EAC Regional Centre of Excellence for Vaccine, Immunization and Health Supply Chain Management (EAC RCE-VIHSCM)

EVALUATION OF GOOD DISTRIBUTION PRACTICES OF NON VACCINE COLDCHAIN PRODUCTS IN RWANDA.

CASE STUDY: RWANDA MEDICAL SUPPLY Ltd

Dissertation submitted in fulfillment of the requirements of the degree of Masters of Health Supply Chain Management (MSc HSCM)

By

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DECLARATION

I, Ariane MUTABARUKA declare that "This Dissertation is my original work and has not been presented for a degree in any other University". Any parts, words, or ideas in the thesis, however, limited, that is quoted from or based on other sources, have been acknowledged as such without exception.

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Approval

I, the undersigned, certify that this dissertation has been under my supervision and has been submitted with my approval

Signature 

Supervisor: Dr .Eric NYIRIMIGABO

DEDICATION

This work is dedicated to:

My parents Alfred and Geneviève MUTABARUKA

My daughter Abiella R. ISHIMWE

My sisters Nadine, Alice, Aline, Consolate, Arlette, and Carine.

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ABSTRACT

A strong health system cannot function without a well-designed, well-operated, and well-maintained supply chain management system, one that can ensure an adequate supply of essential health commodities to the clients who need them. Temperature-sensitive products within supply chain management are products that encompass any pharmaceutical good or product, which, when not stored or transported within predefined environmental conditions and/or within predefined time limits, is degraded to the extent that it no longer performs as originally intended.

The present study evaluated the compliance to the good distribution practices of temperature-sensitive products (TSPs) in Rwanda against the WHO standards.

The study was cross-sectional in nature where empirical data were collected from personnel involved in temperature sensitive products management through interview and the temperature and relative humidity data analyzed to assess the compliance with international standards.
The study was conducted at Rwanda Medical Supply Limited where a total of 30 staff in quality assurance and quality control unit, warehouse unit, sales and distribution unit, RMS branch directors and store managers were interviewed. In addition, historical data on recorded temperature and humidity levels in store rooms and refrigerators/freezers as well as transit temperature data from representative district RMS branches were consulted for three years (2017-2019). The data were analyzed quantitatively.

It was found out that SOPs are available but not updated to ensure compliance. However, the scarcity of trained staff hinders adherence, hence monitoring of temperature and relative humidity sometimes has loopholes that need to be addressed. The study discovered that adherence to recommended temperature ranges for the products is compromised by the fact that they were inconsistency in taking and reporting the records done and a lack of temperature monitoring tools and qualified equipments. Therefore, training to boost personnel capacity is encouraged and procurement of enough logistics (data loggers and other continuous temperature monitoring devices) to store and transport temperature-sensitive products as it is done for vaccines.

Keywords: Good Distribution Practices, Cold Chain, Temperature Sensitive Products, Corrective and preventive actions, Rwanda Medical Supply Ltd.

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ABBREVIATION AND ACRONYMS

CAPA: Corrective and Preventive Actions

DP : District Pharmacy

GDP : Good Distribution Practices

HSCM: Health Supply Chain Management

HQs : Head Quarters

MOH : Ministry of Health

MPPD: Medical Procurement and Production Division

RBC : Rwanda Biomedical Centre

Rwanda FDA: Rwanda Food and Drug Authority

RMS : Rwanda Medical Supply

SOP : Standards Operation Procedures

TSPs : Time and Temperature Sensitive Products

UR : University of Rwanda

WHO : World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background

According to the Council of Supply Chain Management Professionals (CSCMP) — "Supply chain management encompasses the planning and management of all activities involved in sourcing, procurement, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies" (1).

A strong health system cannot function without a well-designed, well-operated, and well-maintained supply chain management system, one that can ensure an adequate supply of essential health commodities to the clients who need them.

With the ultimate goal of aligning supply and demand, supply chain management encompasses the logistics activities plus the coordination and collaboration of staff, levels, and functions. A public health supply chain is a network of interconnected organizations or actors that ensure the availability of quality health commodities to the people who need them thus improving their health outcomes.

“Logistics activities are the operational component of supply chain management, including functions such as quantification, procurement, inventory management, warehousing, transportation and fleet management, and data collection and reporting”(2).

More people are likely to use health services if the supply chain provides a reliable supply of quality, affordable and efficient commodities. They feel more confident about the health program,

which motivates them to seek and use health services. An effective supply chain improves cost-effectiveness in all parts of a program, and it can stretch limited resources.

Because most product manufacturers are based internationally, distribution plays an essential role in the health logistics system. Distribution consists of moving products down the pipeline from the national central warehouse until they are dispensed to the final patient(3,4).

According to WHO, accessing good quality medicines is a crucial part of universal health coverage and an essential contribution to reaching the "triple billion" target " (1 billion more people benefiting from universal health coverage, 1 billion more people better protected from health emergencies and 1 billion more people enjoying better health and well-being) " set by WHO's 13th General Programme of Work (5)**.**

Good distribution practices (GDP) are imperative to ensuring the good quality of pharmaceutical products across the supply chain and throughout the product life cycle, from the manufacturer to the patient. However, managing the quality of pharmaceutical products during distribution is challenging because each product has its own distinct shelf life and storage conditions. The varying dosage forms (injection, syrup, tablets, etc.) require different environmental conditions thus cannot be handled with general rules. That's why GDP has significant importance in the pharmaceutical industry (5,6).

Good Distribution Practices (GDP) is a quality system for distribution centers and warehouses dedicated to medicines. Internationally accepted pharmaceutical GDP regulations prescribe that the entire supply chain, from the early delivery of raw materials to the manufacturing premises to the final shipment of finished drugs to the end-user, must be monitored and validated (3,7,8).

The World Health Organization and European Union guidelines are models for standardized good distribution practice for worldwide. According to the European Commission Good Distribution Practice guideline on medicinal products for human use, " Good Distribution Practice (GDP) is the part of quality assurance which ensures that the quality of medicinal products is maintained throughout all stages of the supply chain from the site of the manufacturer to the pharmacy or person authorized or entitled to supply medicinal products to the public "(3,8).

Due to the multiple uncontrolled variables that are present in the distribution process, GDP requires that the transportation of temperature-sensitive medicinal products should be done according to a recommended temperature and humidity monitoring program, using calibrated equipment and avoiding the exposure of these products to unacceptable degrees of heat or cold(9,10).

WHO defines **Temperature-sensitive pharmaceutical products** as:

"Any pharmaceutical good or product which, when not stored or transported within predefined environmental conditions and/or within predefined time limits, is degraded to the extent that it no longer performs as originally intended." In practice, temperature-sensitive pharmaceuticals are mainly represented by those that must be stored in a refrigerator within a temperature range between 2 and 8 °C(7).

A great number of the critical and major deficiencies recorded by the Medicines & Healthcare products Regulatory Agency inspectors in 2016 were related to the equipment and control and monitoring of transportation temperatures(11). Another study on quality risk management during pharmaceutical 'good distribution practices' by Nirmal Kumar and Ajeya Jha has identified exposure of pharmaceutical products to the temperature outside their specified limits as being at level 5 of severity score value, based on medical and pathological consequences on the scale of 1–5, against the quality risks) (10).

Compliance with GDP ensures control of the distribution chain and therefore maintains integrity and the quality of medicinal products while any deviation from the requirements may affect the stability of the medicines and therefore their efficacy and even safety. This compliance should be checked regularly by regulatory agencies.

In Rwanda, the Rwanda Food and Drug Authority is responsible for the regulation and control of good compliance to pharmaceutical good distribution practices and has developed a guideline to support all personnel involved in the distribution of pharmaceutical products with special consideration to temperature-sensitive products. While the import of active ingredients is rather well managed and controlled with storage within the desired temperatures; the distribution chain needs to be more adaptive to the standards to better preserve the stability, efficacy, and safety of the medicines(9).

From the manufacturer to the patients, the ownership of pharmaceutical products changes multiple times depending on the country's supply chain distribution model thus the need to establish and record the 'condition' of the product as it changes hands and state. Supply chains include many players, all of whom need to have a clear understanding of the products that they are handling, specific requirements, and remedies in the event of a problem (12).

Country distribution starts when the goods arrive in the country and are released from customs (port clearing) for delivery to the central warehouse and from the central warehouse to district stores. In Rwanda, products flow through a supply chain system that consists of a central medical store that carries out procurement, storage, and delivery to branches.

The central medical store in Rwanda, Rwanda Medical Supply was created in August 2020 from what used to be the Medical Procurement and Production Division at the Rwanda Biomedical Center (RBC/MPPD) and all former district pharmacies that used to be independent establishments, currently RMS branches.

The national distribution system to supply pharmaceuticals across the country is mostly active. The central warehouse delivers medicines to RMS branches, which in turn supply health facilities.

At the district level, health facilities place orders at the RMS branch based on their needs, and the branches distribute ordered products. RMS central medical store and branches are in charge of storing and supplying temperature-sensitive products along with other health commodities to the lower levels of the in-country supply chain except for vaccines.

Rwanda as a country that imports all pharmaceutical products used in the public health sector through Rwanda Medical Supply Ltd has different regulatory needs to tackle the barrier that the population face in accessing good quality pharmaceutical products that is mainly due to a lack of suitable financial investment and expertise among supply chain personnel.

1.2 Problem statement

The distribution of temperature-sensitive products is very complex and sustains a lot of challenges. During inspections in the United Kingdom in 2016, the top-cited major deficiencies against GDP requirements were found; 22% were due to quality systems, 13% due to transportation, 12% due to responsible person/personnel while documentation, equipment and temperature control were each 9%. Customer qualification and storage each had 5%(11).

The distribution of temperature-sensitive products in low-income countries also still faces problems like the lack of appropriate equipment, knowledge on the proper handling and storage, to ensure appropriate maintenance of their stability. A big number of pharmaceutical and biological products prescribed worldwide such as oxytocin, insulin or chemotherapeutic agents and antibiotic are temperature sensitive. A study by Peter Lambert and al. conducted on oxytocin quality in 2020 revealed that while short temperature excursions may not harm product quality, cumulative heat exposure is generally not tracked, yet present a very serious threat to the product quality in terms of its stability where too much exposure of the products to temperatures out of the recommended range can shorten the products shelf life and result in failure to attain the desired therapeutic outcome i.e. safety and efficacy(12–14).

Another study conducted in 2019 at RMS Ltd, former RBC/Medical Procurement and Production Division assessing the storage conditions of Pharmaceutical products in Rwanda found that temperature-sensitive pharmaceuticals at RMS were stored in good conditions and compliance with the Good Storage Practices. However, the study also highlighted that at one site the temperature data was near the upper limit of 8ºC and another site had recorded a temperature excursion and also a lack of data on the temperature of the products during transit from one level to the other of the supply chain within the country (15).

In Rwanda, the distribution of temperature-sensitive products is done from Rwanda Medical Supply Limited (RMS Ltd) through 3 other lower levels of the in-country supply chain up to the patient. All these stages when examined individually may not present any risk to the product quality but the cumulative exposure of temperature-sensitive products to heat at every step of the distribution coupled with the risk the products incurs during international distribution and in-

country storage may result in the population using products with lost potency thus yielding resistance for example in the case of antibiotics(16).

Rwanda's average temperature varies according to its topography. Low temperatures with an average ranging between 15 and 17°C are observed in the regions of high altitude. Temperatures can go below 0°C in some parts of the volcanic region. Moderate temperatures with an average varying between 19 and 21°C are found in areas with intermediary altitudes. In the lowlands (east and southwest) during February and July-August, temperatures are higher and the extreme can go beyond 30°C (17).

These temperature variations if not monitored during transportation can affect the product's stability and may cause harm to the population that uses them. The lack of prior studies evaluating the status of compliance to Good Distribution practices in Rwanda and ensuring adherence to quality standards through Good Distribution Practices is what motivated this study. Because ensuring the integrity and potency of the product has implications beyond those related to financial and social issues, human health consequences of product degradation cannot be underrated when lives are at stake.

1.3 Objectives of the Study

The main purpose of this study is to evaluate the compliance with the good distribution practices of temperature-sensitive (TSP) products in Rwanda against the WHO standards.

1.3.1 Specific Objectives

1. To assess the compliance to standards of distribution practices of temperature-sensitive products at RMS Ltd
2. To assess the qualification of staff involved in the management of temperature-sensitive products in Rwanda.
3. To assess the availability and compliance of tools and equipment used in cold chain management of TSPs at RMS Ltd against national and international standards.
4. To identify risks of products degradation due to poor distribution practices and propose Corrective and Preventive Action (CAPA)

1.3.2 Research Questions

1. Are the current distribution practices of temperature-sensitive products at RMS Ltd compliant with the standards?
2. Are supply chain personnel involved in the management of Temperature-sensitive products at RMS Ltd qualified/trained?
3. Are cold chain management of temperature-sensitive products tools and equipment available/ used compliant with the standards?
4. Are temperature-sensitive products distributed by RMS Ltd at risk of degradation identified and what Corrective and Preventive Actions (CAPA) can be implemented regarding the identified risks?

1.5. Significance of the study

1.5.1. Personal interest

This work will help the researcher to gain deep knowledge and deal with the theory about the good distribution practices of temperature-sensitive products in Rwanda and match the practical and theory relating to the research.

1.5.2. Academic and scientific interest

The results of the study added to the existing body of knowledge on Rwanda Medical Supply Ltd and Good Distribution Practices contains empirical data for future researchers and can be used as a reference. This dissertation is part of fulfilling the requirement of awarding of Master of Health Supply Chain Management at the University of Rwanda, College of Medicine and Health Sciences (UR/CMHS). They also can contribute towards evidence-based regulatory actions and policymaking in ensuring Good Distribution Practices adherence throughout the supply chain thus ensuring pharmaceutical products quality.

1.6. DELIMITATIONS

The study was conducted at Rwanda Medical Supply Head Quarters and it extended to nine representative district Branches.

Although there are different factors to be considered in evaluating compliance with Good Distribution Practices, the study only focused on temperature and humidity records of temperature-sensitive products in the selected sites, and the results were compared to the predefined limits to see whether the sites comply with the required standards and therefore give the guarantee on products quality across the whole shelf life.

To get the needed information, the researcher worked with RMS Ltd Warehouse Operations Unit staff, Quality Assurance and Quality Control Unit staff, Logistics staff, and District Branches' personnel.

1.7. LIMITATIONS

There is a risk of missing historical records on temperature and humidity records either during storage or the distribution process due to a lack of monitoring devices or SOPs for performing the monitoring. Access to some relevant information was either delayed or denied, partially provided. As the time to perform the study was relatively short and due to the budget constraint, the study did not reach the lower levels of the supply chain even though this could have given a clearer picture of the status of compliance to the Good Distribution Practices while highlighting the risks incurred by temperature-sensitive products during the in-country distribution process.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter tries to show all the writings and research that had been carried out about the topic under study. It focuses on and reviews the related literature on the impact of good distribution practices on temperature-sensitive products.

2.1 Temperature sensitivity

Temperature sensitivity is defined as “the physiological or behavioral response of an organism to changing temperature conditions. A high degree of temperature sensitivity implies that a small change of temperature causes a dramatic response, whereas a low degree of sensitivity suggests that the response is small”(18).

2.2. Good distribution Practices

According to the WHO, Good Distribution practice is "That part of quality assurance that ensures that the quality of a pharmaceutical product is maintained using adequate control of the numerous activities which occur during the distribution process as well as providing a tool to secure the distribution system from counterfeits, unapproved, illegally imported, stolen, counterfeit, substandard, adulterated, and/or misbranded pharmaceutical products" (3).

Good distribution practice (GDP) outlines the minimum standards that must be met by every wholesale/retail distributor to ensure that the integrity and quality of medicines are maintained throughout the supply chain. Compliance with GDP ensures that: medicines in the supply chain are authorized following legislation; medicines quality is maintained at all times, including during transportation and storage; Cross-contamination (contamination by or of other products) is avoided; an adequate turnover of stored medicines takes place; the right products reach the right

addressee within a satisfactory time. A tracing system to enable finding defective products should also be put in place by the distributor to enable an effective recall procedure (8,7,3).

2.3 Cold Chain

Cold Chain refers to the transportation of temperature-sensitive products along a supply chain to protect their integrity using refrigerated and thermal packaging methods from the manufacturer to the patient.

Because in the health sector/pharmaceutical sector any deviation from the recommended storage conditions by the manufacturer of the products can affect the stability of the product hence reducing its potency and leading to the failure to attain the desired response in treatment, it is of utmost importance that the product's temperature is controlled during transport and storage to avoid that the patients receive an inadequate product that has lost its potency and may be life-threatening in some cases (11).

2.4 Temperature and environment control

During storage and distribution, suitable procedures and equipment should be in place to check the environmental conditions of the medicinal products storage area. Environmental determinants to be considered include temperature, light, humidity, and cleanliness of the premises and Transportation trucks. There is a need to initially carry out a temperature mapping exercise for all premises, active or passive equipment, and tools that will be used for the storage or distribution of temperature-sensitive products, under representative conditions. The results of the temperature mapping exercise guide the placement of temperature monitoring devices, ensuring that monitoring devices are located in the areas with the extremes of fluctuations. Based on the risk assessment exercise results, the mapping exercise should be repeated for significant changes. Temperature monitors should be placed accordingly to a potential risk assessment (e.g. heater/air-conditioner) results (10).

2.5 Calibration and verification of control and monitoring devices

All devices used in the temperature and humidity control and monitoring should be calibrated at least every year against a certified traceable reference standard to demonstrate how accurate the equipment is over the entire range of temperatures at which the equipment is to be used (10).

2.6 Transportation

To preserve the integrity of the temperature-sensitive products during the distribution process, all road vehicles used must be qualified and the details and responsibilities for this process should be set. These vehicles should be equipped with calibrated temperature monitoring/logger devices and with sensors to alert in case of temperature excursions(7,20).

2.7 Equipment impacting on storage and distribution of medicinal products

All equipment with an impact on the storage and distribution of medicinal/pharmaceutical products should be designed, located, maintained, and cleaned per the standard that is suitable to their intended purpose. There should be a maintenance plan in place for key equipment critical to the operation's functionality. Temperature equipment used to monitor or control the environment in storage rooms should be calibrated at defined intervals based on a risk and reliability assessment. Calibration of equipment should be done in reference to a national or international measurement standard and this should be traceable. In case of temperature excursions from recommended temperature storage conditions, there should be a suitable alarm system in place to provide alerts and the alarm levels should be appropriately set and regularly tested to ensure their functionality. The integrity and quality of products should be maintained and not be compromised during equipment maintenance, repair, or calibration operations. Equipment failure should never compromise products quality or integrity; written procedures should be in place to ensure their integrity at all times. Key equipment's adequate records of calibration, maintenance, and repair activities should be made and the results retained (7).

2.8 Cold chain equipment

There are different types of equipment used in the cold chain such as cool packs, refrigerators, cold boxes, and temperature monitoring devices amongst others.

There is a difference between domestic refrigerators and medical prequalified refrigerators. Temperature-sensitive pharmaceutical products are therefore supposed to be stored in prequalified equipment only that is designed to operate within the required 2ºC to 8ºC and maintain the temperature within a reasonable period during a power supply cut. Having equipment is important but it is of no use to have equipment without reliable power or a well-established maintenance plan and qualified personnel.

2.9. Personnel in management of temperature-sensitive products

Personnel involved in the management of temperature-sensitive products should be well trained, and qualified to do so. Personnel involved in the management of temperature-sensitive products need to fully comprehend the Quality Assurance governing good storage and distribution practices. (21).

2.10. Challenges affecting the cold chain

With the introduction of biopharmaceuticals, many countries face challenges in cold chain management to meet the demand. A study that was conducted in six countries established that the main challenges of cold chain include poor refrigerator performance of 58% which lead to freezing. The second problem revealed was improper ice pack conditioning 28%. The study conducted in Uganda established that power access and roads were some of the challenges the cold chain encountered. The challenge affected 75% of Health facilities in Uganda. Lack of performance management systems was also a challenge indicated to be affecting the cold chain. it was also established that lack of latest or optimal technologies, inadequate temperature monitoring, and lack of maintenance were some of the challenges encountered by the cold chain in Uganda, another study established that some of the challenges faced by cold chain include extreme temperature, humidity, interrupted power supply, insufficient maintenance of cold chain system,

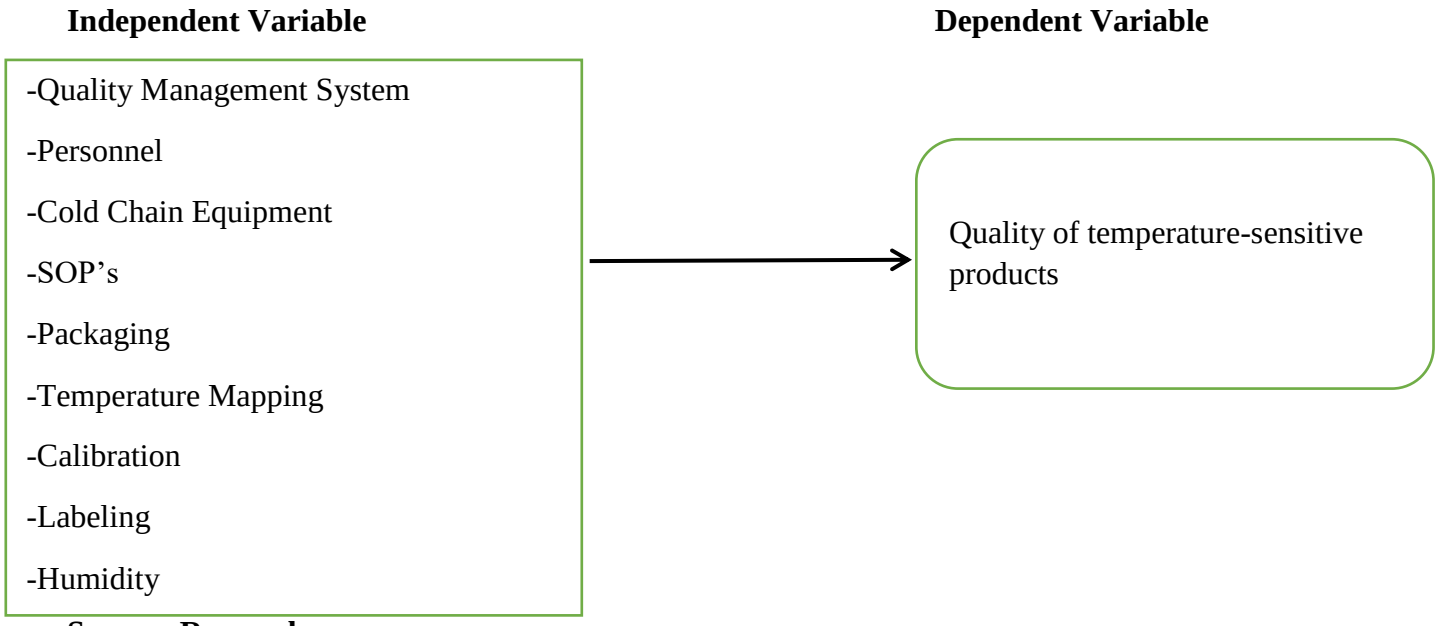
lack of spare parts and high failure rate of cold chain equipment. The study recommends tracking and evaluation of cold chain equipment for properly informed decisions (14).

Power cuts and interruption are some of the major problems that cause losses in potency, damage equipment and alter temperatures of the cold chain. A study in Tanzania assessing cold chain storage conformity to the WHO guidelines in Health facilities in Dodoma and Dar-es-Salaam established that power cuts and lack of gas were among the major issues hindering compliance with the guidelines(23).

Another on transforming cold chain performance and management in lower-income countries stressed that lack of technology to improve cold chain capacity, information, decision making, and infrastructure were some of the challenges for the cold chain management. Apart from that, less education, experience, and knowledge were established to be some of the challenges for cold chain management. Finally, additional studies stressed that challenges to storage temperature and transport for Temperature-sensitive products differ based on region (15, 25).

2.10 Conceptual framework

The mission of Rwanda Medical Supply Limited (RMS Ltd) is to ensure the availability of quality and affordable pharmaceutical products, medical equipment, and consumables to the population of Rwanda. The conceptual framework points out the independent variable and dependent variable.



Source: Researcher

The quality of temperature-sensitive pharmaceutical products and all pharmaceuticals depend on the storage conditions provided by the product manufacturer according to their stability testing results (4).

Additionally, to observing and complying with the recommended storage conditions, monitoring the temperature and humidity of these products during storage and distribution is also key to ensuring the product integrity during its lifecycle. Using appropriate and qualified/calibrated cold chain equipment, packaging materials and SOP's will also help to achieve efficiency, uniformity of performance hence quality outcome, while reducing failure to comply with the standards (7,26).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Study design

The study was a descriptive cross-sectional research, where the actual status of distribution practices of temperature-sensitive pharmaceutical products in Rwanda was done to describe and evaluate the Good Distribution Practices to reveal any deviation from the standards and recommend corrective and preventive measures.

3.2. Target Population

To achieve the objectives of this study, the target population was Rwanda Medical Supply employees at the central and district level, from the various units of the organization such as:

- Quality Assurance and Quality Control Unit staff
- Warehouse Unit staff (Receiving, Checking, Inventory, Picking, and Dispatch)
- Sales and Distribution Unit
- RMS branch Directors and store managers

3.3. Sample size and location

The researcher analyzed historical data on recorded temperature and humidity levels in different storerooms and refrigerators/freezers as well as transit temperature data, data from RMS Ltd HQs and the 9 representative District RMS Branches among 30 in the country were consulted for three previous years.

The selected sites were Rubavu and Rusizi (Western Province), Musanze and Rulindo (Northern Province), Huye and Muhanga (Southern Province), Gasabo, and RMS HQs (Kigali City), and Kayonza and Bugesera (Eastern Province).

These sites were purposively chosen following their different geographical location which helped to capture the variation in environmental conditions in the country thus have a clearer picture of the impact of environmental conditions on the temperature-sensitive products during their distribution.

For this study, no sample size calculation was done since a purposeful sampling technique was used to define the sample population according to their role in the management of temperature-sensitive pharmaceutical products at RMS.

3.4. Description of the site

Our study was conducted at Rwanda Medical Supply Limited, which is a large-scale corporation created and owned by the Government of Rwanda. RMS ltd objective is to ensure the availability of medicines, medical supplies, and consumables in the right quantity, with acceptable quality, to the right place and customers, at the right time, and with optimum cost to the Rwandan population. It is responsible for the procurement, storage, and distribution of all health technologies used in all public health facilities in Rwanda.

Rwanda Medical Supply has units such as Production, Quantification & Stock monitoring, Procurement, Warehouse & Distribution, Sales & Marketing as well as Quality Assurance & Control. Each unit is composed of different sections, which are the smallest working teams. The population involved in distribution is composed of these sections: Receiving, Picking, Dispatch, Inventory control, and Checking.

3.5 Data collection procedures

In this research**,** primary and secondary data were collected.

3.5.1. Primary data

Primary data were collected using a survey questionnaire which was distributed to RMS HQs and selected Branches personnel/ key Informants who can provide accurate information on temperature-sensitive products management in their respective settings and their compliance to the Good Distribution Practices.
A Good Distribution Practice Checklist was used to collect data on the level of compliance with the national and international standards.

The collected information from the questionnaire and the checklist helped us in understanding and interpreting previous data records, and formulating appropriate recommendations and CAPAs where necessary.

3.5.2. Secondary data

Previous records on temperature and humidity recorded in the last three years were also examined and analyzed against the recommended standards. These data were part of archived data from RMS Ltd former Medical Procurement and Production Division at RBC.

The documentary review was done on other reports, SOPs, and publications about the same topic or related subjects to collect useful information for better interpretation of the primary data.

3.6. Data Analysis and Discussions

The collected data from different reports and a questionnaire provided by RMS Ltd key informants were captured in excel and analyzed using Descriptive Statistics with SPSS version 25, and the

results were presented in tables, and then compared to the recommended standards to identify the level of compliance or non-compliance and CAPAs were suggested where necessary.

3.7 Ethical considerations

Approval from the University of Rwanda/ CMHS Institutional Review Board was sought.

The research protocol was shared with RMS Ltd Management and the researcher ensured the data provided are used for academic purposes only. Before collecting and using data, consent was obtained and reference indicated the source of data.

CHAPTER FOUR: RESULTS PRESENTATION

4.0.Introduction

The present chapter reports the results of the present study. The results presented are responding to the objectives of the study. It starts with demographic characteristics of the study participants followed by participants responses to compliance to standards of good distribution practices of temperature-sensitive products at RMS Ltd, qualification of staff involved in the management of temperature-sensitive products in Rwanda, availability, and compliance of tools and equipment used in cold chain management of TSPs at RMS Ltd against national and international standards and finally the results on risks of products degradation due to poor distribution practices.

The reported results are also discussed to interpret the data in respective paragraph.

4.1.Demographic characteristics

Table 4. 1 Participants' gender

Variables	**N**	**%**
Male	15	50
Female	15	50
Total	30	100

The results in table 4.1 show that both males 15(50%) and females 15(50%) participated equally in the present study.

Table 4. 2 Participant' working experience

Variables	N	%	Mean	Minimum	Maximum
5 Years	1	3.3	11.4	5	21
7 Years	2	6.7			
8 Years	3	10.0			
10 Years	7	23.3			
11 Years	5	16.7			
13.5 Years	2	6.7			
14 Years	2	6.7			
16 Years	2	6.7			
21 Years	2	6.7			
Non-response	4	13.3			
Total	30	100.0			

The results in table 4.2 highlight that the majority (23.3%) of the participants have 7years of work experience in the medical supply profession. Participants with 5 years of working experience were few (3.3%) compared to the rest of the work experience.

Table 4. 3 Department

Variables		N	%
Department at the central level	Quantification	2	7
	Warehousing and logistics	9	30
	Sales and marketing	3	10
	Quality Assurance and Quality Control	7	23
	Finance and Administration	1	3
	Non-response	8	27
Total		30	100
Department at the peripheral level	District Pharmacy	15	50
	Other health facilities (hospitals, health centers, etc.)	1	3
	Non-response	14	47
Total		30	100

The results on which departments participants work from showed that at the central level, the majority work in warehousing and logistics 9((30%) while the minority 1(3%) works from the finance and administration department. On the other hand, at the peripheral level, 15(50%) of the participants reported that they work from district pharmacies while only one (3%) showed to be affiliated with other health facilities such as hospitals, health centers, or any other.

4.2 Compliance with good distribution practices standards of TSP.

Compliance to good distribution practices of temperature-sensitive requires basic training, presence of SOPs, well-coordinated inspections, drug packaging following minimum standards as well as adherence to the existing guidelines, availability of supply chain personnel, temperature and environment control where humidity needs to be taken into account, equipment's, as well as vehicles, vehicles, and packaging (27,28).

Table 4.4 reports how participants responded to which practice exists in their respective departments.

Table 4. 4 Distribution practices of temperature-sensitive products

Variables		**N**	**%**
Attendance in training on cold chain management	No	9	30
	Yes	21	70
Frequency of training attendance	Once	12	40
	Twice	7	23
	Thrice	2	7
	Not attended	9	30
Written standard operating procedures availability	No	10	33
	Yes	20	67
Inspection upon receipt of cold chain products	Medicine should be in a box with ice packs	0	0
	Expiry date and Transit temperature data	4	15
	All of the above	22	85
Checking the storage condition before distribution	No	3	10
	Yes	27	90
WHO's Good Storage Practices	No	12	40
	Yes	18	60
WHO's Good Distribution Practices	No	23	77
	Yes	7	23
EU's Good Distribution Practices	No	29	97
	Yes	1	3
RFDA Good Distribution Practice Guidelines	No	28	93
	Yes	2	7
US Pharmacopoeia	No	29	97
	Yes	1	3
Don't know	No	24	80
	Yes	6	20
Others (Mention)	No	28	93
	Yes	2	7
Reading through the available guidelines	No	12	43
	Yes	16	57

The results in table 4.4 indicate that the majority 21(70%) have attended training on storage, distribution, and handling procedures of cold chain medicines. Among those who had training, 12(40%) have attended at least once. The results also reported a big number of participants 9(30%) who did not attend any training. Regarding the availability of written instructions (SOPs) on storage, materials handling, documentation/ records keeping, 20 (67%) of the participants mentioned that they are available in their departments while only 10(33%) mentioned that they do not have them.

Regarding inspection upon receipt of cold chain products, the big majority of the participants 22(85%) highlighted that medicine should be in an icebox and show expiry date and transit temperature data. And this is an indicator of good practice.

The majority of the participants 27(90%) mentioned they check the storage condition of the temperature of pharmaceutical products before distribution as it is very crucial for ensuring good distribution; while only 10% did not mention that this is important.

Regarding the adherence to the existing standards, 18(60%) mentioned that they use WHO's Good Storage Practices in their department, 7(23%) mentioned using WHO's Good Distribution Practices, only 1(3%) mentioned using EU's Good Distribution Practices, 2(7%) mentioned to use RFDA Good Distribution Practice Guidelines, 1(3%) mentioned to use US Pharmacopoeia in their department while 6(20%) participants mentioned that they don't know which guidelines they use. 16 (57%) of the participants mentioned that they have ever gone through the existing guidelines to check if their departments adhere to them.

Table 4. 5 Qualification of supply chain personnel in Good Distribution Practices

Variables		**N**	**%**
Availability of written job descriptions.	No	1	11
	Yes	8	89
	Not applicable	0	0
Availability of personnel qualified in GDP requirements	No	6	66
	Yes	2	22
	Not applicable	1	11
Personnel receive initial and continuing training	No	6	67
	Yes	3	33
	Not applicable	0	0
Specific training on how to manage and handle excursions	No	6	67
	Yes	2	22
	Not applicable	1	1
Assessment of effectiveness of training and its records	No	6	68
	Yes	1	11
	Not applicable	2	22

With regards to the qualification of supply chain personnel, it was noted that 8(89%) of the respondents mentioned that the role, responsibility, and interrelationships of all personnel are indicated in written job descriptions. Only 2(22%) said that all personnel involved in distribution activities are qualified as per the GDP requirements, while 6(67%) said that personnel do not receive initial and continuing training relevant to their tasks, based on written standard operating procedures (SOPs). It was again mentioned by the majority 6(67%) that no specific training is provided on how to manage and handle temperature-sensitive products and their management in the event of unexpected occurrences such as non-delivery or vehicle breakdown; and no periodic assessment and documentation on the effectiveness of the training.

Table 4. 6 Temperature and environment control

Variables		**N**	**%**
Availability of suitable equipment and procedures	No	3	33
	Yes	6	67
	Not applicable	0	0
Storage areas are temperature mapped.	No	4	44
	Yes	4	44
	Not applicable	1	12
Temperature monitoring equipment is located according to the results of the mapping exercise.	No	2	22
	Yes	2	22
	Not applicable	5	56
Availability of adequate controls of temperature	No	4	44
	Yes	4	44
	Not applicable	1	12
Equipment used are calibrated at defined intervals.	No	2	22
	Yes	7	78
	Not applicable	0	0
Appropriate alarm systems are in place	No	7	78
	Yes	1	11
	Not applicable	1	11
A procedure is in place for investigating excursions	No	6	667
	Yes	1	11
	Not applicable	2	22

The results on temperature and environment control indicated that suitable procedures and equipment are in place to ensure proper control of the environment as mentioned in 67% of the cases observed. It was again observed that adequate controls are in place to maintain all parts of the storage area within recommended temperature range. On the other hand, no procedure is in place to investigate and handle the temperatures. The participants mentioned that storage areas are temperature mapped though no records available for further use.

Table 4. 7 Equipment

Variables		N	%
Planned preventive maintenance is in place	No	5	57
	Yes	4	43
	Not applicable	0	0
The calibration of equipment is traceable to a standard	No	5	56
	Yes	4	44
	Not applicable	0	0
Adequate record of repair, maintenance, and calibration	No	5	57
	Yes	3	33
	Not applicable	1	11
Validation and qualification activities is determined by a documented risk assessment approach and is documented in a plan.	No	5	56
	Yes	2	22
	Not applicable	2	22
	Not applicable	0	0

The results in table 4.7 indicated that many participants 5(57%) did not show that there is planned preventive maintenance for key equipment in place. Calibration of equipment is not traceable to a primary standard as required, 5(56%) observations made did not show any plan and there are no records of the results of the maintenance exercise.

Table 4. 8 SOPs

Variables		N	%
SOPs are reviewed regularly, kept up-to-date and approved	No	7	78
	Yes	2	22
	Not applicable	0	0
Superseded or obsolete SOPs are archived	No	8	89
	Yes	1	11
	Not applicable	0	0

It was observed that the SOPs are not regularly reviewed, as the 7(78%) observations made did not show any updated SOPs.

Table 4. 9 Vehicles, equipment's and packaging

Variables		**N**	**%**
Required storage conditions are maintained during transit	No	2	22
	Yes	7	78
	Not applicable	0	0
Suitable vehicles and equipment are used to prevent exposure	No	3	33
	Yes	6	67
	Not applicable	0	0
Validated temperature-control systems are used	No	3	33
	Yes	6	67
	Not applicable	0	0
Temperature mapping is performed in refrigerated vehicles	No	6	67
	Yes	0	0
	Not applicable	3	33
Equipment used during transport is maintained and calibrated	No	7	78
	Yes	1	11
	Not applicable	1	11
If cool packs are used in insulated boxes, they are well located such that the product does not come in direct contact with the cool pack.	No	2	22
	Yes	7	78
	Not applicable	0	0
If non-dedicated vehicles and equipment are used procedures are in place to maintain the quality of the medicinal product.	No	4	44
	Yes	4	44
	Not applicable	1	12

It was worth noting that required storage conditions are maintained during transportation because 7(78%) observations showed it. The vehicles and equipment are suitable and appropriate as well.

4.3 Availability and compliance of tools and equipment used in the management of TSPs

Table 4. 10 Tools and equipment used in cold chain management of TSPs

Variables		N	%
Use of vehicles in transportation equipped with temperature devices with alarm	No	26	87
	Yes	4	13
Availability of historical data for Refrigerating temperature range of used cold chain transport trucks	No	20	67
	Yes	10	33
Occurrence of an unexpected situation during transportation?	No	18	60
	Yes	12	40

It was reported by the majority of study participants 26 (87%) that there were mainly no vehicles equipped with temperature devices with alarms available to transport temperature-sensitive products in their respective institutions. It was further reported by 20 (67%) participants that there was no historical data for refrigerating temperature range of used cold chain transport trucks available at their disposal. A significant number of participants 12(40%) mentioned that there was some unexpected situation where the refrigerated truck is not cooled or the route exceeds the temperature control time during transportation (27,28).

4.4 Risks of products degradation due to poor distribution practices

The risk of product degradation due to poor distribution practices is reflected in factors leading to distribution conditions, the robustness of the technology used in the monitoring and transportation process, the temperature range, measures that can be taken in a case of temperature excursion (TOR), and the storage condition (27,28).

Table 4. 11 Risks of products degradation due to poor distribution practices

Variables		**N**	**%**
Underlying factors that lead to a fault in distribution	Unreliable Power supply	1	4
	Lack of gas	0	0
	Low level knowledge of supply chain personnel	5	19
	Delayed replacement	9	35
	All of the above	11	42
Does RMS use technology in transportation process	No	24	80
	Yes	6	20
Measures taken in case of temperature excursion	Continue to store	0	0
	Stop using and record	3	10
	Transfer to near facility	18	60
	Not applicable	9	30
Record of discarded cold chain drugs due to excursions	No	27	90
	Yes	3	10
How storage conditions are maintained in the event of a power failure?	Automated Generator	26	86
	Solar	0	0
	No measures	4	13
Recommended temperature range for cold chain medicines stored in refrigerators? −15˚C to -25˚C	No	25	83
	Yes	5	17
Recommended temperature range for cold chain medicines stored in refrigerators? +2˚C to + 8˚C	No	1	3
	Yes	29	97

The results in table 4.11 indicated that the majority of the participants 11 (42%) are aware that low level of knowledge of supply chain personnel, unreliable power supply, lack of gas, and delayed replacement of malfunctioning cold chain equipment are all underlying factors that lead to a fault in distribution conditions. 24(80%) of the participants did not know that RMS incorporates the use of technology like RFID, data loggers, or any other continuous monitoring devices in the transportation process (27).

Regarding measures taken by study participants in case of temperature excursion (TOR), the majority of the participants 18(60 %) mentioned that they transferred medicines to a nearby facility

while no one mentioned continuing to store in cold chain for future use; and the majority 29(90%) said that they do not record cold chain medicines discarded due to incorrect storage temperature. The automated generator was mentioned by the majority 26 (86%) to be appropriate to maintain storage conditions in the event of power failure. The most recommended temperature range for coldest chain medicines stored in refrigerators as reported by the participants 29(97%) is between +2˚C to + 8˚C.

4. 5 Findings on temperature and humidity records for the last three years (2017-2019)

To adhere to good distribution practices of temperature-sensitive products, temperature, and humidity monitoring should be ensured throughout the storage and distribution of the drugs so that their therapeutic effect is maintained. The expiration of the drug is as important as the condition in which it is kept.

The results in this section are recorded temperature and humidity that were recorded to ensure the safety and quality of the drugs in the study setting.

4.5.1 Temperature records in Cold rooms

The World Health Organization recommends that temperature-sensitive medicine should be kept at a temperature between +2˚C to +8˚C (10,23). Keeping this range has a positive implication on the potency of the drugs. The relative humidity(RH) should be kept in the range of 40%-60%(10).

The temperature records are analyzed for three consecutive years from 2017 to 2019 to report on compliance with the range as recommended by WHO.

Status of temperature records in Cold-rooms

Table 4. 12 Temperature and humidity monitoring in 2017 in cold-rooms

Year: 2017	Measurements	Records	Minimum	Maximum	Mean	Std. Deviation
March	Max T°(°C)	59	5.6	**9.4**	6.4	0.7
	Min T°(°C)	59	4.0	4.3	4.1	0.1
	Max RH(%)	59	91.5	97.0	94.4	1.6
	Min RH(%)	59	72.9	76.8	75.1	0.8
April	Max T°(°C)	59	5.7	**16.2**	8.3	2.7
	Min T°(°C)	59	4.2	6.2	5.5	0.5
	Max RH(%)	59	82.1	96.6	90.0	3.5
	Min RH(%)	59	73.1	81.7	78.9	2.4
July	Max T°(°C)	55	5.5	**16.2**	6.4	1.4
	Min T°(°C)	55	3.6	4.9	3.9	0.2
	Max RH(%)	55	86.4	96.1	91.0	2.0
	Min RH(%)	55	70.3	75.8	72.6	1.0
Sept	Max T°(°C)	60	4.0	**15.4**	8.1	3.2
	Min T°(°C)	60	3.5	4.2	3.9	0.1
	Max RH(%)	60	90.3	97.0	93.7	2.3
	Min RH(%)	60	66.5	77.8	74.6	2.1
October	Max T°(°C)	57	5.5	**15.6**	8.2	3.1
	Min T°(°C)	57	3.8	4.2	4.0	0.1
	Max RH(%)	57	90.6	97.1	94.1	2.3
	Min RH(%)	57	68.2	78.0	75.3	1.6
December	Max T°(°C)	59	5.7	**16.1**	7.4	2.3
	Min T°(°C)	59	4.0	5.0	4.4	0.4
	Max RH(%)	59	89.3	97.1	92.8	2.4
	Min RH(%)	59	64.4	77.8	75.3	1.9

The results in table 4.12 highlighted that it is evident that temperature measurements recorded during the year 2017, most of the records fell within the recommended average. It was highlighted that the mean cold room temperature for almost all the records reported was between +2˚C to +8˚C. However, some records went beyond the average whereby some reached the highest temperature of 9.4 ˚C in March, 16.2 ˚C in April, 16.2 ˚C in July, 15.4 ˚C in September, 15.6 ˚C in October and 16.1 ˚C in December 2017.

On the other hand, recorded humidity indicated that it is beyond the recommended international average, which is 40%-60%. There was no single record that has fallen in that range. All the minimum records were above 60%. It is again clear that measurements were not taken sometimes; in July 2017, only 55 records were taken and this is an indication that temperature monitoring was not done as it was supposed to be done.

Table 4. 13 Temperature and humidity monitoring in 2018 in C-room

Year: 2018	Measurements	Records	Minimum	Maximum	Mean	Std. Deviation
March	Max T°(°C)	62	5.4	**11.1**	6.7	1.1
	Min T°(°C)	62	1.9	4.2	2.9	0.6
	Max RH(%)	62	94.0	98.0	96.7	1.0
	Min RH(%)	62	78.7	93.6	82.4	1.9
April	Max T°(°C)	59	5.7	13.5	6.8	1.5
	Min T°(°C)	59	1.3	**10.8**	3.2	1.3
	Max RH(%)	59	86.7	98.2	96.8	1.9
	Min RH(%)	59	71.8	84.4	81.5	2.2
June	Max T°(°C)	60	5.6	9.9	6.2	0.8
	Min T°(°C)	60	2.0	3.2	2.4	0.2
	Max RH(%)	60	92.8	98.0	95.4	1.5
	Min RH(%)	60	76.4	82.8	79.4	1.6
July	Max T°(°C)	61	5.2	9.9	6.0	0.8
	Min T°(°C)	61	2.1	3.1	2.3	0.2
	Max RH(%)	61	89.8	97.7	92.7	2.2
	Min RH(%)	61	73.4	81.8	76.0	1.8
September	Max T°(°C)	54	5.2	**12.2**	6.0	1.4
	Min T°(°C)	54	2.6	3.2	3.0	0.2
	Max RH(%)	54	93.1	97.7	94.8	1.2
	Min RH(%)	54	70.9	81.7	79.3	1.5
October	Max T°(°C)	62	5.9	13.1	6.9	1.3
	Min T°(°C)	62	2.6	4.3	3.0	0.3
	Max RH(%)	62	92.9	98.5	96.0	1.2
	Min RH(%)	62	73.0	82.8	80.0	2.0
December	Max T°(°C)	62	5.3	11.2	6.5	1.0
	Min T°(°C)	62	2.3	4.8	2.7	0.5
	Max RH(%)	62	92.4	98.1	94.777	1.6103
	Min RH(%)	62	76.5	80.5	78.721	0.8272

The results in table 4.13. show that the average recorded temperatures in cold rooms at the study site were within the recommended range, however, some records went beyond that recommended temperature. For example, in March, the maximum temperature reached 11 ˚C, 10.8 ˚C in April, and 12.2 ˚C. Although these might be a single recorded rise in some hours of the day; such kinds of variations expose the highly temperature-sensitive product to lose their therapeutic effects when there is such repetitive exposure. The humidity records were all high as of 2017 and 2018 because all the records are beyond the recommended humidity values between 40 and 60%, some have even reached 96%.

Table 4. 14 Temperature and humidity monitoring in 2019 in Cold-room

Year: 2019	Measurements	Records	Minimum	Maximum	Mean	Std. Deviation
March	Max T°(°C)	62	6.2	**11.9**	7.0	0.8
	Min T°(°C)	62	2.1	5.3	3.2	0.8
	Max RH(%)	62	92.4	97.8	95.4	1.5
	Min RH(%)	62	75.9	87.8	79.4	1.8
April	Max T°(°C)	60	5.8	**13.5**	7.5	1.7
	Min T°(°C)	60	2.3	6.5	3.4	1.0
	Max RH(%)	60	91.5	98.8	95.9	1.9
	Min RH(%)	60	77.0	90.0	80.8	2.8
July	Max T°(°C)	59	5.8	**11.3**	6.8	1.1
	Min T°(°C)	59	2.4	4.8	3.2	0.7
	Max RH(%)	59	90.3	98.1	94.4	1.7
	Min RH(%)	59	72.7	82.7	77.9	2.0
September	Max T°(°C)	61	5.4	**12.3**	6.8	1.2
	Min T°(°C)	61	**0.6**	2.6	2.2	0.3
	Max RH(%)	61	88.1	97.8	93.4	2.9
	Min RH(%)	61	71.5	81.0	76.3	2.1
October	Max T°(°C)	62	5.3	**11.5**	6.9	1.4
	Min T°(°C)	62	**0.8**	2.8	2.4	0.4
	Max RH(%)	62	90.1	98.1	94.7	2.4
	Min RH(%)	62	72.2	82.4	78.5	2.1
December	Max T°(°C)	62	5.7	**9.7**	6.8	0.8
	Min T°(°C)	62	3.7	4.2	3.9	0.1
	Max RH(%)	62	92.8	98.3	95.5	1.6
	Min RH(%)	62	75.0	85.3	80.1	2.0

It is worth noting that during the year 2019, the average recorded temperatures were not far from the recommendations though it was again reported to have some months where the records went beyond the normal range.

Status of temperature and humidity records in Freezer-room

Monitoring of the temperature and humidity started during the year 2018 onwards at the study site. The present section, therefore, is the reported data on both temperature and humidity for two mentioned consecutive years.

The recommended range for the freezer temperature is set to -25 to -5°C (29).

Table 4. 15 Temperature and humidity monitoring in 2018 in Freezer-room

Year: 2018	Measurements	Records	Minimum	Maximum	Mean	Std. Deviation
June	Max T°(°C)	60	-9.1	5.2	-6.258	2.4937
	Min T°(°C)	60	-13.8	-10.9	-12.137	0.6682
	Max RH(%)	60	91.9	95.4	93.732	0.8701
	Min RH(%)	60	67.3	72.4	69.945	1.0806
July	Max T°(°C)	55	-10.2	3.3	-5.473	2.1122
	Min T°(°C)	55	-12.8	-7.8	-10.169	1.1532
	Max RH(%)	55	84.7	96.1	93.329	1.8320
	Min RH(%)	55	68.3	75.8	72.113	1.6892
Sep	Max T°(°C)	54	-2.9	10.1	**3.611**	3.0843
	Min T°(°C)	54	-14.0	-7.6	-10.804	1.4621
	Max RH(%)	54	82.8	95.1	91.067	3.3763
	Min RH(%)	54	55.0	65.4	59.798	2.7350
Oct	Max T°(°C)	62	-13.1	23.0	**4.089**	3.6387
	Min T°(°C)	62	-26.3	-11.7	-22.284	3.0474
	Max RH(%)	62	3.0	95.2	92.353	11.5945
	Min RH(%	62	-24.7	66.0	59.835	11.1808
Dec	Max T°(°C)	55	-15.1	39.3	**6.133**	8.3058
	Min T°(°C)	55	-27.6	10.7	-22.809	5.9313
	Max RH(%)	55	88.4	95.9	93.631	1.3047
	Min RH(%)	55	29.2	63.8	56.856	5.4818

Table 4. 16 Temperature and humidity monitoring in 2019 in Freezer-room

Year: 2019	Measurements	Records	Minimum	Maximum	Mean	Std. Deviation
March	Max T°(°C)	62	-18.5	10.4	-4.098	7.2880
	Min T°(°C)	62	-26.8	3.5	-16.326	7.7841
	Max RH(%)	62	84.5	96.9	93.506	2.3773
	Min RH(%)	62	56.7	94.7	74.821	9.2022
April	Max T°(°C)	60	-20.1	10.7	-7.637	9.4604
	Min T°(°C)	60	-28.5	9.5	-18.950	9.4223
	Max RH(%)	60	87.5	97.1	93.028	2.3979
	Min RH(%)	60	62.5	94.8	76.050	8.2213
June	Max T°(°C)	60	-19.2	9.4	-15.538	4.6864
	Min T°(°C)	60	-26.4	-19.3	-22.775	1.4707
	Max RH(%)	60	85.2	96.5	90.993	1.8297
	Min RH(%)	60	62.8	83.8	74.932	4.4233
July	Max T°(°C)	59	-18.3	8.1	-9.283	7.6141
	Min T°(°C)	59	-25.2	-5.6	-18.151	5.3676
	Max RH(%)	59	89.2	96.8	92.956	2.2439
	Min RH(%)	59	69.7	89.6	80.244	4.9803
Sep	Max T°(°C)	60	-17.4	9.3	0.888	7.1691
	Min T°(°C)	60	-25.0	-4.2	-15.345	5.8875
	Max RH(%)	60	83.4	96.5	93.922	3.4394
	Min RH(%)	60	60.8	78.0	68.270	3.8455
Oct	Max T°(°C)	62	-11.3	9.5	**3.481**	3.9064
	Min T°(°C)	62	-21.5	-11.1	-17.698	2.2214
	Max RH(%)	62	89.7	96.9	95.544	1.3032
	Min RH(%)	62	60.1	88.6	68.132	5.7864
Dec	Max T°(°C)	62	-20.4	6.8	-7.774	10.3932
	Min T°(°C)	62	-22.1	**22.0**	-19.924	5.4688
	Max RH(%)	62	78.0	96.1	89.292	5.6166
	Min RH(%)	62	59.0	82.9	65.852	4.7224

The data in table 4.15 and 4.16 indicated that the products that were exposed to the coldness in the freezer were at a greater risk to be deteriorated since temperatures were changing too much throughout the months. Although the average for most of the months in 2018 was in range the results in the table show that there was temperature excursion whereby the maximum temperatures during the year went up as high as +23°C.

The average temperature was out of range for September, October, and December [-10.8 to +3.6°C], [-22.3 to +4.1°C], and [-22.8to +6.1°C] respectively.

In 2019, the maximum temperatures were mostly out of range with the minimum reaching +22°C in December and the average hiking up to +3.841°C in October.

CHAPTER FIVE: DISCUSSION

5.0. Introduction

The present chapter discusses the results in relation to the objectives of the study. It starts by discussing the compliance to standards of good distribution practices of temperature-sensitive products at RMS Ltd, qualification of staff involved in the management of temperature-sensitive products in Rwanda, availability, and compliance of tools and equipment used in cold chain management of TSPs at RMS Ltd against national and international standards and finally provides insights in risks of products degradation due to poor distribution practices, findings on temperature and humidity records of last three years(2017-2019) are discussed and Corrective and Preventive Action (CAPA) are proposed.

5.1. Compliance with good distribution practices standards of TSPs at RMS Ltd

The present study unpacked that the distribution of temperature-sensitive follows the existing SOPs, but adherence to international standards was quite low. For example, participants mentioned that only 60% use WHO's Good Storage Practices in their department, 7(23%) mentioned using WHO's Good Distribution Practices, only 1(3%) mentioned using EU's Good Distribution Practices, 2(7%) mentioned to use RFDA Good Distribution Practice Guidelines, 1(3%) mentioned to use US Pharmacopoeia in their department while 6(20%) participants mentioned that they don't know which guidelines they use. On the other hand, 16 (57%) of the participants mentioned that they have never gone through the existing guidelines to check if their departments adhere to them. This is an indication that full adherence to the international standards is required and harmonization of the guidelines used by Rwanda Medical Supply is of utmost importance to be able to have products that are safe and efficient. It was recommended by the WHO that in the management of temperature-sensitive products during the distribution process, all road vehicles used must be qualified and the details and responsibilities for this process should be set and recorded. These vehicles should be equipped with calibrated temperature monitoring/logger devices and with sensors to alert in case of temperature excursions (7)(9).

5.2. Qualification of staff involved in the management of TSPs

The present study showed the qualified personnel working in the management of temperature-sensitive products where only 2(22%) said that all personnel involved in distribution activities are qualified as per the GDP requirements. Although most of the staff had an experience of more than 5 years on average, the staff training also is not enough as far as management of the temperature-sensitive product is concerned. The literature suggests that continuous training should be done to keep up to date with the new development related to temperature-sensitive products, transportation, and management (21). The reason for the shortage of training can be attributed to the shortage of experts in this area, especially in the developing world, and can be bridged when all actors involved play their part.

5.3 Availability and compliance of tools and equipment used in the management of TSPs

The results pointed out the shortage of tools mainly vehicles equipped with temperature devices with alarms available to transport temperature-sensitive products if using the active thermal system during distribution as mentioned by 26 (87%) and when using the passive thermal system, no historical data for refrigerating range of used cold chain transport carriers were available. It was further noticed that there was some unexpected situation where the refrigerated truck or the used passive packaging is not cooled or the route exceeds the temperature control time during transportation.

This study highlights the need to have state-of-the-art tools and equipment required to manage temperature-sensitive products and stresses that the integrity and quality of products should be maintained and not be compromised during equipment maintenance, repair, or calibration operations. Equipment failure should never compromise products quality or integrity, there should be a written procedure in place to ensure their integrity at all times. Key equipment's adequate records of calibration, maintenance, and repair activities should be made and the results retained (7).

5.4. Risks of products degradation due to poor distribution practices

It was well stated that awareness regarding underlying factors that lead to a fault in distribution conditions that can lead to products degradation is high (80%). To mention a few; the unreliable power supply is among many. However, for the practitioners to manage temperature excursion (TOR), the majority of the participants 18(60%) mentioned that they transfer medicines to a nearby facility while no one mentioned continuing to store them in cold chain for future use; and no record of cold chain data is available for future use if needed. Participants are also aware of the temperature range for coldest chain medicines stored in refrigerators, which is between +2˚C to + 8˚C. The results are in line with the study, which highlighted that power cuts and interruption are some of the major problems that cause losses in potency, damage to equipment, and alter temperatures of cold chain. A study in Tanzania assessing cold chain storage conformity to the WHO guidelines in health facilities in Dodoma and Dar-es-Salaam established that power cuts and lack of gas were among the major issues hindering compliance with the guidelines(23).

5.5. Temperature and humidity records for the last three years (2017-2019)

The temperature and relative humidity data clearly indicated most of the recorded temperature and humidity data were in the recommended international range, but inconsistencies in records were reported throughout 3 years. The inconsistency in temperature and relative humidity for temperature-sensitive pharmaceutical products affect the products and might cause them to lose their therapeutic effect hence drug resistance to the consumer. It is highly recommended that the efficacy of temperature-sensitive medicines should be preserved throughout the logistics management in the pharmaceutical supply chain(20)(21) by ensuring that the recommended range for cold rooms and freezers are kept throughout the storage and transport of the products. It was again noticed that mapping of storage areas is done in most of the areas before storing the products., no records are available for further use; this affects the good practice of where medicine can be safely positioned to ensure that all safety is maintained.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

Conclusion

To safely manage temperature-sensitive products, all SOPs should be observed and regularly updated. The present study evaluated the compliance with the good distribution practices of temperature-sensitive (TSP) products in Rwanda against the WHO standards.

The study revealed that SOPs are available to ensure compliance, however, they are outdated and the scarcity of trained staff and cold chain tools and equipment hamper adherence, hence monitoring of temperature and relative humidity sometimes has loopholes that need to be bridged.

The study discovered that trained staff were very few, adherence to the recommended temperature of $+2^{o}$ C to 8^{o} C for cold room or refrigerators and -25 to -5 ^{o} recorded for freezer room is compromised by the fact that they were inconsistency in taking and reporting the records done coupled with the lack of appropriate tools.

Recommendation

We, therefore, propose the following corrective and preventive actions(CAPA)

Weakness	**CAPA**
Personnel are with very limited training in the management of temperature-sensitive product	Training manual to be availed by RMS Management
The record for temperature and relative humidity are not consistently reported with some days missing	Preparing the manual to report all daily data and putting in place a monitoring and evaluation plan
Shortage of tools mainly vehicles equipped with temperature devices with alarms available to transport temperature-sensitive products	Rwanda Medical Supply Ltd to procure enough logistics to store and transport temperature-sensitive products as it is done for vaccine

Weakness	CAPA
The lack of continuous temperature monitoring devices during in-country distribution	Rwanda Medical Supply Ltd to procure enough logistics to monitor products temperature.
Personnel don't fully understand their role and how it contributes to the goal and mission of the institution as far as temperature-sensitive products are concerned	RMS management to update the SOP's on how to handle and distribute temperature-sensitive products, train the personnel on them and have a plan to assess the practical effectiveness of this training and document it/ record keeping.
The lack of a record of a defined/ written plan of calibration of temperature and humidity monitoring devices.	RMS Quality Assurance and Quality Control Unit to work with the calibration company to establish a plan and advice the calibration company to use stickers that inform on who performed the calibration when it was performed and when is the next calibration due.
No written procedure on how to handle temperature excursion	RMS Management to strengthen supplier relationships with products manufacturers and develop a written temperature excursion management procedure whereby the excursions are recorded and shared with the product's manufacturer for further investigations and risk analysis.
The lack of a backup temperature monitoring device at peripheral levels/ RMS branches to support record keeping.	RMS Management to procure electronic temperature monitoring devices to support daily temperature records from peripheral levels and enhance data quality and availability.
Lack of storage room and transport, packaging tools temperature mapping record.	RMS management through the quality assurance unit to introduce the temperature mapping culture at central and peripheral levels to ensure good practices in the management of temperature-sensitive products.
The lack of harmony in the used good distribution guidelines at the central and peripheral levels.	RMS management through the Quality assurance and Quality control unit to harmonize the documentation on good distribution practices used at the central and peripheral levels.
The lack of monitoring and evaluation of compliance to GSP and GDP for public and private health institutions.	Rwanda FDA to implement the monitoring and evaluation for all public and private health institutions managing health technologies.

REFERENCES

1. JSI. The Supply Chain Manager's Handbook. Arlington, Va John Snow, Inc. 2017;105.
2. Mukhamedjanova KA. Concept of supply chain management. J Crit Rev. 2020;7(2):759–66.
3. WHO. Annex 5: WHO good distribution practices for pharmaceutical products. WHO Tech Rep Ser [Internet]. 2010;(957):235–64. Available from: https://www.who.int/medicines/areas/quality_safety/quality_assurance/GoodDistributionPracticesTRS957Annex5.pdf?ua=1
4. Ammann C. Stability studies needed to define the handling and transport conditions of sensitive pharmaceutical or biotechnological products. AAPS PharmSciTech. 2011;12(4):1264–75.
5. Plan WHOA. Quality-Assured Medical Products. 2019;
6. Kumar N, Jha A. Quality Perspective of "Good Distribution Practices" in Indian Pharmaceutical Industry. IOSR J Bus Manag I [Internet]. 2015;17(11):2319–7668. Available from: www.iosrjournals.org
7. Ziehr H. Annex 9: Model guidance for the storage and transport of time and temperature–sensitive pharmaceutical products. WHO Tech Rep Ser No961, 2011. 2011;(961):324–72.
8. European Commission. European Commission Guideline 2013/C343/01 – on Good Distribution Practice of medicinal products for human use. Off J Eur Union. 2013;1–14.
9. Practices GD, Products M, No R, Date R, Date E, Date RD. Guidelines for Good Distribution Practices of Medical Products. 2020;
10. Kumar N, Jha A. Temperature excursion management: A novel approach of quality system in pharmaceutical industry. Saudi Pharm J [Internet]. 2017;25(2):176–83. Available from: http://dx.doi.org/10.1016/j.jsps.2016.07.001
11. Brown P, Madigan T, Ault M. MHRA GDP inspection deficiency data 2016. 2017;(November). Available from: https://mhrainspectorate.blog.gov.uk/2017/12/13/gdp-inspection-deficiency-data-for-2016/
12. Socarras S, Magari RT. Modeling the effects of storage temperature excursions on shelf life. J Pharm Biomed Anal. 2009;49(2):221–6.
13. Lambert P, McIntosh MP, Widmer M, Evans L, Rauscher M, Kuwana R, et al. Oxytocin quality: evidence to support updated global recommendations on oxytocin for postpartum hemorrhage. J Pharm Policy Pract. 2020;13(1):1–13.

14. N K, A J. Regulatory Approach to Ensure Quality of Products - An Indian Perspective of Missing Linkage. Pharm Regul Aff Open Access. 2016;05(01):1–5.

15. Charlotte A. ASSESSMENT OF STORAGE CONDITIONS OF PHARMACEUTICAL PRODUCTS IN RWANDA Case of Rwanda Biomedical Center / Medical Procurement and Production Division and District Pharmacies. 2019;

16. Rwanda Ministry of Health. REPUBLIC OF RWANDA Health Supply Chain Management Module for RMS branches and Central level. 2021;(March).

17. Twagiramungu F. Environmental profile of Rwanda. Kigali; 2006.

18. Gilchrist GW. Chapter 5 - The Evolution of Thermal Sensitivity in Changing Environments. In: Storey KB, Storey JMBT-C and MR to S, editors. Environmental Stressors and Gene Responses. Elsevier; 2000. p. 55–70.

19. EMUNGAT GA. Determinants of Quality Standards Adherance By Cold Chain Pharmaceutical Distributors in Kenya. Strateg J Bus Chang Manag. 2018;5(2).

20. Journal SA, Sciences M. Preserving Efficacy of Temperature Sensitive Medicines Logistics Management in Pharmaceutical Supply Chain. South Asian J Manag Sci. 2015;9(1):1–9.

21. Bishara RH. Cold chain management - An essential component of the global pharmaceutical supply chain. Am Pharm Rev. 2006;9(1):105–9.

22. Luzze H, Badiane O, Mamadou Ndiaye EH, Ndiaye AS, Atuhaire B, Atuhebwe P, et al. Understanding the policy environment for immunization supply chains: Lessons learned from landscape analyses in Uganda and Senegal. Vaccine [Internet]. 2017;35(17):2141–7. Available from: http://dx.doi.org/10.1016/j.vaccine.2016.10.089

23. Ringo S, Mugoyela V, Kaale E, Sempombe J. Cold Chain Medicines Storage Temperature Conformity by the World Health Organisation in Tanzania. Pharmacol & Pharm. 2017;08(10):325–38.

24. Ashok A, Brison M, LeTallec Y. Improving cold chain systems: Challenges and solutions. Vaccine [Internet]. 2017;35(17):2217–23. Available from: http://dx.doi.org/10.1016/j.vaccine.2016.08.045

25. Kitamura T, Bouakhasith V, Phounphenghack K, Pathammavong C, Xeuatvongsa A, Norizuki M, et al. Assessment of temperatures in the vaccine cold chain in two provinces in Lao People's Democratic Republic: A cross-sectional pilot study. BMC Res Notes [Internet]. 2018;11(1):1–6. Available from: https://doi.org/10.1186/s13104-018-3362-1

26. Kumar N, Ajeya Jha P. Pharmaceutical Quality During Product Life Cycle – a Need of Holistic Approach. 2016;(November 2015).

27. 1 A. Appendices Appendix 1 Research Questionnaire.

28. Personnel SC, Control E. Appendix 2: Good Distribution Practice Compliance Checklist.

29. World Health Organization. Annex 9: Model guidance for the storage and transport of time and temperature–sensitive pharmaceutical products. WHO Tech Rep Ser No961, 2011. 2011;(961):324–72.

30. Karam R, Fransawi C. Good Cold Chain Management for Pharmaceutical Products. Repub Lebanon, Minist Public Heal - QAPPP. 2017;1–17.

31. International Conference on Harmonisation. ICH Guideline Q9 on Quality Risk Management. Regul ICH [Internet]. 2005;44(1):1–20. Available from: https://www.ema.europa.eu/en/documents/scientific-guideline/international-conference-harmonisation-technical-requirements-registration-pharmaceuticals-human-use_en-3.pdf

APPENDICES

Appendix 1

Research Questionnaire(30)

"EVALUATION OF GOOD DISTRIBUTION PRACTICES OF TEMPERATURE SENSITIVE PRODUCTS IN RWANDA: Case of RWANDA MEDICAL SUPPLY Ltd (RMS Ltd)"

I humbly need your contribution in this research to make it successful by providing the needed information on the following questions taking not more 20 minutes.

Instructions:

- Kindly fill in the blank spaces and tick appropriately answers corresponding to your view(s) and knowledge on the question(s);

- Answer the open question(s) where you have additional information for the closed questions.

1. Your gender: Male ☐ Female ☐

2. Number of years of experience in pharmaceutical supply chain management: ……..

3. Department / Unit of work (tick the right answer):

a) Central level (RBC/MPPD)

Quantification ☐

Warehousing and logistics ☐

Procurement ☐

Sales and marketing ☐

Quality Assurance and Quality Control ☐

Finance and Administration ☐

Production ☐

b) Peripheral level

District Pharmacy ☐

Other health facility (Hospital, Health center, etc.) ☐

4. Have you ever attended training on storage, distribution and handling procedures of cold chain medicines?

Yes ☐

No ☐

5. How many times have you attended such a course within last three years?

Once ☐

Twice ☐

Thrice ☐

Not attended ☐

6. Are there written instructions (SOPs) describing storage procedures, materials handling and documentation/records Keeping? (If yes, ask to see them)

Yes ☐

No ☐

7. What do you inspect when you receive cold chain product from Suppliers?

Medicine should be in a box with ice packs ☐

Expiry date and Transit temperature data ☐

All of the above ☐

8. While storing and packaging pharmaceutical products before distribution, do you strictly check and consider the labeled storage conditions of temperature and other recommended conditions by the manufacturer?

Yes ☐

No ☐

9. What guidelines do you use for managing the Quality Management System during your practice?

WHO's Good Storage Practices ☐

WHO's Good Distribution Practices ☐

EU's Good Distribution Practices ☐

RFDA Good Distribution Practice Guidelines ☐

US Pharmacopoeia ☐

Don't know ☐

Others (Mention)

10. If you have Guidelines, have you ever gone through it to find out proper ways of storage and handling temperature sensitive medicines at your facility up to the point of administration?

Yes ☐

No ☐

11. Are the vehicles used in transportation equipped with temperature monitoring devices with alarm? (If yes, how are these transit data transferred)?

Yes ☐

No ☐

12. What is the refrigerating temperature range of used cold chain transport trucks? Are there historical data available?

Yes ☐

No ☐

13. Has there ever been an unexpected situation where the refrigerated truck is not cooled or the route exceeds the temperature control time during transportation?

Yes ☐

No ☐

14. What do you think are the underlying factors that lead to fault in distribution conditions at your facility?

Unreliable Power supply ☐

Lack of gas ☐

Low level of knowledge of supply chain personnel ☐

Delayed replacement of malfunctioning cold chain equipment ☐

All of the above ☐

15. Does RMS incorporate the use of technology like RFID, Data loggers or any other continuous monitoring devices in the transportation process? (Is yes, ask which ones?)

Yes ☐

No ☐

16. What is the recommended temperature range for most cold chain medicines stored in refrigerators?

−15˚C to -25˚C ☐

+2˚C to + 8˚C ☐

Don’t know ☐

17. In case of temperature excursion (TOR), what measures or actions do you specifically take?

- Continue to store in cold chain for future use ☐
- Stop using and recorded in book for cold chain medicines discarded due to incorrect storage temperature ☐
- Transfer medicines to nearby facility ☐
- Not applicable ☐

18. Is there any record of cold chain medicines discarded due to incorrect storage temperature? (If yes, ask the physical sample)

Yes ☐

No ☐

19. How do you maintain appropriate storage condition in the event of power failure?

Automated Generator ☐

Solar ☐

No measures ☐

20. Can you please share the temperature and humidity records for the last three years i.e. 2018-19-2020 for further analysis in the frame of this study?

Thank you very much for your contribution!

Interviewee:

Names: ……

Institution: ……

Telephone: ……

Email: ……

Interviewer:

Names: Ariane MUTABARUKA

Institution: National University of Rwanda/EAC- RCE-VIHSCM

Telephone: (+250)788747930

Email: arianemutabaruka@gmail.com

Appendix 2Good Distribution Practice Compliance Checklist(29)(31)

Feature	Pass	Fail	N/A
Supply Chain Personnel			
The responsibility, role and interrelationships of all personnel is clearly indicated in written job descriptions.			
All personnel involved in distribution activities are qualified in GDP requirements.			
Personnel receive initial and continuing training relevant to their tasks, based on written standard operating procedures (SOPs) according to a written training programme.			
Specific training is provided on how to manage and handle temperature sensitive products and their management in the event of unexpected occurrences such as vehicle breakdown or non- delivery.			
The practical effectiveness of training is periodically assessed and documented.			
Temperature and Environment Control			
Suitable equipment and procedures are in place to ensure adequate control of the environment.			
Storage areas are temperature mapped.			
Temperature monitoring equipment is located according to the results of the mapping exercise.			
Controls are adequate to maintain all parts of the relevant storage area within recommended temperature parameters			
Equipment used to control or to monitor the environment, is calibrated and their correct operation and suitability is verified at defined intervals.			
Appropriate alarm systems are in place and appropriately set to provide alerts when there are deviations from recommended storage conditions.			
A procedure is in place for investigating and handling temperature excursions.			

Equipment			
Planned preventive maintenance is in place for key equipment.			
Calibration of equipment is traceable to a primary standard.			
An adequate record of repair, maintenance and calibration activities for key equipment is made and the results are retained.			
Extent of validation and qualification activities is determined by a documented risk assessment approach and is documented in a plan.			
SOPs			
SOPs are reviewed regularly and kept up-to-date, approved, signed and dated by appropriate authorized persons and version control is applied.			
Superseded or obsolete SOPs are archived and removed from workstations.			
Vehicles, equipment and Packaging			
Required storage conditions are maintained during transportation.			
Vehicles and equipment are suitable and appropriately equipped to prevent exposure of the products to conditions that could affect their quality and packaging integrity, and to prevent contamination of any kind.			
Validated temperature-control systems (e.g. thermal packaging, temperature-controlled containers, and refrigerated vehicles) are used to ensure correct transport conditions			
If refrigerated vehicles are used temperature mapping is performed under representative conditions including seasonal variations.			

Equipment used for temperature monitoring during transport within vehicles and/or containers, is maintained and calibrated at regular intervals at least once a year.			
If cool-packs are used in insulated boxes, they are located such that the product does not come in direct contact with the cool-pack.			
If non-dedicated vehicles and equipment are used procedures are in place to ensure that the quality of the medicinal product will not be compromised.			

APPENDIX 3: INFORMED CONSENT FORM

Title: EVALUATION OF GOOD DISTRIBUTION PRACTICE OF TEMPERATURE SENSITIVE PRODUCTS IN RWANDA.

PART I: Information Sheet

Introduction

This project on the Evaluation of Good Distribution Practices of temperature sensitive products in Rwanda will be focusing on reviewing data on temperature sensitive products during the in country distribution at Rwanda Medical Supply, which is the Rwanda national hub of Procurement, storage and distribution of medical products in Rwanda. Primary data from a survey questionnaire to key informants, good distribution practices checklist and secondary data from documentary and past temperature and humidity reports review will be analyzed and compared to the national and international standards on good Distribution practices; that are crucial in ensuring medical products quality thus the health of the population at large to identify their compliance or non-compliance.

Considering the sensibility of temperature sensitive products to environmental variations and that cumulative exposure of these products to temperature out of recommended range by the products manufacturer affects the products stability; and lead to a lack of clinical response or can even be life threatening for the patients who use these products; coupled with other financial and economic negative impact that substandard products presents, the researchers choose to focus on them to ensure that corrective and preventive actions are recommended in case risks of poor distribution practice are found at Rwanda Medical Supply.

Purpose of the research

The main purpose of this study is to evaluate the compliance to the good distribution
Practices of temperature-sensitive (TSP) products in Rwanda against the WHO standards.

Type of Research Intervention

This research is of utmost importance to identify and fix problems encountered during the distribution process of Temperature sensitive products in the country, but also to prevent these problems from happening again through the recommendation of a strong CAPA Process.

Selection of participants

The participants of the study will be purposively selected amongst RMS Ltd staff at the central/Headquarters and district level. The identification and recruitment criteria of potential participants in the study will be based on the participant's role in the management of Temperature-sensitive products in their settings.

Voluntary Participation

Your participation in this study is voluntary. It is your choice whether to participate or not. The choice that you make will have no bearing on your professional standing or your everyday life. You may change your mind later and stop participating even if you agreed earlier.

Procedures

Primary data will be collected using a survey questionnaire which will be distributed to the selected RMS HQs and Branches personnel/ key Informants who can provide accurate information on temperature-sensitive products management in their respective settings and their compliance to the Good Distribution Practices.

A Good Distribution Practice Checklist will also be used to collect data on the level of compliance to the national and international standards.

Previous records on temperature and humidity recorded in the last three years will also be examined and analyzed against the recommended standards.

The documentary review will be done on other reports, SOPs, and publications about the same topic or related subjects to collect useful information for better interpretation of the primary data.

Duration

Providing answers to the questionnaire will take approximately 20min of your time.

Risks and Discomforts

The risks to you as a participant in this study are minimal. During the group discussion, you may decide to share information. But, again, you may decline to answer any questions that you do not wish to answer or stop the interview at any time, without giving any reasons.

Benefits

There will be no direct benefit to you, but with your participation we hope to improve the distribution practices of temperature sensitive products in Rwanda.

The findings of this study will help the management of RMS Ltd to make evidence based decision on improving the distribution practices of temperature sensitive products and to establish a quality management system. They will also benefit the staff involved in the management of these products through continuous training to help them perform their duty even more better and it shall benefit the Rwandan population to use quality assured products thus creating credibility of our health system.

Reimbursements/ Incentives

You will not receive any payment or any other benefit to take part in this study, but your participation in this research is essential.

Confidentiality

All collected data will be stored confidentially in a database accessible merely by the principal investigator.

The signed consent form ensures that provided information will not be disclosed to unauthorized person.

Sharing of Research Findings

At the end of this research, the findings will be shared with Rwanda Medical Supply Ltd management before publication.

We will in the future publish on the process and the results, but you and your feedback will remain anonymous.

Right to refuse or withdraw

To reiterate, you do not have to take part in this research if you do not wish to do so, and choosing to participate will not affect your job or job-related evaluations in any way. You may stop participating in the group discussion(s) or interview at any time that you wish without your job being affected.

Who to contact in case you have questions about your rights as a research participant

All research on human volunteers is reviewed by CMHS institutional review board that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject, or if you would like to obtain information or offer input, you may contact the IRB through the:

Chairperson:	**Secretary:**
……..	…….
Mobile phone: …….	Mobile phone: ……

If you have any questions about this research, you may address your query to lead investigators:

Local Lead Investigator: Ariane MUTABARUKA

Tel: (+250)788747930

Supervisor: Dr Eric NYIRIMIGABO

Tel: (+250) 788 644 823

If you choose to be part of this research study, I will also give you a copy of this consent form to keep for yourself.

Do you have any questions?

PART II: Certificate of Consent

I have been asked to participate in a project on the Evaluation of Good Distribution Practices of temperature sensitive products in Rwanda

I have read the information provided above. I have asked all the questions; I have at this time. I voluntarily agree to participate in this research study. I may withdraw my consent at any time and stop participation without penalty. By agreeing to be in this research, I have not given up any of my legal rights.

I consent voluntarily to be a participant in this study: Yes / No

Print name of participant:

Signature of participant:

Date (day/month/year):

Print name of Researcher:

Date (day/month/year):

Copy provided to the participant

Appendix 4

Source: https://maps-rwanda.com/rwanda-map-with-districts

UNIVERSITY of RWANDA
COLLEGE OF MEDICINE AND HEALTH SCIENCES
DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 3rd/11/2021
Ref: CMHS/IRB/318/2021

MUTABARUKA Ariane
Master's in Health Supply Chain Management
CMHS, University of Rwanda

Dear Mutabaruka Ariane

RE: ETHICAL CLEARANCE

Reference is made to your application for ethical clearance for the study entitled ***"Evaluation of good distribution practices of temperature sensitive products in Rwanda case study: Rwanda Medical Supply Ltd".***

Having reviewed your application and been satisfied with your protocol, your study is hereby granted ethical clearance. The ethical clearance is valid for one year starting from the date it is issued and shall be renewed on request. You will be required to submit the progress report and any major changes made in the proposal during the implementation stage. In addition, at the end, the IRB shall need to be given the final report of your study.

We wish you success in this important study.

Dr Stefan JANSEN
Ag Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:

- Principal, College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR