed and published the "Strategic Plan for the Prevention and Control of Non-Communicable Diseases 2013-17", which is in line with targets to be achieved by 2020 and 2030 that were set at the South African Summit on the Prevention and Control of Non-Communicable Diseases held in September 2011. This strategic plan is designed around the set of ten goals and targets, issued from the Declaration at the Summit, which cover the following: reducing the relative premature mortality; reducing tobacco use; reducing the per capita consumption of alcohol; reducing mean population intake of salt ;

reducing the prevalence of people with raised blood pressure; increasing the prevalence of physical activity; reducing the prevalence of cervical cancer; increasing the percentage of people controlled for hypertension, diabetes and asthma and increasing the number of people screened and treated for mental disorders (Ministry of Health, 2013).

Following the release of the survey SAHANES-1 in 2013, the Government of South Africa explicitly indicated the need to determine the minimum necessary package of resources to address the epidemic of NCDs, and hypertension in particular. Our research project findings will contribute to a discussion of the minimum resource package requirements.

Drugs treatment and supply management

The availability of new and essential medicines and other health technologies to treat life-threatening illness has helped millions of people lead long and productive lives. However, global availability does not necessarily translate to access especially in low-and middle-income countries. Effective supply chains are needed to deliver these health products in hard-to-reach and resource-constrained settings that often times are inhospitable to collaborative, high-performing supply chain systems (Holm, Rudis, & Wilson, 2015; Landry & Beaulieu, 2013). The World Health Organization estimates that a third of the population in developing countries does not have access to essential medicines (World Health Organization, 2004). In addition, many governments and health care facilities do not have a sustainable, uninterrupted, drug supply chain process. Unreliable monitoring of medication utilization, inconsistent supplies of medications, concerns for medication integrity, and illicit drug diversion among hospital staff for personal use, all highlight the many supply chain problems in under-resourced settings (Bix,

Clarke, Lockhart, Twede, & Spink, 2007). Supply chain management hence remains a challenge for health systems.

Wisloff et al. (2012) argue that antihypertensive medications are available in generic forms in most African countries although their supply is highly variable. Assuming sufficient funds are available to scale up access to antihypertensive medications, a drug supply chain management system would need to be developed to ensure these drugs reach patients. Windisch, Waiswa, Neuhann, Scheibe, and de Savigny (2011) suggest that supply chain management has been an especially weak component of national health systems in sub-Saharan Africa. This can largely be attributed to a lack of coordination. Integration of an antihypertensive supply chain with that of preexisting mechanisms (e.g. government import agencies or international NGOs), however, may be preferable to direct private importation. This is supported by Enyinda (2009) who argued that integrating supply chains on pre-existing government infrastructure, in particular, is more likely to result in effective and sustained availability of essential medicines than direct private importation. To ensure the successful delivery of medications to patients when scaling up interventions, special attention should be paid to local socio-politico and economic contexts.

Quantifying the requirements for medicines is an essential step in the overall process of procurement with the aim of ensuring access. Various approaches are being used to quantify drug requirements based on data available. The "Morbidity Method" from the WHO is one of these approaches (World Health Organization, 1988b). In the standard version of the "Morbidity Method", the total quantity of drugs required for a health problem is formulated by taking the quantity of drugs given as a standard treatment for the problem, and multiplying it by the number of treatment episodes of that problem. Quantification seeks to answer the question: "How much

of each medicine is needed?" It is the process of determining the quantity of each selected medicinal product required to meet the needs of a specified location (clinic, hospital, region or country) or program (e.g. TB program) for a specified period of time. In addition to being a step in the procurement process, quantification of requirements also provides vital information for managing the distribution of medicines (World Health Organization, 1988a).

Standard treatment will vary according to the age category of the individual therefore patient age group, gender, and other characteristics may be considered. More than one medicine may be included in a standard treatment and the same medicine might be considered according to different health problems. All occurring quantities of the same medicine must therefore be added together to get the total quantity of that medicine required. Detailed methodology is provided in a World Health Organization manual about estimating drug requirements (World Health Organization, 1988a). The morbidity method is more of a theoretical model and assumes prescriber adherence to standard treatment guidance. To acquire the two sources of data for this model, the work and cooperation of health care workers outside the medicine supply sector is required. The morbidity method can be used at all levels from the primary care clinic to the national level assuming that the required epidemiological data is available. It is particularly useful for major public health problems such as TB, malaria, diabetes and HIV where there is a more uniform approach to selection and treatment. This also renders the model well suited for hypertension. As suggested in the World Health Organization (1988a) practical manual, morbidity-based methods are particularly useful when estimating needs for new or expanded services and also in emergency situations caused by natural disasters or epidemics.

Scaling-up and its challenges

A long-standing mission in global health funding and programs has been the scaling up of effective health services and interventions. The rapid growth in global health initiatives to promote the widespread roll-out of anti-retroviral therapy for HIV/AIDS has led to a recognition of the importance of scaling up interventions that have been effective on a smaller scale. Despite increased funding for scaling up health services in LMICs, many developing countries were not on-track to achieve global Millennium Development Goal (MDGs) targets (Paina & Peters, 2011; Yamey, 2012). Subramanian, Naimoli, Matsubayashi, and Peters (2011) added that plans to scale up health interventions to reach the MDGs had presumed a rather linear and predictable process which involved replicating implementation arrangements, costs and impacts that were produced on a small scale, often under relatively controlled conditions, and usually through a standardized public health services model across countries. Unfortunately, in practice, this assumed implementation process does not often work well because it takes place in diverse social, political and cultural contexts. Arnold, Arana, Mäusezahl, Hubbard, and Colford (2009) reported that it has been well established that the local context greatly affects program implementation in health. Local influence over the behavior of patients and communities is less 'controlled' in a non-research setting, so that even simple biomedical interventions often involve complex social interventions.

The complexity of health interventions is a constraint to implementation that needs to be managed to increase coverage. Tan, Wen, and Awad (2005) report that of the few studies that touch upon this issue, they all focus either on establishing the link between complexity and health services, or describing how change and innovation occur in complex health care organizations. Subramanian et al. (2011) argued that there is no unifying theory that can account

for how the scaling up of health services actually occurs across countries or types of services. They do however point out at least six distinct conceptual models in the literature that question how to scale up health services in developing countries. They include "A Learning Process Approach" published in 1980, "Alternative Strategies for Scaling Up NGOs" in 1995, "Diffusion of Innovations" in 1995, "SEED-Scale" in 2002, "Scaling Up Management (SUM) Framework" in 2003, and "Expandnet Framework" in 2008 (Subramanian et al., 2011). A table summarizing each of these conceptual frameworks is presented in Appendix 14. These findings prompt us to explore and assess the model for antihypertensive medication supply chain management in place in the Western Cape Province of South Africa, with special consideration of the processes to quantify drugs needed, to procure the drugs, and to store and control drug inventory, to distribute the drugs to clinics, and to estimate human resource requirements to ensure the adequate care of patients.

CHAPTER 3:

RESEARCH METHODS

The Setting

South Africa is one of the wealthiest African countries and is considered a middle income country. In 2011, the population was estimated to be 54.9 million spread across nine provinces, with a gross domestic product (GDP) per capita of about USD 3000. The Western Cape (WC), one of the nine provinces, has about 11.3% of the country's population and is its fourth largest populated province. We chose the Western Cape Province for our field investigations in South Africa largely because of the facilitated access through the South African Medical Research Council (SA MRC) with which we had secured. The WC province is divided into six municipalities, the largest being the City of Cape Town Metropolitan Municipality where over 64% of the province population is located (Statistics South Africa, 2015). Our study was conducted in the WC province, both in the metropolitan and the rural districts presented in the map below. Given the high concentration of the province population in the City of Cape Town Metropolitan Municipality, we opted to randomly select five sites there and 4 sites in the rural municipalities for the Health Care Personnel data collection. Preference was given to sites where the NCD Research Unit at the South Africa Medical Research Council (SA MRC) had previously conducted research to ease our access. We applied to access a certain number of sites selected randomly in all the six health districts of the province but the Department of Health granted us access to only a few as indicated on the DOH Approval Letter presented in Appendix

12. Key informants to investigate the drug supply chain management system were selected progressively throughout the province using a snow-balling approach until data saturation. Data was actively collected between January 2015 and July 2015 by myself as I conducted all interviews. The staff at the SA MRC provided great assistance in the background on logistical issues and networking to facilitate access at some sites but was not involved in the actual collection of data.

Figure 2: Map of the Western Cape with municipalities labelled

Source:

https://en.wikipedia.org/wiki/Western_Cape#/media/File:Map_of_the_Western_Cape_with_municipalities_labelled_(2011).svg

Study Design

This research is a cross-sectional study with a qualitative component, a document review and a quantitative modeling component. The overarching research question of this thesis proposal is to determine the health system requirements to ensure successful delivery of antihypertensive medications in the developing country of South Africa, particularly in the

Western Cape Province, when scaling-up interventions to control the epidemic of hypertension. Systems requirements include materials and human resources linked by processes and policies. This research question is addressed using a variety of research methods appropriate to each sub-research question presented here, which are informed by the theoretical framework. The proposed design with combined methods is suitable for our research as it advantageously offers multiple ways to explore the research problem. It also allows the flexibility of using different sample sizes based on the method and the sub-research question, along with different data collection tools. In addition, analysis and interpretation of data was continuous and influenced stages of the research process.

A combined qualitative and quantitative method is used to answer the following specific research questions: (1) What are the challenges of the South African health care system, particularly of the Western Cape Province, in the care of hypertensive patients? (2) How is the current supply chain management system of antihypertensive medications in the Western Cape Province organized? (3) Using modeling tools, how can one determine the minimum number of health workers required at each supply chain interval to ensure successful delivery of medications when scaling up interventions? At a very broad level, an antihypertensive medication supply chain will include processes to quantify the drugs needed, to procure the drugs, to store and control the inventory, to distribute the drug to clinics, and to ensure an adequate level of quality assurance. I conducted fieldwork from October 2014 and had access to secondary data through the South African Medical Research Council. In order to answer our overarching research question, this thesis is articulated around the three specific objectives and study components mentioned above and represented here.

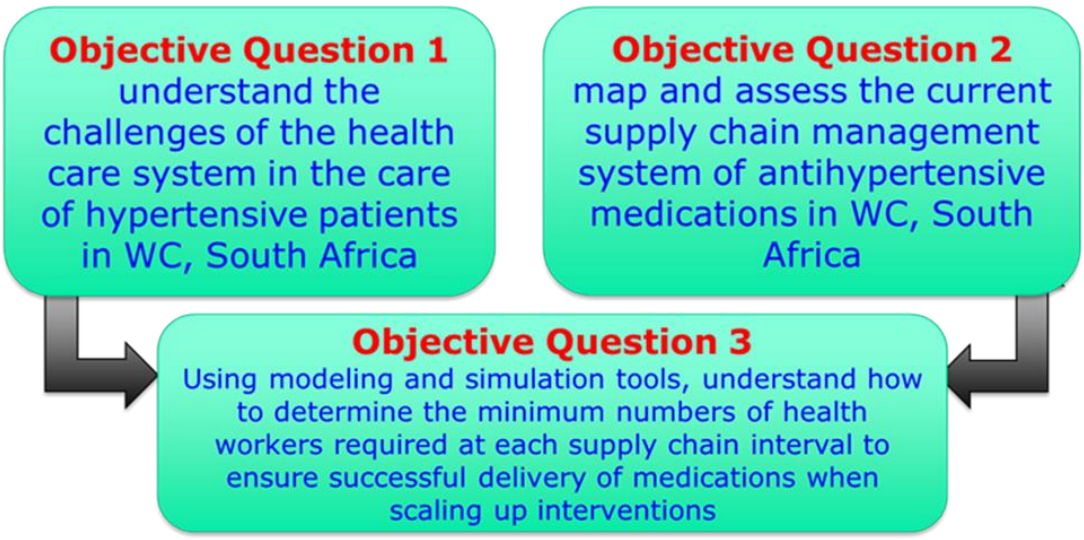

Figure 3: Study design - Objectives linked

We recognize that the epidemiology of hypertension may vary from one province to another, but our research focuses mainly on procedures and operations within the health system which are comparable between provinces. Results obtained in the Western Cape Province are not directly generalizable throughout the country but could serve as reference for similar studies in other provinces. Methods and models could also be potentially replicated. The next paragraphs delineate describe how each of the research questions was investigated from the perspective of the data collected to the method used for its analysis and interpretation.

First, the research assesses the challenges of the health care system in the care of hypertensive patients, particularly in the Western Cape Province. An assessment of the standard procedures in a number of primary health care facilities identifies key processes and responsibilities in diagnosis and treatment provision. Primary and secondary data are combined to perform this assessment. Primary data are collected through key informant interviews of medical personnel in the form of semi-structured questionnaires. Data collected are used to describe how patients are processed at the primary health care facilities from arrival through

health assessment and medication collection to departure. Special attention is given towards individual processes at the health care facilities involved. Each type of health care personnel was asked to elaborate on their current tasks, the duration estimation, and as well as the potential tasks that could be added or removed to inform task-shifting options. Key informants include facility managers and health care providers (nurses, pharmacists, doctors, allied healthcare providers) working in primary health care facilities of the province. Interviewing directly the personnel involved to perform this assessment insured that we retrieved the most accurate and practical data regarding the view of the providers on the care of hypertensive patients. This supports the main objective of this sub-research question, which is to understand the challenges faced by the health system in caring for those hypertensive patients. The approach linked to this sub-research question is particularly appropriate as we are investigating the specific operations that take place when caring for these patients.

We selected a total of nine primary health care facilities, of the public sector, distributed between the Cape Town metropolitan area (five facilities) and the rural municipalities (four facilities). The main inclusion criteria for the selection of a primary health care facility for our study was the implementation of at least a weekly dedicated hypertension or chronic NCD treatment clinic at the healthcare facility. We also included facilities that treated these chronic patients any day of the week without a specific day allocated to a condition. The SA MRC, our host in South Africa for this project, has access to a number of primary and secondary level public health care facilities in the Western Cape with which it has already established a good working relationship. A preselected list of thirty health care facilities was compiled for our purpose based on accessibility and working relationships with our host for this research, the SA MRC, and the final sample was decided based on the Western Cape Department of Health

feedback on our application to access facilities in the province. Secondary data to complement our field investigation consisted of documents received from study participants and databases accessed through the SA MRC. Overall data collected contained information about the levels of staffing, hypertension screening practice in the health center (routine or opportunistic), the volume of patient visits over a period such as the last twelve months (when available), the average time allocated to the patient at each station, the presence of task shifting mechanisms, the level of adherence to treatment, the availability of drugs, the frequency of drug shortage, the presence of equitable distribution policy during a drug shortage, the personal assessment of the services rendered and last, but not least, the challenges and potential solutions. The interview guide for health care personnel presented in Appendix 6 provides more detail about the data collected. The Demographic data collected allowed us to account for sex and gender, as well as age distribution when analyzing the data. Data collected in nine public health centers are analyzed qualitatively and quantitatively to understand the current state of practice and highlight strengths and challenges of the health care system in regards to the care of hypertensive patients. Data on hypertensive patient flow within the primary health care facilities is analyzed to feed into the third objective of our research project related to the modeling and simulation of the care provided.

Second, the research investigated the current state of the drug supply chain for antihypertensive medications in South Africa, particularly in the Western Cape Province, using an exploratory design. Exploratory qualitative design is appropriate for a problem that has not been clearly defined and this fits our research because we were trying to map and assess a process without knowing ahead of time who were the main stakeholders involved. The research design allowed us to identify them as the research progressed. Exploratory research in general

helps determine the best research design, data collection method and selection of subjects. In our case this approach mainly supports our selection of participants. Antihypertensive medications do not have a separate supply chain management system from other medications used in the province, therefore, the investigation covered the general drug supply chain management system with particular attention on antihypertensive drugs. This was done through the mapping of the current public drug supply chains for medications in this country which uncovered the gaps, weaknesses, and strengths of the current supply chain.

Practically, we describe the supply chain by following the flow of medications backwards from the service delivery point or health center, to the program management unit where drug selection and quantification take place. This investigation required interviewing key informants at each step of the flow to determine the current operational procedures at that step, the various stakeholders at each step, and the next step to which it led. Semi-structured interviews were administered with both close and open-ended questions. The interview guide for key informants presented in Appendix 7 provides more detail about the data collected. Other individuals identified during the interviews were also contacted for their input. As such, the selection of participants was achieved using a "snow ball" approach. Also, secondary data available, such as operational guidelines, were collected and analyzed at each step. As we built on the existing infrastructure, scaling-up services in this project involves doing more than what is currently achieved by the health system in terms of coverage, quality of services and cost effectiveness of processes. This investigation helped to identify factors that either enhance or hinder accessibility to antihypertensive drugs. In addition, it developed a comprehensive supply chain map that revealed the labyrinths of the South African logistics infrastructure, distribution channels,

government regulations, and business customs. The identification of potential leverage points can inform strategies to scale-up interventions to manage the epidemic of hypertension.

A basic model for logistics process redesign by Persson (1995b) served as the basis for describing and analyzing logistics processes involved in the flow of information and goods of the public drug supply chain (see Figure 4). At the management level, we selected key informants from the provincial Department of Health (DOH) and used available secondary data to identify procedures in place to gather information on estimating how much of each drug is needed. For the procurement level, which deals with selecting suppliers, placing and monitoring orders, checking delivery quantities and quality, and paying suppliers, key informants involved at the DOH were interviewed, combined with available data to identify lead times, ordering frequencies, and demand patterns. The distribution component was investigated by interviewing managers at these levels to gather information on order reception, storage, stock control, transportation, and record keeping for monitoring and control, which was analyzed to determine shortage frequencies, inventory management practices, stock fluctuations and uncertainties. The service delivery points provided data on prescription, dispensing and use of drugs, and patients' compliance with prescriptions.

We complemented our investigation by using various data sources from the South African National Health and Nutrition Survey (SANHANES), Hypertension Society of Southern Africa, trade, government reports, manufacturers, and customs to perform our mapping. The expected outcome of this investigation was to identify and evaluate the key elements and processes of the current supply chain management system of antihypertensive medications in South Africa, particularly in the Western Cape Province. Special attention was given to principal public actors (government departments, various levels), volumes and cost of supplies per year,

choice of majors suppliers, frequency of orders, transportation actors and processes, shortage management strategies, variation of demands level, storage conditions and processes, inventory management, quality assurance processes, staffing levels and numbers at each interval, volume level at each storage level, monitoring and record keeping of drug availability and utilization patterns. We focused on public sector primary health care clinics known as Community Health Centers (CHCs) for this study as they provide a network of accessible and free primary care for acute and chronic illnesses. We believe that they are fairly representative of clinical practices for the vast majority of hypertensive patients.

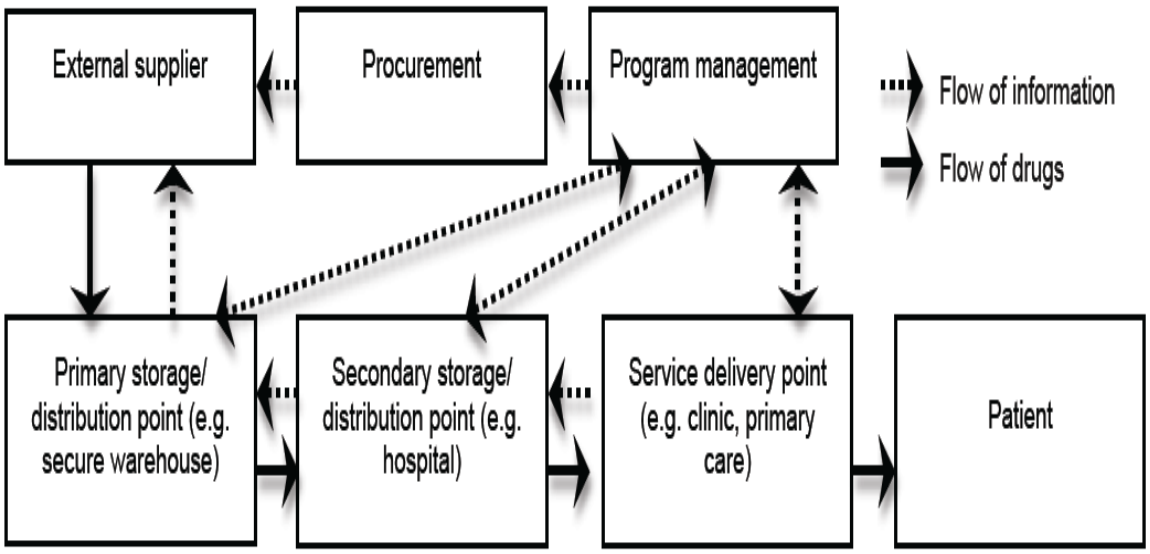

Figure 4: Supply chain management framework
Source: Persson (1995a)

Finally, our research explored modeling and simulation tools to determine the minimum numbers of health workers required at each supply chain interval to ensure successful delivery of medications when scaling up interventions. In the event that authorities would like to put in place programs to increase diagnosis and treatment of hypertensive patients, in other words scaling-up interventions, the modeling of current processes will help to determine what would be needed of

the health system to be able to tackle such volumes of patients. Our study was not actually implementing any scaling-up activity, nor proving real estimates. Data analysis of the earlier study component on how hypertensive patients are processed at the primary health care facilities from arrival through health assessments and medication collection to departure, with details on individual processes including tasks descriptions with time duration estimations, provided parameters to build the model and to program the simulation software. Tasks and time duration estimations per task or per station were computed in the simulation software to determine how to derive estimates of the minimum number for each type of health worker needed. The organization and management of hypertension services has implications for staffing. The model of service delivery is an important parameter in estimating the human resource needs.

Participants

In this study, our stakeholders are of various types and levels but inform the analysis in a concurrent manner. We interviewed Provincial Department of Health staff involved with the drug supply chain management system and health care personnel within the nine public health centers selected. Participants interviewed on the drug supply chain management system were recruited through referrals using the snow ball strategy until data saturation. We were also guided by the known functions of a drug supply chain management system in the identification of potential participants. The health care personnel interviewed were identified at each facility selected by their operational manager or their facility manager. The choice was also based on the pathway of hypertensive patients within the health facility when they come for their regular visit.

I conducted all interviewed at the participants' work place using a voice recorder. No patient was interviewed as the focus is on processes followed by providers within the health systems. There were no translation issues as we used only English in dealing with professional staff. As a general rule, only individuals who have been in their positions for at least 3 months were included in the study. Each participant signed a consent form to participate in the study after a verbal briefing about the purpose and structure of the study. Sample consent forms used for this study are presented in Appendixes 8 and 9.

In the process of studying how patients are processed at the primary health care facilities from arrival to departure, with details on individual processes and health care facility personnel involved, participants at each location were mostly operational managers (MGR), administration staff at the reception (ADM), enrolled nurse assistants or enrolled nurses (ENA), clinical nurse practitioners (CNP), medical officers or doctors (MDO) and pharmacists or pharmacist assistants or dispensing nurses (PHAR). We interviewed an average of six health care personnel at each facility. These were identified as the main health care professionals routinely involved in the care of hypertensive patients. Table 1 below gives more details about the training levels of each participant interviewed.

Table 1 – Cadres interviewed and levels of training

Cadre	Number Participants	Function	Minimum Level of Training	Characteristics
ADM	9	Clerk reception	High School Diploma	Training usually not specifically health related. Some had college training in administration
ENA	10	Enrolled nurse assistant (EN) / Enrolled nurse (ENA)	One or two years of training after high school	In the care of hypertensive patient both EN and ENA performed similar duties
CNP	9	Clinical nurse practitioner	Four years of training after high school	Training usually in phases. Has limited prescribing privileges
MDO	8	Medical officer / Doctor	Six years of training after high school plus residency	Medical degree holder. Some were general practitioners (GP) and other had specialized in family medicine.
PHAR	9	Pharmacist / Pharmacist assistant	Four years of initial training then internship for a year and community service for a year; Pharmacist assistant get two years of training	In some settings, only pharmacist assistants were in charge at the clinic working under the supervision of a pharmacist that is in charge of more than one facilities
MGR	9	Operational manager	Clinical nurse practitioner training plus management training in form of short courses	They were all experienced CNP promoted to Operational Manager role at one point. Some still have to perform duties of CNP within the facility due to lack of staff while ensuring the role of MGR

The final sample was N=54 participants with six participants in average for each of the nine sites selected. Figure 5 below shows the locations where these health care providers were recruited and interviewed.

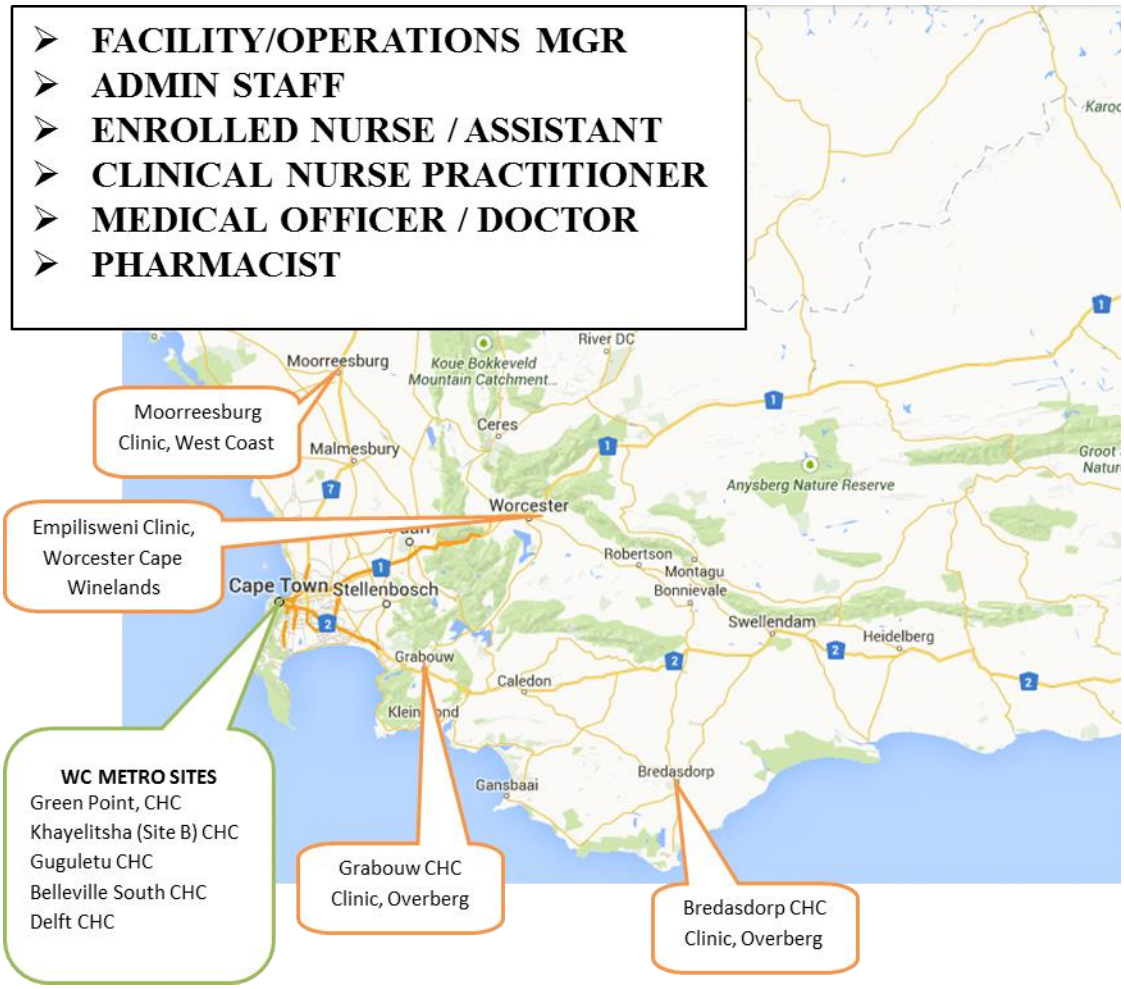

Figure 5: Data collection phase for health care personnel – approved sites
Source: Google Maps

For the mapping of the current public drug supply chain for antihypertensive medications in the Western Cape Province of South Africa, participants were identified at each stage of the supply chain management framework. As described earlier in the Study Design section, key

informants were interviewed in various locations within the province and we used a referral system to identify further participants. We interviewed a total sample of N=17 key informants from the central administration at the Provincial Department of Health, the health districts (both metro and rural) and the identified agencies involved in the drugs supply chain. We stopped at N=17 when we reached data saturation as were confident that we received enough information to map the supply chain management system and when the same information re-appeared in data collection. Figure 6, below, presents the professional title of all the key informants interviewed for this study.

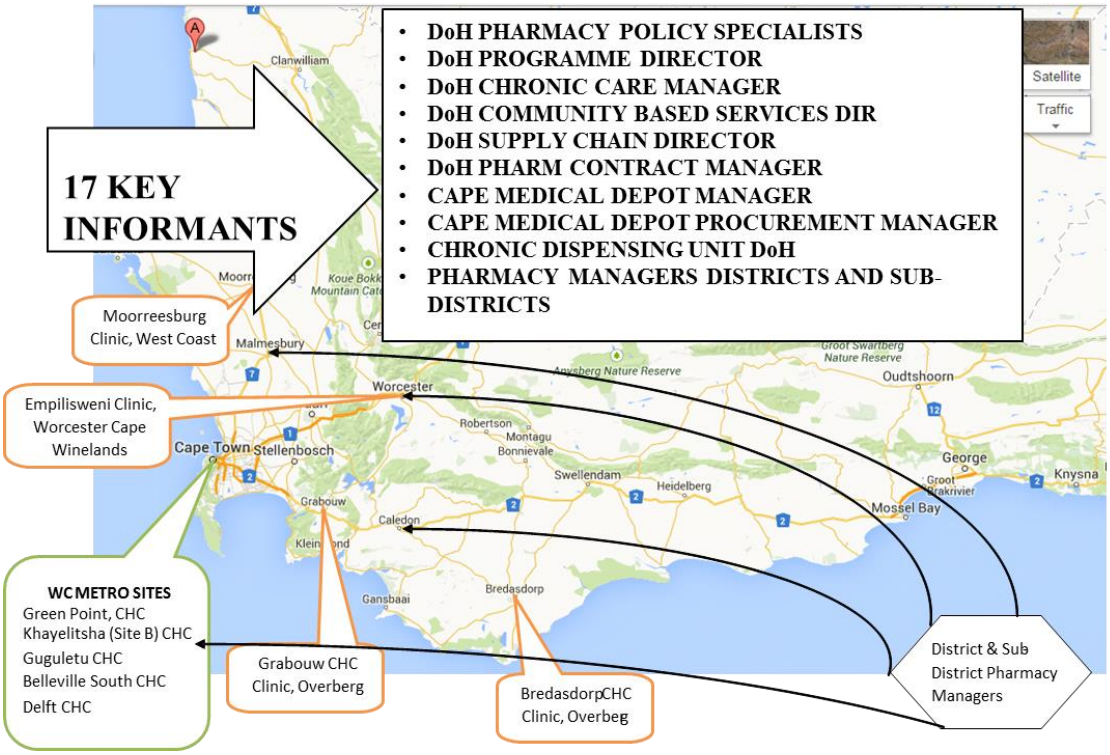

Figure 6: Data collection phase for key informants – approved sites
Source: Google Maps

In the process of developing the model of care for hypertensive patients and programming the simulation to determine how to estimate the minimum human resource needs

when scaling up the interventions, data from the two interview schedules were used. Additionally, support from the ARENA Simulation Software team was received to help with the technical aspects of setting up and programming.

Data Collection Techniques

In this research, the techniques to collect data were semi-structured interviews, surveys, administrative data and a review of documents. The semi-structured interviews were conducted using interview guides that we developed based on topics related to our research questions. The semi-structured interview guide was appropriate for our research as it allowed us to extensively cover the topics of interest with the possibility to stray from the guide when appropriate and necessary to acquire more information. There were two semi-structured questionnaires: one for the managers and policymakers in the provincial Department of Health and related agencies involved with the drug supply chain management system, and a second for health care personnel involved with the care of hypertensive patients in the selected primary health care facilities. The choice of semi-structured interview format with predominantly open ended questions gave respondents much flexibility to organize and articulate fully their responses (Aberbach & Rockman, 2002). The interview guides were developed and finalized after informal pilot-test interviews of a few participants. Feedback received from participants during the informal pilot-test interviews helped to re-shape the interview guides and make them more fluid. All interviews were held in the office of the respondents or at a time and place of their own convenience within the facility. At the beginning of every interview, I introduced myself, the purpose of my research, the source of funding, how I will disseminate the findings of my research and asked for

permission to record the interview. At the end of the interview, I asked my respondents if they had any additional comments or questions regarding my research. This was helpful in knowing whether I had overlooked critical questions. I also asked if it was fine to contact them again if I needed some clarification. All participants were given the option to review the transcript of their interview but just a few accepted, mostly medical officers and pharmacists.

All primary data obtained through semi-structured interviews were recorded and transcribed before analysis. Consent was obtained for recording the interviews and no personal information was recorded. Inputs from knowledgeable individuals at the Western Cape Department of Health and a couple of primary health care facilities were obtained to help finalize the semi-structured interview guides after approval for the study was obtained from the Ethics Committees.

Secondary data came largely from hypertension statistics, administrative data and a review of documents. Some hypertension statistics were extracted from accessible surveys such as SANHANES. Administrative data was extracted from records at health institutions and agencies where I interviewed study participants. Examples of the administrative data used include daily and monthly patients' logs, pharmacy logs, and hypertension prevalence data from surveys. We also gathered information through the review of other applicable documents such as the Manual for Integrated Chronic Disease Management Audit, sample tender contracts, treatment guidelines, and the Chronic Dispensing Unit work flow document, just to name a few. As I approached key informants and health professionals, I requested access to available administrative data and documents. Data extracted from documents such as the Manual for Integrated Chronic Disease Management Audit, sample tender contracts, or treatment guidelines,

were also helpful to adapt our semi-structured questionnaires in order to ask more appropriate questions tailored to our research objectives.

Data Analysis

A content analysis approach was implemented in this research, which guided our initial analysis and the coding process, where we looked for redundant and similar codes. This approach was appropriate for our research design as qualitative data collected was descriptive data to investigate operations and processes in place and to identify potential challenges. The validation strategy used was triangulation as the processes and operations investigated were described by various types of participants and also in some of the documents that we reviewed. Qualitative data collected through semi-structured interviews was transcribed by a professional third party in Cape Town, South Africa. Sample recordings were initially transcribed by the third party selected and the transcription was reviewed by myself for validation before the transcription of the entire set of recording started. The final transcripts were loaded into the Atlas ti software for the analysis phase and each transcript file loaded was designated by the software as a primary document. Primary documents were encrypted in the software to ensure that no personal information about the participant would be released. Interview data collected from the field were coded using two basic types: manifest and latent. Manifest coding items refer to direct responses to particular questions by the respondents. Latent coding considers responses that were not explicitly called for by the question (Aberbach & Rockman, 2002). Code lists were developed in an iterative manner as we had a few rounds of coding. A structured approach

guided by semi-structured interviews was used to determine salient themes emerging from the data after coding.

To understand the current state of the drug supply chains for antihypertensive medications in the Western Cape Province of South Africa, the data collected through interviews of managers and policy makers in the provincial Department of Health and related agencies were analyzed to identify the social actors, the various connections and the processes involved in the drug supply chains for antihypertensive medications in South Africa. These elements were further refined by taking into consideration available secondary data to produce a map organizing and representing knowledge extracted from the data about the current state of the drug supply chain management system for antihypertensive medications in Western Cape, South Africa. The assessment of this comprehensive supply chain management system map revealed the labyrinth of the South African supply chain as it relates to the Western Cape Province, distribution channels, government regulations, technologies, weaknesses and strengths that will need to be addressed in the event that interventions to manage the hypertension epidemic were to be scaled up.

Data collected through interviews of health care personnel were analyzed to extract common reported challenges in the care of hypertensive patients. The challenges were organized by category and then grouped around salient themes that are presented in the results chapters of this dissertation. The same data set was analyzed to identify the variations in models implemented across the facilities for the care of hypertensive patients. These initial models were further analyzed to produce a high level model of care accounting for the major variations identified. This generic model of care was then programmed in the ARENA Simulation Software for validation and various scenarios were run to see how the estimates of health workers would

be determined when scaling up interventions. The variable tested when simulating the model was the volume of patients visiting the facilities as a result of scaling up interventions to manage the hypertension epidemic. Parameters to program the simulation of the various entities of the model were extracted from the same data set. The parameters consist mainly of quantitative data revealing time duration estimates for the various tasks performed at each station of the model of care.

Efforts to go back to our key informants, stakeholders and participants with our findings and recommendations in order to disseminate, promote knowledge translation, and obtain their feedback and comments to inform further studies have been ongoing with the support of the SA MRC. These efforts included presentations both at the South Africa Medical Research Council (SA MRC) and Cape Peninsula University of Technology in South Africa (CPUT) where some of the participants and other experienced researchers in the field of health systems research were present.

Ethics

The study was conducted within the approved conditions of the ethics committees and in accordance with the World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects adopted by the 18th WMA General Assembly Helsinki, Finland, June 1964 and amended by the 52nd WMA General Assembly, Edinburgh, Scotland, October 2000. We followed the principles of Emanuel, Wendler, Killen, and Grady (2004) to ensure ethical conduct in clinical research, when applicable. These principles include collaboration with local and national researchers, engagement of the community in determining

the health-related needs, and respect for the local community's values, traditions and social practices.

Ethics approval was obtained from the South African Medical Research Council and the institutional review board of the University of Ottawa. Furthermore, an application to request access approval to facilities under the authority of the Western Cape provincial Department of Health was registered and submitted as required online through the National Health Research Database (NHRD) in South Africa. Copies of approval letters from the ethics committees in Canada and South Africa, as well as the Department of Health approval granting access to a number of primary health care facilities are presented in Appendix 10, 11 and 12. We have securely archived the informed consent forms signed by all participants prior to their enrolment into the study, as well as the audio recordings, transcripts and all relevant materials produced during this study. This study has also contributed to the enhancement of research capacity at our partner organizations.

Feasibility

This research project was to be implemented in parallel with another broad study initiated by the South African MRC, looking at assessing the readiness of the existing healthcare system in dealing with co-morbid chronic NCDs and related risk factors among people with HIV/AIDS. Our affiliation with the SA MRC allowed us to share some resources for this study which is funded through a grant from the Global Alliance on Chronic Disease (GACD). The support received from the SA MRC and particularly its Non-Communicable Diseases Research Unit (NCDRU) was critical for the successful completion of our study. I was provided office space

and all necessary office supplies including data analysis software by the NCDRU. The unit covered the charges for the transcription of all the audio recordings of the interviews performed. Some staff of the unit gave me rides to the field during my first months there. A couple of months after I arrived in South Africa, I realized that the limitations of the public transport would have a serious impact on my timelines so I eventually took driving lessons in Cape Town in order to become comfortable driving on the left side of the road. This allowed me to rely on rental cars to move around during the remaining period of my stay in Cape Town, saving productive research time.

There were substantial difficulties to access the facilities despite the authorization received from the provincial Department of Health. Many of the facilities claimed not to be informed of our research and we had to do a lot of negotiation through emails and phone call to schedule our visit to each approved facility. Some facilities were not reachable and we had to travel there just to undertake negotiations and obtain a date for interviews. One of the facilities that was approved for the research was dropped because it was very far in the north of the province and the road was not in good condition. Colleagues at SA MRC advised not to take the chance to travel there alone and together with the supervisors we agreed to drop the site. Access to key informants was also hectic as we used a referral approach to identify our participants and scheduling meetings always required many back and forth communications and considerable re-scheduling due to last minutes cancellations for various work-related reasons. It is important to note that in all instances, both for the key informants and the health care personnel, once we secured the visit date and we arrived at the site, we were very well treated and they were always friendly and excited about this study.

There were some security concerns about the field work, as I had to travel alone to new places. Fortunately, there were no security events. The Ebola outbreak in West Africa was ongoing during my field work and I experienced a severe flu during my first week in Cape Town, which caused an admission to a private clinic. They had to keep me there until they were able to rule out Ebola, due to my travel history.

This research project would not have been possible without the funding received from the International Development Research Centre (IDRC) through its Doctoral Research Award. The funding received helped cover the costs related to travel, accommodation and other expenses during my research stay in South Africa.

CHAPTER 4:

CHALLENGES OF THE PRIMARY HEALTH CARE SYSTEM IN THE CARE OF HYPERTENSIVE PATIENTS

The purpose of this study was to determine the minimum health systems requirements to ensure successful delivery of antihypertensive medications when scaling-up interventions to manage the hypertension epidemic in the primary health care facilities of the Western Cape Province in South Africa. The first three chapters of this dissertation offered an introduction to the problem surrounding the near-absence of practical guidance and experience delivering long-term medical care for NCD patients within resource-limited health systems, a review of the literature, and the methodological design that was utilized for this study. This chapter and the next two present the findings that emerged from the data collected and analyzed using the "Yamey Framework" introduced in the previous chapter and adopted to guide the study. This chapter, in particular, concerns the challenges encountered within the primary health care (PHC) facilities of the Western Cape Province in the care of hypertensive patients, from the perspective of health care professionals (HCP). Strategies, proposed solutions and recommendations by HCP to address these challenges are also highlighted.

A cross-sectional analysis of data collected through documents, observations and semi-structured interviews of various HCP in both rural and urban PHC facilities was conducted to extract the findings presented here. Names of PHC facilities, health districts and HCP

participants were codified to ensure that all participants' identities were kept private. The reference for each quotation includes the code for the type or position of HCP, the PHC facility (numbered 1 to 9), and the setting either rural or urban. An example would be (PHAR, PHC 2, rural), with "PHAR" as the type of HCP for pharmacist or pharmacist assistant. The different types of HCP interviewed are detailed in the next paragraph. All findings presented served to answer the following specific research question for this study:

RQ1: What are the challenges of the South African primary health care system, particularly of the Western Cape region, in the care of hypertensive patients?

Characteristics of respondents

The findings in this chapter present the view of a sample of HCP involved on a daily basis in the care of hypertensive patients within their respective PHC facilities. Professionally, they include operational manager (MGR), administration staff at the reception (ADM), enrolled nurse assistant or enrolled nurse (ENA), clinical nurse practitioner (CNP), medical officer or doctor (MDO) and pharmacist or pharmacist assistants or dispensing nurse (PHAR). These are the main cadres that directly interact with hypertensive patients and are in charge of the management of their care. All the respondents had been in service in the facility for more than 3 months and were able to describe the procedures in place for the care of hypertensive patients within their PHC facility. In interviews it was clear that each facility had established its own processes as they all reflected the same process per facility. Table 2 below presents a summary of the sample and characteristics of the respondents. More detailed characteristics of the respondents are presented in Appendix 1.

Various challenges were identified and conceptualized in five dimensions which are:

- Management of the visit within the PHC facility
- Adequacy of human resources
- Standardization of patients' care
- Infrastructure limitations
- Patients' responsibilities

Mitigating strategies, best practices and recommendations to overcome these challenges are highlighted here followed by a brief discussion and conclusion.

Table 2 - Characteristics of Respondents (N=54)

Health Care Provider	**Rural**	**Urban**	**Overall**
ADM – Clerk reception	4	5	9
ENA – Enrolled nurse / Enrolled nurse assistant	4	6	10
CNP – Clinical nurse practitioner	4	5	9
MDO – Medical officer / Doctor	3	5	8
PHAR – Pharmacist / Pharmacist assistant	4	5	9
MGR – Operational manager	4	5	9
Sex & Age			
Female - Count	19	20	39
Female - Percentage	83%	65%	72%
Male - Count	4	11	15
Male - Percentage	17%	35%	28%
Age - Range	26 - 60	27 - 59	26 - 60
Age - Median	46	41	46
Experience			
Number of years working at the facility - **Range**	<1 - 30	<1 - 35	<1 - 35
Number of years working at the facility - **Median**	6	4	5
Number of years working in the health profession - **Range**	<1 - 40	2 - 35	<1 - 40
Number of years working in the health profession - **Median**	26	15	17

Management of the visit within the PHC facility

Management of patient visits at the PHC facility faces numerous challenges, mainly waiting time, high volumes of patients above facility capacity and sometimes ' "doctor philia" attitudes among patients. The "doctor philia" attitude is described by respondents as the tendency of patients to always want to be seen by a medical doctor even when the clinical nurse practitioner can conveniently attend to their needs. Waiting time has been identified as one of the major challenges both in rural and urban PHC facilities. Hypertensive patients (sometimes referred to as chronic disease patients throughout this dissertation) usually follow a predetermined pathway within the PHC facility during their visits. They enter the PHC facility through the reception to the preparation room where their vitals are measured, then they are consulted either by the clinical nurse practitioner and /or the medical officer, they then finish at the pharmacy; collecting their medication and exiting the facility. At each station there are a set of checks and tests that have to be performed depending on the condition of the patient as illustrated on the image below.

Figure 7: Checks and Test for Diabetes and Hypertension

Although there are some variations of this pathway depending on the facility, it is standard that patients always complete their visit at the pharmacy to collect their medications. Hypertensive patients have their visit every 6 months on average when they are stable and every one to two months when they are not stable. They represent only one type of patient that visits these PHC facilities and resources are shared between all outpatients seeking care at the facility. Sometimes hypertensive patients spend the entire day going through their assigned pathway within the facility and have to miss their work for all or part of the day. A few respondents indicated this was a major challenge:

> *"I think it's just waiting time and if a patient's expectations are not met on the day they become angry and they do complain, that is the only thing."* **(MGR, PHC 3, urban)**

> *"That is our main issue because our patients wait too long to be sorted, that's our main issue here."* **(CNP, PHC 7, rural)**

Some patients decide to leave the facility without completing their visit and come back another day without an appointment creating even more pressure on the system, as explained below:

> *"Okay, so what the patients tend to do is they will sit and wait and then they will just leave, okay. Because they've been sitting long. And then the next day they will just come and tell you I missed my appointment please give me a new date. So that is, ja."* **(CNP, PHC 5, urban)**

The sources of delays are inherent to the procedures in place at each station within the clinic but the reception department and the pharmacy are usually pointed out as the stations where delays are particularly bad:

> *"In the facility they were complaining about the waiting time in the chemist* (pharmacy)*."* **(CNP, PHC 8, rural)**

> *"You know where the wait is, not at the doctors' side, at the pharmacy side. We just spoke about it in the meeting yesterday that I am not happy with the waiting time at the pharmacy. The last waiting times survey that they have done on folders [at the pharmacy] was 70 minutes, the patient waited 70 minutes."* **(MGR, PHC 3, urban)**

> *"So most of the time when they are waiting at reception is not because reception is too busy, it is because they cannot find the file."* **(CNP, PHC 7, rural)**

The pharmacy department as the last service point gets even more blame because patients by the time they arrive there to collect their medicines have already spent many hours within the facility and they become impatient with the pharmacy staff:

> *"The patient is most angered with the last service point. So they're angry with pharmacy, not realizing they were here 05h00 this morning waiting eight hours or six hours to see a doctor, the last 45 minutes he blows his top."* **(PHAR, PHC 3, urban)**

There are various strategies put in place to facilitate the flow of chronic patients within PHC facilities, such as club systems, but unfortunately these are not pushing the patients through as fast as intended. Club systems are specifically designed to deal with large numbers of patients, such as chronic patients, and resources are allocated so that their time within the facility the day of their visit is shortened. Most of the time only patients that are stable and compliant with their treatment are admitted to these clubs. The idea is that chronic patients who are on treatment for the rest of their life should not suffer further loss by spending their entire day at the facility. Respondents have indicated that these strategies fall short because not all of the departments buy into the concept, resulting in patients moving fast through the various stations only to reach the pharmacy where they have to wait for a long time alongside other patients in the facility. Pharmacies usually do not have dedicated lines for chronic or club patients:

> *"Because not all the department buy into this club thing. Because it's at pharma you do all that you go quickly and then you have to wait like everybody at pharmacy there."* **(CNP, PHC 5, urban)**

Another issue identified by HCP is that there are too many patients and facilities are overcrowded, thus overloading providers and affecting the quality of care. Good management of chronic conditions requires that providers take the necessary time to educate patients on their condition and the change of lifestyle that must complement the medicines that they receive.

Unfortunately, the huge volume of patients usually prevent HCP from giving the optimum care to these patients as explained below:

> *"There's too many people and too few clinicians. There's too many patients, way too many."* **(CNP, PHC 5, urban)**

> *"Ja, but then we are pressed for time to at least render a service to everybody and then it compromises the time that I spend with you."* **(MGR, PHC 3, urban)**

> *"Sometimes we are overloaded, and we don't give everybody 100% quality care, because sometimes when you're chasing numbers, your quality sometimes fall by the wayside."* **(PHAR, PHC 4, urban)**

The absence of validated procedures designed to cope with high volumes is identified as another important concern:

> *"People were unhappy at work which then obviously translated to poorer care. I don't think that there are too many patients for us to cope with. I just think that there's a system that needs to be in place for us to deal with the patients that we have here."* **(MDO, PHC 1, urban)**

Finally, the attitude of some patients can undermine efforts to improve the management of the patients' visits. For example, some patients do not necessarily need to see a doctor at some visits, but they don't like it and may insist on seeing a doctor. They have the perception that only the doctor has the ability to deal with their condition. The "patients' doctor philia" has been identified as a real obstacle to improve service and speed up processing:

> *"You can ask the triage nurses and the CNPs [but] the patients want to see the doctor. I don't know why, but they want to see the doctor. So if the patient can understand that the same thing that the doctor is doing can be done by somebody else, then it will make a huge difference. … But most of the patients … they feel more comfortable with the doctors."* **(MDO, PHC 5, urban)**

> *"People are very reluctant to move to the club, the patients, I mean, because they want to see the doctor every six months, and a lot of them are quite stable, they're quite fine, and they sort of save their complaints for the doctor's visit which is, you know, not ideal."***(MDO, PHC 3, urban)**

Effective management of patients' visits requires that patients spend the least amount of time within the facility while still receiving quality care. The challenges illustrated above highlight some of the barriers to such management from the view of providers.

Adequacy of human resources

Staff related issues were identified in all the PHC facilities that were visited and were expressed in various forms, from a basic shortage of staff in general to a high turnover rate. Respondents explained that with the volume of patients visiting the PHC facilities on a daily basis, there is not enough staff to provide services in a timely manner:

> *"So actually the main challenge is the shortage of staff."* **(ENA, PHC 5, urban)**

> "*The challenges that we have now is the shortages of staff and sometimes you know we, you know we can't just take someone and put the person on employment. So we have to go with procedures..."* **(ADM, PHC 2, urban)**

The reception is the common point of entrance for all patients visiting the facilities and the previous section reported that long waiting at the reception was usually due to difficulties locating patients' folders, and is attributed to the lack of adequate level of staffing in this department. Some facilities only have doctors on a part-time basis, sometimes just a few days a week or even half days only. The same situation exists with the pharmacy department, where in some rural PHC facilities there is no permanent pharmacist assigned, just an assistant or a nurse who dispenses the medicines. This creates a conflict with the Pharmacy Council which requires that a pharmacist must be the one dispensing the medicines to patients, particularly for new prescriptions. Doctors and pharmacists seem to be the professionals that are usually in least supply:

> *"…you qualify for a fulltime pharmacist by having a fulltime doctor. So the doctor says, okay fine, I'm here the whole day, I'm writing scripts the whole day, so you're going to need a pharmacist the whole day, right. But now because we only have a part time doctor or half day, they won't give us a fulltime pharmacist. And without a fulltime pharmacist we can't have a learner here."* **(PHAR, PHC 9, rural)**

Facilities usually manage to find a way to get going with the staff assigned to them by implementing procedures that fit with their staffing levels. The reality is that HCP get sick as well or sometimes for various reasons have to be absent from work. Whatever the reason for the absence, the facility has to cope with such disruptions; there is no viable staff replacement system that the PHC facilities can rely on in these situations. This is a major source of concern identified by some respondents:

> *"I don't know about the staffing. I do know people are leaving and they are not being replaced. When you enquire they will tell you the posts are frozen or this or that and there will always be. And then of course staff is also off sick a lot. Okay, that's the other problem. Ja, there is staff but they are not there."* **(CNP, PHC 5, urban)**

> *"Because we are human, we get sick, we go on leave and, and, and that makes it very – how do I call it – difficult to at one point – given point in time, that everybody will be on duty, then things run smooth. But then it comes to staff going on leave, we can't get it – a replacement in, we have to shift within the facility to cover at least – basically cover the areas."* **(MGR, PHC 9, rural)**

It was common among the PHC facilities visited that whatever the internal constraints experienced were, the interest of the patient was always the priority and, as such, no patient was turned away. This put a lot of pressure on the staff in return for which they expressed a desire for better working conditions. Some noted how some of their most time -consuming tasks could be shortened by using new technologies:

> *"Script writing, ja, because I don't think you can take away the responsibility of assessing the patient … but the medication perhaps, you know … whether we all get like touch screen on our desks or something, and we can just quickly select what we need to give the patient, even that is an option, because that will cut down the time … that for me is the main issue."* **(MDO, PHC 3, urban)**

The complexity of the care provided to hypertensive patients requires that there is good communication between the various departments involved. When this communication is poor, this can be a source of tension between departments, preventing them from operating at their full potential:

> *"Inside the clinic I think that, I think that more cooperation between the different elements of the, of the facility where we work because I think that there's not always a very good communication between the reception and the nurses and the doctors and the, you know, the admin staff. And when there's bad communication then your systems don't work well."* **(MDO, PHC 4, rural)**

> *"So different departments work here, fighting against each other. Not really fighting, but not cooperating, you know. Pharmacy is like an island on their own here. Everybody else is like, pharmacy, pharmacy, because all the department one way or the other they have something to do with pharmacy."* **(PHAR, PHC 5, urban)**

A good illustration of this poor communication is the fragile appointment booking system that was described in various PHC facilities, where booked appointments are usually above the capacity of the facility. This creates unnecessary pressure on the already insufficient human resources available:

> *"And then also our booking system is not good. They tend to overbook patients because sometimes they give handwritten appointments to some patients because they're not on the computer system because the computers weren't working."* **(MDO, PHC 4, rural)**

> *"The issue with the pharmacy is that they will book them on a day from the pharmacy side but they might be full at the reception and then they're given a week's late booking which means that they don't have medication for a week. So that's how that problem translates here."* **(MDO, PHC 1, urban)**

The complex interactions between departments and staff sometimes create frustrations among the staff who can get emotional and this can affect their productivity:

> *"Our main problem is our tempers that can fly around the building. Tempers! We easily get.., everybody gets uptight."* **(CNP, PHC 1, urban)**

> *"So there's no congruency between the various units. We can't have […] one shoe fit all. It's impossible. But we had that process in place, one shoe fitting everybody, but the*

> *workloads have different dynamics. And there's no sensitivity to that. So it makes you demoralized at the end of the day."* **(PHAR, PHC 3, urban)**

Finally, another major concern identified is that most providers arrive to these PHC facilities very motivated but the heavy burden of work, the poor working conditions and other factors lead to a high turnover rate of staff, particularly of doctors who are usually overworked:

> *"It seems that before I got here, they didn't have a doctor here for more than, I think, eight months at a time. So it's a high turnover for various reasons but I think that is definitely a weakness. It doesn't seem that anyone has sat down and tried to commit to trying to make the place better. So that's a huge weakness, which is why it seems at the moment there's no real systems in place. Everything is a little bit messy."* **(MDO, PHC 1, urban)**

> *"We can't if it's, if it's 16:30 in this – but the people are still sitting in the waiting room, especially the sick people. We can't leave them and take our bags and go home. We will get in big trouble. But we don't get overtime paid and we don't get our hours back."* **(MGR, PHC 9, rural)**

Overall, the challenges with the adequacy of human resources go beyond the shortage of certain staff and include the way human resources are organized to provide the best possible care for the patients. In providing such care, respondents have expressed concerns about their standardization to ensure that all patients can be followed according to the same standards across the various PHC facilities.

Standardization of patients' care

Respondents have already highlighted that PHC facilities are overcrowded with hypertensive and other chronic patients and that there is generally a high turnover rate of certain staff. Patients also migrate within and across provinces regularly for different reasons, sometimes because of job opportunities or family matters. The standardization of care becomes very important to ensure that patients get the best possible outcome across facilities. There are

standard treatment guidelines in place but their implementation on the field is not always the same.

Hypertensive patients who have to consult with the clinician once every six months see various providers from one visit to another. When there are significant differences in the way the various clinicians handle the patients, it confuses them and sometimes they start doubting the system. Providers' inconsistency in treatment practices has been pointed out as a challenge:

> *"Or they will have a blood pressure of 220/120 [considered high blood pressure as per guidelines] and the doctor will write "stable refer club" and nothing is being done. That is what we are seeing a lot."* **(CNP, PHC 5, urban)**

> *"I always laugh when you refer a patient from, you know, when I do my overtime and I call the hospital and I say I want to refer patient to them and they perhaps give you hard time over the phone. If I were on the receiving end of the phone call, I would respect the fact that my colleague has now assessed the patient, feels that there is nothing more they could do and just simply accept the patient, instead of giving a hard time."* **(MDO, PHC 3, urban)**

In an effort to unclog the PHC facilities, innovative systems have been implemented, keeping stable chronic patients out of the facilities by reducing their visits to about two per year (every six months for hypertensive patients). Stable hypertensive patients are those who have their blood pressure controlled over time under a threshold as per guidelines and comply with their treatment schedule. Hypertensive patients who are on medication receive usually a one or two months' supply of medicines. In between their six month consultations they still need to collect their medicines every month or two, and this considerably increases the number of visitors to the PHC facilities on a regular basis. An innovative solution has been to set up in alternative sites within the community whereby stable patients go on specific days to collect their medicines package, that is pre-packed by the Chronic Dispensing Unit (CDU), a third party contracted by the provincial Department of Health. While this approach helps to unclog the facilities, it brings another concern which is the poor monitoring of blood pressure and other

indicators for hypertensive patients. Even though these patients are considered stable, checking their blood pressure and related indicators only a couple of times a year when they come for their six month visit has been identified by some respondents as a serious concern. There are fewer opportunities to check the patient's blood pressure and other vitals knowing that at these alternative CDU sites patients may send someone else to collect their medicines. The overall monitoring of patients is then quite poor:

> *"…if they send someone we don't see how is their blood pressure and they've got the opportunity, as they said to them, they don't have to come every time themselves, they can send someone."* **(MGR, PHC 7, rural)**

HCP strive to provide the best possible care to the largest number of patients they receive. They are well trained to provide these services and each PHC facility constantly re-visits their procedures to ensure that the patients' experience is improved while also caring for the well-being of their staff. HCPs have to rely on the physical and technical infrastructure to provide their services to patients, and shortcomings in this infrastructure represents another challenge in providing care.

Infrastructure limitations

Infrastructure limitations have been reported in terms of both space and technology. Public services in general are high traffic places where rules to handle high volumes are different depending on the sensitivity of the sector. The public health sector is one that sees large volumes of patients coming in and out on a daily basis, particularly at the primary health care level, which is the first point of contact with the health care system. PHC facilities receive all kinds of patients before referring them to higher level care when necessary. As such, the platform of

services offered at these facilities is sometimes very extensive. Besides chronic units in the facilities, it is common to see other units such as general outpatient (OPD) where walk-in patients are processed, trauma, emergency, maternal and obstetric (MOU), reception, psychiatric, family planning, and pharmacy to just name a few. In an effort to provide a comprehensive service at these PHC facilities, more services are added year after year with appropriate personnel but the space becomes an issue of concern. Staff need appropriate space to provide quality and confidential care. Facilities were built usually for a certain need and when more services are added, the space can become inadequate:

> *"We don't have it because we do not have space for it. We are extremely oversaturated. Because once when the clinic was built, three-quarters of the services that we are rendering now were not even in the pipeline."* **(MGR, PHC 1, urban)**

> *"The clinic is too small, it's very – but I – as I say so, the people didn't think 20 years [ahead]."* **(MGR, PHC 9, rural)**

The reception unit is one of the most strategic areas of the PHC facility as all patients start their journey there. Any issue at that level that creates delays for various reasons has consequences on all other units and the journey of the patient within the facility is therefore affected. One major reason for delays in processing patients at the reception is the time it takes to locate a patient's folder. Besides the lack of adequate staffing level at the reception creating filing problems, another reason for inappropriate filing is lack of space:

> *"… the reception area is very small now, is very small and always very congested. I don't know if you went there."* **(ADM, PHC 2, urban)**

> *"Yes, it is. They don't have the space, they don't have the space, they don't have the filing space, they complain and complain but nothing is changing, nothing is happening."* **(MGR, PHC 4, urban)**

The lack of space within the facilities also creates difficult conditions for patients who sometimes have to stand up for many hours, sometimes even preventing them from being able to wait within the facility:

> *"And a bigger clinic, I think, because some of the patients have to stand outside, because there's no space."* **(ENA, PHC 7, rural)**

In some cases, beside the lack of space, the floor plan of the facility itself has been considered a limitation to the smooth flow of patients within the facility. This is usually the case for older facilities that were not built to provide the range of services provided today and rehabilitation efforts are still very limited:

> *"The problem is our clinic is old; it was built in 1965, when I was born. … our reception, the entrance, used to be in front but now you will ask me what kind of clinic [is this], because when I come in I was expecting to see the reception but when you come this side you can't see the reception. The front place was on that side when they built it [but]…they just built some few halls like this one so the space is not really [adapted] for this [patient] population."* **(MGR, PHC 4, urban)**

The impact of the limitations with the physical infrastructures is worsened by the lack of technologies that could facilitate the work of HCP. Computer systems are great tools to organize information, communicate between units and analyze data within organizations. Actual computer hardware is needed as well as computer software or applications and networking tools to build these computer systems for specific organizations. In addition, Facilities that have their computer system installed must be able to maintain it otherwise the systems fail and clinics revert to manual processes. With computer systems up and running, processes speed up, reducing waiting times for the patients. These computer systems are locally based and also provincially based, ensuring the interconnection between facilities and other services. When facilities lack the computer hardware to access the system or there is no internet to connect to provincial systems, it slows down the flow of patients considerably:

> *"That's another slow down. Because even the blood results they take time to be filed. That is another thing which can be speeded up by having a computer on site. Otherwise I have to pick up that phone and phone for results. It takes time and sometimes there's nobody on the other end."* **(MDO, PHC 2, urban)**

> *"Sometimes, we have a problem to get into the lab and in the old days it was nice just to phone them, but they don't have that much staff just, you know, to get all the incoming. So we have to go onto the computer and sometimes we don't have internet here. So, ja that is, it's like computers everywhere. If they work, they're good, if they don't work it's a problem."* **(MDO, PHC 6, rural)**

The capacity of the network is as essential as the computer desk to access the system. Internet connections required to access these systems are sometimes weak or just not working. When that happens, providers have to go back to their manual procedures. Respondents have explained that weak networking capacities are preventing them sometimes from accessing the systems and providing the services they are set up for.

> *"And the other hampering issue would be the fact that I don't think our network will be able to handle all the PCs and the work that we would - we are sort of proposing that we should do, because even me going on the lab system, check blood results, slows down the whole network, which slows down JAC, [pharmacy dispensing and inventory control computer system], which means pharmacy can't do their job fast enough."* **(MDO, PHC 3, urban)**

In all of the facilities visited, the general view was that computer systems can help to speed up the processing of patients in various ways. Renewing the scripts is one of the common tasks performed by clinicians when they assess chronic patients at their regular visit. After determining if the patient must simply continue on the same set of medicines or a different set, clinicians have to fill out the prescription on a specific form, which requires a lot of details. Appendix 2 presents the template used to write the prescriptions manually that are referred to the CDU, with the entire field that must be completed. On average, every six months for stable hypertensive patients, these redundant tasks have to be completed taking a considerable portion of the time that the clinician spends with the patient. This time could be used alternatively, for

example, in more education of the patient. At the pharmacy, when the provincially approved system is set up, it will allow pharmacy staff to automatically have access to the medication history of the patients, which will be very helpful when dispensing prescriptions. Unfortunately most facilities have complained about not having computer access at all or when they have it, either there are not enough computers for everyone who need to use them or they are not working properly for various reasons:

> *"Definitely, ja. I think that, I think that simply just having access to a computer in your, in your room where you don't have to physically get up and leave your room – which is also just on a, not even a time issue but just for the poor patient that's sitting there and you getting up and leave there, abandon them, it's not a very good condition – I mean not a very good experience for the patient."* **(MDO, PHC 4, urban)**

Patients' responsibilities

The successful implementation of the best possible policies (assuming those identified above were corrected) is still dependent on the patients' adherence to their hypertension management program. It is important to note that the views presented here are solely from the perspective of the providers in the context of their already challenging work environment, as patients were not interviewed. Respondents in all facilities raised concerns about the responsibilities of the patients themselves when it comes to managing their hypertension. This section focuses mainly on issues related to poor patient compliance to treatment schedule, adherence to medications, awareness on their condition and discipline. Hypertensive patients in most cases will carry their condition for the rest of their life as it can rarely be totally reversed. The goal in caring for these patients is to manage and control the condition within acceptable limits which prevents further complications and helps patients to maintain a decent quality of life

while managing their condition. Whatever efforts are made by the HCP to ensure the best possible care for the patients, the ultimate outcomes are highly dependent on the patients' attitudes and abilities to follow the instructions given to them by their providers.

Respondents in most of the PHC facilities visited indicated that the patients themselves often undermined most of their efforts, as they were not fully compliant with their treatment schedule. Patients won't show up on their visit date and time but will come in another day without appointment. This not only prevents them from controlling their blood pressure but also adds an extra burden to the staff, as they have to operate above the capacities of the facilities. Turning patients away, as is usually the case in other public administrations, is not an option in health care, and the providers must cope with such disruption of their planning on a daily basis:

> *"Some come later and some come un-booked. You cannot say go out. Sometimes we get big numbers of un-booked. Because some of our patients live in the Eastern Cape or they travel to and from. That is their home."* **(MDO, PHC 2, urban)**

> *"Because that is something we are quite struggling sometimes with, is the compliance of the patients. If they have a problem, in the Eastern Cape they just get on the bus and there they go. They forgot about blood pressure tablets, whatever, and they just go. And then they come back in two or three months' time and then their blood pressure is still high again. Now we have to start the whole route again."* **(MGR, PHC 6, rural)**

The non-compliance of patients to their treatment schedules leads to important waste of resources within facilities. Patients develop complications and their care becomes more difficult. Providers who go the extra mile to care for these patients also feel demotivated and useless as reported by some respondents:

> *"So putting systems in place, like shout out the names before we start dispensing. At the end of the day there's about 10 to 15 folders of people that didn't pitch up [show up] for their medicine. So if you take that for 7, 10 minutes on a prescription, ja it's quite time consuming to dispense medicine for patients that is not disciplined to [use it]."* **(PHAR, PHC 8, rural)**

> *"…But I think if they can only keep their appointments because we are doing that for them. We go home late [because] they don't keep their appointments. It's the only thing that can make us happy is for them to keep their appointments..."* **(ADM, PHC 3, urban)**

> *"But we had a problem because maybe you draw plus-minus 10 07h00 appointments. Only three pitches [show] up. So then we said no this is a waste because we go home late [as folders are drawn the day before in the evening] and then those patients they don't pitch up [show up]."* **(ADM, PHC 4, urban)**

Patients are advised to take a number of measures to implement life style changes in an effort to help manage their condition. Hypertensive patients that are overweight present higher risks of complications. Clinicians explain to these patients the importance to reduce their weight but it was reported that an important portion of these patients have uncontrolled weight:

> *"Okay, the patient's weight. You have noticed that weight is a big problem in South Africa. It's difficult to get somebody to be compliant if they are not doing something from their side. I mean, you know how many hypertensives would disappear if they just lose weight. So, ja, weight is a problem."* **(MGR, PHC 1, urban)**

Patients are also asked to do more physical activities and follow specific diets compatible with their condition. Respondents have pointed out that many hypertensive patients that are not controlled do not implement these life style changes of the health-benefits in doing so:

> *"No, they do understand it very well; they do understand the health talks. You know what the other staff nurse that is retired she also use to work in the club. She said to them "You know you are not supposed to eat it even if you go to Kentucky [fried chicken]". And they said: "why you must not eat the skin if you go to Kentucky? That is what we are there for we are there for that skin.""* **(MGR, PHC 4, urban)**

> *"You know, you can see that they understand, our people do understand because after they eat they will tell you that they go for these ritual things maybe parties; these African parties of ours, like where they do these African beer, they will eat meat and then they will say "ooooh how is my blood pressure because yesterday I ate and the meat was just like this." So you will find out that they know, but it is just that they are ignoring that."* **(MGR, PHC 6, rural)**

It has been largely reported that adherence to medications is a major concern, although ways to verify if the patients adhere to their medications are very limited. Sometimes clinicians

find it hard to believe the patients who claim that they are actually taking their medicines when there are clear signs indicating the contrary. Issues of trust then arise between the clinicians and the patients.

> *"Then, the older people, some of them stay alone and they get confused. Have I had my tablets yet or not yet. So either they duplicate or they skip because there's not somebody that can tell them, no ma, you've already took your tablets, don't do it…but in fact they're not adhering or some patients choose to omit a certain drug because they feel that it's giving them side effects and they don't advise the prescriber that this is what's been going on. And … they're not stable and then you find that the reason for the instability is that they're not taking their medication."* **(PHAR, PHC 2, urban)**

Respondents also shared the view that poor patients' awareness and education on their condition coupled with poor literacy might be a significant contributing factors in their non-compliant behaviors. Some patients clearly don't understand the condition they are diagnosed with, particularly a condition such as hypertension, which is sometimes asymptomatic until complications arise:

> *"My personal experience is that the vast majority of patients don't actually know why they're taking treatment. And because they don't know why they're taking the treatment there isn't much personal buy-in from the person, from the client. You know, they are – they're doing it because they've been told to do it and often that's the reason they give, that the sister [nurse] said I must take my tablets, you know."* **(MDO, PHC 4, urban)**

> *"… if they're well-informed they will probably be more compliant and then they don't have to come to the clinic as much… I think if the patients are well-informed, and they understand their disease and they know how to take their tablets every day, I think then the chronic problem would be much better."* **(MDO, PHC 8, rural)**

Stable hypertensive patients with controlled blood pressure, as noted, often pick up their medicines at a CDU or have relatives do so. There is not always a pharmacist at a CDU to explain the medications or how to take them, and some patients get confused, as they may have medications for multiple conditions and some tablets look very similar. Also, every few years, the South Africa Government changes the tender for who supplies the medicines and sometimes

the same drug is supplied in a different color by the new supplier, which confuses the patients even more:

> *"They get this packet of tablets and the pharmacists don't have time to look through it and explain to them what is what and no one in the clinic. So it would be nice if there's somebody, you know, they open their bags and somebody will tell them but this is this, because sometimes they get three months, or two months of treatment, but the tablets are not the same that the ones they're used to."* **(MDO, PHC 6, rural)**

The complexity of the interactions between patients and various HCP providing their care can sometimes create frustrations on both sides. While HCP do their best to remain calm and professional, it happens that patients lose it and express their frustration by being rude to the staff. This can affect providers' own stress levels:

> *"They don't go there and complain, they make a noise here. They are down my throat constantly. So, that's really working on my nerves because why, there's nothing I can do."* **(ENA, PHC 1, urban)**

Such attitudes may also have to do with the overall mindset of patients when they walk into a public health care facility. Some respondents felt that patients are just not 'patient' enough as they are when they request services from other public administration offices, and they don't make enough effort to seek the right information about their condition like they do, for example, when they need to get their pension. This attitude might be fueled by top management at the political level who convey to patients that they have extensive rights within the health care system but no one at that level ever talks about patients' responsibilities towards the system that is caring for them. A respondent elaborated extensively on these issues:

> *"Why is there, and Government cannot also understand, this is my understanding now, why is it that a patient or a client, if there is a somewhat of an understanding needed to get your pension next month, that there's certain forms that you need to fill out and certain procedures you need to carry out? Within an hour everybody knows exactly what to do with regards to the SASSA offices which is Social Services, and the pension offices. They know exactly. Come to a day hospital, they cannot understand a simple queuing system. So you know people cannot be selective in their understanding of certain situations, but we entertain it… As management and senior management and directors*

> *and governors and, you, ministers, we entertain that patient and we say, "Yes patient, you have all the rights in the world". And we change our whole healthcare system around and we hurt the healthcare system in that way."* **(PHAR, PHC 3, urban)**

Patients' responsibility is the last dimension of challenges assessed as part of this study, the other four being management of the visit within the PHC facility, adequacy of human resources, standardization of patients' care, and infrastructure limitations. Beyond expressing their concerns by describing all these challenges presented here, respondents also suggested potential solutions to improve the care provided to the patients in an attempt to mitigate those challenges. Some best practices in some facilities that can help in other facilities have also been reported.

Potential solutions and some best practices

The Yamey Framework that has guided our approach to study the research question draws upon insights from interviews with scale-up "leaders," many of whom have led national or global health implementation programs. In line with this framework, HCPs providers are identified as the implementers of strategies or interventions geared towards management of the epidemic of hypertension in PHC facilities. They are at the forefront of the operations and are experiencing the numerous challenges encountered themselves. Hence it makes sense to learn from them about the potential solutions that can be implemented to overcome most of those challenges. In all the PHC facilities visited, HCP showed very positive attitudes despite the reported challenges and suggested various solutions. As the interests of the patients remained at the heart of most HCP concerns, suggested solutions have been grouped under the five dimensions of challenges presented previously.

About the management of patient visits:

Respondents suggested that more strict rules for the processing of walk-in patients and continuous monitoring of patient flow throughout the day will contribute to lessening waiting time. One measure would be to systematically regulate walk in patients by triaging them and deferring mild cases to the following days with booked appointments but only attending confirmed emergencies. In other words, transforming every non-appointment into an appointment or emergency:

> *"No. They have to be triaged. Triaged and emergencies can be seen and the one that are cold cases can be deferred to the following day."* **(ADM, PHC 4, urban)**

Complementary measures would be to rotate CNP as floor manager to monitor the flow throughout the day and address any issue, control patient intake, and improve patient flow and discipline by allowing ENA at preparation rooms to assign patients either to doctor or to CNP based on experience:

> *"Because it's all about time and I think that's what it comes down to, management of your time, ... I forgot to mention that CNPs [can] also rotate being flow managers. So they are constantly watching the flow, because we would ideally like no more patients to go to pharmacy after half past three, to enable us to close at four, otherwise everybody is frustrated, they leave late…."* **(MDO, PHC 3, urban)**

> *"...I more or less know what the doctors see, what the CNPs will be able to see, but if ... they can't manage it, they can just give the folder. So, I said, okay, I'm going to take a cubicle for each of them, for the doctor, and for ... the three CNPs. What I think doctor will be able to see, I put it there in his cubicle and then in the other three, and when I'm done with all the patients, I take all those folders, okay, here's doc's and the three CNPs, which means there are no folders left here in my room, so nobody can fiddle in the folders and there won't be any problems, and nobody will complain by me about the waiting period and whatsoever."* **(ENA, PHC 1, urban)**

Management should limit patients per day to reasonable numbers based on human resources available at the facility to allow quality time for proper care:

> *"Lots and lots and lots, because it's almost like you see one patient, and then you have to rush, rush, rush. You can't have that ... quality time with the patient ... telling the patient*

> *you must eat this [or] that … [because] you have to go fast, because there's still a lot of other patients waiting."* **(ENA, PHC 7, rural)**

Respondents suggested that investigations being conducted at PHC facilities by scanning patients' folders at each sub-station within the facility would allow staff to trace their paths within the clinic and study various waiting times:

> *"I think we need more… high tech like interventions, like … when a patient comes into the waiting area, his folder must be scanned in, so when he leaves it must be scanned out, then we can say this patient waited too long, then we can look at the reasons why he waited so long. So we need to have more access to IT … and use it properly, so we can try and improve the systems here."* **(PHAR, PHC 4, urban)**

Club systems might be the best solution for hypertensive patients because group talks save a lot of time. Otherwise the same talks are repeated to each patient individually, taking up precious recourses. Club systems provide an opportunity to offer standard care to patients using adequate and assigned human resources, making the most out of the available infrastructure and the time spent with the patient for more education.

> *"I think what will help, specifically with chronic patients would be the formation of clubs. We don't have clubs here but I think clubs would definitely be the right way to go, simply because that patient now is going to get individual care and when we're talking about hypertension we're talking about hypertension… With a club you can get an improvement in speed because then they are going to be coming to the club and at that point in time and you could be seeing 50 or 60 patients at one single setting, sitting and talking together like that and there isn't that much of a loss in quality because they can ask questions at that point. You're giving the new, renew their new prescriptions or see their prescriptions at that point as well, so I think that clubs are definitely the way, the next step forward for us."* **(PHAR, PHC 1, urban)**

Some clinicians have suggested comprehensive care for chronic patients at one single place within the facility as the more stations the patients have to go through the more queues they encounter. Comprehensive care at one place will cut down on the number of queues for the patients; hence reducing overall time spent in the facility. This will require robust and working computer systems that will be used to access lab results, write prescriptions and manage

appointment booking in a more efficient way as well as dedicated CNP and MDO assigned to attend chronic patients first before other out patients:

> *"… Last year we were planning we were thinking of getting involved, and how about the chronic club having their own team where everything is going to be done here? We see the patient and if they need to take blood we take blood. If we have a registered nurse let's say next door, take blood here then from here we know that the patient goes straight to the pharmacy. At least that will be two queues, this one for the club and the pharmacy. … If everything could be done in one place, everything, one place, not going from post to pillar before they go home."* **(CNP, PHC 2, urban)**

> *"… if I have to phone for results let's say of the 40 patients I see, if I phone for five, it's usually about a four, five minute wait. So that's a half hour, its three patients that I haven't been able to see because I've been waiting for results. Absolutely, it [computer system] will helps and if we could somehow engage with the reception system [computer system at reception for appointments] as well it would also be very helpful in terms of communication."* **(MDO, PHC 1, urban)**

About human resources:

Staff shortages in health care systems is a common problem that cannot be easily resolved but a way forward suggested by respondents would be a more equitable distribution of clinicians between facilities.

> *"Okay the main thing that could improve the service is if we have another doctor. … that is a main issue, another doctor … because in the past we had two doctors and it worked quite well. Especially when it comes to emergency cases the one doctor can carry on and the other one can stay on the floor."* **(ADM, PHC 1, urban)**

> *"We need more staff, that's the only improvement I think we can do. Yes I think that's all."* **(ADM, PHC 9, rural)**

The other important issue if the fact that when some staff members are absent for various family or health reasons, it seriously impact the performance of the primary health care facility as some HCP then have to cover two positions at the same time. A system to easily replace staff members that are absent will definitely help to mitigate such issues.

About infrastructures:

Accelerated introduction of computer systems and software applications in the day-to-day activities at PHC facilities was considered an important solution to improve the care provided to patients. It is believed that this will inspire faster booking of appointments and referrals, faster access to lab results, reduced time to re-board scripts, and ready access to patients' medication history at the pharmacy when filling prescriptions. Mobile phone technologies were also recommended to communicate with patients about their blood results and for requests to come in when results require immediate interventions:

> *"So, unfortunately we don't [have computer systems] which is a massive issue when it comes to getting blood results and of course [at] the pharmacy, it is a huge problem …, because they have no record of their previous medications. So they are, as far as I know, in the process of getting that sorted out. And also reception has their own computer systems for the patient bookings and stuff like that. But unfortunately there's nothing for myself [doctor] or the nurses."* **(MDO, PHC 1, rural)**

> *"Although we don't have telephonic communication with our patients, but the majority have got cell phones. … If I see blood results which are wrong, they say potassium is low, I want that patient to come. So it's better if I send an SMS which I can do."* **(MDO, PHC 2, urban)**

A best practice reported that can be replicated as an intermediate solution, until full computer systems are set up and working, is the use of excel macros already developed to write and renew scripts in a semi-automatic manner.

About standardization of care:

The implementation of a robust staff development mechanism has being suggested as a way to ensure the standardization of care within and across PHC facilities. Staff debriefing on a regular basis is mentioned as a tool to improve services by allowing staff to share their

experiences and to auto-evaluate. Meetings with HCP from other facilities will give an opportunity to share these best practices:

> *"I think if we can have - I didn't even mention it before… if we can have regular debriefing sessions. Where you can debrief or vent yourself, it will help. Because you must remember we get irritated amongst each other also…"* **(CNP, PHC 1, urban)**

> *"… When we have our monthly meetings with our colleagues in the other facilities we will pick up best practices and start implementing them."* **(MGR, PHC 1, urban)**

More objective and extensive audits are also suggested so that scores accurately reflect the reality and consequently provoke reactions to fix issues. A Patient feedback mechanism has also been reported as a tool to ensure standard care:

> *"I asked them why auditing only being done on the club [patient folders]? Because it's a chronic audit, it's supposed to be on chronic patients. And if it's done on everyone then we can improve the care because then the results will be low and there will be systems put in place for us to improve this."***(CNP, PHC 5, urban)**

> *"You must write [patient feedback] if its right and you are satisfied, you are happy, you must write. If you not happy you can write down and do cross in one of these faces. You see."* **(ENA, PHC 4, urban)**

Respondents recommend increasing collaboration with NGOs to help keep stable patients out of the PHC facilities. Involving more NGOs and liaising with them could help decongest the facilities by doing some basic observations and script re-boarding at alternate sites where NGOs assist to distribute pre-packed medications from CDU and organize support groups.

> *"… We have the support groups that are outside, the NGOs that are involved. If we can liaise with them for those patients [so] that they take medication for them … they don't have to come here. … let's say maybe one day a week a nurse or even me come out of the centre go to them, do the observations, even to write the scripts for them provided they are controlled … So the centre is not flocked with them. That will be great."* **(CNP, PHC 2, urban)**

About patients' responsibility:

Respondents claimed that better education for patients on their condition, health literacy and more counseling, particularly for those newly diagnosed, can only help to improve patient adherence and compliance:

> *"Yes, we've been talking about health promoters, somebody who talks to patients … when they are waiting for the doctors. To explain about the dangers of not taking their medication. What can happen with the high blood [pressure] person who is not taking medication…"* **(MDO, PHC 5, urban)**

Finally, patient behavior might be improved if they are better educated on the services they are receiving in the PHC facilities.

Discussion

Our findings emphasize five challenges with respect to the care of hypertensive patients in the primary health care facilities of the Western Cape Province in South Africa. The reported challenges were largely shared across PHC facilities both rural and urban, except for those about the adequacy of human resources, which were more pronounced in rural PHC facilities.

Most of the challenges identified by respondents are to a certain extent interrelated. For example, waiting time is a central concern across all PHC facilities visited, which is also related to other major issues reported such as over-crowding of the facilities, inadequate staff, lack of space, poor computer systems, and lack of patient's engagement towards their care.

Club Systems as a Potential Wait-Time and Over-Crowding Solution

The implementation of club systems for stable patients to improve on the waiting time is a solution that was reported across most facilities. In theory the club system should greatly reduce waiting times. In practice, however, there are pre-requisites before such an approach can be widely implemented, such as a clear definition of a club system or its different variations with validated inclusion and exclusion criteria. This is important as it was found that the meaning of a club system and the criteria to declare a patient stable (which should be the main inclusion criterion) are not standardized across the PHC facilities. Although inclusion criteria to club systems must be standardized across the province, the structure of such club systems must be adapted to local realities as resources vary between health districts; therefore it will be appropriate not to have a one size fit all approach in defining the implementation of club systems.

Keeping stable hypertensive patients out of the facilities as much as possible by providing them with a one or two months' supply of medicines, and fast-tracking their visits to the facilities when they come in for their regular appointments are shared goals of implementing club systems. An innovation has been the setup of alternative sites where stable patients receive their pre-packed medications every month or two, in between their regular six months visit to the facility. Another innovation is the CDU that plays a central role is this strategy to fast track patients when they come only to pick up their medicines. Studies have also found that with the right kind of community support, it is feasible to provide treatment for longer periods (Hardon et al., 2007). The consequent impact of less frequent monitoring and patient follow-up, however, deserves careful attention (Magadzire, Budden, Ward, Jeffery, & Sanders, 2014), and further studies should be done to determine which club systems designs best meet both patient and PHC

needs. Also, more attention is needed on the increasing numbers of patients that visit PHC facilities that have been reported for the most part as consistently over-crowded. Policies put in place post-apartheid such as the provision of free primary care for all citizens and special cost-free community health centers for pregnant women and children under the age of six (Maillacheruvu & McDuff, 2014) could explain such over-crowding, and complementary measures are needed to resolve the problems caused by over-crowding of the facilities. This is necessary to ensure that the system remains sustainable.

Inadequate Human Resources

Another central issue raised was related to human resources, which were reported as inadequate in both urban and rural settings. Among the potential solutions informants discussed were incentives for providers accepting to work in rural settings where the issue seems to be more severe. This approach is feasible if there are enough health care professionals in the public sector. The reality is that the public sector does not attract health care professionals as much as the private sector in South Africa for reasons other than monetary compensation. George, Atujuna, and Gow (2013) found that the movement of health care workers from the public to private sector was influenced mostly by high levels of stress and low satisfaction with their work in the public health care system rather than compensation. Implementation of the Occupational Specific Dispensation (OSD) in 2007, which creates improved structured salary packages for public health care workers, has been effective in decreasing the movement of workers out of the public health care system (Labonté et al., 2015). Maillacheruvu and McDuff (2014) suggest that by focusing efforts on increasing the quality of work in the public system, the South African

government may be able to further expand and retain its public health care force. An increase of the retention rate in the public health system will help to secure more adequate human resources.

Conclusion

This chapter presented the challenges encountered with the care of hypertensive patients in the public primary health care facilities of the Western Cape Province in South Africa, from the point of view of providers. The key feature of this study was drawing from all levels of health care professionals involved in the care of these patients, which gives great confidence that the most important challenges from the provider perspective have been reported. The challenges reported have been categorized in five interconnected dimensions: Management of the visit within the PHC facility, Adequacy of human resources, Standardization of patients' care, Infrastructure limitations, and Patients' responsibilities. Study participants also indicated several potential solutions to these challenges: Implementation of club systems for stable patients, Use of the Chronic Dispensing Unit along with the community support, Introduction of alternative sites to dispense pre-packed medications, and Access to a well-functioning computer system just to name the key ones. This section of the study covers the actual drug delivery mechanism through the primary health care facilities. As such, it concerns only one end of the drug supply chain management system. The next chapter will explore the other components of the current supply chain management system of antihypertensive medications in the Western Cape Province of South Africa.

CHAPTER 5

MAPPING AND ASSESSMENT OF THE CURRENT DRUG SUPPLY CHAIN MANAGEMENT SYSTEM

In South Africa, although the National Department of Health is responsible for policy formulation, strategic planning coordination, and the functioning of the overall health system in the country, each province through its provincial Department of Health is responsible for coordinating the health system at this level. Indeed, the management of the drug supply in the Western Cape Province is the responsibility of the province, in line with the National Drug Policy (NDP). The NDP aims to provide equal access to medicines for South Africans through the Essential Drugs Program, which includes Essential Medicines List (EML) and Standard Treatment Guidelines (STG). This chapter explores the mechanisms in place to ensure appropriate supply of antihypertensive medications in the province. Since there is no dedicated supply chain management system solely for antihypertensive medications, the findings in this chapter apply to the drugs supply chain management system for most drugs used in the public health sector of the province.

A descriptive analysis of data collected through documents review and semi-structured interviews of key informants in the Western Cape was conducted. Key informants were identified and recruited through a snow balling strategy whereby key informants suggested others that might provide valuable input to the investigation. The interviews were stopped when data saturation occurred and the overall map of the drug supply chain was understood. The

supply chain management framework (Persson, 1995a) was used as a road map throughout the investigation to identify the key players and their role in the drug supply chain management system. All findings presented in this chapter served to answer the following specific research question of the study:

RQ2: How is the current supply chain management system of Antihypertensive medications in WC, South Africa organized?

Characteristics of respondents

Key informants were recruited within the WC Department of Health at the central administration level, the health district level, and two agencies: the Chronic Dispensing Unit (CDU) and the Cape Medical Depot (CMD). At these levels, we interviewed policy managers, district pharmacy managers, and agency managers. The selections of these respondents was made through referrals as we progressed with the investigation. We did not have a set list or sample size prior to starting the field investigation. Names of key informants were codified to ensure that all participants' identities were not disclosed. The reference for each quotation is the code for the participant KIN, numbered 1 to 17. Participants had been at their position for more than three months, which was the main inclusion criterion. Table 3 below presents a summary of the sample and characteristics of the key informants. More detailed characteristics of the key informants are presented in Appendix 5.

Table 3 - Characteristics of Respondents (N=17)

Key Informant	**Overall**
DOH Policy Managers	7
DOH District Pharm Managers	7
DOH Agencies CDU & CMD	3
Sex & Age	
Female - Count	11
Female - Percentage	65%
Male - Count	6
Male - Percentage	35%
Age - Range	33 - 62
Age - Median	42
Experience	
Number of years working at current position - Range	<1 - 14
Number of years working at current position - Median	3
Number of years working in the health profession - Range	12 - 31
Number of years working in the health profession - Median	15

Overall representation of the drug supply chain management system

This section presents a comprehensive summary of the WC drug supply management system, highlighting the key players and the main processes that take place within the system. The next sections will focus on salient aspects of the overall system to describe in more depth the techniques, procedures and technologies in place along with important challenges. The chapter ends with a discussion to briefly assess the system described and a conclusion.

The analysis of documents collected and transcripts from interviews conducted with key informants have informed the design of the overall map of the drug supply management system. Figure 8 below is our representation of the Western Cape Province Drug Supply Chain Management System based on the data collected and analyzed.

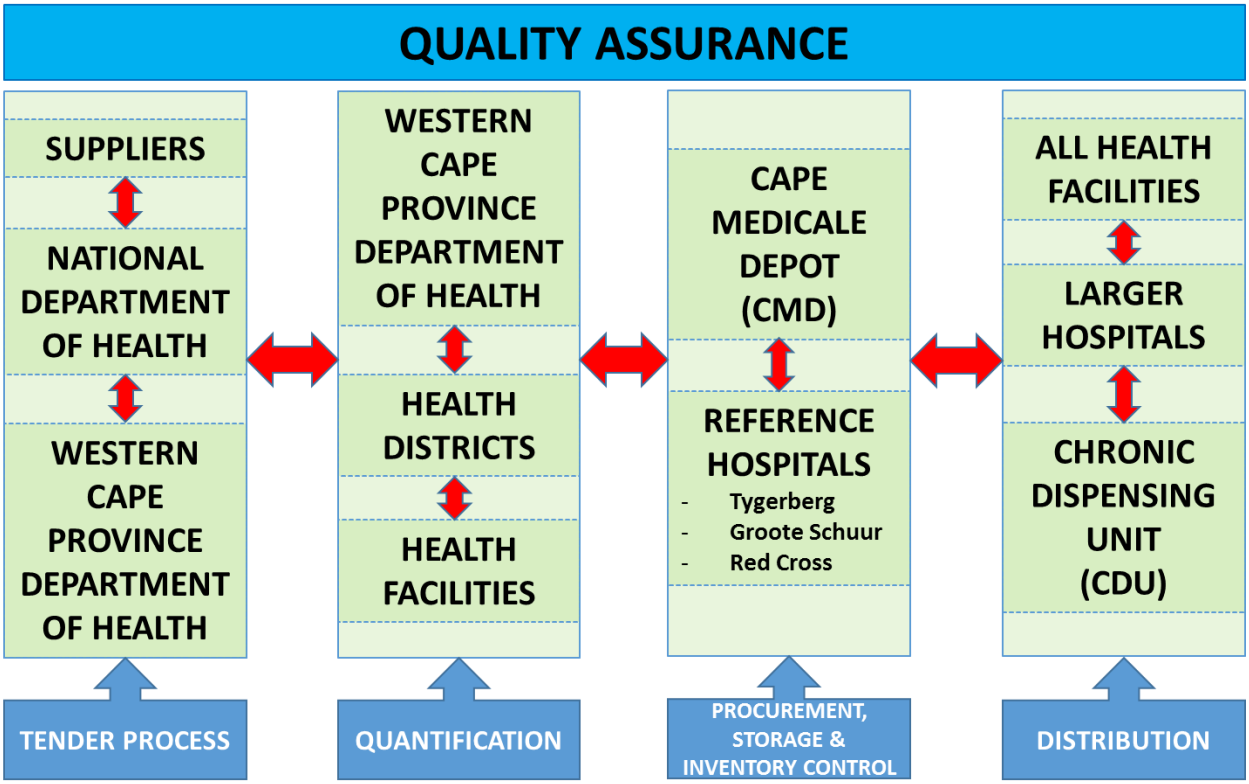

Figure 8: Western Cape Province Drug Supply Chain Management System

The drug supply chain ensures that medicines are always available in adequate quantities at the service delivery points for the patients. The entire process starts with the "Tender Process" which is the set of procedures leading to the award of a contract to a supplier for a specific set of medicines. It includes the preparation of the tender advertisement, which is a call for proposals, the evaluation of the proposals along with a quality check of the drugs, and the award of the contract to the selected supplier or group of suppliers. Essential medicines are organized in classes and a tender is usually issued for a class of medicines. The National Department of Health (nDOH) will request that the provincial Department of Health (DOH) provides estimates of their future needs. Tenders are usually issued for two to three years. The WC DOH will submit estimates of medicines needed based on past consumption with input from all health facilities throughout their health district. The nDOH prepares the tender advertisement that will specify quantity estimates for the period requested ("Quantification"), dosage forms, packaging requirement and all other technical details necessary for the supplier to prepare their submissions. Once their proposals are received, a technical working group coordinated by the nDOH proceeds to their evaluation using a points system. Basically, the evaluation is performed according to the requirements from the tender advertisement and other criteria such as the pricing, availability of the drugs and the lead-time. At the end of the evaluation process, the technical working group makes recommendations to the nDOH who takes the final decision and declares the winner (or winners) of the bid. The selected supplier (s) accept(s) the final terms and thus a contract is awarded. The selected suppliers usually have three months to get the drugs to the country. The WC province also goes through a similar process to award contracts to suppliers for drugs that are not included in the national contract. The Tender Process is initiated when the

contract is about to expire. Once the contract is in place, all provinces are notified and they can start ordering from the suppliers.

In the Western Cape Province, only four entities are allowed to procure directly from the suppliers: the Cape Medical Depot (CMD) and the three reference hospitals of the province that order specialized medicines for tertiary care. This study focuses on the CMD as the bulk of medicines used for hypertension are at the primary care level. The CMD is in charge of the Procurement, Storage and Inventory Control for most of the medicines used in the province. A buffer stock is kept at the depot based on anticipated consumptions. Facilities procure medicines from the CMD through a dedicated software available at most facilities. There are inventory control mechanisms at the CMD that alert staff when a specific drug reaches the re-ordering level. Similar mechanisms are in place in most facilities to help them manage their stock and place orders on time to avoid stock out.

After the placement of orders through the CMD, the WC province has a few mechanisms in place to ensure the distribution of drugs. The first is a courier service that collects the shipments from the CMD and delivers them to facilities following a specific schedule. These shipments supply the stock of the pharmacy at the facility. Hypertensive patients that are not stable get their medicines from pharmacies. Smaller facilities that could not procure directly from the CMD are supplied by larger hospitals in health districts. The last mechanism, which is how the bulk of the hypertensive medications are currently distributed in the province, is through the Chronic Dispensing Unit (CDU) for stable patients. The company in charge of the CDU receives the stable patients' prescriptions directly from the facilities (manual or electronic). This is a private company selected by the province through a call for proposal process. The CDU gets the medicines from the CMD and prepares the individual patients' packages of medicines with

their prescription, then delivers the pre-packed medicines directly to the facility or to an alternative site, usually three days before the collection date. A more detailed explanation of how the facilities organize the actual dispensing of the medicines to patients are covered in chapter 4.

Drug Quality Assurance is ensured through various mechanisms at each step of the drug supply chain management system. Some of those mechanisms are briefly described here for each main function of the system. During the Tender Process, this is ensured by testing the samples provided by the potential suppliers and the evaluation of their proposals against the prescribed requirements. The Quantification process goes through various levels of approval from the facility to the district level then the provincial level. Data on past consumption are used to spot any huge discrepancies between the orders and the usual consumption, which are queried before approval. Procurement, Storage and Inventory Control are done according to specific guidelines and audits are usually performed to ensure these guidelines are properly implemented. Distribution is also done according to specific guidelines. Shipments are checked when they arrive both at the depots and the facilities. The CDU has a strict control system in place with pharmacists that validate the prescription to ensure rational drug usage and they query the prescribing clinician when there are any issues. All these control mechanisms at various levels of the supply chain contribute to the quality assurance of the system.

The next sections of this chapter will focus on the techniques and technologies used to ensure these functions of the drug supply management system.

Tender Process and Quantification

The tender process is a structured set of steps towards the award of a contract to a supplier or a group of suppliers. Respondents agreed in their descriptions of the process, which involves the definition of specifications for what is needed and the quantities, and then the advertisement of the needs so that potential suppliers can submit their bid, followed by the evaluation of the different proposals to select the most appropriate candidate(s). Once the contract is awarded, it has to be managed by all parties during the entire validity period of the contract, ensuring the terms are met by all parties involved. One respondent described these steps by identifying them as demand management, acquisition management, contract management and supply relationship management. The demand management step is where the requirements of what is to be purchased are specified internally, then these requirements or specifications are made available to suppliers so that they can respond with their bid, which comprises the acquisition management step. Once the suppliers are selected, the implementation of the contract is ensured through the contract management and supply relationship management processes, which are ongoing throughout the validity period of the contract. Selecting the right supplier requires a detailed assessment of the various offers specified by a participant:

> *"You then have to evaluate your tender, weigh up the pros and cons of the different offers you've received whether it's qualitative or quantitative and then determine which bidder should receive the award, should be awarded the contract."* **(KIN 17)**

The Essential Medicines List (EML) and the Standard Treatment Guidelines (STG) present the drugs that are the priority needs of the population and information about their rational use. They are the starting points to identify the needs as they guide the selection of the drugs that are going to be put on tender. A respondent explained that:

> *"So especially more recently, there has been a strong drive to align national pharmaceutical tenders to national EML, the National Essential Medicines List. So the whole procurement starts by identifying what we are going to use and what we need and that is supported by the EML. The EML lags behind the actual requirements, because it doesn't take into account sort of very old medicines that have been used historically, but anyway the whole procurement starts with the Tender Specification Meeting. Okay. And that's where you decide what medicines you're going to call for."* **(KIN 11)**

Each tender or contract usually includes medicines of the same dosage form. Antihypertensive drugs are mostly tablets, and are therefore included in the solid dosage forms contract coded as "HP09". An example is the "*Tender No HP09-2016SD: Supply and Delivery of solid dosage forms to the Department of Health for the period 01 August 2016 to 31 July 2018 – Erratum*", which was advertised from 12 February 2016 to 7 March 2016. The nDOH currently has 13 different contracts covering the majority of the drugs on the EML. The importance of the EML and the STG in the tender process was well illustrated by some respondents:

> *"So what happens is that we've got the national essential medicines list, and the standard treatment guidelines which are […] the guiding documents for the country in terms of health care. So what the national Department of Health will do is that all the medicines listed in the EML will be advertised, […] they split up according to dosage forms. We've got 13 contracts in place currently. So it ranges from TB medicines, antibiotics, family planning, and oncology. […] It goes on to tablet dosage forms, liquid dosage forms and your biological products as well."* **(KIN 13)**

Once the nDOH has come up with a comprehensive list of drugs that are to be placed on tender, it requires the input of the provinces that have to provide estimates of their needs for the duration of the contract. The quantification of needed supply is a very important aspect of this tender process as the overall country estimates, which are calculated by putting together the estimated needs of each province with some adjustment coefficients, have an impact on the pricing submitted by potential suppliers and, more importantly, determine the bargaining power that the nDOH will have over the suppliers. A respondent stressed this aspect of the process in the following terms:

> *"Before that, all the different provinces have to forecast and do a quantification of how much stock they might need over that contract period, so the contract period may vary from two years to three years, or sometimes they get an extension so it will be three months, … before they go out on tender, everyone has to quantify what their needs are and then with that amount in place national will go out on tender."* **(KIN 1)**

The accuracy of projections is one of the major challenges in the country drug supply chain management system. Many provinces are struggling to provide accurate estimates, which can create issues with the suppliers during the execution of the contract as they make provisions based on the projections included in the contract.

> *"So the biggest challenge in pharmaceutical procurement in this country is the how many and the veracity of the quantified information. A lot of provinces struggle to quantify their needs. So the Western Cape goes to a great deal of trouble to ensure that the needs projection, the volume projections we're making are accurate. There are few other provinces that do the same. And then unfortunately there are three or four provinces that if they are able to, very seldom provide accurate information which means that the quantity specified in the contract and the supplier's production set up is based on vastly under projected requirements."* **(KIN 17)**

The technique used in the WC province is the consumption method, which is based on the past consumption of the drugs in the facilities. The numbers are aggregated at the provincial level and adjusted when necessary before submitting to the nDOH. The CMD and the three reference hospitals, as central procurement agencies, also keep track of the quantities procured with their respective systems to provide objective input at the provincial level during the forecasting exercise. The reference hospitals, Tygerberg, Grootte Schuur and Red Cross, use their own computer systems to keep track of their procurement, whereas the CMD uses its own that is installed in the health facilities but it generates the same type of data as the one for the reference hospitals:

> *Between Tygerberg, Grootte Schuur and Red Cross, they've got data in terms of what they procure and what they use and the Cape Medical Depot has a different system but the same data. So every year or every six months, we get, an ABC analysis which lists every product from A to Z of what we've bought, the quantities and what we've paid for*

> *it. And over a 12-month period we then can see the annual usage of an item. That is then used as a basis for determining the estimates."* **(KIN 13)**

At the level of the facilities, the electronic system to assist in keeping track of the consumption and developing accurate needs estimates has taken a long time to be rolled out, as explained by a respondent:

> *"We've got software that has been deployed for more than 15 years and it's still being rolled out to smaller facilities."* **(KIN 13)**

The tender specification committee at the nDOH compiles the estimates from the provinces and finalizes the tender document, which is advertised. The potential suppliers can then respond with their bids within the bidding period, which is usually about a month. The tender is advertised through the nDOH website at the following link http://www.health.gov.za/, and also through the Government Gazette, which is the Government official journal. At that point, the nDOH forms the Bid Evaluation Committee (BEC), which has representatives of all the provinces, to assess the bids received. The ranking of the bids is done according to the legislation in place, with the use of a point system, and also the results of the tests performed on samples by the WC and Gauteng provinces, as described by a couple of respondents:

> *"There is legislation which governs procurement in the government, particularly the PMFA, it's an act, and the REB. So within the legislative parameters of those two acts, you have to tender and allocate points and then you get bids by suppliers and the contracts are awarded… Once the contracts are awarded, all the provinces buy off those contracts. So the contracts are awarded with a supplier name and a price and the period, the validity period."* **(KIN 11)**

> *"Then there's a bid evaluation committee where each province has one representative and then its national government and we then evaluate the responses that have been received. And we also take into consideration the sample evaluation reports from the two provinces."* **(KIN 13)**

In recent years, the nDOH has reduced the number of formularies for the same drugs in an effort to increase the Department's bargaining power. More than one formulary will be advertised for the same drug but only one will be awarded on the contract. The goal in doing this is to obtain better pricing as described by a respondent.

> *"Previously the national government would advertise all four of them and potentially award all four of them. What has been happening now is that medicines are being classed according to the ATC classifications system. So four of them might be advertised, but only one of them would be awarded. Because they all would have the same therapeutical effect. So that's been implemented in the last, the latest round of tenders. So it's reducing the number of items available on tender and the idea is that we're then pulling all our estimates for the country in one item, which means we may be able to get that more bargaining power and be able to get better pricing. So that's one of the ways in which to bring down the cost of medicines…."* **(KIN 13)**

While this approach may be increasing the bargaining power of the nDOH, a respondent raised the concern that there are risks associated with relying on one or very few suppliers that produce the selected formulary. In case of any issue with the supplier, options to avoid an out of stock situation for a long period might be limited:

> *"Again the downfall is that you're awarding, you're putting all your eggs in [one] basket. You've only awarded one item. It may only go to one company, probably two but you're now so dependent on that one item that if there's a problem, there are generally very few alternatives in terms of where you can source it. So if the company has a problem in terms of supplying, no one else keeps any significant stock that can assist you in the government sector because they only then keep stock sufficient for the private sector. So that's the one downfall of the system."* **(KIN 13)**

In some cases, the Bid Evaluation Committee (BEC) may be in a position to recommend more than one supplier that will split the contract. A final check is performed to ensure that the selected suppliers are not sourcing their products or raw materials from the same manufacturer, in which case awarding to more than one supplier won't make any difference in the event of a shortage or any other incident. Ideally, suppliers that split a contract should not have the same source. A respondent pointed out this:

> *"We actually go and say okay, we've now awarded for three companies or we potentially will award to three companies, but where are they getting it from? Then we look at the actual manufacturer and we might say you know what? They've got three different factories so that's okay because if three of them get it at the same factory, if there is a breakdown. None of them are going to supply. And if they're getting it from different factories, we then say, okay so who supplies the raw material. And if it's the same raw material supplier then we know there may potentially be a problem as well. Can we then include another one just to be on the safe side that has it from a different supplier? If you can't, you can't. There's quite a lot of detailed data mining that happens behind the scenes that you don't see for face value when you get the product or when you get a bid. You actually need to go and do a lot of, there's a lot of research that gets done."* **(KIN 13)**

The final outcome of the BEC meeting is submitted to the nDOH with recommendations on the suppliers they found to be the most appropriate. The nDOH uses a Bid Adjudication Committee to review the recommendations of the BEC and take the final decision, and then the contracts are awarded. The nDOH prepares the final details with the selected suppliers and sign the contract, which is published and distributed publicly to all provinces so everyone knows the items that are on contract and the price they will pay, along with all the details specified in the contract. Ideally new contracts must be in place at least three months before the end of the current one. Suppliers use that period as their initial lead time to source all the materials, manufacture and transport the initial shipment, while the provinces set up the items awarded in their procurement systems. A respondent summarizes the issue:

> *"So then when the contract goes out … they try to award it three months prior to the end of the current contract… We all know they need some time to stock up, get the active ingredients if they're manufacturing themselves or … buying from other companies or getting from their overseas company to get back to South Africa and go through the Quality Assurance process and then the provinces need to prepare for these new drugs coming in, …they need to assess how the contract has changed."* **(KIN 1)**

The tender process ends with the official award of the contract and provinces can start placing their orders directly to the suppliers. There are special instances when the province needs

some drugs that are not included in the national contract and they have to either put in place a provincial tender or authorize insolated purchasing of these drugs directly from a company that supplies them. These processes are usually problematic as the availability is not always guaranteed and the pricing may be very high compared to drugs that are on the national contract. A respondent clearly describes these issues:

> *"The problem with a buy out is it's usually for one off, or you know minimal amounts or one off events, but that company cannot guarantee a fixed supply because it's like an ad hoc order. So they might have forecasted for the private sector and why should they both if they didn't win an award. So they might not have enough stock floating around to help us out. So in all a buyout is dangerous because the supplier did not include your demand or your need in their forecast because they didn't know. So a buyout is outside the normal tender process. So you can't do a buy out if there's, for an item that's in the contract."* **(KIN 1)**

Contracts that are in place theoretically guarantee the availability of the drugs for the duration of the contract unless there are unplanned circumstances that lead to shortages. In the WC province, the CMD essentially procures most of the anti-hypertensive drugs. The next section will look into the processes and technologies that support the procurement, storage and inventory control of the drugs through the CMD.

Procurement, Storage and Inventory Control

These functions are performed both at the facility and the CMD level as most chronic medications are procured through the CMD.

About procurement:

Facilities submit their orders to the CMD through the Windows Remote Demander's Module (Win RDM), which is the client interface of the MEDSAS system, the procurement software at the CMD. They are allowed to place orders every month, which is actually what suppliers prefer, regular orders, rather than irregular massive orders. All the drugs that have reached their minimum re-order level are then included in order and the estimates are based on the past three months' consumption average as indicated by a respondent:

> *"The system will use the ordering data averaging it from the last three months. It's system-generated. So you program the system to say I want to reorder, and it's usually 12 weeks, so you keep a minimum of three months stock, or at three months' stock level, you reorder and then it will generate an order for a month. So if you keep on doing that every month, because this is also what the suppliers want, they want regular monthly orders from us, they don't want massive orders and then no orders, because supply chain for them, because they have to get the API, they have to manufacture, it takes months. So they like consistent, steady ordering, predictable ordering. So you'll have variances in winter and you'll have variances in summer, but generally it's a system-generated average, moving average that it's based on."* **(KIN 11)**

The province is organized such that each health district has a specific day in the month to place their order through the system and the lead time is usually within a week after the order date. Orders are validated for availability and alternatives are suggested to the facilities when the items requested are out of stock. A respondent describes this process below:

> *"So those other facilities order from the Cape Medical Depot. They've got a schedule so medicines (orders) are placed. They order on a particular day, the Cape Medical Depot then processes those requests and on a particular day they will have a set delivery schedule for that district. So usually it's within a week of when the order was placed, the deliveries would be made. Generally it's within three days if they follow the schedules. But let's call it a week maximum and they will receive their stock. If there's anything that's not available at the Cape Medical Depot then the facility will be informed. There's a weekly report to say these are the items that are out of stock and they will either give them a recommendation to say, as an example, Enalapril 28s is out of stock but you can order the 56s. So they'll tell them there's something, a different pack size."* **(KIN 13)**

At the level of the CMD, there is a system in place to identify items that have reached their re-order level on a weekly basis. Each province has a code list that is largely made up of medicines on the national EML, and a few others that are approved for use. The pharmaceutical and therapeutic committee of the province is in charge of maintaining the provincial code list. Only medicines that are on the provincial code list can be ordered as reported by a respondent below:

> *"In the Western Cape we've got an additional document which is called the provincial code list. So that is the list of all the medicines that are allowed to be used within the province and … 95% of it is EML. Then there's a portion that is non-EML, but we've allowed it to be used within the province. The provincial code list will then specify at which level of care that patient can, should be seen or which prescriber."* **(KIN 13)**

There are circumstances where, because of the nature of the order, the CMD will submit it to the supplier who will deliver the shipment directly to the facility. This happens for certain types of drugs that require particular storage conditions or when the volumes needed are going to create storage issues at the CMD. This process is referred to as using the Direct Delivery Voucher (DDV) as pointed out by a respondent:

> *"Okay, so like I said, we have got two processes of ordering, we've got order stock directly and it comes to the depot and then we have got the DDV system which is the direct delivery system, where we use this for certain lines where it is limited to only specific demanders or the quantity is bulk lines where space is an issue for us or when it is a limited or smaller line that we don't use that much of, so it's not worth keeping in the depot. So those lines we basically have as a DDV depot where we still manage the orders we do, we place the orders, we send it to the suppliers, we enact payment, the only difference is the delivery goes directly to the facility and doesn't get stored on our premises."* **(KIN 16)**

About storage and inventory control:

At the level of the facilities, storage space dictates the size of the stock that can be kept in hand. There are guidelines for storage facilities and they get audited from time to time. Ensuring security of the stocks can be challenging in some settings as there have been cases of burglary reported. Issues with electricity provision in some areas create challenges for the storage of products in cold chains. The CMD is the main storage warehouse of the province. A respondent reported that there are infrastructural challenges that the CMD has to manage:

> *"Ja, storage at the Cape Medical Depo is problematic. The Cape Medical Depot is set over three floors. So logistically it's difficult to move things up and down. And there is too little space. They do have space constraints, however they do, I think, by moving things directly to the chronic dispensing unit, they're trying to make more space available."* **(KIN 11)**

The electronic system at the CMD, MEDSAS, allows constant monitoring of the inventory. The CMD ensures that there is, on average, a three months' supply of stock. Every Monday, the system prints out re-order advice notices for all drugs with less than three months of stock in the system. At the level of the facilities, procedures in place for inventory control vary depending on the availability of computer systems. The JAC-Pharmacy electronic medicines management program is used to monitor inventory. The JAC-Pharmacy automatically calculates the quantities to order based on the parameters programmed for re-order levels and the history of medicines orders, as summarized by a respondent:

> *"We are so fortunate now. Since December2014, we are now using an electronic inventory control system which can use our historic usage to estimate how much we will need in future … we don't really base it on the population as yet. We use historic usage to predict our how much we will use."* **(KIN 4)**

When electronic systems are not available, the inventory control is done manually with the use of stock card systems. Obviously, risks of errors are greater with the manual system, but pharmacists have been using it for a long time and are able to determine when there are

discrepancies. The technique of the stock card system is that the pharmacy splits its stock in two, a closed stock and an open stock. The closed stock is in the back in the store room and the open stock is in the front, as prescriptions are dispensed from the open stock. This open stock is replenished from the closed stock and records are kept on the stock card. A respondent describes the stock card manual system:

> *"There, mostly we try where we can have a manual stock card system where you record what you receive and what you use and then according to that you can also calculate your average monthly consumption and then based on that you decide how much you want to order. You take into account how long the delivery takes... We try and have our pharmacies like a store room and a dispensary. We call it the storeroom, we call the closed stock and then the dispensary we call the open stock. So when we take something from the storeroom, then we would deduct it from the card. And then normally the open stock won't be a lot of stock."* **(KIN 4)**

When the pharmacy is too busy or when staff are not in adequate number, the open stock may become depleted and the pharmacist runs to the store room to fetch extra stock without recording it on the stock card. This creates discrepancies that are avoided with the electronic system. A sample stock card is presented in Appendix 3.

Distribution

The distribution function of the supply chain management system includes both the movement of drugs shipments from the CMD to the facilities and the actual dispensing or deliverance of the drugs to the patients. Antihypertensive drugs are distributed via two distinct routes based on the status of the patient. Non-stable patients get their medicines at the pharmacy of the facilities whereas stable patients get pre-packed medicines through the Chronic Dispensing Unit (CDU). In both situations, the movement of drugs from the CMD or CDU to the facility is ensured by third party courier companies. The CDU gets its stock from the CMD before pre-

packing the prescriptions for dispensing, but the facility that is handling the patient is billed for the drug collected by CDU as explained by a respondent:

> *"The CDU then orders directly from the depot and they bill that facility. So this happens all behind the scenes. So that facility will still be, at the end of the day still have to pay for the stock that the CDU used but they don't physically have to keep it in their facility."* **(KIN 1)**

CDU delivers the parcels three days before the patient collection date. About fifteen to twenty thousand scripts are process by CDU every day and an average of two hundred seventy thousand medicine parcels are delivered per month. The lead-time for CDU to process scripts is ten to fifteen working days. CDU parcels are usually distributed at alternative sites outside the PHC with the help of NPO staff as explained by a respondent below:

> *"We do have sites where these central dispensing, pre-packed medication will go to. It either goes to factories where people are working and it goes to old age homes. It also goes to, in the rural districts they call it off sites and then in the metro they have like support groups or adherence groups where it will go to and patients will collect it there. So when I talk about off sites, it's a place, it's an alternative dispensing site rather than the hospital or from a pharmacy. So these groups are run by an NPO. It's a Non-Profit Organization."* **(KIN 5)**

This system works well when patients are compliant but issues start arising when patients do not show up to collect their medicines parcel, which now have to be returned to the prescribing facility and sometimes to the CDU:

> *"The big problem that we have at the moment is when patients don't collect their medication and it has to come back because you can't leave it at the alternative site and you also can't leave it at the facility because packing space is a problem. So that is still an on-going problem and, I think, for me that is the big, big thing."* **(KIN 5)**

Another respondent argued that the CDU role could be much more efficient if the medicine parcels could be delivered directly to the patients' home rather than the alternate sites or the facilities:

> *"When it comes to chronic hypertensives, of course the final additional piece to the puzzle is the Chronic Dispensing Unit which fulfils a fantastic function but unfortunately*

> *in the context of the South African environment is unable to perform it as efficiently as it could, I feel because my background or most of my adult life I spent in the UK and various countries in Europe, the postal service in those countries is so much more reliable and robust than the postal service in this country that you could, for example, simply post chronic medication to a patient for a very, very small cost and know that it would get there or courier it for that matter for a slightly higher cost. In this country the infrastructure is so poorly established that there is no reliability to that service and the cost is so much higher should you choose to privatize the courier delivery process. So something that makes me very sad is that the Chronic Dispensing Unit still only dispenses to clinics. It doesn't deliver direct to patient."* **(KIN 17)**

At the pharmacies where the JAC-Pharmacy is implemented, the program also supports the dispensing of medicines to patients, as its memory recalls what medications were dispensed to the patient previously. This saves considerable time when filling the prescriptions for patients. Finally, as previously reported, the definition of stable versus non-stable patient is still not clear cut for many clinicians, which could undermine efforts of the providers as commented by a respondent:

> *"The other thing that I have a challenge with is how you stratify a stable patient. For me a patient that is on a pre-packed medication must be a controlled patient but what is control? Is it only the clinical signs that you will look at or is it the adherence that you look at because we know, to manage a chronic patient, it is not just about his clinical condition. It's how he manages and how he understands his condition in order to become controlled. So what is control and when is a patient stable...I think I'm grappling with that, in order for patients to be adherent to their medication."* **(KIN 5)**

The introduction of the CDU to deal with repetitive scripts for stable patients is definitely the corner stone of the distribution function of the drug supply management chain in the WC province. While it helps to decongest PHC facilities, it raises some of the issues presented above. The complete detailed CDU process is presented in Appendix 4 below.

Overall assessment

The WC drug supply chain management system is heavily dependent on the national tender process. Any issue such as the late award of the contract will have a negative impact on the provincial system despite all the safeguards and procedures in place in the province. The usual consequence is a stock out, which disrupts the care of chronic patients and contribute to the development of drug resistance. At the moment of our data collection there were about 90 items out of stock. There is an implicit agreement between the provinces and the nDOH that prevents provinces from having alternate suppliers for products that are included in the national contracts. Although this measure ensures that the country has a strong bargaining power in purchasing drugs, the downside is that the WC province is forced to cope with the shortcomings caused by the national process. Some provinces have a poor forecasting capability that results in issues with the suppliers when the demand is higher than what was anticipated initially. All provinces bear the consequences of such flaws regardless of the accuracy of their particular estimates. Despite these challenges, the national tender process to ensure availability of essential drugs for the entire country seems to be quite efficient, particularly with regards to the pricing, and efforts needed to be done at the level of the provinces to increase their capability to provide accurate estimates of their future needs. The nDOH also needs to be much more proactive in ensuring that suppliers have more time to prepare their bids. Most of the suppliers rely on their manufacturers that are usually overseas and the duration of the bidding period (usually a month) is sometimes very tight to produce all the required documents to submit their bid. The bidding system could also be improved by implementing an online bidding system at the national level with a database that keeps records of suppliers who will have their own account and the system will allow them to submit most of the required documentation online. At any time the suppliers will be able to

update their information through their online account. That will cut down on recurrent tasks that are performed manually for each tender. The other functions of the WC drug supply chain management system that fall within the provincial authority are assessed below.

One of the particularities of the primary health care system in the WC province is that patients collect their medication at the facility pharmacy during their visit, making the public sector health system the biggest buyer of medicines. In most other SSA countries, this is not the case as patients receive their scripts from the clinician and have to rely on private sector pharmacies to fill their prescriptions, usually paying out of pocket. The majority of the patients in the WC province rely on the public health system and get their medicines usually free of charge from the facility. This is a clear added value to the service provided to the patients in the public health system in the WC province and most provinces in South Africa. In order to ensure a comprehensive service, the functions of the drug supply chain management system must be robust to cope with potential challenges that can arise at any point in the chain and that will always have a considerable impact on the care of patients that are fully dependent on the system.

Some strengths of the system in the WC province are the CMD and the distribution concept that work pretty well with lead times of around 48 to 72 hours between placing the order and the time stock arrives to the facility. Improvement, however, is needed in the communication procedures between the suppliers and the provincial depot as notifications of non-availability of certain products are usually sent too late. It is also a fact that alternative sources of medicines are very limited for the provinces. A more proactive notification system, for example when the production line of a product is stopped, would be very useful to the provincial depot in planning for rationalization of available stock ahead of time. This could help mitigate the recurrent issue of stock out that severely affect the care provided to the patients.

At the level of the facilities, the rollout of the JAC-Pharmacy program to support the functions of dispensing, inventory control and procurement has definitely made the system more efficient and provide additional data that can be analyzed to better understand the usage of medicines in the province. The JAC-Pharmacy reduces the dispensing time while keeping track of medication history of patients, which is very valuable information for clinicians when it is readily available as such. Another great feature provided by the JAC-Pharmacy is the ability for pharmacy managers at the health district level to have a global view of stock levels at all facility pharmacies in the district. This feature is an important tool to ensure equitable distribution of drugs that are not available at the depot temporarily for various reasons. Facility managers can then easily shift stock around between facilities, making sure that the most in need receive the available medications. This is made possible because the JAC-Pharmacy makes the information about stock levels available to the pharmacy manager in real time.

At the moment of the data collection, the limitation to this great feature was the fact that the rollout of the JAC-Pharmacy was still ongoing, particularly in the rural areas; so many facilities were still waiting to receive the program. As discussed earlier there remains limitations on the availability of electricity and network data connections, which are needed for the JAC-Pharmacy program to operate. Without network data connection, the system can always operate locally, but without electricity and in the absence of power generators, providers usually have to switch back to manual procedures until electricity is back. Data captured manually during power outage are usually not entered in the system retrospectively because of lack of time and human resources. Electricity power outage in the WC province is becoming a recurrent problem that has a negative impact on the drug supply chain management system.

The JAC-Pharmacy program also provides great assistance for the procurement function as it uses historic data of medicine dispensing to calculate the past three month average and to suggest estimated needs for future orders that the pharmacist has the ability to adjust before placing the order. Facilities that do not have the JAC-Pharmacy implemented yet rely upon their usual manual methods. It has been observed that because orders can be placed on a regular basis, some facilities do not worry about ensuring their estimates are accurate since they can always place additional orders whenever they realize that their stock levels are low and the lead time is pretty good. It is anticipated that with the full rollout of the JAC-Pharmacy program across the province, these issues will disappear.

Suppliers on national contracts deal individually with all provinces that procure from them and which make payments as per the provisions of the contracts. Administrative procedures sometimes may delay payments as many other departments are involved such as the Department of Finances and the Treasury. The WC province has been able to streamline these procedures between the departments involved to make sure that suppliers are paid within the period specified in the contracts, usually thirty days. As a result, the WC province maintains good business relations with the national suppliers, which ensures priority treatment of their orders by suppliers.

Our findings have reported a number of computer systems that support the functions of the WC province drug supply chain management system such as JAC system, MEDSAS, or Win RDM for example. The fact that most of these systems do not talk to each other is a serious limitation that prevents them from operating to their full potential. Ideally, a comprehensive computer system that integrates all the functions of the drug supply chain management system, including the payments and logistics management, would be preferable and more cost effective.

Maintaining various systems and attempting to improve them individually will likely be more costly without providing the best possible results. A single system will eliminate some tasks that are duplicated at the moment, such as the configuration of items with pricing. Budget management becomes problematic when pricing is not calculated the same way from procurement at the depot to distribution at the facility pharmacy, and reconciliation becomes very difficult as discrepancies appear at various levels. These discrepancies might be negligible at the current scale, but in the event that the care of hypertensive patients were to be scaled up with more patients, these discrepancies could create very serious budget management issues.

To some extent, the current fragmentation of the computers systems that support the various functions of the drug supply chain management system could be considered a threat to the safety of the patients. In the event that there is a recall of a batch of medicines by the manufacturer for any reasons, retrieval of such medicines once in the hands of the patients will be very difficult, as data about the medicines are handled by different computers systems that are not linked. A single system would allow easy tracking of drugs from arrival at the provincial depot to dispensing to the patient. The system would track which patient got medicines from which batch of medicines, and retrieval in case of emergency recall would be more efficient and safer.

Finally, the innovative concept in the WC province to pre-pack recurrent medicines for stable chronic patients through the Chronic Dispensing Unit (CDU) described previously serves its purpose of keeping stable patients away from the main stream of regular patients at the facilities. Our findings highlighted that there was no clear-cut definition of stable patients across the province, which could limit the positive impact of CDU on the supply chain and the care of these patients in general. Efforts should be made to reach a clear definition for a stable patient

that will be shared among clinicians and included in standard treatment guidelines. This will allow the CDU to operate at its full potential, ensuring that all qualified patients are actually put on CDU processing. An underpinning ethical issue created by the implementation of the CDU concept also needs to be settled at the level of regulations in the province or nationally. This issue has to do with the pharmacist responsibility in handing over the pre-packed CDU package to the stable patients. The CDU employs pharmacists that fill and check the prescriptions that are prepacked and the facility pharmacists only distribute the parcels to the patients without necessarily checking their content. There is ambiguity as to which one of the pharmacists is legally responsible for the dispensing of the drugs to the patients, either the pharmacist that validated the filling of the prescription at the CDU or the pharmacist at the facility that has no control over the medicines in the package that is handed over to the patient. This ethical issue needs to be settled to avoid any potential crisis in the event of future malpractice or omission. One approach that could be considered for study is the delivery of the medicine parcel directly to the patients, similar in vein to a postal service.

Conclusion

The mapping of the WC drug supply chain management system has provided a good overview of the various stakeholders and the interactions that take place between them to ensure availability and delivery of medications to the patients in the province. An important portion of the system is out of the control of the WC province. The most recurrent issue is stock out of drugs at the level of the suppliers for various reasons, sometimes out of the control of the

province. One of the common causes is the late awarding of a contract because of the lengthy tender process time, particularly when the contract results in a change of suppliers. The EML and STG guide the design of the tendering process, and drugs are grouped in 13 different contracts and dosage forms. The WC province also sets up provincial tender for drugs that are not included in the national tenders but are in used in the province. Some of the strengths of the WC province's drug supply chain management system are the performance of its depot (the CMD), the computers systems that support its functions, on-time payments of suppliers and the CDU. The CDU, unique in the country for distributing medicines to stable patients, provides a baseline model that could be further developed and adapted in other provinces or even other SSA countries.

Our data gathering and assessment nonetheless identified issues that need to be tackled to improve the entire system. The most important one is the current fragmentation of the computer systems that support the drug supply chain management system. A single system will resolve a lot of the issues currently observed and provide more safety to the patient. Despite these issues, the WC drug supply chain management system is well structured and ensures timely delivery of the medicines to the patients in the province. Findings in this, and the previous chapter, both suggest room for improvements, even though the WC system is considered ahead of most other provinces in the country. The results presented in this and the previous chapter provide the context and data to support the development of a model of care for hypertensive patients in PHC facilities of the WC province, allowing estimates of the resources needed to be simulated for various scenarios using the ARENA Simulation Software (the topic of the next chapter).

CHAPTER 6:

MODELING AND SIMULATION OF PROCESSES FOR THE CARE OF HYPERTENSIVE PATIENTS IN PRIMARY HEALTH CARE FACILITIES USING ARENA SOFTWARE

The care of hypertensive patients in primary health care (PHC) facilities involves a mix of operations conducted by various personnel according to standard operation procedures adopted in the facility. Modeling and simulation tools allow one to imitate a real-world process, estimate measures of system performance (such as average time spent in the system, number of patients processed, etc.), and test possible changes to the system without altering or destroying it (e.g., what if we hired an extra person?). The overall functioning of the system can therefore be analyzed to make appropriate recommendations for the improvement of system performance.

This chapter uses the ARENA modeling and simulation software to understand how one could determine the minimum required numbers of health care personnel in a PHC facility necessary to process a targeted volume of patients. Analysis of data collected through observation, documents and semi-structured interviews of health care personnel, as well as findings from the previous two chapters, led to the development of the model and the identification of parameters for the simulation. Findings presented in this chapter served to answer the following specific research question of the study:

RQ3: Using modeling tools, how to determine the minimum numbers of health workers required at each supply chain interval to ensure successful delivery of medications when scaling up interventions?

Description of the approach

The data analysis led to the development of a generic base model for the care of hypertensive patients within the PHC facilities of the WC province. We conveniently selected one of the nine PHC facilities visited to use for programming the simulation model with the ARENA software, while allowing the program so that it could be customized for any other PHC facility. Data used in the simulation model was to demonstrate the usefulness of the program, and how it could be utilized across all PHC facilities. The programming of the simulation model was an iterative process intended to mimic the real system as close as possible. The functioning simulation model allowed us to identify the specific parameters that will need to be collected for any PHC facility where the simulation could be implemented in the future. The base simulation model represents the system as it operates currently. We elaborated a set of scenarios to test changes to the system in order to improve its performance and also to estimate the minimum human resources necessary when the arrival rate of patients to the facility is increased in the event of scaling up interventions.

This approach is used in order to guide the development of a simulation model with the ARENA software in any other facility using accurate data. It would start with the customization of the generic base model of care with specificities of the facility of interest, followed by the collection of pre-identified data to run the customized simulation model. Once the simulation model is validated, the changes are tested with the “what if” scenarios to determine ultimately the required health care personnel that will produce the best performance. The scenarios are

selected based on respondents' insights and our personal analysis of the model in place. Our approach provides a clear understanding of how to determine the minimum human resources needed when scaling up interventions to manage the hypertension epidemic in the population.

Building the generic base model of care

Our observations at all the nine PHC facilities gave us a sense of the most common pathway of hypertensive patients within the system. This was confirmed and elaborated upon with findings from the data analysis of the semi-structured interviews with health care personnel to understand the pathway of the hypertensive patients during their regular visits. While there were some variations between PHC facilities, particularly between those having a form of club system and those which did not, we identified common processes shared by all facilities. This led to the building of a generic base model of care illustrating patient flow, as presented below:

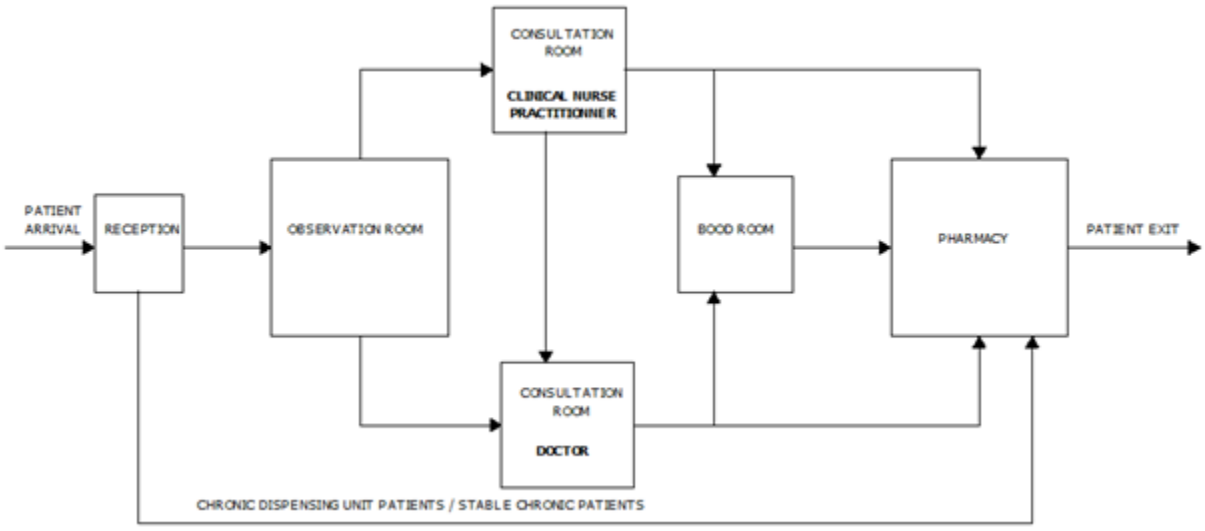

Figure 9: Generic base model of care in PHC facilities, WC

In all facilities, hypertensive patients arrive through the “Reception” area where they are identified and their file is drawn if necessary. Patients that are coming just to collect their pre-packed medications will go straight to the designated window at the pharmacy and exit the facility after the collection of their parcel. All other patients go to the “Observation Room” where their vitals are taken and then to the “Consultation Room”. Depending on their situation, some patients may need to see only a Clinical Nurse Practitioner (CNP) that day, or a Doctor, or both. Those who need their yearly blood exam to be performed have to get their blood drawn before heading to the pharmacy to collect their medications and leaving the facility. In general, stable patients go through this path once every six months, but non-stable patients visit every two months or sometimes every month. Facilities that have implemented the club system have the same process for patients but hypertensive patients are only seen on specific days of the week. Another variation of the club system does not have specific days for hypertensive patients but all chronic patients are cared for by the same staff. In both cases, some facilities check the vitals of hypertensive patients along with health talks in a “Club Room”, which is equivalent to the “Observation Room” in the generic model.

This generic model represents the most common patient flow in the PHC facilities visited. The logic of this model led us to identify the type of data that needed to be collected in order to develop the simulation model. The ARENA software was then used to develop and program the simulation model presented in the next section.

Development and configuration of the simulation model with ARENA

The logic of the generic model described above was used to develop the simulation model represented by a flow chart. The step of the blood exam was absorbed in the "Consultation Room" to simplify the programming of the simulation model. The flow chart representing the simulation model is presented below:

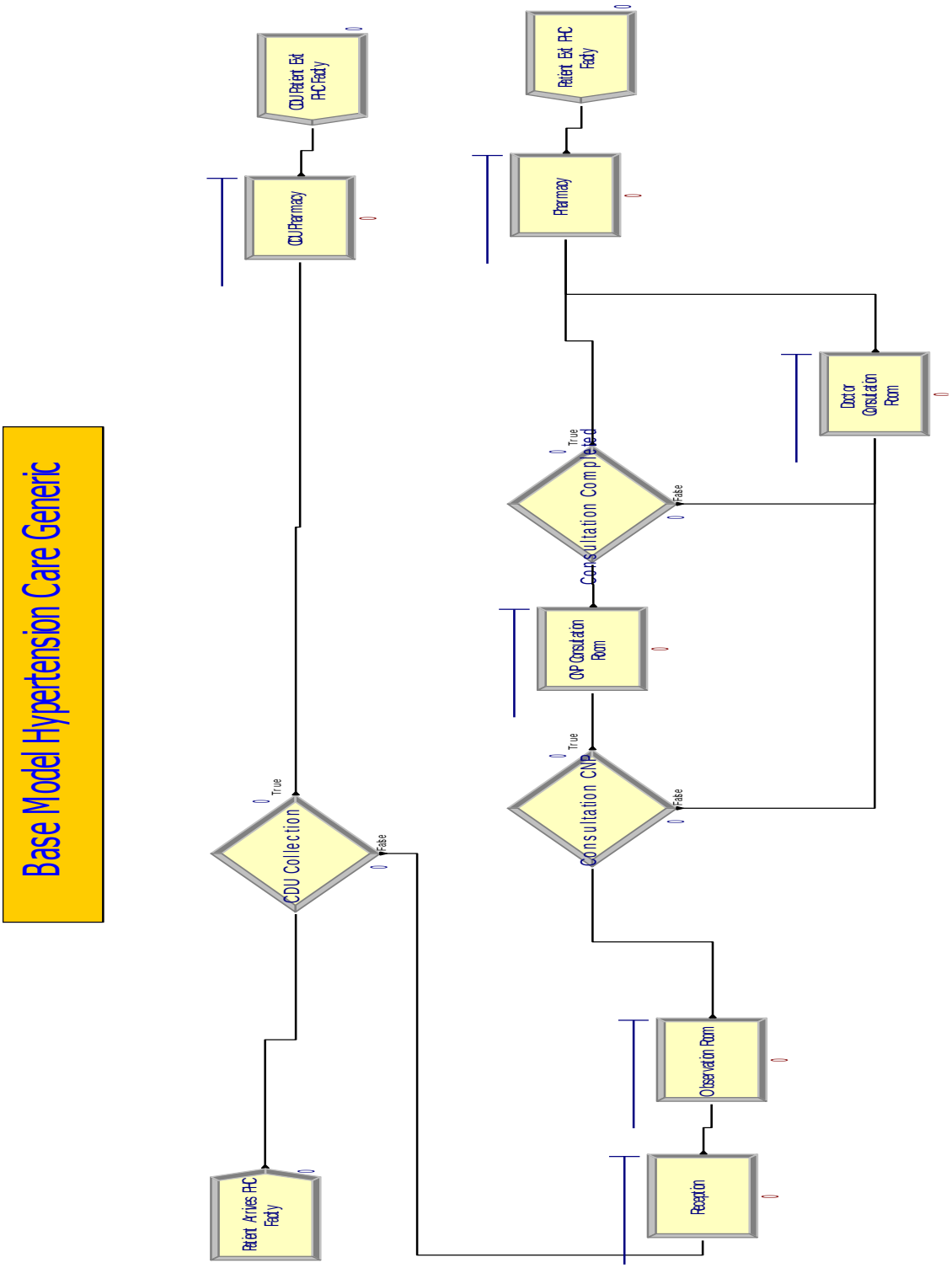

Figure 10: Generic simulation model of hypertension care in PHC facilities, WC

The flow chart representing the generic simulation model is made of blocks that follow the algorithm of the patient flow and the label within each block is self-explanatory. A bigger version of this flow chart is presented in Appendix 13 for better reading of the labels. In our simulation model with ARENA, entities are represented by patients arriving at a certain rate throughout the day. The resources are the various HCP (ADM, ENA, CNP, MDO and PHAR) that process the patients at their respective stations. The horizontal "T" bars on top of some blocks indicate the queue of patients waiting to be processed at those stations. The prism blocks represent decision steps where percentages of each option are inputted into the simulation model. All the rectangle blocks represent stations where the entities are processed using human resources. Behind the scene we had to specify parameters for each block from "patient arrival" to the "patient exiting" the system. The parameters represent the distributions for patient arrival rate and waiting times at each station along with the characteristics of the resources used. We programmed the simulation model using the resource set features to allow easy adjustment of resource quantities when customizing the simulation model for a specific facility.

In practice, the distributions are selected based on evidence in the literature for certain processes. To be more accurate, quantitative data of the patient arrival rate and the processing time per patient at each station will need to be collected in order to find the most appropriate distribution for each station. This is done with the Arena Input Analyzer where data collected is inputted and the Analyzer matches them with an Arena distribution, specifying the required parameter's values associated with it. The software computes the variations of the processing time to estimate the delay time in each queue when the simulation runs.

As indicated previously, for the purpose of the demonstration here, we used data from one of the PHC facilities to find the Arena distributions at each station based on the scope of data available. Table 4 below lists the data to be captured for this simulation model at each station:

Table 4 – Data for the simulation model

Station	**Data need**
Patient Arrives PHC Facility	Patient's arrival rate
CDU Collection Decision	Percentage of patients coming for CDU package
CDU Pharmacy	Processing time per patient
Reception	Processing time per patient
Observation Room	Processing time per patient
Consultation CNP Decision	Percentage of patients going to CNP after vitals
CNP Consultation Room	Processing time per patient
Consultation Complete Decision	Percentage of patients visit complete after CNP
Doctor Consultation Room	Processing time per patient
Pharmacy	Processing time per patient

Whenever this simulation model needs to be customized for a specific facility, the accuracy of data collected at each station as indicated above is important to ensure that the simulation model will mimic as closely as possible the real system. For the purpose of demonstration, the following parameters were entered into the simulation model of the PHC facility we selected. Note that the distributions identified here were based on data available.

Table 5 – Parameters of the sample simulation model

Station	Distribution	Parameter Values	Resource
Patient Arrives PHC Facility	Exponential	Mean = 5 (1 patient arriving every 5 min)	N/A
CDU Collection Decision	Percentage of patients coming for CDU package	50%	N/A
CDU Pharmacy	Poisson	Mean = 3 min (Average processing time per CDU patient at CDU Pharmacy)	CDU Pharmacist (CDU PHAR)
Reception	Uniform	Min = 3 min; Max = 10 min	Set of Admin (rs ADM)
Observation Room	Poisson	Mean = 5 min (Average processing time per patient)	Set of ENA (rs ENA)
Consultation CNP Decision	Percentage of patients going to CNP after vitals	60%	N/A
CNP Consultation Room	Poisson	Mean = 10 min (Average processing time per patient)	Set of CNP (rs CNP)
Consultation Complete Decision	Percentage of patients visit complete after CNP	80%	N/A
Doctor Consultation Room	Triangular	Min = 10 min Mode = 15 min Max = 20 min	Set of MDO (rs MDO)
Pharmacy	Poisson	Mean = 9 min (Average processing time per patient)	Pharmacist (PHAR)

The capacity of each resource in our simulation model was set to one even though most of the resources were programmed as “Set” except at the pharmacy. Programming resources as “Set” will allow more easy modification and adaptation of the program when the capacity of a type of resource increases or decreases. Pharmacy was hard coded to one resource only because there is one window at a time that is usually designated to dispense the medications, despite the

fact that there might be a team of pharmacists and assistants working in the background to prepare the prescriptions. The availability of the resources is set to 100% as the simulation will run for one 8-hour day. This means the resources work 8 hours a day but actually spent more time at the facility since they have breaks and lunch. In practice, we would create schedules for each resource to account for their breaks and lunch times, particularly when we have more than one resource at a station.

The sample simulation model programmed here mimics the real system at the selected facility. Validation was performed by getting feedback from HCP at the facility and by comparing the outcome of the simulation with the observed data at the facility. All the parameters presented above can be modified in the software when customizing this simulation model for other facilities.

Running the simulation model in ARENA and analyzing the results

Simulation models in ARENA require a set of Run Conditions to be inputted in order to simulate what happens in the real system. The length and the number of replications are the main conditions to be set in the Run Setup menu. As presented in Figure 11 below, we set the number of replications to the default value of one for demonstration purpose. We do not use the Start Date and Time field, which is for associating a specific calendar date and time with a simulation time of zero. The Warm-up Period is also left at the default value zero for the purpose of this demonstration. We could specify the Warm-up Period at the beginning of each replication, after which the statistical accumulators are all cleared to allow the effect of possibly atypical initial conditions to wear off. The length of Replication is set to one 8-hour day and the Base Time Unit

is Minutes. It specifies the default time units in which time-based outputs will be reported, as well as how ARENA will interpret some time-based numerical inputs.

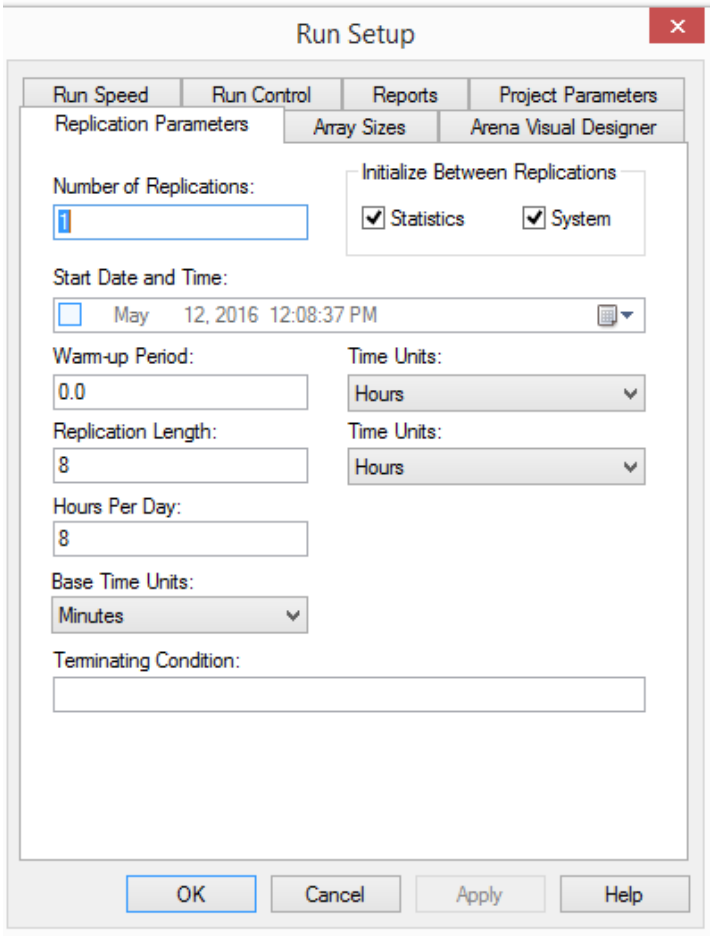

Figure 11: Replication Parameters Dialog Box

Figure 12 below shows the Project Parameters tab where we specify the Project Title, Analyst Name and Project Description, as well as the kind of output performance measures we want to be told about afterwards in the reports.

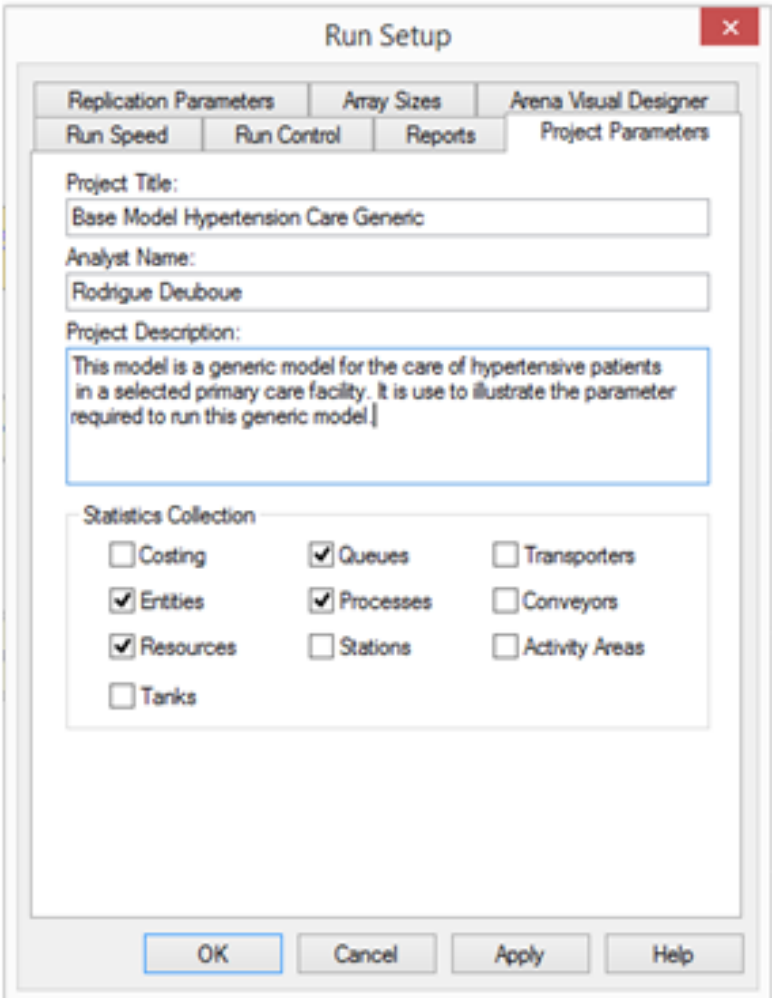

Figure 12: Project Parameters Dialog Box

Once the setup of the Run Conditions is complete, the simulation runs after ARENA has checked for errors. When we run the simulation model, we can watch the model animation where we see the Patient entities arriving and departing the facility. The Resource Picture changes its appearance as the Resource state changes between Idle and Busy. The Queues change as Patient entities enter and leave the facility. Figure 13 shows the simulation running with the number of entities processed at each station. A more readable image of this is presented in Appendix 13.

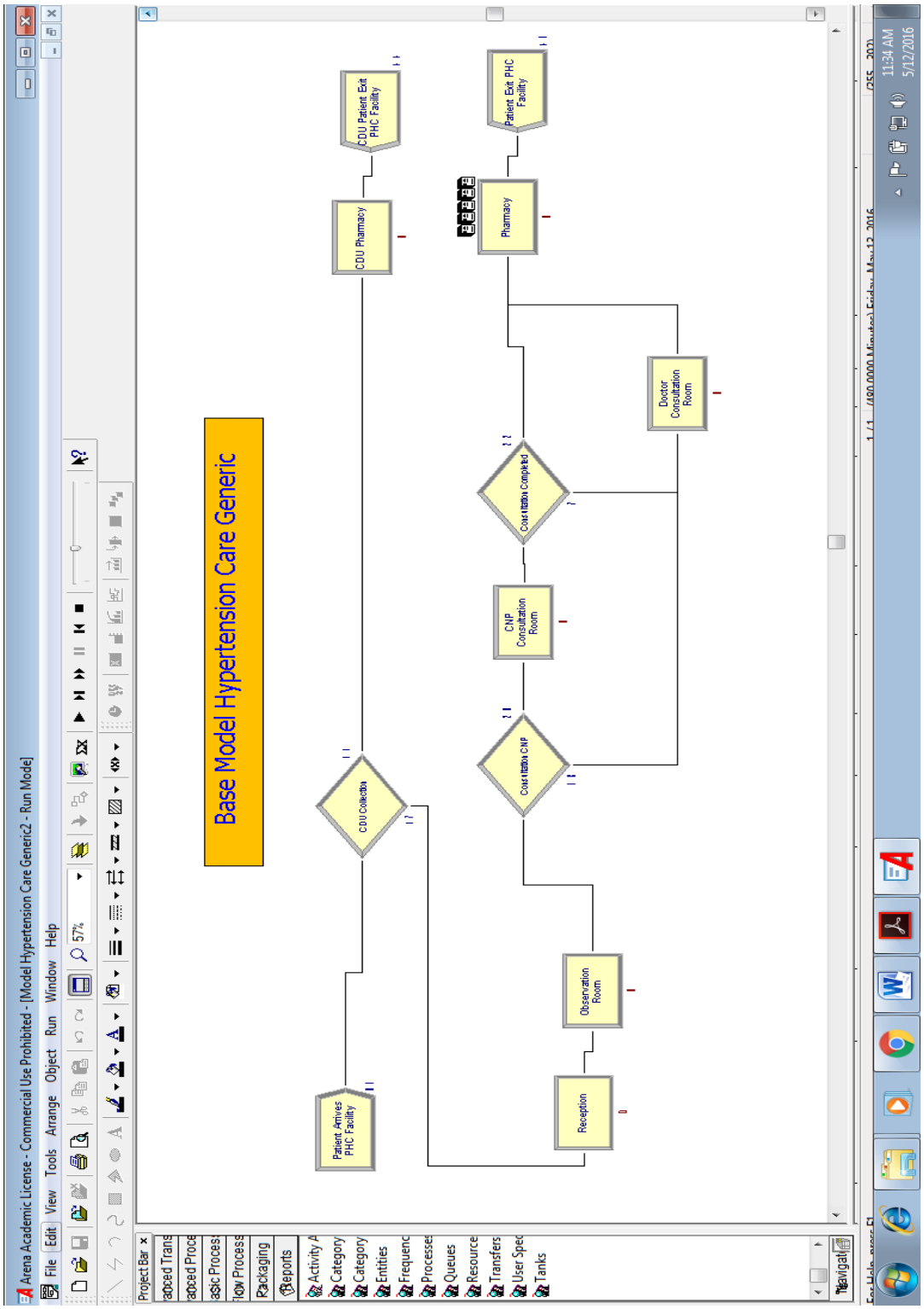

Figure 13: Simulation running in ARENA

At the end of the run, ARENA presents a box asking if we would like to view the Reports generated by the software. There are several Reports generated, but for our purpose we focus on the "Category Overview Report" that provides numerical results in terms of times and numbers in/out for the categories specified in the Run Setup window above: Entities, Resources, Processes and Queues. The full "Category Overview Report" for the sample simulation run here is presented in Appendix 15. An excerpt of this report with the parameters of interest is presented in Table 6 below.

Table 6 – Results of the sample simulation model

ENTITIES (Patients)				
Number In	**Number Out Total**	**Number In System at Closure Time**	**Total Time Average (min)**	**Total Time Maximum (min)**
91	85	6	36.35	166.01
PROCESSES, RESOURCES & QUEUES				
Resource (Qty)	**Usage (%)**	**Number Out**	**Wait Time Average (min)**	**Wait Time Maximum (min)**
Reception (1)	60.61	47	5.57	16.70
CDU Pharmacy (1)	29.17	44	0.90	9.41
CNP Consultation Room (1)	51.88	29	8.64	34.71
Observation Room (1)	52.50	47	2.28	15.18
Doctor Consultation Room (1)	81.75	25	19.98	47.97
Pharmacy (1)	75.29	41	14.23	63.73

This report summary shows that at the sample health center selected for demonstration purpose, at the end of an 8 hour work day, about 85 patients are fully processed with 6 more remaining in the system. In practice, the remaining patients will be processed completely before leaving, causing overtime work for the HCP. Some patients could spend close to 3 hours at the facility (166.01 min) during their visit. The reception, doctor and pharmacy are the most utilized resource-areas. The wait times are the highest at the doctor and the pharmacy level. Wait time at the pharmacy increases as the day goes by because it is the last station for all patients. Some patients may have to wait more than an hour (63.73 min) at the pharmacy. These performance measures might be improved by making changes to the system as investigated in the next section.

Testing possible changes to the system

The goal in investigating possible changes to the system is to increase the number of patients processed per day while improving their experience by reducing the waiting times and the total time spent at the facility. The main constraint is the limitation of the HCP available, particularly of pharmacists, doctors and nurse practitioners. The changes tested here are a combination of our personal analysis and the propositions collected during the interviews of the HCP at the various facilities visited. We investigated several possible changes, but we retained the following two scenarios for the purpose of this demonstration.

Scenario #1:

The following changes are made to the base simulation model for this scenario:

- Number of staff at Reception increased from one to two
- Number of staff at CNP Consultation Room increased from one to two
- Process improved at the Pharmacy to reduce mean processing time from 9 to 5 min

Following these changes, we ran the simulation model again and the results are summarized in Table 7 below.

Table 7 – Results of the sample simulation model Scenario #1

ENTITIES (Patients)				
Number In	**Number Out Total**	**Number In System at Closure Time**	**Total Time Average (min)**	**Total Time Maximum (min)**
159	136	23	56.34	174.75
PROCESSES, RESOURCES & QUEUES				
Resource (Qty)	**Usage (%)**	**Number Out**	**Wait Time Average (min)**	**Wait Time Maximum (min)**
Reception (2)	66.61	106	3.64	21.57
CDU Pharmacy (1)	32.92	52	0.98	6.94
CNP Consultation Room (2)	76.95	73	1.69	11
Observation Room (1)	99.14	99	45.82	90.64
Doctor Consultation Room (1)	84.05	26	21.38	45.04
Pharmacy (1)	87.68	84	9.68	40.00

This scenario assumes that the volume of patients coming to collect their CDU package remains sensibly the same as in the initial base simulation model. Also, a better triage system is put in place to limit the number of patients seen by the doctor to those who absolutely need it. The increase of patients arriving to the facility represents the additional flux of patients coming for their regular visit following scale up of interventions to treat more hypertensive patients in the population. These results show that by adding just two staff and slightly improving processes at the pharmacy, the number of patients processed overall increases by more than 50%. The utilization rate of all the stations also increases. The CDU Pharmacy remains at about 33% utilization rate on an 8-hour work day, which suggests that in practice, that station will be opened for CDU collection only a fraction of the day (8 am to 11 am for example). The number of patients processed for regular visits at the time of facility closure increases from 41 to 84, more than a 100% increase. The wait time is improved at most stations, particularly at the Pharmacy where the maximum wait time is reduced from 63.73 min to 40 min. The wait time at the doctor's office remains stable along with the number of patients that see the doctor. The overall time spent at the facility by patients and the wait time at the observation room station increase considerably. Scenario #2 focused on improving these performance measures while keeping the gains obtained with Scenario #1.

Scenario #2:

The following changes are made to the base simulation model for this scenario:

- Same changes as for Scenario #1
- Number of staff at Observation Room increased from one to two

After running the simulation for Scenario #2, the results are summarized in Table 8 below.

Table 8 – Results of the sample simulation model Scenario #2

ENTITIES (Patients)				
Number In	**Number Out Total**	**Number In System at Closure Time**	**Total Time Average (min)**	**Total Time Maximum (min)**
132	128	4	24.04	59.57
PROCESSES, RESOURCES & QUEUES				
Resource (Qty)	**Usage (%)**	**Number Out**	**Wait Time Average (min)**	**Wait Time Maximum (min)**
Reception (2)	54.85	82	0.93	10.22
CDU Pharmacy (1)	34.58	49	0.95	5.82
CNP Consultation Room (2)	65.01	63	2.54	10.78
Observation Room (2)	40.10	82	0.08	2.86
Doctor Consultation Room (1)	67.05	21	7.05	31.56
Pharmacy (1)	75.21	79	3.76	13.69

Scenario #2 maintains the same assumptions as in Scenario #1. As shown in the results table above, the performance improvements gained in Scenario #1 are kept and even enhanced. An important improvement obtained with the changes in Scenario #2 is the "Number In System at Closure Time" which is reduced from 23 to only 4, which means that less overtime will be required from HCP to flush the facility before actual closure. The maximum total time spent by patients in the facility is reduced from 166 minutes to about 60 minutes, which is by far the most important gain based on possible changes. This is linked to the significant reduction of the

maximum wait time at the doctor's office and at the pharmacy. It appears that Scenario #2 provides a much improved system both in terms of number of patients coming for regular visits processed, which double, and in overall time spent in the facility, which is reduced by almost 200%. Overall Scenario #2 is more efficient and offers a better quality of service, as wait times are significantly reduced.

Discussion

The results presented in this chapter show how the care of hypertensive patients can be modeled and simulated in order to test changes that can make the system more efficient. The data used here are mostly for demonstration purposes. In practice, key parameters that will need to be collected for each facility or health district have been identified in Table 4 of this chapter. Discrete data collected for each of these key parameters will be inputted into the ARENA Input Analyzer that automatically matches input data with the appropriate data distribution. The data distributions found may vary between facilities, depending on the characteristics of the patient population and the specific procedures implemented at the facility. The base model developed in ARENA could also be slightly modified if necessary for specific cases. The Run Set up parameters may be modified as well, depending on the facility, such as the number of hours per day for example. We need to acknowledge that in some facilities, the care of hypertensive patients may be combined with other patients experiencing other chronic conditions. Customization of the base simulation model for such facility will require the programming of schedules for each resources in the ARENA Software to account only for the time that the

resource is utilized for the care of hypertensive patients. The Schedule feature of the ARENA software also accounts for the break time assigned to resources on a daily basis.

The key performance parameters identified in our study are mostly related to various time measures such as time spent in the facility or waiting times. Khlie and Abouabdellah (2015) suggest, in their study on modeling and simulation of the patient pathway with ARENA, that the common performance indicators to assess health services are hospital bed occupancy rates, utilization of human resources, the period of appointment, waiting time, mortality rate, and average length of stay. This supports our choice of key performance assessment parameters, which must be compatible with the study objectives. The indicator volume of patients processed appears to be an important key parameter to assess the performance of the system, particularly when the aim of the modeling and simulation is to study resource allocation decisions in the event of increased patients' intake. Konrad, Tang, Shiner, and Watts (2015) recognize that there is currently no systematic method to determine the workforce necessary for a projected patient increase and recommend the use of discrete-event simulation as an analysis tool to quantify changes in performance indicators arising from experimental operational changes. Gunal and Pidd (2010) further suggest that simulation has long provided strong decision-making tools for health-care operations even before global accessibility to computers and the development of widespread software. Overall, simulation is considered to be more conducive for modeling systems of patient care (Davies & Davies, 1994) because of its ability to address the variability, complexity, and experimental nature common to health-care resource allocation problems (Roberts, 2011). All this reinforces our decision to use this approach to estimate the human resource needs in the event that interventions are scaled up to manage the epidemic of hypertension.

A major limitation of this approach is that it is very time consuming. After the base model is validated, experimental operational changes to improve targeted performance indicators appear to be similar to a trial and error method. One might need several attempts to obtain satisfactory performance indicators. Nevertheless, a good understanding of the logic of the patient flow within the facility will ease the process. A thorough analysis of the report generated after running the simulation of the base model will provide clues as to which parameters to change in order to obtain the desired performance indicators. At this stage, other considerations such as budget constraints and availability of space in the facility will need to be taken into account in order to reach the efficiency level targeted.

Conclusion

This important chapter shows how one can model and simulate the care of hypertensive patients in a given facility. It illustrates how the model can be used to answer some of the strategic and operational questions posed by the facility to improve the delivery of services, particularly when faced with an increased patient volume. The essential starting point of such a process was a good understanding of the existing patient flow patterns in the facility, acquired through data analysis of the interview transcripts conducted with HCP. This led to the development of the base model, and then the identification of the various parameters needed to program our model in the ARENA Software. After Run Set Up configurations, the simulation was run and generated reports with numerical results of the chosen key performance indicators. Based on the results obtained and the understanding of the logic behind the patient flow, experimental operational changes were implemented in the ARENA Software to find the

configuration that would provide the targeted performance indicators. The implementation of these experimental operational changes in the software were found to be very time consuming. In practice, this chapter has identified the key data that will need to be collected and processed with the ARENA Input Analyzer, in order to configure the discrete-event simulation model for a given facility. Overall this chapter has developed the road map to be followed by each facility to estimate the resources needed to handle increased patient volume.

CHAPTER 7:

SUMMARY OF FINDINGS, IMPLICATIONS, AND CONCLUSION

This final chapter summarizes the research findings, then discusses various implications of the findings at different levels and concludes with some recommendations. The summary of research identifies key findings for each research question based on interviews, observation, and analysis.

Summary of Findings

Key Findings Related to Research Question 1

What are the challenges of the South African health care system, particularly of the Western Cape Province, in the care of hypertensive patients?

1. Long waiting time, high volumes of patients above facility capacities and patients' "doctor philia" attitudes severely affect the management of the patients' visits at the PHC facilities. Effective management of patient visits requires that patients spend the least amount of time within the facility while still receiving quality care.
2. The human resources available at the PHC facilities are not always adequate in relation to the volume of patients visiting on a daily basis. High turnover rates were identified as an important contributing factor to staff shortages. Staff related issues go beyond the shortage of certain staff, mainly doctors and pharmacists, and address the way human resources are organized to provide the best possible care for the patients

3. Variances in the implementation of treatment guidelines prevents standardization of care. As patients migrate within and across provinces, lack of standardized care leads to poor treatment outcomes.
4. Space, floor plans and technology were identified as the main infrastructure limitations impacting the care of hypertensive patients. The impact of the limitations with the physical infrastructure is worsened by the lack of technologies that could facilitate the work of HCP. The general view was that computer systems can help to speed up the processing of patients in various ways.
5. Poor patient's compliance to treatment schedule, adherence to medications, awareness of their condition and discipline highlighted issues about patient responsibilities. The ultimate outcomes are highly dependent on patient attitudes and abilities to follow the instructions given to them by their providers.
6. Potential solutions to these challenges were suggested by providers: implementation of club systems for stable patients, use of the Chronic Dispensing Unit along with the community support, introduction of alternative sites to dispense pre-packed medications, and access to a well-functioning computer system were the most important ones identified.

Key Findings Related to Research Question 2

How is the current supply chain management system of antihypertensive medications in the Western Cape Province organized?

1. The drug supply chain management system features a set of functions that are closely interrelated: Tender Process, Procurement, Storage, Inventory Control, Distribution and

Quality Assurance. A map of the system has been developed highlighting the main stakeholders.

2. The Tender Process, which is an important portion of this supply chain management system, is out of the control of the province. The late award of contracts because of the lengthy tender process is usually the cause of the most recurrent issue: out of stock.
3. The Chronic Dispensing Unit is an important innovation that allows the pre-packing of medications for stable patients at a central location and direct delivery at their assigned health center.
4. Distribution of pre-packed medications is sometimes done at alternative sites in the community, closer to the patients and outside the PHC facility.
5. There are issues that need to be tackled to improve the entire system. The most important issue is the current fragmentation of the computer systems that support the drug supply chain management system. A single system will definitively resolve a lot of the issues currently observed and provide more safety to the patients.

Key Findings Related to Research Question 3

Using modeling tools, how to determine the minimum number of health workers required at each supply chain interval to ensure successful delivery of medications when scaling up interventions?

1. A generic base model of care for hypertensive patients was developed, which represents the common pathway of patients in the PHC facilities of the WC Province. The particularity is

that all patients end their visits at the Pharmacy where they collect their medication before leaving the facility.

2. The ARENA Software is a modeling tool that is used to simulate the current model of care with the reported staffing levels and test changes virtually to the model to improve the waiting time, while increasing the patient intake. Testing changes is an iterative process that could be time consuming but the reports generated by the software provided adequate information to guide the changes depending on the target results.
3. The sample data used showed that with a few more nursing staff and slight changes to the processes in place, the facility could process many more patients with much improved waiting times.
4. The model configured in the ARENA Software could be easily customized for specific PHC facilities and the set of data to be collected for the model's parameters has been specified. The ARENA Input Analyzer tool is used to determine the various distributions for the specific facility based on data collected.

Implication of Findings

As stated earlier, hypertension is a major health concern world-wide and is also the most common cardiovascular disease risk factor. Poorly managed hypertension results in a wide range of complications such as heart failure, kidney failure, damage to coronary arteries, disability, poor quality of life and eventually death (Bielecka-Dabrowa, Aronow, Rysz, & Banach, 2011; Georgiopoulou, Kalogeropoulos, & Butler, 2012). Many of these complications are irreversible

and very costly to the health system. Adequate blood pressure control in the population is necessary to prevent organ damage and life-threatening complications due to hypertension. While prevention of hypertension is possible, early detection and effective management of treatment can significantly reduce the incidence of adverse clinical outcomes (Israili, Hernandez-Hernandez, & Valasco, 2007). Population-based health education, dietary and life-style modification and pharmacological therapy are all effective measures to reduce the prevalence and increase the control rate of hypertension (Shrivastava, Shrivastava, & Ramasamy, 2014).

It is evident from this research that significant challenges to the effective management of hypertension in the primary health care facilities of the Western Cape Province in South Africa need to be addressed for the health system to be ready to tackle the present and increasing hypertension epidemic. This will require a multitude of actions by various stakeholders at different levels such as policy makers, health care personnel management and educational institutions. The suggested actions described below will help to satisfy the recommendations of the Yamey Framework when scaling up interventions. These actions cut across the various levels of the framework from the importance of simplicity of the interventions to be scaled up at level I of the framework, to the systematic use of evidence to guide the process and incorporate new learning as the scaling up at level VI of the framework.

As reported in our literature review chapter, the majority of people with hypertension are undiagnosed and not on treatment, while primary health care facilities are already overcrowded with high volumes of patients above their current capacities. Tackling the hypertension epidemic suggests that most of those undiagnosed hypertensive patients that require treatment with medication are brought into the health system through massive screening programs and taken care of for the long term to ensure that their hypertension condition is well managed. This

research study did not cover the screening mechanism that could be put in place targeting these undiagnosed patients. Regardless, actions by the various stakeholders will have to be coordinated to provide effective health services to a much larger hypertensive patient population than is presently being served, within limited overall health care resources. Cost-efficiency in health care service provision is especially important from a population health perspective because unnecessary health care spending represents an opportunity cost to public investments in other important social determinants of health (e.g., employment, education, sanitation, food security and so on). We acknowledge however that some of the suggested actions presented below might be already considered as part of the National Health Insurance program that is still in its pilot phase.

Implication for Policy Makers

Research findings are useful only when they can be translated into policy changes. As such it is very important that possible policy changes based on our findings be discussed here. The disparity observed between rural and urban areas regarding the availability of human resources, particularly pharmacists and doctors, needs to be addressed by revisiting the Occupational Specific Dispensation (OSD) policy of 2007 mentioned in chapter 4. A new addition to this policy could focus mainly on these two cadres, pharmacists and doctors. A mandatory term assignment in rural areas for all new recruits in the public sector could help ensure that more of these cadres are available in adequate numbers and in a more sustainable way. Financial incentives geared specifically for assignments in rural areas could also complement these policy changes, which may increase their retention rate.

Another action to address the human resource issue could be the implementation of a third party nursing staff replacement agency that will support health facilities when they experience critical temporarily staff shortages, beyond a set threshold. This suggestion was derived from comments received when interviewing health care personnel where they highlighted the need to facilitate the quick replacement of staff when they are temporarily absent for various unpredictable reasons. This third party agency would employ nursing staff on an on call basis, covering the entire province with regional hubs in charge of predetermined geographic areas. PHC facilities process these patients at a certain rate as we saw in the simulation chapter, and the staffing level is intimately linked to the volume of patients that could be processed each working day. Scaling up interventions to bring more patients into the system implies that PHC facilities will be required to maintain a minimum rate of patient processing on a daily basis for the system to be sustainable. The health department will determine the critical staffing level below which a PHC facility will be allowed to request temporary staff through this third party agency. Further economic studies will need to be done to verify the cost effectiveness of such measures prior to actual implementation.

The National Treasury in South Africa enforces the implementation of the Public Finance Management Act (PMFA), which sets the scene for government to get good value for money ("The Public Finance Management Act," 1999). As such, strict rules for the use of money have to be followed that sometimes do not serve the intended purpose in the pharmaceutical sector, which would be to get good value for health Rands in drug purchasing and procurement. Some administrative requirements are too stringent for big pharmaceutical companies for which South Africa represents a very small market and, as such, they do not show interest to supply the country even though they could offer competitive pricing. The majority of these companies are

foreign companies with local representation in South Africa, but a lot of the documents required usually have to come from their headquarter overseas. There is a need for a smoother application process to bid for tender. This was suggested in several interviews by key informants that are involved in the tender process for pharmaceutical products. A national database of suppliers with online application features, will definitely improve this process by eliminating a lot of repetitive tasks that companies now have to fulfill each time they bid for a contract. This suggestion was derived from our analysis of the challenges reported.

The CDU is a central piece of the drug supply chain in the WC province and comes with a cost. In the event that interventions are scaled up to serve many more patients in the public health system, the volume of prescriptions processed by the CDU will equally increase. The CDU charge by prescription processed. It would be advisable that a study be conducted to project the potential cost of the CDU services in the future, using the current pricing scheme to ensure that the projected cost will be sustainable and cost-effective. That study could also provide a deeper assessment of the CDU process and suggest possible improvements to handle considerably increased service demand to the CDU system. In the meantime, other alternatives could be explored such as a postal service delivery system.

The South African Pharmacy Council (SAPC) is the regulator established by the Pharmacy Act to regulate pharmacists, pharmacy support personnel and pharmacy premises in South Africa ("Pharmacy Act," 1974). There is a debate in the profession regarding the determination of the pharmacist professionally responsible for CDU medication packages, whether it is the pharmacist located at the CDU office who supervised the filling of the prescriptions or the pharmacist at the PHC facility (or alternative site) who hands out the medication package to the end-user patient without necessarily checking its content. Currently,

as per the SAPC regulations, the pharmacist responsible is the last one to hand out the medication to the patient, which is problematic for CDU packages as the CDU pharmacist has not checked the prescription against the package content. It is evident that the Pharmacy Act was not written considering a useful service such as the CDU and it would be advisable to amend the Act to provide more clarity on this issue.

South Africa has developed and published an ambitious strategic plan for the prevention and control of non-communicable diseases for the period 2013 to 2017 with 10 clear 2020 goals and targets among which target 9 is to "Increase the percentage of people controlled for hypertension, diabetes and asthma by 30% by 2020 in sentinel sites" (Ministry of Health, 2013). Using our simulation approach developed in chapter 5, it would be advisable to commission an economic study to assess the projected financial burden to reach these targets as the simulation will give an idea of human resources required to process diagnosed hypertensive patients following the controls. The simulation study, however, suggests that minimal increases in staff could yield hugely increased patient flows, making its findings both economically and politically attractive.

The implications discussed here are related to levels II, III, and V of the Yamey Framework. The attributes of the implementers described at level II are illustrated through the proposal to amend the Occupational Specific Dispensation (OSD) policy of 2007 and third party staff replacement recommendation. The Chronic Dispensing Unit (CDU) is a representation of the delivery strategy for the service provided, which is the theme of level III. The socio-political, fiscal and cultural context described at level V has inspired the recommendations to revisit the pharmacy act and conduct further economic studies on the proposed solutions.

Implication for Health Care Personnel Management

The recommendations discussed here have a direct impact on the attributes of the people in charge of delivering the services and the way the service itself is designed. These refer to the levels I and II of the Yamey Framework. The simulation approach developed in chapter 5 has identified a set of parameters that would be required to configure the model of care in the ARENA Software for specific PHC facilities. This implies that procedures to routinely collect these data would need to be implemented in the facilities by HCP management prior to the configuration of the model. Given the management structure of the public health system in South Africa, these data could be aggregated at the level of the health districts or sub-districts so that each of them will have customized models of care configured in the ARENA Software. Training will need to be provided to managers so that they are able to input parameters and run the simulation to determine the appropriate staffing levels needed for the volume of patients they target to process on a daily basis. The health district management team should supervise and coordinate these operations to ensure that when it is time to add staff, it is added at the right place.

Each health district or sub-district will need to study the various models of care in place in their jurisdiction and attempt to harmonize the procedures within their jurisdictions. Considering the foreseen increase of patient intake, health district management teams will also have to determine the appropriate models of care suitable to their environment, taking in account the characteristics of their patient population. A study to determine the usefulness of widespread implementation of the club system should be undertaken, with the results harmonized for each district.

More exchanges between management of PHC facilities is needed to ensure that best practices across the province are shared and replicated accordingly. Some brilliant solutions were reported in some facilities which other facilities in similar situations were unaware of. Improved communication between facilities will also help to harmonize the implementation of treatment guidelines and clarify certain concepts such as the definition of a stable patient in order to standardize care.

Implication for Educational Institutions

Educational institutions present in the community offer the required training that the providers will need to deliver the appropriated services. Providers themselves come from the community and these institutions are supported by the community in various ways. Recommendations to these educational institutions are guide by level II and IV of the Yamey Framework that are related to the attributes of the implementers and the attributes of the adopting community. The primary health care system in South Africa is nurse-driven with clinical practitioner nurses holding positions of operational manager for the most part. There is a need for additional management training to provide them with appropriate skills to manage high volumes of patients using simulation tools. Operational managers should be able to test changes to their current services before actually implementing those changes. This requires minimum training on the use of simulation software. Operational managers will be able to predict the impact of adding or moving staff on productivity in terms of patient processing. This additional training for the use of simulation software can be designed in the form of short courses or seminars.

In the event that more interventions to treat more hypertensive patients are implemented, a comprehensive re-assessment of the human resource needs is necessary and the simulation

tools will provide useful information for that. The needs will be assessed based on the targets set by the Department of Health. This should translate into action at the level of educational institutions that should be able to set their students' intake target based on the needs in the field. Nursing staff with reinforced capacities are the bulk of the human resources necessary to scale up these interventions. They in fact appear to be less costly to train than doctors or pharmacists.

Implication for the rest of South Africa and other countries

The Western Cape Province, despite the numerous challenges identified, is well ahead of other provinces in South Africa and other Sub-Saharan African countries in hypertension control. Many procedures and best practices can be replicated in other settings. Models of care developed can be customized as well. The simulation configured in the ARENA Software can be easily adapted in other settings to estimate the human resource needs. The findings of this research will serve as evidences for future scale up projects, and this refers to level VI of the Yamey Framework, the research context, which recommends the systematic use of evidences to guide the scale up process. Overall this research implemented in the Western Cape Province might inform other provinces and countries in Sub-Saharan Africa, given their lack of data and likely much poorer health infrastructure. Also, policies and recommendations from international organizations could be informed by our research, which will therefore assist with better targeted funding. The possibility to apply our findings to others countries or regions is an added value to our work.

Conclusion

This research suggests that there are numerous challenges to the effective management of the hypertension epidemic in the PHC facilities of the WC province in South Africa. The current system is working to a certain extent but is full of limitations that need to be addressed if interventions are going to be scaled up. It is a fact that the majority of hypertensive patients remain undiagnosed and effective management of this epidemic requires that the large portion of these patients are brought into the system. High volumes of patients will put more pressure on the PHC system but proper planning with appropriate tools should make this manageable. This research has shown how the resources needed can be estimated based on set targets over a period of time. Further economic studies based on our findings will be necessary to determine the financial resources required to reach these targets. The study has also identified barriers both at the operational level in PHC facilities and within the drug supply management system that will need to be overcome to improve the current processes and ensure that they remain sustainable when increasing exponentially patient intake. Potential solutions have been explored and discussed coming from study participants and further analysis of our data.

Addressing this hypertension epidemic is a huge and difficult task that will require a significant amount of resources. This dedication of resources however will be beneficial in the long run as many complications such as cardiovascular and cerebrovascular will arise without such intervention that are more costly for the health system to manage, and loss-of-life can be prevented. Political will is necessary for such an initiative to be successful and we are confident that this research is timely and very much in line with a present ‘window of opportunity’ for the policy makers in South Africa in general and the WC province in particular. This province has

already begun inquiring about the minimum resources package necessary to address this epidemic. The results of this research clearly contributes to the determination of that minimum package and also provides many other insights into how the management of hypertensive patients in the PHC facilities of the WC province might be improved. Other provinces in South Africa and other countries in Sub-Saharan Africa can definitely benefit from the results of this research as they can be easily customized to different environments.

Dissemination plan for results

As mentioned before, there is discordance between the evidence available for prevention and control of hypertension in Africa and the evidence needed to scale up services. We were affiliated with the South Africa Medical Research Council (SA MRC) and Cape Peninsula University of Technology in South Africa (CPUT) for this research project that is of high interest to them as well. Together we will continue the dissemination of our results at the local and national levels through a variety of media and mechanisms, including news media, stakeholder meetings, public presentations, and web-based and social media. The MRC and CPUT have a substantial track record in dissemination of knowledge. The MRC is a reference in South Africa on health related issues.

We have already made presentations to researchers both at the SA MRC and the CPUT. They were able to comment on the preliminary results of our field investigation both on the process and the findings. Their input was important for the data analysis phase that followed. Our study protocol was published in the Journal of Medical Internet Research (JMIR) Research Protocol and can be accessed at: http://www.researchprotocols.org/2016/1/e35/

We are also planning to continue to publish our findings in scientific journals after the dissertation defense. This will ensure the dissemination of our results at the international level. Our abstract was accepted for oral presentation at the International Health Conference 2016 held at the Kings College London, UK in June 2016 (http://globalhealthcongress.org). The presentation received great feedback and attendees showed much interest in the topic. We will continue to look for opportunities to present our research at local and international conferences.

Thesis Strengths and Limitations

Strengths:

- This empirical study used mainly primary data obtained from interviews of practitioners and stakeholders that are directly involved in the day to day activities linked to the care of hypertensive patients. They are the potential implementers of any future policy changes.
- The integration of modeling and simulation tools into our research is a great illustration of how techniques from various disciplines can be used to provide solutions to population health issues. Such interdisciplinary approaches allow for innovative solutions to health issues.

Limitations:

- A major shortcoming of this research is the fact that we were not given access to the two health district of the Western Cape Province where the National Health Insurance pilot project was being conducted. There are chances that some of our findings and recommendations do not apply to those two health districts.

- The study was circumscribed to the Western Cape Province whereas the initial intend was to cover the entire country. Due to financial and logistical limitations, we had to choose only one province to conduct the study, losing out on the comparative analysis that could have enriched the study if we were to collect data in more than one province.

Reflections: A Postscript

I embarked in the PhD program 4 years ago, coming from the professional world where I was working full time in the pharmaceutical industry, mainly clinical research. Switching back to the academic life as a full time student was both challenging and exciting. It was quite difficult to adjust to the high pace in the program during the first year because I had too much to learn in a short period of time, but I enjoyed the progression that I made, particularly with my scholarly writing and my critical thinking skills. During the course of this PhD program, I also developed and improved my academic research skills including literature review with databases, the importance of accurately citing references, the design and implementation of all phases of study field work, and the management of research projects with strict timelines. My involvement with the student's association and the PhD program committee allowed me to contribute to the improvement of the students' experience in the program and participate actively to collective actions organized by the student body. I had the privilege to serendipitously meet so many wonderful new colleagues over the past four years, and developed close relationships with some of them. I hope to keep interacting with many of them both professionally and socially after I graduate.

Looking back at my journey in this PhD program in population health, I have to admit that my previous academic and professional background have influenced my choice of research topic and the approach I followed in my research. Population health has always represented for me a complex concept that requires a mix of disciplines to be studied, just like complex systems in engineering. In fact the population health lenses that I have acquired through this program now makes me see everything in life as connected, with multiple ways to understand and make

changes to systems. Having previously studied electrical and pharmaceutical engineering, then working in the pharmaceutical industry for many years mostly in drug development research, I later developed high interests in broad health issues, particularly in areas of health systems and pharmaceutical products. My thesis embodied very well these two components that are also recognized as important social determinants of health in the population. My research topic led me to conduct field work in a foreign country, which was a very rewarding experience.

Going to South Africa for the first time to conduct research, the assistance of the team at the Non-Communicable Diseases Research Unit (NCDRU) of the South Africa Medical research Council (SA MRC) was very important to the success of my research. I had the opportunity to network with very talented individuals that did all they could to assist me during my stay there. The health care personnel and the various key informants that I met on the field taught me, each in their own way, a bit about the South African culture and realities. I literally took driving lessons, as their driving system is different from what I am used to in North America, to overcome the transportation challenge that was delaying my work on the field. During the course of my field work, I experienced a couple of situations that could have been life threatening, and that made me to consider how important this thesis was to me personally as I did not give up despite the risks associated.

The theoretical approach that guided my research through the Yamey Framework was found to be appropriate to investigate my research topic. The concept of "learning by doing", which is central to this Framework, had allowed us to develop a research design focusing on the implementers, and that led us to the important findings presented in this thesis. To that extend, this thesis suggests that this Framework is appropriate to study such research questions related to scaling-up interventions.

Overall this research project allowed me to develop further my skills in research project management, particularly in foreign countries. I have learned a bit about how to take in consideration local context and culture when implementing a research project. Visiting health centers, particularly in poor neighborhoods, was a very touching experience. The ability to contribute to the improvement of health systems in resources-limited settings is a source of motivation that encourages me to seek further similar opportunities for my future career. I am interested in working in international development, focusing on health related issues, including access to pharmaceutical products. I have recently committed to six months volunteer placement within the United Nations system, where I will be contributing to an ongoing medicines procurement support service project in a foreign country. I am confident that the experience acquired during the course of this thesis, as well as my previous education and professional experience, will help me make valuable contributions to international development projects in my future career.

Finally, I personally think that doing a PhD is really a challenge, not particularly the work itself, but the process of it, the many sacrifices, and the need to be very self-reliant. I have definitely learned to motivate myself, which was much needed, and to set up and keep to a timetable. The journey was long, difficult, but rewarding.

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Appendices

APPENDIX 1

SUMMARY OF RESULTS FROM THE HCP DATA

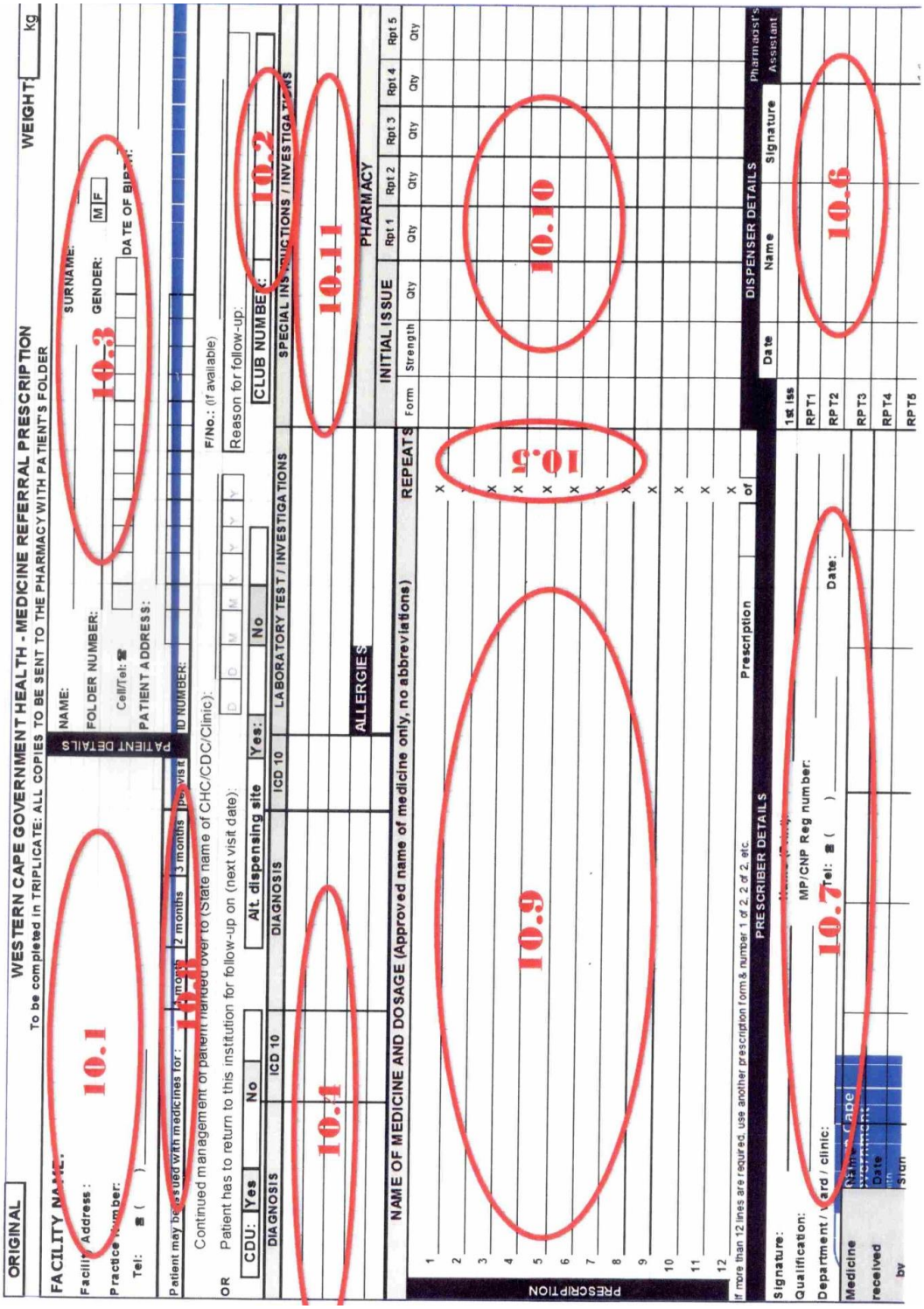
DEMOGRAPHICS: AGE – SEX – POSITION – LOCATION – SETTING – EXPERIENCE

P-DOCS	SETTING MET/NMET	EXP: Cur	EXP: Over	POSITION	AGE	SEX: M/F	PHC#
P1	MET	13	35	MGR	53	F	PHC1
P2	MET	4	4	ENA	41	F	PHC1
P3	MET	7	30	MDO	59	F	PHC2
P4	MET	2	2	ENA	38	M	PHC2
P5	MET	8	12	ADM	33	M	PHC2
P6	MET	4	26	MGR	58	F	PHC2
P7	MET	1	4	MDO	28	M	PHC1
P8	MET	20	24	CNP	56	F	PHC2
P9	MET	35	35	ADM	53	F	PHC1
P10	MET	14	14	CNP	52	F	PHC1
P11	MET	2	2	MDO	28	M	PHC3
P12	MET	28	28	MGR	55	F	PHC3
P13	MET	7	30	ADM	54	F	PHC3
P14	MET	3	4	ENA	27	F	PHC3
P15	MET	4	29	CNP	52	F	PHC3
P16	MET	5	25	PHAR	47	M	PHC4
P17	MET	1	5	MDO	28	M	PHC4
P18	MET	8	10	ENA	37	F	PHC4
P19	MET	27	27	ADM	54	F	PHC4
P20	MET	3	25	MGR	49	F	PHC4
P21	MET	24	24	ENA	58	F	PHC4
P22	MET	3	23	CNP	54	M	PHC4
P23	MET	1	18	MGR	41	F	PHC5
P24	MET	3	15	CNP	37	F	PHC5
P25	MET	1	5	PHAR	29	M	PHC2
P26	MET	1	11	PHAR	33	M	PHC1
P27	MET	4	11	PHAR	35	M	PHC3
P28	MET	8	14	PHAR	40	M	PHC5
P29	NMET	2	14	PHAR	38	F	PHC6
P30	NMET	11	34	PHAR	60	M	PHC7
P31	NMET	5	30	PHAR	55	F	PHC8
P32	NMET	2	4	PHAR	46	F	PHC9

P33	MET	2	4	ENA	31	F	PHC5
P34	MET	2	10	MDO	35	F	PHC5
P35	MET	16	16	ADM	48	F	PHC5
P36	NMET	6	35	MGR	53	F	PHC6
P37	NMET	11	11	ENA	33	F	PHC6
P38	NMET	15	28	MDO	52	F	PHC6
P39	NMET	2	27	CNP	49	F	PHC6
P40	NMET	10	15	ADM	32	M	PHC6
P41	NMET	1	30	ENA	51	F	PHC7
P42	NMET	1	40	MGR	59	F	PHC7
P43	NMET	14	20	CNP	45	F	PHC7
P44	NMET	1	1	ADM	27	F	PHC7
P45	NMET	1	14	MDO	39	M	PHC7
P46	NMET	30	30	CNP	53	F	PHC8
P47	NMET	9	9	ENA	32	F	PHC8
P48	NMET	5	10	MDO	34	F	PHC8
P49	NMET	8	10	ADM	37	F	PHC8
P50	NMET	1	30	MGR	53	F	PHC8
P51	NMET	30	30	ENA	60	F	PHC9
P52	NMET	14	26	MGR	46	F	PHC9
P53	NMET	2	5	ADM	26	M	PHC9
P54	NMET	17	26	CNP	55	F	PHC9
P-DOCS	SETTING MET/NMET	EXP: Cur	EXP: Over	POSITION	AGE	SEX: M/F	PHC#

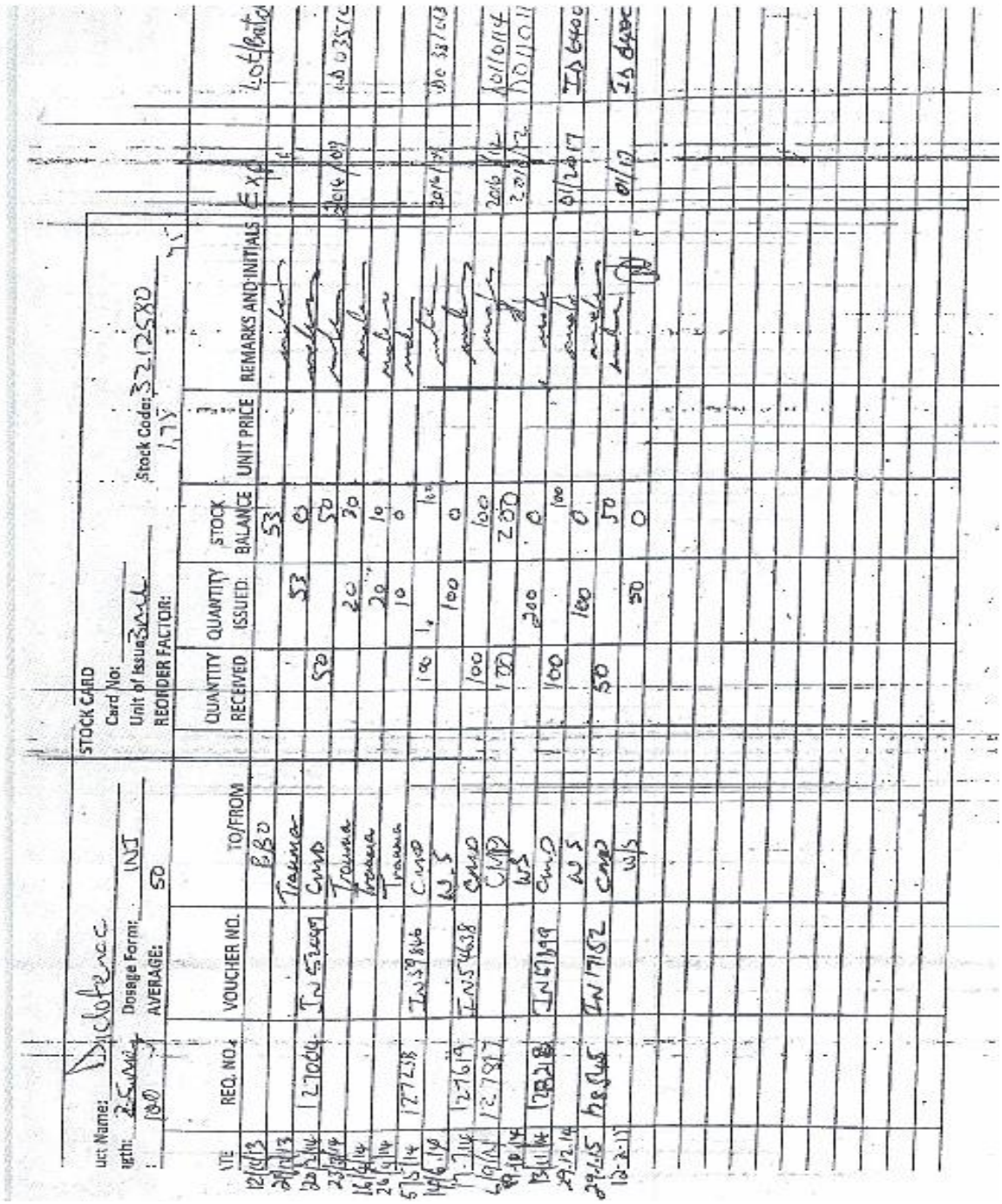
APPENDIX 2

WESTERN CAPE GOVERNMENT HEALTH - MEDICINE REFERRAL PRESCRIPTION



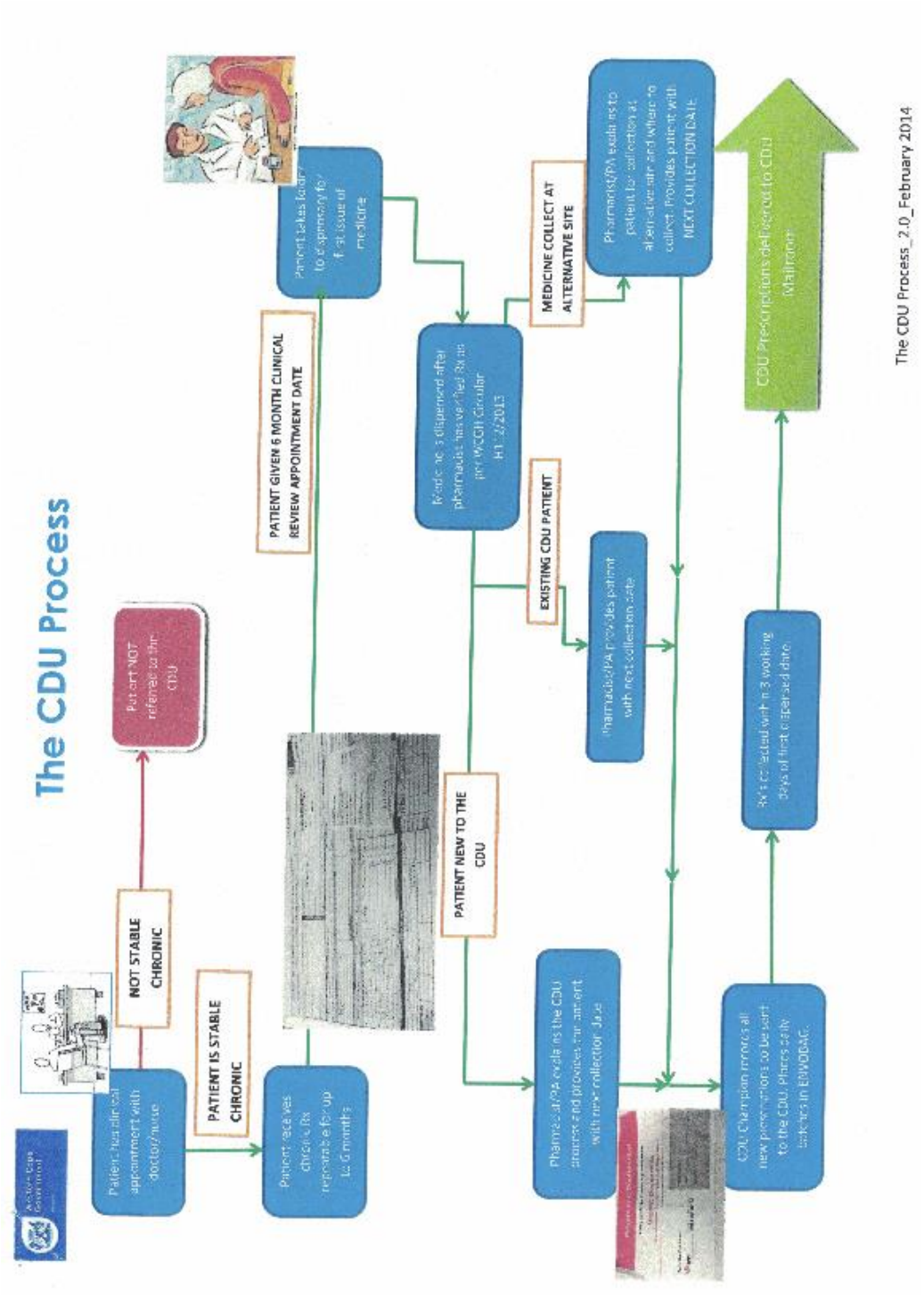
APPENDIX 3

SAMPLE STOCK CARD – MEDICINE INVENTORY CONTROL



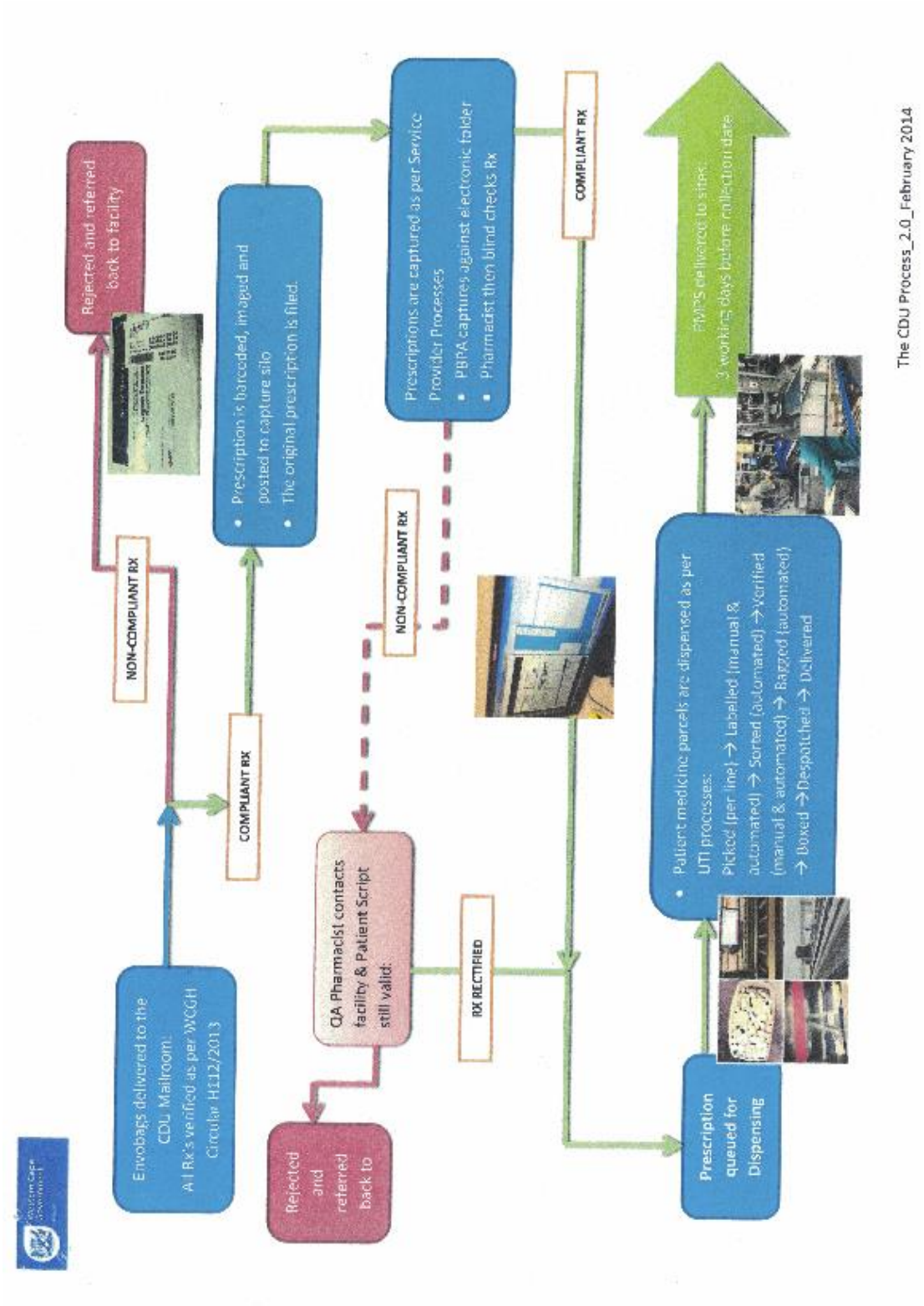
APPENDIX 4

THE CDU PROCESS (1)



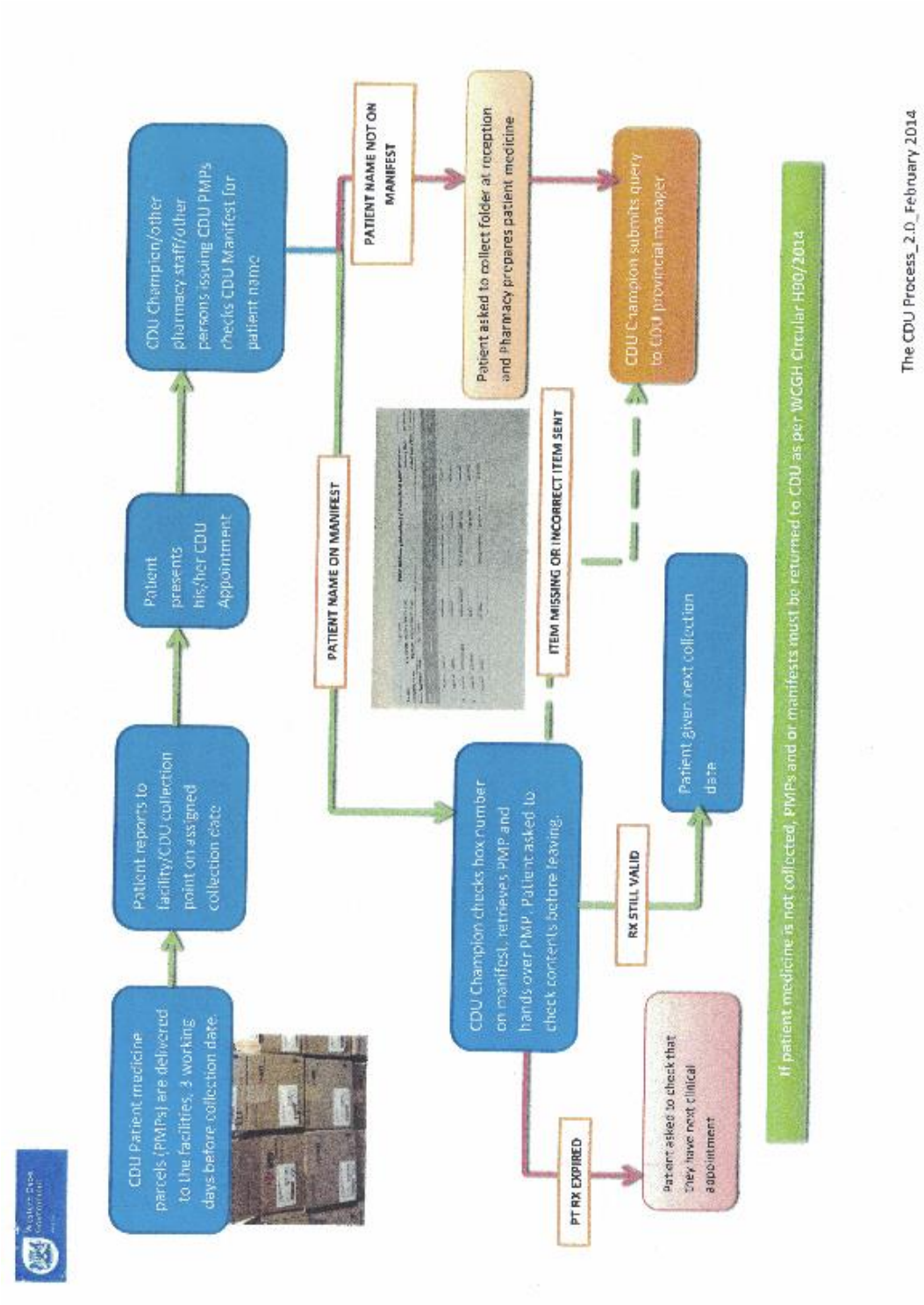
APPENDIX 4

THE CDU PROCESS (2)



APPENDIX 4

THE CDU PROCESS (3)



APPENDIX 5

SUMMARY OF RESULTS FROM THE KIN DATA

DEMOGRAPHICS: AGE – SEX – POSITION– SETTING – EXPERIENCE

P-DOCS	SETTING/POSITION	EXP: Cur	EXP: Over	AGE	SEX: M/F
P 1	DOH Policy Managers	0.5	13	37	F
P 2	DOH District Pharm Managers	6	12	37	M
P 3	DOH District Pharm Managers	0.6	26	49	F
P 4	DOH District Pharm Managers	9	12	36	F
P 5	DOH Policy Managers	8	15	62	F
P 7	DOH District Pharm Managers	6	25	55	F
P 8	DOH Policy Managers	1	15	41	F
P 9	DOH District Pharm Managers	14	31	55	M
P 10	DOH District Pharm Managers	0.5	23	44	F
P 11	DOH Policy Managers	2	30	53	F
P 12	DOH Policy Managers	2	20	42	F
P 13	DOH Policy Managers	1.3	12	33	M
P 14	DOH District Pharm Managers	5	30	53	M
P 15	DOH Agencies CDU	5	15	38	F
P 16-1	DOH Agencies CMD	5	30	56	M
P 16-2	DOH Agencies CMD	3	14	37	M
P 17	DOH Policy Managers	1.5	14	33	F

APPENDIX 6

INTERVIEW GUIDE – HEALTH CARE PERSONNEL

Interview Guide - HEALTHCARE PERSONNEL

Public Hospital - Hypertension Clinic/ NCD unit Healthcare Personnel: Semi-Structure Interview Guide

Good Day Mr. / Mrs.

We are conducting a research study on Health Systems Readiness to Manage the Hypertension Epidemic in the primary health care facilities in the Western Cape, South Africa with the collaboration of the South African Medical Research Council.

The purpose of the study is to provide information on the diagnostic, treatment and control of hypertension in South Africa public health sector.

You have been identified as a key person that could provide valuable information for the success of this study. We would like to invite you to participate to this important study for the South African Health System. We are providing you with the informed consent form for your consideration should you agree to participate to the study.

Identification:

1. Gender: Male / Female
2. Age:
3. What is your current position in the organization?
4. In average how many hours do you work a week?
5. How long have you been at this position?
6. What was your previous position?
7. Overall how many years of professional experience do you in this field?
8. Did you receive an academic training in relation to your current position? If so what training, content and duration?

Questions for facility managers:

9. Describe briefly the typical pathway of NCDs patients in this clinic from entrance to exit, including rough estimates of average overall time duration. What unit or department usually takes the most time per patient?
10. Describe briefly the organizational structure of this facility including the various units or department, staffing levels, appointment system, and health information systems in use.
11. How are patients with or at risk of hypertension processed at the hospital, from making an appointment through arrival through health assessments and medication collection to departure? Please describe the individual processes and healthcare facility personnel involved.
12. What ensures that these processes are effective and efficient? Are there identifiable issues that could improve effectiveness and efficiency?

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13. Are there any problems or obstacles experienced by patients or healthcare providers within these processes? What actions are being undertaken to overcome these problems or obstacles?
14. Does the hospital have a dedicated hypertension clinic? If so…How often is it run and for how long? What is the composition of the team that runs the clinic? Approximately how many patients are consulted in average per run?
15. Describe the software or computer applications used for the management of patients within this facility including appointment system, referral to other hospital, drug prescriptions, lab work, pharmacy, etc…

Questions for pharmacy personnel and pharmacy managers:

Please answer the following questions with reference to anti-hypertensive medications:

16. Describe briefly the organizational structure of the pharmacy department including staffing levels.
17. Describe briefly the typical pathway of NCDs patients in this pharmacy department from entrance to exit, including rough estimates of average overall time duration. Any particularity in the care of hypertensive patients?
18. Describe briefly your role within the pharmacy department.
19. What are the commonly prescribed anti-hypertensive drugs in this hospital?
20. Quantification: What systems are used to estimate drug needs?
21. Procurement: How are medications procured and how are adequate levels of required drugs maintained?
22. Storage and inventory control: How are medications stored and kept safe?
23. Distribution: How do medications reach patients? How is accessibility insured?
24. Quality assurance: How are medications assessed for quality and safety?
25. Describe how you use computer software or applications in the pharmacy department both for the management of patients and the overall pharmacy management including drug supply.

Questions for healthcare personnel involved in hypertension clinic or NCD care:

26. Describe briefly the organizational structure of this unit including staffing levels.
27. Describe briefly the typical pathway of NCDs patients in this unit from entrance to exit, including rough estimates of average overall time duration. Any particularity in the care of hypertensive patients?
28. Describe your role within the hypertension clinic or NCD care unit.
29. Who are your direct collaborators?

30. Who do you report to?
31. During the hypertension clinic or when processing hypertension patients in general, list the specific tasks that you perform. Estimate the average time to process each patient at your level. Are these processes and estimates similar for other NCD patients?
32. What do you do when a patient walks in with severe abnormal BP reading? What process in place to handle that kind of situation?
33. Are there some tasks that you feel could be performed prior to the patient reaching your station, which would make your role and the overall process more efficient? If yes…What tasks and who could perform them instead of you? Do you feel they have the required training for that? If yes, could you elaborate on the training? If no, why is the current training not inadequate and what could be done to improve it?
34. Are there some tasks not currently assigned to you that you believe you can perform to make the overall process more efficient? What are those tasks and why do you think you can perform them?
35. After you have processed the patient, where do you direct her/him to? How is info about the patient transferred to the next step? Approximate wait time for the patient to the next step?
36. What other responsibilities do you have in your current position? Approximate the percentage of your time at work consumed by these other responsibilities.
37. Describe how you use computer systems within the unit for the care of the patients.
38. In your opinion how do you rate the patient experience through the hypertension clinic or the NCD care unit in general with focus on hypertension care?

Personal assessment:

39. In your opinion how do you rate the processes in place through the hypertension clinic or the NCD care unit in general with focus on hypertension care? Why?
40. What are its strengths and weaknesses in your opinion?
41. In your view what could be done to help improve the efficiency of healthcare providers involved with the hypertension clinic or the NCD care unit in general with focus on hypertension care?
42. What in your opinion could be done to improve the patient experience through the hypertension clinic or the NCD care unit in general with focus on hypertension care?
43. In your opinion, are the different computer systems or applications you use in the clinic contribute to a better care of the patients? Why? How can they be improve in your view?

APPENDIX 7

INTERVIEW GUIDE - KEY INFORMANTS DOH AND RELATED AGENCIES

Interview Guide - KEY INFORMANTS DOH AND RELATED AGENCIES

Description of the hypertensive/NCD drugs supply chain in South Africa public health sector by key individuals identified in the Department of Health (DOH) and related organizations: Semi-Structure Interview Guide.

Good Day Mr. / Mrs.

We are conducting a research study on Health Systems Readiness to Manage the Hypertension Epidemic in the primary health care facilities in the Western Cape, South Africa with the collaboration of the South African Medical Research Council.

The purpose of the study is to provide information on the diagnostic, treatment and control of hypertension in South Africa public health sector.

You have been identified as a key person that could provide valuable information for the success of this study. We would like to invite you to participate to this important study for the South African Health System. We are providing you with the informed consent form for your consideration should you agree to participate to the study.

Identification:

1. Gender: Male / Female
2. Age:
3. What is your current position in the organization?
4. How long have you been at this position?
5. What was your previous position?
6. Overall how many years of professional experience do you in this field?
7. Did you receive an academic training in relation to your current position? If so what training, content and duration?

Policies and role description:

8. Briefly describe the drug supply chain management system from the national level to the WC province?
9. Describe your role within the supply chain management system.
10. In this role who are your direct collaborators?
11. Who do you report to?
12. What other responsibilities do you have in your current position? Approximate the percentage of your time at work consumed by these other responsibilities.
13. Given your current position and role, in which of the following do your activities fall into: quantification, procurement, storage, inventory control, distribution and quality assurance? Explain.

1

14. Are there government/DOH policies/procedures in place for the supply chain management (quantification, procurement, storage, inventory control, distribution and quality assurance) of drugs in general and hypertensive drugs in particular? If so
    a. When were these policies drawn up?
    b. When was the last time they were reviewed?
    c. Who are the key stakeholders involved in the supply chain management?

With reference to the current hypertension/NCD/Chronic Disease drug supply chain: Focus on any particularity regarding hypertension drugs

15. Quantification: What systems are used to estimate drug needs?
    a. Who are the key players involved in this process?
16. Procurement: How are medications procured and how adequate levels of required drugs maintained?
    a. Who are the key players / suppliers involved in this process?
17. Storage and inventory control: How are medication stored and kept safe?
    a. Who are the key players involved in this process?
18. Distribution: How do medications reach patients? How is accessibility insured?
    a. Who are the key players involved in this process?
19. Quality assurance: How are medications assessed for quality and safety?
    a. Who are the key players involved in this process?
20. Are there other stakeholders within or outside your organization that you think could give us more details on these processes?
21. Describe the computer systems or software applications that are used to support the supply chain operations, particularly to facilitate the flow of information and the flow of drugs.

Personal assessment:

22. In your personal view, how do you rate the current performance of the hypertensive/NCD drug supply chain in South Africa of in your region?
23. What are its strengths and weaknesses in your opinion?
24. What constitute the main barriers or obstacles to a better hypertensive/NCD drug supply chain?
25. What in your opinion should be improved or changed that is most important?
26. In your opinion do you think that the computer systems or software applications that are used to support the supply chain operations, particularly to facilitate the flow of information and the flow of drugs are efficient? Why? What can be done to improve their efficiency in your view?

2

APPENDIX 8

CONSENT FORM HEALTH CARE PERSONNEL

uOttawa
L'Université canadienne
Canada's university

MRC
SOUTH AFRICA

Consent Form

Université d'Ottawa
Faculté des études supérieures et postdoctorales

Programme de doctorat en santé des populations

University of Ottawa
Faculty of Graduate and Postdoctoral Studies

PhD in Population Health Program

1 rue Stewart, pièce 302B
Ottawa, ON K1N 6N5 Canada

Tél.: 613.562.5691

1 Stewart Street, Room 302B
Ottawa, ON K1N 6N5 Canada

Tel.: 613.562.5691

www.uOttawa.ca

HEALTH CARE PERSONNEL

Title of the study: Health Systems Readiness to Manage the Hypertension Epidemic in the primary health care facilities in the Western Cape, South Africa.

Name of researcher: Rodrigue Innocent Deuboué Tchialeu
Population Health PhD Program, Faculty of Graduate and Postdoctoral Studies
University of Ottawa
Telephone: 780-716-3879

Supervisor: Professor Sanni Yaya
Interdisciplinary Health Sciences, Faculty of Health Sciences
University of Ottawa
Telephone: 613-562-5800 ext. 8903

Co-Supervisor: Professor Ronald Labonté
Institute of Population Health / Faculty of Medicine
University of Ottawa
Telephone: 613-562-5800 ext. 2288

Local Supervisor: Professor Andre Pascal Kengné
Director, Non-Communicable Diseases Research Unit
South African Medical Research Council
Telephone: +27 (0) 21 938 0345

Invitation to Participate: I am invited to participate in the above mentioned research study conducted by graduate student Rodrigue Innocent Deuboué Tchialeu and supervisors Professor André Pascal Kengné, Professor Sanni Yaya, and Professor Ronald Labonté from the University of Ottawa.

1

Purpose of the Study: The purpose of the study is to provide information on the diagnostic, treatment and control of hypertension in South Africa public health sector. The information I will be providing will include key players involved in the hypertension clinic, their specific roles including mine, detailed list of tasks performed when processing hypertensive patients, average duration estimation to process hypertensive patients, various processes in place and possible re-allocation of tasks, and my personal assessment of the system in place.

Participation: My participation will consist essentially of making myself available for an interview with the researcher and the validation of the transcription afterwards. I will meet with the researcher, Rodrigue Innocent Deuboué Tchialeu, for about 30-45 minutes for an interview within reasonable time after the signature of this consent form. The interview will be questions about my position, related training and expertise, key players involved in the hypertension clinic, policies and processes in place, and possible avenues for process improvement. The entire interview will be audio-recorded. The interview session will be scheduled at a designated location within the hospital. The date and time will be decided according to my availability.

I am aware that the information collected will be used as data and analyzed for the study, and may be included in final publications of the report.

Risks: There are no risks to participating in this research study.

Benefits: I will not be reimbursed for my participation in this study, but my participation in the research may assist in broadening our knowledge of the current practices to diagnose, treat and control hypertension in our healthcare system and therefore estimate the system's needs when scaling up such interventions.

Confidentiality and anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. I understand that the contents will be used only for research purposes and that my confidentiality will be protected. **Anonymity** will be protected by having my name and identification left out of the research, analysis and any possible publications.

Conservation of data: The data collected on the audio recordings, transcripts and hand-written notes will be kept in a secure manner locked and stored in the Interdisciplinary Health Sciences Graduate offices at the University of Ottawa. The data will only be accessible to the researcher and supervisors of the study and will be retained for 15 years following completion of the study. After this period, it will be destroyed.

Voluntary Participation: I am under no obligation to participate and if I choose to participate, I can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If I choose to withdraw, all data gathered until the time of withdrawal will not be included in the study.

Acceptance: I, *(Name of participant)*_____, agree to participate in the above research study conducted by Rodrigue Innocent Deuboué Tchialeu of the Population Health PhD Program, Faculty of Graduate and Postdoctoral Studies, University of Ottawa, under the supervision of Professor Sanni Yaya and Professor Ronald Labonté.

Transcripts: Would you like to review transcripts of your interview? **YES** **NO**

If I have any questions about the study, I may contact the researcher or supervisors.

If I have any questions regarding the ethical conduct of this study, I may contact:

- The Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5
  Tel.: (613) 562-5387
  Email: ethics@uottawa.ca
- The Chairperson of the Research Ethics Committee at the Medical Research Council, Cape Town. P.O. Box 19070, Tygerberg. 7505.
  Tel.: (021) 938-0687
  Email: adri.labuschagne@mrc.ac.za

There are two copies of the consent form, one of which is mine to keep.

Participant's signature: Date:

Researcher's signature: Date:

3

APPENDIX 9

CONSENT FORM KEY INFORMANTS DOH AND RELATED AGENCIES

uOttawa

L'Université canadienne
Canada's university

Consent Form

KEY INFORMANTS DOH AND RELATED AGENCIES

Title of the study: Health Systems Readiness to Manage the Hypertension Epidemic in the primary health care facilities in the Western Cape, South Africa.

Name of researcher: Rodrigue Innocent Deuboué Tchialeu
Population Health PhD Program, Faculty of Graduate and Postdoctoral Studies
University of Ottawa
Telephone: 780-716-3879

Supervisor: Professor Sanni Yaya
Interdisciplinary Health Sciences, Faculty of Health Sciences
University of Ottawa
Telephone: 613-562-5800 ext. 8903

Co-Supervisor: Professor Ronald Labonté
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University of Ottawa
Telephone: 613-562-5800 ext. 2288

Local Supervisor: Professor Andre Pascal Kengné
Director, Non-Communicable Diseases Research Unit
South African Medical Research Council
Telephone: +27 (0) 21 938 0345

Invitation to Participate: I am invited to participate in the above mentioned research study conducted by graduate student Rodrigue Innocent Deuboué Tchialeu and supervisors Professor André Pascal Kengné, Professor Sanni Yaya, and Professor Ronald Labonté from the University of Ottawa.

Purpose of the Study: The purpose of the study is to provide information on the anti-hypertensive drugs supply chain in South Africa public health sector

1

Université d'Ottawa
Faculté des études supérieures et postdoctorales

Programme de doctorat en santé des populations

University of Ottawa
Faculty of Graduate and Postdoctoral Studies

PhD in Population Health Program

1 rue Stewart, pièce 302B
Ottawa, ON K1N 6N5 Canada

Tel.: 613.562.5691

1 Stewart Street, Room 302B
Ottawa, ON K1N 6N5 Canada

Tel.: 613.562.5691

www.uOttawa.ca

by key individuals identified in the Department of Health (DOH) and related organizations. The information I will be providing will include key players involved in the current supply chain management system, their specific roles including mine, the various processes in place and my personal assessment of the system in place.

Participation: My participation will consist essentially of making myself available for an interview with the researcher and the validation of the transcription afterwards. I will meet with the researcher, Rodrigue Innocent Deuboué Tchialeu, for about 30-45 minutes for an interview within reasonable time after the signature of this consent form. The interview will be questions about my position, related training and expertise, key players involved in the supply chain, policies and processes in place, and possible avenues for process improvement. The entire interview will be audio-recorded. The interview session will be scheduled preferably at my office. The date and time will be decided according to my availability.

I am aware that the information collected will be used as data and analyzed for the study, and may be included in final publications of the report.

Risks: There are no risks to participating in this research study.

Benefits: I will not be reimbursed for my participation in this study, but my participation in the research may assist in broadening our knowledge of drug supply chain management systems in developing countries.

Confidentiality and anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. I understand that the contents will be used only for research purposes and that my confidentiality will be protected. **Anonymity** will be protected by having my name and identification left out of the research, analysis and any possible publications.

Conservation of data: The data collected on the audio recordings, transcripts and hand-written notes will be kept in a secure manner locked and stored in the Interdisciplinary Health Sciences Graduate offices at the University of Ottawa. The data will only be accessible to the researcher and supervisors of the study and will be retained for 15 years following completion of the study. After this period, it will be destroyed.

Voluntary Participation: I am under no obligation to participate and if I choose to participate, I can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If I choose to withdraw, all data gathered until the time of withdrawal will not be included in the study.

Acceptance: I, *(Name of participant)* _____, agree to participate in the above research study conducted by Rodrigue Innocent Deuboué Tchialeu of the Population Health PhD Program, Faculty of Graduate and Postdoctoral Studies, University of Ottawa, under the supervision of Professor Sanni Yaya and Professor Ronald Labonté.

Transcripts: Would you like to review transcripts of your interview? **YES** **NO**

If I have any questions about the study, I may contact the researcher or supervisors.

If I have any questions regarding the ethical conduct of this study, I may contact:

- The Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5
  Tel.: (613) 562-5387
  Email: ethics@uottawa.ca
- The Chairperson of the Research Ethics Committee at the Medical Research Council, Cape Town. P.O. Box 19070, Tygerberg. 7505.
  Tel.: (021) 938-0687
  Email: adri.labuschagne@mrc.ac.za

There are two copies of the consent form, one of which is mine to keep.

Participant's signature: Date:

Researcher's signature: Date:

3

APPENDIX 10

ETHICS APPROVAL – UNIVERSITY OF OTTAWA

File Number: H03-14-18 **Date (mm/dd/yyyy):** 10/16/2014

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Ethics Approval Notice

Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Sanni	Yaya	Health Sciences / Others	Supervisor
Rodrigue Innocent	Deuboue Tchialeu	Health Sciences / Population Health	Student Researcher

File Number: H03-14-18

Type of Project: PhD Thesis

Title: Health Systems Readiness to Control the Hypertension Epidemic in Developing Countries : Investigations in South Africa

Approval Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
10/16/2014	10/15/2015	Ia

(Ia: Approval, Ib: Approval for initial stage only)

Special Conditions / Comments:
N/A

550, rue Cumberland, pièce 154 Ottawa (Ontario) K1N 6N5 Canada
550 Cumberland Street, room 154 Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/

File Number: H03-14-18 **Date (mm/dd/yyyy):** 10/16/2014

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement (2010) and other applicable laws and regulations in Ontario, has examined and approved the ethics application for the above named research project. Ethics approval is valid for the period indicated above and subject to the conditions listed in the section entitled "Special Conditions / Comments".

During the course of the project, the protocol may not be modified without prior written approval from the REB except when necessary to remove participants from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the project (e.g., change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, including consent and recruitment documentation, should be submitted to the Ethics Office for approval using the "Modification to research project" form available at: http://www.research.uottawa.ca/ethics/forms.html.

Please submit an annual report to the Ethics Office four weeks before the above-referenced expiry date to request a renewal of this ethics approval. To close the file, a final report must be submitted. These documents can be found at: http://www.research.uottawa.ca/ethics/forms.html.

If you have any questions, please do not hesitate to contact the Ethics Office at extension 5387 or by e-mail at: ethics@uOttawa.ca.

Signature:

Protocol Officer for Ethics in Research
For Daniel Lagarec, Chair of the Health Sciences and Sciences REB

2
550, rue Cumberland, pièce 154 550 Cumberland Street, room 154
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/

APPENDIX 11

ETHICS APPROVAL – SA MRC

SOUTH AFRICAN MEDICAL RESEARCH COUNCIL

ETHICS COMMITTEE

PO Box 19070, 7505 Tygerberg, South Africa
Francie van Zijl Drive, Parowvallei, 7500
Tel: +27 (0)21 938-0687; Fax: +27 (0) 866-854023
E-mail: adri.labuschagne@mrc.ac.za
http://www.mrc.ac.za/ethics/ethics.htm

14 October 2014

Mr R Deuboué
Non-Communicable Diseases Research Unit
MRC Cape Town

Dear Mr Deuboué

Protocol ID: EC011-7/2014
Protocol title: Health systems readiness to control the hypertension epidemic in developing countries: investigations in South Africa
Meeting date: 30 September 2014

Thank you for your responses to the Ethics Committee, dated 8 September and 13 October 2014. The responses were found to be acceptable. I am pleased to inform you that ethics approval is now granted for the study.

Please note that the approval is valid for 1 year, i.e. from 30 September 2014 to 29 September 2015. Any changes to the research protocol must be submitted as an amendment. Any adverse events must be reported within 48 hours. Any protocol deviations have to be reported.

Wishing you well with your research.

Yours sincerely

CHAIRPERSON: MRC ETHICS COMMITTEE

APPENDIX 12

DEPARTMENT OF HEALTH APPROVAL LETTER

Western Cape Government
Health

STRATEGY & HEALTH SUPPORT
Health.Research@westerncape.gov.za
tel: +27 21 483 6857; fax: +27 21 483 9895
5th Floor, Norton Rose House, 8 Riebeek Street, Cape Town, 8001
www.capegateway.gov.za

REFERENCE: WC_2014RP3_240
ENQUIRIES: Ms Charlene Roderick

South African Medical Research Council
Non-communicable Disease Research Unit
PO Box 19070
Tygerberg
7505

For attention: **Mr Rodrigue Deuboue Tchiale and Andre Kengne**

Re: HEALTH SYSTEMS READINESS TO MANAGE THE HYPERTENSION EPIDEMIC IN THE PRIMARY HEALTH CARE FACILITIES IN THE WESTERN CAPE, SOUTH AFRICA.

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.

Please contact the following people to assist you with any further enquiries in accessing the following sites:

Green Point CHC	**A Smith**	**Contact No. 021 421 0288**
Maitland CHC	**J Cilliers**	**Contact No. 021 510 6473**
Khayelitsha (Site B) CHC	**D Binza**	**Contact No. 021 360 5208**
Guguletu CHC	**L Makamba**	**Contact No. 021 637 1280**
Bellville South CHC	**M Ferreira**	**Contact No. 021 951 2326**
Delft CHC	**J van Heerden**	**Contact No. 021 954 2237**

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, providing that normal activities at requested facilities are not interrupted.

2. Researchers, in accessing provincial health facilities, are expressing consent to provide the department with an electronic copy of the final report within six months of completion of research. This can be submitted to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).

3. The reference number above should be quoted in all future correspondence.

ACTING DIRECTOR: HEALTH IMPACT ASSESSMENT

DATE: 19/12/2014

CC	**K GRAMMER**	**DIRECTOR: SOUTHERN / WESTERN**
CC	**A HAWKRIDGE**	**DIRECTOR: KHAYELITSHA / EASTERN**
CC	**P OLCKERS**	**DIRECTOR: MITCHELLS PLAIN / KLIPFONTEIN**
CC	**L BITALO**	**DIRECTOR: NORTHERN / TYGERBERG**

STRATEGY & HEALTH SUPPORT
Health.Research@westerncape.gov.za
tel: +27 21 483 6857; fax: +27 21 483 9895
5th Floor, Norton Rose House, 8 Riebeek Street, Cape Town, 8001
www.capegateway.gov.za

REFERENCE: WC_2014RP3_240
ENQUIRIES: Ms Charlene Roderick

South African Medical Research Council
Non-communicable Disease Research Unit
PO Box 19070
Tygerberg
7505

For attention: **Mr Rodrigue Deuboue Tchiale and Andre Kengne**

Re: HEALTH SYSTEMS READINESS TO MANAGE THE HYPERTENSION EPIDEMIC IN THE PRIMARY HEALTH CARE FACILITIES IN THE WESTERN CAPE, SOUTH AFRICA.

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.

Please contact **Ms R Zondo** on **028 214 5800** to assist you with any further enquiries in accessing the following sites:

Overberg District Offices

Bredasdorp CHC

Grabouw CHC

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, providing that normal activities at requested facilities are not interrupted.

2. Researchers, in accessing provincial health facilities, are expressing consent to provide the department with an electronic copy of the final report within six months of completion of research. This can be submitted to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).

3. The reference number above should be quoted in all future correspondence.

ACTING DIRECTOR: HEALTH IMPACT ASSESSMENT

DATE: 19/12/2014

CC **W KAMFER** **DIRECTOR: OVERBERG**

Western Cape Government
Health

STRATEGY & HEALTH SUPPORT
Health.Research@westerncape.gov.za
tel: +27 21 483 6857; fax: +27 21 483 9895
5th Floor, Norton Rose House, 8 Riebeek Street, Cape Town, 8001
www.capegateway.gov.za

REFERENCE: WC_2014RP3_240
ENQUIRIES: Ms Charlene Roderick

South African Medical Research Council
Non-communicable Disease Research Unit
PO Box 19070
Tygerberg
7505

For attention: **Mr Rodrigue Deuboue Tchiale and Andre Kengne**

Re: HEALTH SYSTEMS READINESS TO MANAGE THE HYPERTENSION EPIDEMIC IN THE PRIMARY HEALTH CARE FACILITIES IN THE WESTERN CAPE, SOUTH AFRICA.

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.

Please contact **Dr T Marshall** on **044 803 2752** to assist you with any further enquiries in accessing the following sites:

Eden District Offices

Conville CDC

Pacaltsdorp Clinic

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, providing that normal activities at requested facilities are not interrupted.

2. Researchers, in accessing provincial health facilities, are expressing consent to provide the department with an electronic copy of the final report within six months of completion of research. This can be submitted to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).

3. The reference number above should be quoted in all future correspondence.

ACTING DIRECTOR: HEALTH IMPACT ASSESSMENT

DATE: 19/12/2014

CC H SCUMANN DIRECTOR: EDEN / CENTRAL KAROO

Western Cape Government
Health

STRATEGY & HEALTH SUPPORT
Health.Research@westerncape.gov.za
tel: +27 21 483 6857; fax: +27 21 483 9895
5th Floor, Norton Rose House, 8 Riebeek Street, Cape Town, 8001
www.capegateway.gov.za

REFERENCE: WC_2014RP3_240
ENQUIRIES: Ms Charlene Roderick

South African Medical Research Council
Non-communicable Disease Research Unit
PO Box 19070
Tygerberg
7505

For attention: **Mr Rodrigue Deuboue Tchiale and Andre Kengne**

Re: HEALTH SYSTEMS READINESS TO MANAGE THE HYPERTENSION EPIDEMIC IN THE PRIMARY HEALTH CARE FACILITIES IN THE WESTERN CAPE, SOUTH AFRICA.

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.

Please contact **Dr D Schoeman** on **022 487 9207** to assist you with any further enquiries in accessing the following sites:

West Coast District Offices

Lamberts Bay Clinic

Moorreesburg Clinic

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, providing that normal activities at requested facilities are not interrupted.

2. Researchers, in accessing provincial health facilities, are expressing consent to provide the department with an electronic copy of the final report within six months of completion of research. This can be submitted to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).

3. The reference number above should be quoted in all future correspondence.

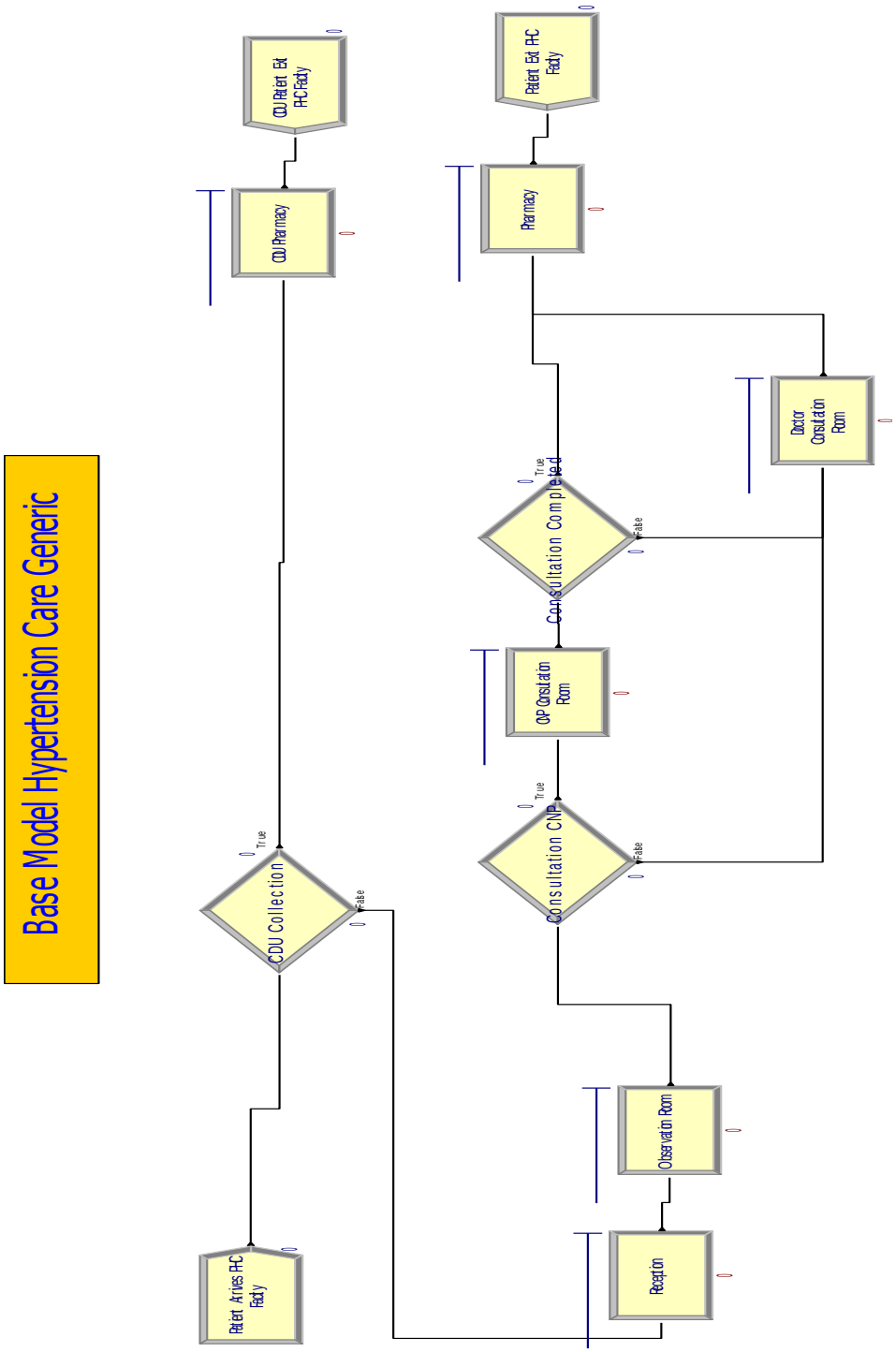
ACTING DIRECTOR: HEALTH IMPACT ASSESSMENT

DATE: 19/12/2014

CC **C BESTER** **DIRECTOR: WESTCOAST**

APPENDIX 13

GENERIC SIMULATION MODEL OF HYPERTENSION CARE IN PHC FACILITIES, WC



APPENDIX 14

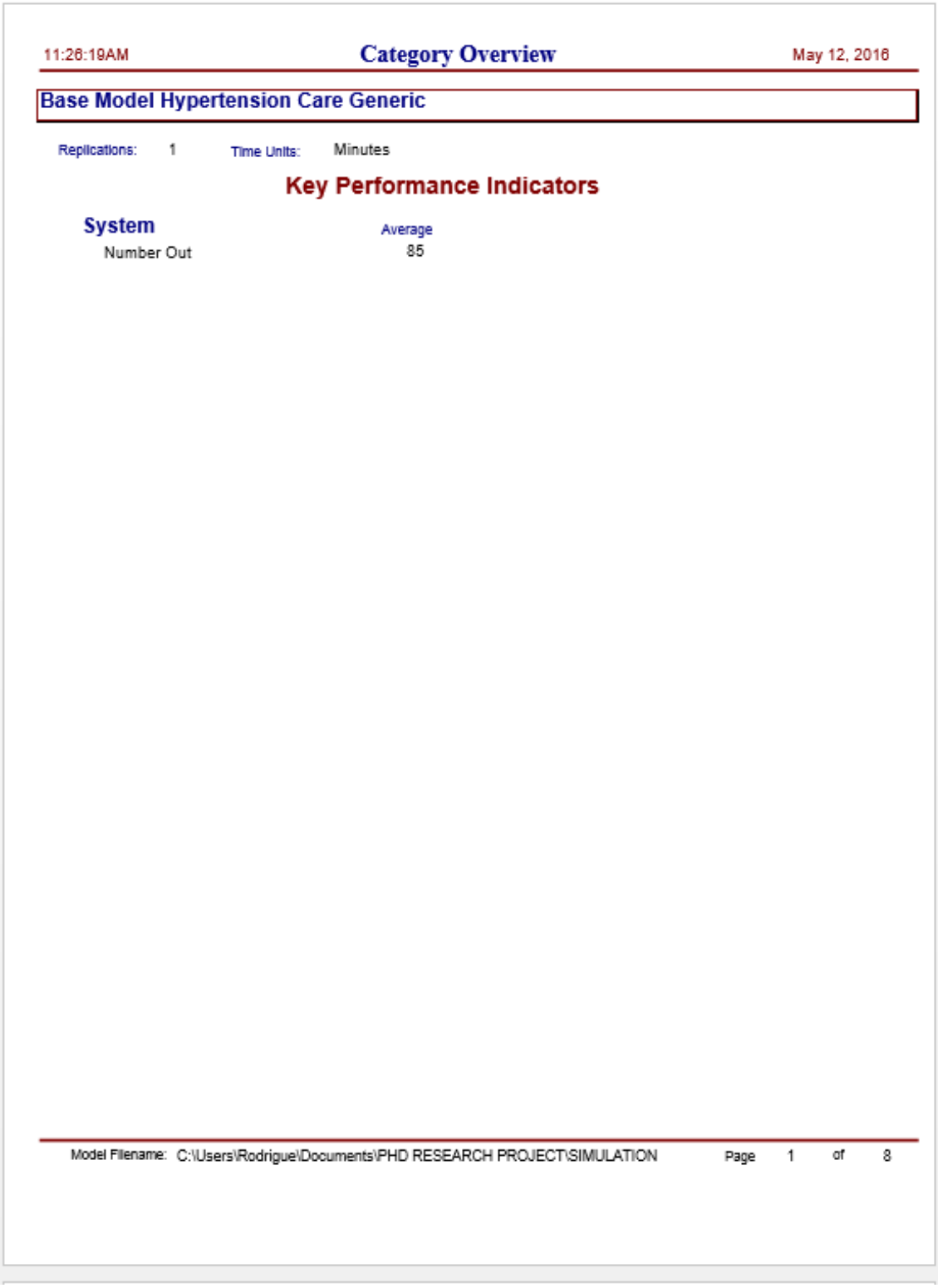
CONCEPTUAL FRAMEWORKS IDENTIFIED FOR SCALING UP HEALTH SERVICES

Name of Framework	Description of Framework	Year of Publication
A Learning Process Approach	A model that describes a learning process to building program strategies and organizational competence. It suggests that a new program should progress through three developmental stages in which the focal concern is successively on learning to be effective, learning to be efficient, and learning to expand.	1980
Alternative Strategies for Scaling Up NGOs	A model that describes four dimensions of scaling up of programs and organizations: (i) quantitative, (ii) functional, (iii) political and (iv) organizational development.	1995
Diffusion of Innovations	Diffusion of innovations theory seeks to explain how, why, and at what rate new ideas and technology spread through cultures. The four main elements involve: (i) the innovation, (ii) communication channels, (iii) time and (iv) a social system	1995
SEED-Scale	A model involving three principles for scaling up: (i) forming a three way partnership of community members, officials and experts, (ii) basing action on locally specific data, (iii) using a community work plan to change collective behavior	2002
Scaling Up Management (SUM) Framework	A framework for those planning, implementing and funding pilot projects with the intention of scaling up. The three steps include: (i) developing a scaling up plan, (ii) establishing the pre-conditions for scaling up and (iii) implementing the scaling up process based on the identification of factors that can promote extension and sustainability	2003
Expandnet Framework	A framework that presents the scaling up process within a systems context involving the following components: (i) determining the innovation, (ii) identifying the user organization, (iii) defining and analyzing the environment, (iv) identifying the resource team. It also involves identifies the need for considering the role of: (i) policy/legal/political scaling up, (ii) physical expansion of services and programs, (iii) diversification, and (iv) spontaneous scaling up	2008

(Subramanian et al., 2011)

APPENDIX 15

CATEGORY OVERVIEW REPORT



11:26:19AM **Category Overview** May 12, 2016

Base Model Hypertension Care Generic

Replications: 1 Time Units: Minutes

Key Performance Indicators

System	Average
Number Out	85

Model Filename: C:\Users\Rodrigue\Documents\PHD RESEARCH PROJECT\SIMULATION Page 1 of 8

11:26:19AM **Category Overview** May 12, 2016

Base Model Hypertension Care Generic

Replications: 1 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Value	Maximum Value
Patient	18.0831	(Insufficient)	0.00	49.8665

NVA Time	Average	Half Width	Minimum Value	Maximum Value
Patient	0.00	(Insufficient)	0.00	0.00

Wait Time	Average	Half Width	Minimum Value	Maximum Value
Patient	18.2665	(Insufficient)	0.00	118.53

Transfer Time	Average	Half Width	Minimum Value	Maximum Value
Patient	0.00	(Insufficient)	0.00	0.00

Other Time	Average	Half Width	Minimum Value	Maximum Value
Patient	0.00	(Insufficient)	0.00	0.00

Total Time	Average	Half Width	Minimum Value	Maximum Value
Patient	36.3496	(Insufficient)	0.00	166.01

Other

Number In	Value
Patient	91.0000

Number Out	Value
Patient	85.0000

WIP	Average	Half Width	Minimum Value	Maximum Value
Patient	7.4715	(Insufficient)	0.00	16.0000

Model Filename: C:\Users\Rodrigue\Documents\PHD RESEARCH PROJECT\SIMULATION Page 2 of 8

11:26:19AM **Category Overview** May 12, 2016

Base Model Hypertension Care Generic

Replications: 1 Time Units: Minutes

Process

Time per Entity

VA Time Per Entity	Average	Half Width	Minimum Value	Maximum Value
CDU Pharmacy	3.1818	(Insufficient)	0.00	7.0000
CNP Consultation Room	8.5862	(Insufficient)	4.0000	15.0000
Doctor Consultation Room	15.6960	(Insufficient)	11.5143	19.6649
Observation Room	5.3617	(Insufficient)	0.00	12.0000
Pharmacy	8.8049	(Insufficient)	4.0000	14.0000
Reception	6.1897	(Insufficient)	3.0922	9.9593

Wait Time Per Entity	Average	Half Width	Minimum Value	Maximum Value
CDU Pharmacy	0.9021	(Insufficient)	0.00	9.4086
CNP Consultation Room	8.6436	(Insufficient)	0.00	34.7136
Doctor Consultation Room	19.9808	(Insufficient)	0.00	47.9752
Observation Room	2.2791	(Insufficient)	0.00	15.1857
Pharmacy	13.0185	(Insufficient)	0.00	52.5009
Reception	5.5749	(Insufficient)	0.00	16.7006

Total Time Per Entity	Average	Half Width	Minimum Value	Maximum Value
CDU Pharmacy	4.0839	(Insufficient)	0.00	13.5713
CNP Consultation Room	17.2298	(Insufficient)	6.0000	41.7136
Doctor Consultation Room	35.6769	(Insufficient)	15.4835	66.5283
Observation Room	7.6408	(Insufficient)	1.0000	20.9781
Pharmacy	21.8234	(Insufficient)	4.0000	66.5009
Reception	11.7646	(Insufficient)	3.2091	22.0292

Accumulated Time

Model Filename: C:\Users\Rodrigue\Documents\PHD RESEARCH PROJECT\SIMULATION Page 3 of 8

11:26:19AM **Category Overview** May 12, 2016

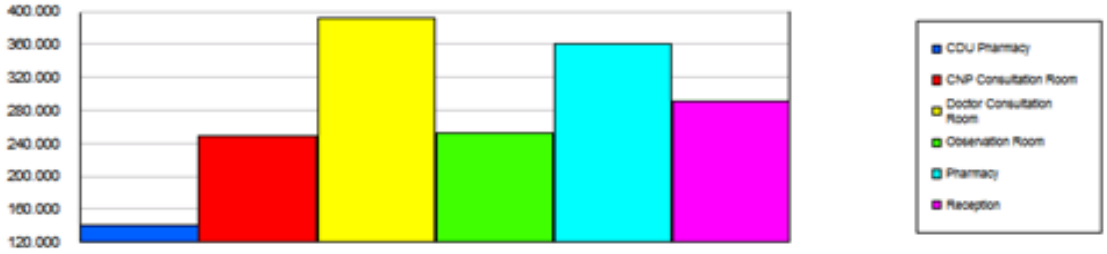
Base Model Hypertension Care Generic

Replications: 1 Time Units: Minutes

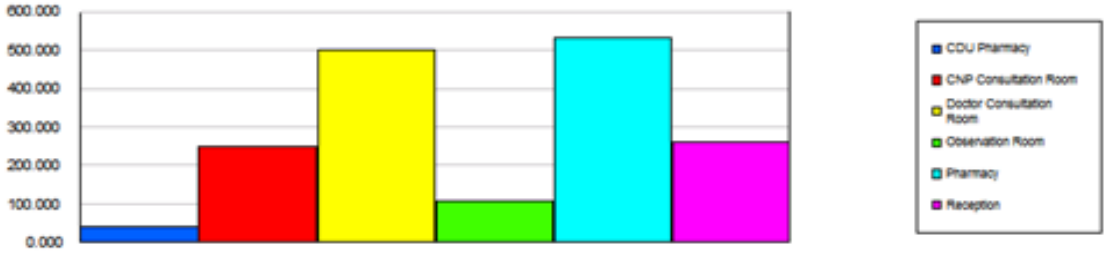
Process

Accumulated Time

Accum VA Time	Value
CDU Pharmacy	140.00
CNP Consultation Room	249.00
Doctor Consultation Room	392.40
Observation Room	252.00
Pharmacy	361.00
Reception	290.91



Accum Wait Time	Value
CDU Pharmacy	39.6917
CNP Consultation Room	250.67
Doctor Consultation Room	499.52
Observation Room	107.12
Pharmacy	533.76
Reception	262.02



Other

11:26:19AM **Category Overview** May 12, 2016

Base Model Hypertension Care Generic

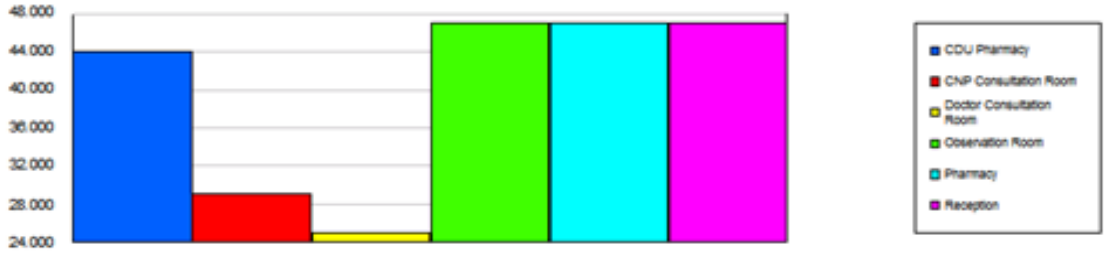
Replications: 1 Time Units: Minutes

Process

Other

Number In

	Value
CDU Pharmacy	44.0000
CNP Consultation Room	29.0000
Doctor Consultation Room	25.0000
Observation Room	47.0000
Pharmacy	47.0000
Reception	47.0000



Number Out

	Value
CDU Pharmacy	44.0000
CNP Consultation Room	29.0000
Doctor Consultation Room	25.0000
Observation Room	47.0000
Pharmacy	41.0000
Reception	47.0000

11:26:19AM **Category Overview** May 12, 2016

Base Model Hypertension Care Generic

Replications: 1 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Value	Maximum Value
CDU Pharmacy.Queue	0.9021	(Insufficient)	0.00	9.4086
CNP Consultation Room.Queue	8.6436	(Insufficient)	0.00	34.7136
Doctor Consultation Room.Queue	19.9808	(Insufficient)	0.00	47.9752
Observation Room.Queue	2.2791	(Insufficient)	0.00	15.1857
Pharmacy.Queue	14.2260	(Insufficient)	0.00	63.7302
Reception.Queue	5.5749	(Insufficient)	0.00	16.7006

Other

Number Waiting	Average	Half Width	Minimum Value	Maximum Value
CDU Pharmacy.Queue	0.08269099	(Insufficient)	0.00	2.0000
CNP Consultation Room.Queue	0.5222	(Insufficient)	0.00	4.0000
Doctor Consultation Room.Queue	1.0407	(Insufficient)	0.00	4.0000
Observation Room.Queue	0.2232	(Insufficient)	0.00	3.0000
Pharmacy.Queue	1.5450	(Insufficient)	0.00	7.0000
Reception.Queue	0.5459	(Insufficient)	0.00	3.0000

Base Model Hypertension Care Generic

Replications: 1 Time Units: Minutes

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Value	Maximum Value
r ADM1	0.6061	(Insufficient)	0.00	1.0000
r CDU PHAR	0.2917	(Insufficient)	0.00	1.0000
r CNP1	0.5188	(Insufficient)	0.00	1.0000
r ENA1	0.5250	(Insufficient)	0.00	1.0000
r MDO1	0.8175	(Insufficient)	0.00	1.0000
r PHAR1	0.7529	(Insufficient)	0.00	1.0000

Number Busy	Average	Half Width	Minimum Value	Maximum Value
r ADM1	0.6061	(Insufficient)	0.00	1.0000
r CDU PHAR	0.2917	(Insufficient)	0.00	1.0000
r CNP1	0.5188	(Insufficient)	0.00	1.0000
r ENA1	0.5250	(Insufficient)	0.00	1.0000
r MDO1	0.8175	(Insufficient)	0.00	1.0000
r PHAR1	0.7529	(Insufficient)	0.00	1.0000

Number Scheduled	Average	Half Width	Minimum Value	Maximum Value
r ADM1	1.0000	(Insufficient)	1.0000	1.0000
r CDU PHAR	1.0000	(Insufficient)	1.0000	1.0000
r CNP1	1.0000	(Insufficient)	1.0000	1.0000
r ENA1	1.0000	(Insufficient)	1.0000	1.0000
r MDO1	1.0000	(Insufficient)	1.0000	1.0000
r PHAR1	1.0000	(Insufficient)	1.0000	1.0000

11:26:19AM **Category Overview** May 12, 2016

Base Model Hypertension Care Generic

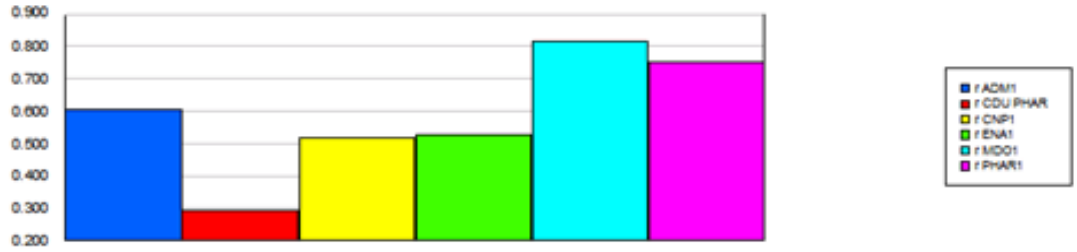
Replications: 1 Time Units: Minutes

Resource

Usage

Scheduled Utilization

	Value
r ADM1	0.6061
r CDU PHAR	0.2917
r CNP1	0.5188
r ENA1	0.5250
r MDO1	0.8175
r PHAR1	0.7529



Total Number Seized

	Value
r ADM1	47.0000
r CDU PHAR	44.0000
r CNP1	29.0000
r ENA1	47.0000
r MDO1	25.0000
r PHAR1	42.0000