UNIVERSITY OF CAPE COAST

KNOWLEDGE, ATTITUDE AND PRACTICE OF COLD CHAIN MANAGEMENT AMONG HEALTH PRACTIONERS IN THE SEKYERE CENTRAL DISTRICT

BY

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DECLARATION

Candidate Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature.....Date.....

Name: .....

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature.....Date.....

Name .....

Co-Supervisor's Signature ..... Date.....

Name .....

ABSTRACT

Cold chain management is the process of storing vaccines in a potent state from the manufacturer to the recipient. This study assessed the knowledge, attitude and practice of cold chain management among health practitioners in the Sekyere Central District of Ghana. The study used a mixed method approach. Eighty- six participants responded to a questionnaire. Twelve cold chain sites were observed and a key informant interview was conducted with 11 health practitioners to explore the challenges on cold chain management. The major findings from the study indicated that (68.6%) of the participants level of knowledge was good and (67.4%) of them had good attitude towards cold chain management. With respect to cold chain management practices, (66.7%) also observed that the district was involved in incorrect cold chain practices such as storage of non-vaccines in vaccine refrigerators, inadequate monitoring of vaccine temperature (50%), inadequate temperature range for vaccine storage (41.7%), few facilities arranging vaccines correctly (16.7%), inadequate emergency power supply (8.3%) and non-availability of contingency plan (100%).The major challenges identified were poor cold chain infrastructure such as state of constant pressure and stress, electricity or power failure, delays in reaching the underserved communities. It is therefore recommended that the Regional Health Directorate should supply the district with cold chain equipment and logistics, especially the remote and underserved areas of the district, and sensitize the staff to refrain from incorrect cold chain practices.

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DEDICATION

To my family and all children under 59 months.

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LIST OF ACRONYMS

BCG	Bacillus Calmette and Guerin
CDC	Centers for Disease Control
CHPS	Community Based Health Planning and Services
DHMT	District Health Management Team
DTR	Thirty – day Electronic temperature loggers
EPI	Expanded Programme on Immunization
EVM	Effective Vaccine Management
GAVI	Global Alliance for Vaccine and Immunization
GHS	Ghana Health Service
KAB	Knowledge Attitude Behaviour Model
MOH	Ministry of Health
PATH	Programme for Appropriate Technology in Health
SCT	Social Cognitive Theory
TPB	Theory of Planned Behaviour
UNICEF	United Nations International Childrens Emergency Fund
US	United States
VPDs	Vaccine Preventable Diseases
VVM	Vaccine Vail Monitor
WHO AFRO IVD	World Health Organization Regional Office for Africa Immunization and Vaccines Development
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

Background to the Study

Vaccination has seriously lessened the problem of infectious diseases universally and has intensely reduced the risk of diseases that were once wide spread and often times deadly (Doherty, Buchy, Standaert, Giaquinto, & Prado-Cohrs, 2016; Pezzotti et al., 2018; Saffar, Saffar, & Saffar, 2013; Rao, Schreiber, & Lee, 2017). Vaccination declines health care cost to both patients and the health care system by reducing the incidence of vaccine preventable diseases (VPDs) (Ogboghodo, Omuemu, Odijie, & Odaman, 2017). This indicates that the introduction of vaccines has made a meaningful impact in the lives of mankind where VPDs are gradually declining as a result of the immunologic efforts of vaccines. VPDs that were once considered as fatal to the health of the populace, especially women and children under the age of 59 months, are also becoming a thing of the past. The introduction of vaccines has also brought a lot of economic benefits to countries worldwide. This is because the huge amount of money that was previously spent on diseases, especially tuberculosis, measles, yellow fever, whooping cough, diphtheria, poliomyelitis, pneumonia, rotaviruses, tetanus and a host of other diseases, can be invested into nationwide developmental programmes (Pezzotti et al., 2018). This suggests that without vaccines, the world may encounter series of disease outbreaks, especially in developing countries where water and sanitation, nutrition, accommodation and general host characteristics are low or poor to some extent to aid the individual resist infections (Saffar et al., 2013). These weak host characteristics may serve as a catalyst for disease outbreaks which

could lead to an increase in case fatality rates, disabilities and other health burdens. Although vaccines have become the pivot for the control and prevention of communicable diseases, its ability to work effectively depends on a well-coordinated vaccine cold chain management system which has always been the cornerstone for vaccine maintenance and distribution.

The cold chain system has been accepted and it is practiced worldwide, especially in countries with access to vaccines, through various international collaborations. Internationally, the achievement of higher vaccination coverage depends on maintainable and competent distribution of vaccines including storage, equipment and personnel. This is also dependent on cost effective vaccines that can also be stored at the appropriate temperatures through quality cold chain management systems. Vaccines as biological medical preparations are very sensitive to temperature and they easily lose their potency when they are not stored properly (Pillay, 2014; Dairo & Osizimete, 2016; Hanson, Anupa, Adama, & Schreiber, 2017). This makes vaccines and vaccination activities meaningless (World Health Organization [WHO] Regional Office for Africa, 2009). In order to keep vaccines ideally preserved from its production to vaccination sites, it demands a suitable cold chain mechanism, submission to criteria, and operative management systems (Pillay, 2014; Hanson et al., 2017; Ogboghodo et al., 2017).

The cold chain system is a system of keeping vaccines in a potent state right from the manufacturer to the recipient at a temperature of + 2 ºC to + 8 ºC. It involves efficient and reliable equipment coupled with well-trained motivated staff and efficient distribution of vaccines (African Medical & Research Foundation, 2007). All these forms the elements of the cold chain system which

work in equilibrium to promote the health of the individuals in the community (African Medical & Research Foundation, 2007). Vaccines must be stored in the right temperature in order to prevent freezing, exposure to sunlight and high temperatures. This is because alterations in the temperature of the vaccines have serious effects on the health of individuals who receive the vaccine. Poor cold chain management also contributes to unnecessary vaccine wastage which has an effect on vaccine safety and vaccination coverage (Billah et al., 2017; Ministry of Health [MOH], 2016). However, if vaccines are not stored at the right temperature, its safety would be compromised, hence an increase in vaccine preventable diseases. For an effective vaccine delivery system, essential vaccines must be available but the availability does not depend on only the quality of the vaccine but the temperature under which the vaccine is stored must be considered (World Health Organization [WHO] Regional Office for Africa, 2009; Widsanugorn, Suwattana, Rashid, Sakamoto, 2011). This indicates that temperature management of vaccines is key to vaccine storage. If not, millions of vaccines would be wasted annually. When these vaccines are wasted, it would affect overall health promotion and public health in general.

The cold chain system assists in the control and prevention of infectious diseases (Ateudjieu, Kenfack, Nkontchou, & Demanou, 2013; Purssel, 2015; Ogboghodo, Omuemu, Odijie, & Odaman, 2018). It is one of the pivots of public health and health promotion, especially in developing countries where vaccine-preventable diseases continue to pose challenges to human lives (Yakum, Ateudjieu, Pélagie, Walter, & Watcho, 2015). To achieve universal vaccine coverage and prevent VPDs worldwide, an appropriate cold chain system management needs to be ensured at all levels of health systems delivery,

right from the manufacturer- international level- up to the recipient in the country who is targeted for vaccination (Ahmed, Faizal, Neuman, Louis, & Dawuod, 2010). Effective Vaccine Management (EVM) was launched by the WHO and United Nations International Children's Emergency Fund (UNICEF) in 2010, as a means to create quality upgrading process for vaccine systems to match their effectiveness against best-practice yardsticks (WHO/ UNICEF, 2010).

The quality of vaccines can only be ensured by a functional cold chain system. Vaccines are highly thermo-sensitive substances which have a fixed shelf life that lose viability over time. This loss is irreversible and accelerated if proper storage and temperature conditions are not maintained (Ogboghodo et al., 2017). Freezing or heat exposure can totally or irreversibly damage the efficacy of vaccines and increase the risk of side effects (Ogboghodo et al., 2017). Administration of vaccines that are not potent will lead to failed immunization of the individual against VPDs (Mugharbel & Al-Wakeel, 2009). This indicates that effective cold chain management is very important in vaccines handling and utilization. Although effective cold chain management is very crucial to vaccine efficacy, various capacity deficits always exist at different levels in diverse forms, and it has been identified as one of the causes of non-adherence to the vaccine cold chain management principles. One of these causes, apart from equipment errors, is the nature of the health workers and staff involved in cold chain management (Mallik et al., 2011). This is because the role of health workers in the management of the cold chain cannot be neglected due to the fact that other organs of the cold chain management system depend on human influence.

Health workers play a paramount role not only in the collection of vaccines but also the handling, storage and maintenance of appropriate cold chain management (Ericksen, Mharmoud, Kenneth, & Vander-Harrt, 2013). Health care providers in primary health care must have adequate knowledge to manage the cold chain (Mavimbe & Gunnar, 2007). Having adequate knowledge to handle the cold chain means an improvement in cold chain system, which has a long-term effect on the reduction of VPDs or reducing infectious diseases case fatalities at the end of the day. Bankole et al. (2010) reported that health workers working in private health settings are deficient in vaccine administration and management. Its effects would be the inoculation of the public with ineffective vaccines, which can lead to VPDs.

Although health workers play a critical role in vaccine management, some do not practice appropriate cold chain management or may not have the necessary logistics to maintain the cold chain management system (Maxwell, Johannes, Lesly, & Zhanks, 2012). Once they do not have the logistics, it affects the overall outcome of the vaccine cold chain system. Again, if they do not have the logistics to operate the cold chain system, it gradually affects their skill because that skill can fade off since the individual does not use it often.

Furthermore, poor handling of vaccines has been detected as one of the cardinal causes of a reduction in the effectiveness of vaccines during the period of vaccination (Ashok, Brison, & LeTallac, 2017). This inability of the vaccine to initiate an appropriate immune response after vaccination becomes obvious when the vaccine which is meant to play a protective role in the susceptible individual refuses to do so (Dairo & Osizimete, 2016). This break in the potency of vaccines could be attributed to human errors where the knowledge level of

individuals involved in the management of the vaccine cold chain management system is the antagonistic factor behind the break in cold chain (Wiysonge et al., 2012). This is due to the fact that the efficacy of the vaccine is also dependent on the person who is conducting the vaccination. If the vaccination agent does not follow standard recommendations for the handling of vaccines, the vaccines could become useless.

Statement of the Problem

The use of vaccines has contributed significantly to the reduction of (VPDs) but the achievement of these results depends on reliable cold chain management system (Ogboghodo et al., 2017). Despite the training given to Health Practitioners (HPs) in their various training institutions, a cross section of HPs sometimes overlooks certain basic cold chain principles, which affects cold chain management in the health sector. Again, someone may be trained and still mismanage the cold chain system due to knowledge gap, skill, poor attitude and non-adherence to cold chain guidelines which have a lot of challenges for the health sector and the population at large (Neizer, Konnheyeh, & Albert, 2009).

A survey conducted in Ghana, Kenya and Uganda indicates that an average of 16.6% of the sampled facilities were not complying with the guidelines laid out by regulatory authorities and 50% of these facilities had temperatures 4°C or more outside the recommended temperatures (Burstein et al., 2013). For example, only 4% of facilities stored vaccines in cold boxes, while the remainder used refrigerators and storage outside the recommended range (Burstein et al., 2013).

Another study in Ghana by Agyekum (2012) indicated that as much as 95% of retailers do not inspect the temperature of supplied products during the period of collection, 49% of the participants also specified that none vaccines such as energy drinks and water are stored in the fridge meant for medical products, this leads to temperature alterations in the refrigerator, most 90% of the shops involved in retailing did not have documented directives on procedure for storage, handling of materials and recording which creates problems for tracing the storage conditions of supplies.

The study also found that 92% of the devices that were used to store products did not have thermometers to monitor the temperature of cold chain medical supplies, this has implications for the quality as well as the potency of medicines. The temperature of facilities 95% that stored vaccines were not monitored so documentation was not available. It was also discovered that most of the storage facilities 63% did not have generators to power the refrigerators during emergencies. With respect to instructions on the management of the cold chain none of the participants were mindful of it (Agyekum, 2012).

This poor attitude, non-adherence coupled with inadequate knowledge could break the cold chain management system and even affect the quality of the vaccines that are to be administered. This impairs vaccine safety which contributes to vaccine related morbidity and mortality, especially in children under 59 months and pregnant women who are more vulnerable to vaccine preventable diseases. Again, it also puts a financial burden on the economy (Listowel & Maclean, 2014).

Vaccine wastage is sometimes high, which is due to the fact that some facilities do not have generators to store vaccines during power cut offs, which

affects vaccine storage and utilization. The use of temperature monitoring charts to monitor the cold chain at least twice daily is not also practised at times in some health facilities, which also creates a problem for vaccine storage (Neizer et al., 2009).

Although the Ghana Health Service's Expanded Programme on Immunization (EPI) is responsible for cold chain activities in Ghana, there is inadequate literature on the knowledge level and adherence to cold chain management among health practitioners in the Sekyere Central District of Ghana. Again, the Ministry of Health in collaboration with the Ghana Health Service has developed a guideline on vaccination, which includes cold chain system and it needs to be researched if these guidelines are followed.

There seem to be a literature gap on the knowledge and adherence to cold chain management among health practitioners in the Sekyere Central District since little is known about the knowledge, attitude and practice of cold chain management among health practitioners in this district. It is against this background that this study becomes important to be conducted to know the knowledge, attitude and practice of cold chain management among health practitioners in the Sekyere Central District.

Purpose of the Study

The purpose of the study was to assess the knowledge, attitude and practice of cold chain management among Health Practitioners in the Sekyere Central District of Ghana. Specifically, the study sought to assess the level of knowledge of Health Practitioners in the Sekyere Central District on cold chain management, determine attitude of Health Practitioners in the Sekyere Central District towards cold chain management, identify to what extent do facilities in

the Sekyere Central District support cold chain management, and explore challenges towards cold chain management in the Sekyere Central District.

Research Questions

The following research questions guided the study:

1. What is the level of knowledge of health practitioners in the Sekyere Central District of Ghana on cold chain management?
2. What is the attitude of health practitioners in the Sekyere Central District towards cold chain management?
3. What is the Association between Attitude and knowledge on cold chain management?
4. To what extent do facilities in Sekyere Central District support correct cold chain management?
5. What are the challenges with cold chain management in the Sekyere Central District?

Significance of the Study

The significance of the study was to improve cold chain management in the Sekyere Central district of Ghana. The findings of this study would inform the Ghana Health Service, specifically the Regional Health Administration and the District Health Administration, and the District Assembly on the need to support cold chain management activities. This study is also necessary because it would serve as a tool for the identification of the vaccine cold chain management gaps that exist in the district and assist to make appropriate recommendations on how these gaps can be addressed, thus serving as a guide to identifying areas to focus vaccine cold chain management interventions.

Delimitation

The study was delimited to only health practitioners who are working in the Sekyere Central District. The study involved participants from both remote and non- remote parts of the study area. Also, the respondents were also drawn from both government and non- government health facilities.

Limitations

The participants did not know that they were being observed for cold chain management practices. However general consent was obtained for the study and the covert observation did not pose any risk to any of the respondents.

Definition of Terms

Adherence: Complying to guidelines laid down by a regulatory authority (Azira, Norhayati, & Norwati, 2013).

Attitude: A health practitioners' level of commitment to a particular task.

Cold Chain Management System: is the process of keeping vaccines in a potent state from the manufacturer to the recipient (African Medical & Research Foundation, 2007).

Challenge: Anything internal or external that prevents a health practitioner from achieving expected cold chain system management results.

Epidemiological Sciences: is the study of the distribution, causes and frequency of diseases in human population for the necessary action to be taken (Bonita, Beaglehole, Kjellstrom, 2006; United States Department of Health and Human Services & CDC, 2012).

Health Practitioners: A group of people who practice health service delivery.

Incidence: The number of new cases of a disease occurring at a particular point in time.

Infectious Diseases: is a disease that can be transmitted from one person to the other.

Immunologic: the ability to defend the body against an infection or a disease.

Immunization: is the ability of the body to initiate an immune response after the introduction of a vaccine into the body.

Knowledge: The information, understanding and skills that an individual gain through education or experience.

Practice: The process of working according to expected standards.

Vaccination: is the process of introducing a vaccine into the body.

Vaccine Preventable Disease: is a disease that can be prevented with a vaccine.

Vaccine: is any substance which is capable, under appropriate conditions of producing or initiating immunity against any disease.

Organization of the Study

The study is organized into five main chapters. The first chapter dealt with the introduction of the study. Chapter two comprised the literature review on the topic under study. The chapter three entailed the research methods that were used for the study. Chapter four comprised the results and discussion whilst chapter five captured the summary, conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This purpose of the study was to assess the knowledge, attitude and practice of cold chain management among health practitioners in the Sekyere Central District of Ghana. This chapter is centered on other studies that were carried on cold chain management globally, continentally, that is in Africa, and nationally to evaluate available literature that would give a broader perspective on the knowledge, attitude and practice of cold chain management. The literature review was derived from textbooks, journals, and internet sources. The act of reviewing literature on this study is an important step in the research process. Literature review aids the researcher to collect more accurate evidence about previous and current theoretical and scientific information about a particular issue which is to be studied. It also permits inferences to be made based on what is discovered and what is about to be discovered through the study (Maggio, Sewell, & Atino, 2016; Ogah, 2013). Polit and Beck (2008) also indicated that the literature review is a solid rock summary of the research on an interested topic which is mostly prepared to put a research problem in context. In addition, the literature review also creates a platform for the study to have a supporting literature that can be used to back the findings of the study, and also guides on the choice of questions that can be structured to guide the study. The literature is organized under the following headings:

1. Concept of Cold Chain Management System
    i. Trained, skilled and motivated staff
    ii. Efficient and reliable equipment
    iii. Efficient distribution of vaccines
2. Concept of Vaccination/ Immunization
3. National Immunization Policy (Expanded Programme on Immunization)
4. Theories of Health Behaviour Change
5. Knowledge Level of Health Practitioners on Cold Chain Management
6. Attitude of Health Practitioners towards Cold Chain Management
7. Association between attitude and knowledge on cold chain management
8. Cold Chain Management Practices
9. Challenges to Cold Chain Management
10. Conceptual Framework on Cold Chain Management System.

Concept of Cold Chain Management System

The cold chain management system is a system of keeping vaccines in a potent state from the manufacturer to the recipient at a temperature of + 2 º Celcius to + 8 º Celcius (African Medical & Research Foundation, 2007). The cold chain mainly focuses on items that are mostly not stable to heat. These items include vaccines, serum, insulin among others (Justin, 2015; Hanson et al., 2017). Craig (2008) indicated that vaccines are biological preparations that are sensitive and for that matter must be kept in a cool atmosphere from the manufacturer to the recipient. These vaccines are purchased from the international level to the destination country where it is received through

customs clearance, inspection of the vaccines, inventory control, storage at the national level where it is distributed to the various regions (Frost & Reich, 2008). Damage from accidental freezing can cause damage to freezing sensitive vaccine such as diphtheria, pertussis, tetanus, Haemophilus Influenza type B and hepatitis B. To maintain the cold chain effectively, it requires enough infrastructure and compliance to standard as a means of ensuring that vaccines are stored in a potent state (Azira, Norhayati, & Norwati, 2013). The global concept on cold chain management system is to ensure that vaccines and biological preparations get to their end point in a potent state as a means to improve human survival and reduce the challenges that diseases pose to the human race. In this regard, the WHO (1998a) component on the Expanded Programme for Immunization issued a guideline for the keeping and transporting of vaccines from one place to the other. This was a means to provide a conducive atmosphere for the transportation of vaccines under a controlled temperature and also the knitting of such knowledge into planned schemes for an accurate balance of temperature (Conway et al., 2012). Managing the cold chain correctly is the basis for ensuring that vaccines are kept safely and of good quality (Maglasang, Butalid, Pastoril, Pratana & Tan, 2018). For the cold chain to function properly, it needs the combined efforts of efficient equipment and qualified staff (WHO African Region, 2019a). The inability to get any one of the elements would lead to a failed cold chain system (Ogboghodo et al., 2017). These elements are:

i. trained, skilled and motivated staff,
ii. efficient and reliable equipment and

iii. efficient distribution of vaccines (African Medical & Research Foundation, 2007; Tamimi, Sundarakani, & Prakash 2010)

Trained, Skilled and Motivated Staff

Various technologies have been developed to improve the cold chain management system and to develop the human resources required to manage and implement the immunization supply chain. Although this technology has been developed, the availability of trained, skilled and motivated staff is still crucial to the cold chain management system. In this regard, there should be availability of staff to handle the cold chain management system well so that vaccine safety can be ensured. Managers have to organize training sessions for the staff on the handling of vaccines as a means to ensure vaccine quality (Kholood & Safa, 2009).

In cold chain management, the personnel start from the international level which aids in the transport of the vaccines to the country of destination. The personnel include the cold chain technicians who are skilled in the maintenance of vaccine temperature and the repair of equipment for cold chain management. The health workers at the international and local levels also play a key role in the management of these vaccines. They are also involved in keeping the vaccines in an appropriate temperature (+2 degree Celsius to + 8 degree Celsius) and during emergencies such as equipment failure and power cut offs (Kholood & Safa, 2009).

Efficient and Reliable Equipment

The ability of organizations to function properly does not depend on human resource alone but functionable and reliable equipment. The objective of any cold chain management system is to prevent freezing and heating of

vaccines as a means to keep vaccines in a potent state. Cold chain management includes managing equipment and also managing people (Justin, 2015). The equipment are used in the storage and the collection of vaccines from one point to the other until it gets to the user. They are mostly supplied to countries by donors, especially the developing nations. These equipments are mostly given to facilities free of charge. But some also depend on the nature of the facility so far as power as a fuel source is concerned. Vaccine logistics are still important in solving cold chain problem (Ashok et al., 2017).

In cold chain management, the equipment ranges from electrical to non-electrical ones. The electrical ones are mostly the refrigerators and the freezers and their stabilizers. There are different types of refrigerators that are used for storing vaccines; these refrigerators range from the front opening (standing ones) to the icelined top opening (chest types). But the best among them is the purpose vaccine refrigerators since they are made mostly to store vaccines at the appropriate temperature. The refrigerators mostly rely on electricity, kerosene, gas and solar. The electricity type is the most common and reliable. Some have adsorption models which have a higher cooling system; they are easy to maintain and the safest to use in terms of maintenance (WHO, 1998; WHO, 2015a; Young et al., 2015).

The icepack is one of the non-electrical equipment used in the storage of vaccines. They are mostly made up of flat rubber packs. These rubber packs are filled with water which is frozen. But there are types that are also gel-based which are also used for the same purpose in vaccine (WHO, 1998; WHO, 2015a & Young et al., 2015). There are also insulated cold boxes and cold vans which are lined with isotherm materials that are responsible for the storage of vaccines

from a day to a week. Their ability to store the vaccines is also dependent on the constant changing of icepacks. The cold box can store large quantities of vaccines within temperatures of +2 degree Celsius to +8 degree Celsius to several days at least a week. Again, there are foam pads that are used to cover the icepacks in the vaccine carriers as a means to preserve the temperature of the vaccine. In terms of temperature maintenance, thermometers are mostly used but there are other temperature monitoring charts which are also attached to the refrigerators or placed inside the refrigerators to aid in checking the temperature of vaccines. Some of the temperature monitoring charts are thirty-day electronic temperature loggers (DTR). These loggers record the temperature of vaccine within ten minutes' interval and can be retrieved to indicate the temperature of the vaccine for the last thirty days. There are also electronic freeze indicators. This device has a visual display which indicates whether the vaccine has been exposed to freezing. When the vaccine is frozen, it gives an alarm for the necessary action to be taken. This device is not used in the same refrigerator that contains thirty-day electronic temperature loggers (DTR) (WHO, 1998; WHO, 2015a; Young et al., 2015).

The vaccine vails monitor (VVM) is also a heat sensitive device on the vaccine that indicates the cumulative heat that the vaccine has been exposed to: it seeks to prevent the administration of heat damaged vaccines to individuals. It is mostly attached on the vaccine label, the neck of the vaccine or the ampoule. It also guides the vaccinator to decide on the vaccine that can be selected for vaccination or not. There are four types of the VVM. These are VVM 2, 14, 7 and 30. The VVM number is the time in days that it takes for the inner square of the VVM chart to match or reach the colour. The biggest disadvantage of the

VVM is that it cannot detect freezing due to the way it is programmed. This deficiency can also affect freeze sensitive vaccines, because it has to be frozen physically before such errors are detected, which can lead to the destruction of a lot of vaccines (WHO, 1998; WHO, 2015a). There are also rooms designed to store vaccines. These rooms are designed in such a way that it cannot be too warm. It aids in the stabilization of temperature. The rooms are then stocked with large freezing equipment and gadgets to help maintain the temperature of the vaccines. In addition to the equipment discussed, there are cold vans or special trucks which are used in the transportation of vaccines from one place to the other. These trucks are also modeled in such a way that it would aid in the transportation of vaccines from one point to the other (MOH, 2016; WHO, 2017).

Each year, millions of vaccines are wasted throughout the world as a result of inadequate reliable equipment which creates unnecessary freezing or exposing the vaccines to heat. This exposure to heat and freezing creates financial burden to those who invest their money in vaccines. The long-term effect would be children suffering from vaccine preventable diseases (Hanson et al., 2017). This study went further to state that there was a difference in the temperature ranges for vaccines in developed countries as compared to developing countries: the temperatures recorded were a bit higher for the developing countries during storage than the developing ones. This may not be as a result of personnel alone, but equipment utilization in the maintenance of the cold chain could be a major factor (Hanson et al., 2017).

Immunization activities can succeed if there are dependable distribution of vaccines through appropriate cold chain system, but Africa is challenged with

cold chain issues such as inadequate staff, poor transportation to some areas and hot temperatures. The document went further to encourage countries to have good system for the management of vaccines and also ensure that there are logistics available for the delivery of vaccines (WHO Regional Office for Africa, 2009). On the other hand, low- and middle-income countries do not often provide means for the repairing of cold chain equipment (Assi, 2007). In summary, efficient cold chain depends on efficient and reliable equipment right from the production point to the recipient in the community which has been discussed well in this literature.

Efficient Distribution of Vaccines

The World Health Organization and UNICEF collaborate with each other to work in partnership with countries to see to it that vaccines are available for use in all countries (WHO, 2016). For accessibility and availability, countries need to partner with the manufacturers of the vaccines, regulatory agencies, national and international public health systems. The vaccines are certified under standard international guidelines to ensure safety and efficacy before they are distributed for human use (Smith, Lipsitch, Almond, 2011). The efficient distributions of vaccines also depend on the availability of cold chain equipment of all types to help in the distribution chain. The distribution chain is made up of the skilled personnel, the efficient and reliable equipment as well as the availability of potent vaccines. It also relies on each countries policy and the number of the eligible target calculated in doses prevailing. In simple language, the quantity of vaccines to be supplied for vaccination is dependent on the percentage of the population in need. If vaccines are not distributed in line with the needs of the people, it would lead to missed opportunities (a

situation where an individual who is valid to be vaccinated does not receive the vaccine due to shortage) which sometimes creates annoyance for recipients where some of them refuse to come for the vaccination during next sessions (African Medical & Research Foundation, 2007; Assi, 2007; MOH, 2016; WHO African Region, 2019a).

There are a lot of difficulties in vaccine distribution systems in low-income countries, which calls for emphasizing the need for pioneering solutions regarding the cold chain. Generally, the idea of vaccine distribution demands on quality control and appropriate distribution channels at all levels to make sure that vaccines reach their assigned destinations in good quality. An idea on the time vaccines spend in reaching the recipient is very important for the overall nature of the cold chain system and cold chain uptime monitoring. Vaccines that spend too much time in the distribution process without appropriate quality control are more likely to become weak for future use as a result of change in their chemical nature or temperature alterations (Ashok et al., 2017). A summary of how vaccines are distributed from the manufacturer to the recipient is indicated in Figure 1 below.

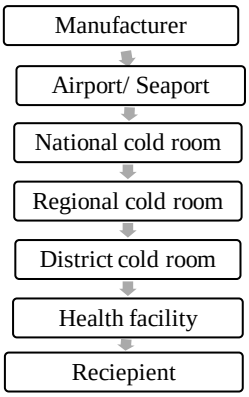

Figure 1: The cold Chain Management System (WHO, 2015; WHO, 2016)

Concept of Vaccination and Immunization

Vaccines are biological preparations that are made from live or weakened pathogens. These vaccines have the ability to protect an individual from a disease after introduction into the body. This involves initiating physiological processes to aid in the production of antibodies to fight infections. The vaccines are basically to prevent diseases (prophylactic) or to treat diseases in some instances (therapeutic). In terms of administration, it is administered through the oral, dermal, subcutaneous and intramuscular roots (Vaccine fact Book, 2012). Vaccines are of various types and are made from microbes (inactivated, killed, toxins or surface proteins from the microbe). Some types of vaccines are live attenuated, non- live vaccines, inactivated vaccines, toxoid vaccines, subunit vaccines and polysaccharide conjugate vaccines (Vetter, Denizer, Friedland, Krishnan, & Shapiro, 2017). In terms of characteristics, they all lose their potency when exposed to freezing temperatures, excessive heat and when they are also left to direct sunlight or fluorescent light. When this happens, the harm caused to these vaccines cannot be revived (MOH, 2016; WHO, 2015a).

In terms of immunity and protection, these vaccines decline in their ability to make an individual immuned when they are exposed to these unfavourable conditions or they are not able to foster the initiation of an immune response (Young et al., 2015). Vaccination produces artificial immunity to the susceptible host. This artificial immunity could be passive or active; due to the important role vaccines play in immunity, vaccination cannot exist without a vaccine with the reason being that vaccination simply is the introduction of a vaccine into the body to protect the person from a disease. Immunization, on

the other hand, is making an individual immune or resistant to an infectious disease through the administration of a vaccine (Peter, Delves, Martin, Burton, & Riot, 2017; Zabriskie, 2009).

The immune system is a complex physiological system which helps the body to fight against diseases. It is structured to recognize and destroy harmful organisms that are not friendly to the body and also neutralize the toxins that are produced by some of these foreign pathogenic organisms especially bacteria (Thompson, 2015). The immune system operates with a lot of apparatuses within the body. Most of the tools rely on blood since it carries red blood cells and white blood cells. The white blood cells are basically responsible for destroying contagions (Anderson, Brodsky, & Mangalmurti, 2018; Chico, Nombela, Puente-Marín, Ortega-Villaizan, 2018; Nicholson, 2016).

These cells are made up of T-lymphocytes, B-lymphocytes and macrophages. All these components of the white blood cells combine efforts to destroy antigens as a means to protect the individual from developing a disease. Although this happens under natural circumstances through the individuals own efforts, vaccines can also be used to induce the immune system to initiate an immune response. This is because when a vaccine is introduced into the body, it aids to produce antibodies which are also required to fight opportunistic infections. This vaccination reaction replicates the body's normal reply to an infection (Peter et al., 2017; Virella, 1998).

This immune response is often triggered by antigens (the constituent of disease-causing organism or the component of a vaccine that also triggers an immune response). Vaccines assist the body to foster immunity by emulating an infection, but they do not cause an illness; rather, they influence the immune

system to manufacture B-lymphocytes and antibodies to fight against pathogenic organisms. These organisms are mostly infectious organisms which are often times viruses and bacteria. When this happens, it leads to the production of antibodies (Vaccine Fact Book, 2012; Peter et al., 2017; Centers for Disease Control, 2018). These antibodies also attach themselves to the matching antigens to prompt their demolition by other cells of the immune system and finally combat the pathogenic organisms. When the ‘‘emulated infection” leaves, the body is left with a stock of “memory” T-lymphocytes, as well as B-lymphocytes that would recollect how to fight that disease in the near future. So, when the body encounters that organism for the future, then it would produce antibodies to fight it. For some vaccines, a dose is enough for all these immune processes to take place but for some, it requires more than that (Centers for Disease Control, 2018).

National Immunization Policy for Ghana

Immunization is the ability of the body to initiate an immune response after the introduction of a vaccine into the body. Immunization is often times associated with infectious diseases. It is a tried and tested mechanism for the control and elimination of infectious diseases that are also very risky to the health of the population (WHO, 2019b). It is one of the best means to prevent vaccine preventable diseases. It comes with a lot of benefits to all walks of life which is not limited to the increase in an individual’s life on earth but national development as well (Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017; Najwa & Minhat, 2016).

Immunization has been able to prevent between two and three million deaths each year. (WHO, 2019b; WHO,2019c). Globally, the Expanded

Programme on Immunization (EPI) was launched in May 1974 during the 27th General Assembly (WHO, 2019d). The establishment of the EPI was to make sure that all children in the world irrespective of where they find themselves on the globe would have access to life saving vaccines. The EPI inauguration suggested the usage of six vaccines to protect children. The vaccines were tuberculosis, measles, poliomyelitis, yellow fever, pertusis and tetanus. Different vaccines have been added to these vaccines which have played a major role in the prevention of Vaccine Preventable Diseases (VPDs), about eighty percent of the children under one year of age in the world have access to vaccines (WHO, 2019d).

In Africa, the Expanded Programme on Immunization was launched in 1978. This became necessary because member countries needed to reduce vaccine preventable diseases from the continent. Through the efforts of member countries, by the middle part of the 1980's, all the countries in Africa had established a nationwide immunization programme. The countries approved a resolution to embark on faster efforts to achieve this noble vision. During this acceleration stage, there was strong political will with the involvement of first ladies of these African countries (Kamadjeu, 2017).

In Ghana, the Expanded Programme on Immunization (EPI) was also established in 1978 by the Ministry of Health as part of the global strategy to prevent VPDs. The EPI initially started with six vaccines which was included in the global launching. As part of this, the national policy on immunization was developed to handle immunization activities in the country. As time went on, the number of vaccines that are to be used have increased from the six vaccines to about thirteen which have been included in the National Immunization

Programme which also has the EPI as the main umbrella. The mission of the immunization programme is to reduce poverty through the reduction of vaccine preventable diseases (VPDs) (MOH, 2016).

This is implemented through the use of cost effective, efficacious and safe vaccines. As a policy, children are supposed to be protected under the children's act of 1988 (Act 560) of the constitution of Ghana (Acts of Ghana Fourth Republic Childrens's Act,1988(ACT 560). Due to this, all children irrespective of religion, tribe and geographical location are supposed to be vaccinated. In view of this, various strategies are put in place to reach these eligible children so that they would be protected from VPDs. In addition, the immunization policy also captured pregnant women and women in reproductive age (MOH, 2016). To achieve this mission, immunization activities are carried at all levels and delivered as part of routine EPI services and National Immunization Campaigns. Due to this, the EPI is conducted through an order ranging from the national level through the regional levels to the districts, subdistricts and the community: this immunization order is also centered on the WHO criteria for immunizations (Yawson et al., 2017).

The EPI as part of national policy guidelines on immunization in Ghana seeks to provide the needed assistance for routine immunization (immunizing children against tuberculosis, poliomyelitis, diphtheria, whooping cough, tetanus, hepatitis B, heamophilus influenza type 2, rota virus diarrhoea, pneumonia, measles, rubella, fellow fever, meningococcal meningitis), foster the control of vaccine preventable diseases(VPDs), embark on surveillance for vaccine preventable diseases, give assistance to cold chain and vaccine

management, injection safety and waste management practices (MOH, 2016; MOH/GHS, 2011).

The national policy on immunization indicates that each child in Ghana from birth to five years of age is targeted for routine immunizations. This child should receive BCG and oral poliomyelitis vaccines at birth. At the age of six weeks, ten weeks (oral poliomyelitis, pentavalent vaccine, rota virus vaccine and the pneumococcal conjugate vaccine should be administered to any eligible child within this age frame) and at fourteen weeks, that child is also entitled to oral poliomyelitis, pentavalent vaccine, IPV vaccine and the pneumococcal conjugate vaccine. At nine months, the immunization policy for Ghana states that the child should receive measles-rubella (1) vaccine and yellow fever vaccines respectively. Then, at the age of eighteen months, the child would receive measles-rubella (2) and Meningococcal A vaccines accordingly. With the exception of BCG and rotavirus vaccines which have age limits, all the other vaccines can be administered to a child who is under five years but did not get access to any other vaccine which is part of the routine immunization services. Pregnant women, on the other hand, are also targeted for tetanus- diphtheria as a means to protect them and the foetus from tetanus and diphtheria. Children with symptomatic HIV should not be vaccinated with BCG, yellow fever, rota virus and measles-rubella but should be vaccinated with other vaccines. Again, vaccines should not be administered to individuals who experienced adverse effects following a previous dose (MOH, 2016).

The strategies for the immunization of children are grouped into three: these are health center (static), outreach and mass campaigns. These services are mostly delivered by the Disease Control Officers and Community Health

Officers (MOH/GHS, 2011). Besides these strategies, National Immunization Days and Supplemental Immunization Days are also set up as a means to improve immunization coverages in the country.

In terms of operational activities within the GHS, the EPI is operated by the Disease Control Department of the Public Health Division of the Ghana Health Service. As a policy, the unit is headed by a specialist who has a background in public health. There are other trained personnel with a background in cold chain management, injection safety and so on who also contribute to immunization activities in the GHS and they all support in the delivery of quality vaccines to enhance immunization activities in the country (MOH/GHS, 2011).

To achieve this, the EPI is decentralized where it is implemented at the district level by the District Health Management Team in collaboration with the subdistricts. Ghana has accepted an integrated approach to disease surveillance and response with emphasis on some VPDs which include Measles, Polio, Neonatal Tetanus, and Yellow Fever as part of the national policy on immunization. This is part of the policy to detect VPDs as a means to control VPDs in the country (MOH/GHS, 2011, WHO/ Ghana, n.d).

Theories of Health Behaviour Change

A theory is a set of concepts, definitions, and propositions that explain or predict these events or situations by illustrating the relationships between variables (U.S. Department of Health and Human Services National Institutes of Health, 2005). A variety of processes may be more relevant to diverse decisions in the behaviour change process (Baranowski et al., 2003). Some of the behaviour change theories and models are the knowledge –attitude –

behaviour model, health belief model, stages of change model, social cognitive theory, theory of planned behaviour, as well as ecological and social ecological model. This study would review three of these theories as a guide to the conceptual framework of the study.

Knowledge –Attitude – Behaviour Model

The Knowledge-Attitude-Behavior (KAB) model has been suggested as a technique of clarifying the role of knowledge. It reflects that knowledge is vital for carrying out differences in behaviour. As a result of that, individuals can acquire knowledge and skills through the idea of studying (Liu, Liu, Wang, An, & Jia, 2016). As knowledge accumulates in a health behavior field, variations in attitude are introduced. Above a certain time, frame, modifications in attitude gather, resulting in behavioral revolution. The attitude section describes the individuals feeling and ideas defined (Gusti, 2016). This model assumes that a person is rational and has been called the Theory of Enlightened Self-Interest (Baranowski et al., 2003). The model adapts human health-related behaviours by assigning modifications into three unceasing processes: knowledge acquisition, belief generation and behaviour formation.

The relationship between the level of information and overt behaviour and the relationship between attitude and overt behaviour are generally positive (Liu et al., 2016). The first subdivision of this model shows the relationship between knowledge and behaviour alone. Thus, informing people about a situation is likely to reduce the tendency of the individual engaging in a behaviour that would lead to a negative consequence. The second component of this model is the assumption that attitude is thoroughly connected to behaviour. The effect of this is that a change in attitude is also linked to a change in

behaviour. This means that a change in attitude is likely to influence behaviour change. Empirically, it has been applied in the field of education programme for Chinese adults undergoing maintenance haemodialysis: Randomized controlled trial (Liu et al., 2016). In another study, Schrader and Lawless (2007) also used the model to assess the knowledge, attitudes, and behaviors approach to how to evaluate performance and learning in complex environments.

The weakness of this model is that knowledge does not necessarily mean a change in attitude or behaviour and for that matter it makes the use of this model especially for health education programmes a bit limited (Goodstadt, 1978 cited in Pennsylvania State University, 2016). The major strength is that knowledge is a requirement for learning which has the ability to gradually mould the individual (Liu et al., 2016).

Social Cognitive Theory (SCT)

The Social Cognitive Theory (SCT) was originally propounded by Albert Bandura in the 1960s as the social learning theory (LaMorte, 2019). This theory gradually developed into the Social Cognitive Theory (SCT) in 1986(LaMorte, 2019). It specifies that learning occurs in a social context with a dynamic and reciprocal interaction of the person, environment and behaviour. The special attribute of this theory is that it gives more emphasis on social influence and its emphasis on external and internal social reinforcement. This theory also considers a person's past experience which factors into whether behavioural action would occur or not (LaMorte, 2019). The main constructs of the theory are divided into six. These are reciprocal determinism (self-motivated and mutual association between a person and behaviour), behavioural capacity (the real capacity of the person to carry out a particular behaviour through

relevant knowledge and skills), observational learning (this indicates that individuals can perform a task by observing others doing it), reinforcement (this is in line with the external and internal stimuli (responses) that are likely to influence the individual to carry on with the task or terminate the activity), expectations (this refers to the expected implications of the behaviour that the individual will demonstrate) and self -efficacy which demonstrates the confidence level of the individual to perform the activity successfully or not (LaMorte, 2019).

The theory provides an inclusive framework for understanding behaviours that are related to health and how these behaviours can be changed. The SCT indicates that there is a relationship between personal factors, environmental factors and human behaviour which employs an influence upon each other. In the context of SCT, for a person to change a health behaviour depends on three factors: these are self-efficacy, goals and outcome expectancies (U.S. Department of Health and Human Services National Institute of Cancer Research, 2005).

In practical sense, this theory has been used in the area of health promotion with concentration on the individual and the environment (LaMorte, 2019). This theory has been used in health education and promotion programmes by Whitehead (2001) to investigate the place and validity of contemporary social cognitive models for health education practice in nursing settings and in so doing establish a specific model for this purpose. It can be applied to health behaviours by addressing needs of families and parents in any group and in any part of the world (Portugal, 2018), in applying social cognitive theory in a naturopathy healthcare educational program for parents and families.

Doerksen and McAuley (2014) also used this theory to assess the social cognitive determinants of dietary behaviour in university employees. The strengths of this theory include its concern for vital human social behaviours: it also concentrates on necessary theoretical information such as the firmness of behaviour and the part played by reward in learning. It also has certain limitations such as the theory depends on self-reports extremely. Again, it is also not completely structured because to some extent it is weakly systematized. It also does not pay much concentration to motivation, conflict and the emotions of the individual (Meisslerm, 2012). The SCT is of the view that a change in the environment will lead to a change in the individual which is not always constant. The theory does not factor the host characteristics such as biological and hormonal attributes that are also likely to have an effect of a person's behaviour irrespective of the expectations and the experience the person was expose to in the past (La Morte, 2019).

Theory of Planned Behaviour (TPB)

Theory of Planned Behaviour (TPB) is a sound authenticated decision-making model on behaviour that has been used to envisage social and health behaviours (Javadi, Kadhodaee, & Yaghoubi, 2013). According to (Ryan & Carr, 2010), the TPB was propounded by Fishbein and Ajzen (1975) and Azjen & Fishbein,1980) as an expansion of the Theory of Reason Action. TPB is made up of six constructs, namely; attitude, behavioural intentions, subjective norms, social norms, perceived power, perceived behavioural control (LaMorte,2019). It was originally developed to highlight the connection between attitude and behaviour. From the TPB point of view, a certain set of motivational influences which include attitude toward a behaviour, subjective norms and perceived

behavioural control lead to intention to perform a behaviour. When people are given the right opportunity, they will convert this intention into actual behaviour (Collins & Carey, 2011).

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This theory has been applied to predict the physical activity of children: probing gender differences (Wang & Wang, 2015). According to TPB, behavioural ability is influenced by attitude, subjective norms and perceived behavioural control. In the study, attitude represents the positive or negative assessment of participation in moderate to vigorous physical activity (MVPA), whereas subjective norms encourage perceived social pressures to perform MVPA, on the other hand, Perceived Behavioural Control (PBC). PBC refers to the resources and obstacles that increase or decrease the ability of an individual to engage in MVPA behaviour. Behaviour is likely to be determined by intention and PBC. According to this study, children who have high drive to participate in MVPA are more likely to have high MVPA levels. In addition, children who express strong desire of control over their PA are likely to be engaged in more MVPA (Wang & Wang, 2015).

This theory was also applied to self-report dental attendance in Norwegian adults through structural equation modelling approach (Åstrøm, Lie, Gulcan, & 2018). Some of the strengths of this theory are it has succeeded in predicting and explaining a variety of behaviours and intents which consist of smoking, drinking, health services utilization, breastfeeding, and substance use and a host of other activities. It also recognizes the role of motivation and ability in achieving behaviour. The weakness of the theory also includes its inability to consider other characteristics such as fear, threat, mood, or past experience that also have a bearing with behavioural intentions and motivations. Although it

recognizes normative influences, it does not take into account the environmental or economic issues that may impact a person's intent to portray a behavior (LaMorte, 2019).

What is the Level of Knowledge of Health Practitioners on Cold Chain Management?

Appropriate knowledge in cold chain management among general health practitioners who are involved in immunization is very important, but some of the contributing factors to poor adherence to appropriate cold chain management is poor knowledge. Health practitioners or workers must have enough knowledge and skills that are in line with appropriate cold chain management (Najwa & Minhat, 2016). The use of guidelines and trained personnel is also inadequate (Azira et al., 2013). The most important components of the cold chain system that controls its ability to be successful are personnel who are trained, transportation and systems for the storage of cold chain equipment and administrative measures that are very well-organized (Rogers, Dennison, Adepoju, Dowd, & Uedoi, 2010). In all, the elements of the cold chain management system are three but the presence of skilled staff is very vital (African Medical & Research Foundation, 2007; Ogboghodo et al., 2017).

It is the role of health care workers to have adequate knowledge to maintain the potency of vaccines since they are part of the key elements of the cold chain system. The knowledge involved in the maintenance of vaccine cold chain system should be a combination of appropriate storage of vaccines, proper procedures for handling of these vaccines, maintenance of cold chain equipment and procedures for the repairing of cold chain equipment's, correct technical decision to be taken in the event of a vaccine exposure to heat and freezing including contingency plans and ensure that they are in place in the event of

premises closure during staff vacation, equipment failure and or electrical disruptions (Public Health Unit Ontario, as cited in Najwa & Minhat, 2016). Krishnappa et al. (2014) also indicated that the level of knowledge of cold chain handlers on Deep Freezer (DF) temperature, ice pack conditioning and the adjustment of thermostat was weak. This could also have a negative effect on cold chain effectiveness.

Again, a lot of studies have shown that knowledge of good vaccine operation and cold chain system among healthcare workers in maintaining the vaccine cold chain are inadequate (Naik et al., 2013; Oliveira et al., 2015, as cited in Najwa & Minhat, 2016). The ability of these vaccines to maintain their potency also have a connection with proper cold chain system. In view of this, the World Health Organization (WHO) has stated that vaccines should be stored at the right temperature till it reaches the person in the community who is due for the vaccine (WHO, 2015a: WHO, 2015b). The findings from some countries also indicated that vaccines were exposed to heat and frozen temperatures, especially when transported to the far end (Yauba et al., 2018). This study indicates that vaccination cannot be achieved without cold chain management and for that matter appropriate vaccine cold chain management must be a priority for all especially health workers.

Although knowledge is a requirement for vaccine management, a cross section of health workers may not have enough knowledge about cold chain management which would also affect vaccination and immunity. The findings from (Bogale, Amhare, & Busaleh, 2019) indicated that 38.3% of the participants had adequate knowledge on how to manage the vaccine cold chain. This shows that knowledge is still a problem that needs to be attended to so far

as cold chain management is concerned. In another literature (Azira et al., 2013), most of the respondents (78. 7%) had knowledge about cold chain management, but this finding was different from Efe, A- Neel and Ozer (2008) who recorded 95% knowledge for midwives who were involved in cold chain management.

The study indicated that 95% knowledge level was as a result of the experiences that midwives had in the handling of vaccines: this cannot dispute the fact that experience is the best teacher. The ability of an individual to gain knowledge is also dependent upon attending workshops, sharing knowledge with colleagues. Again, the period of service also plays a role in an individual's ability to get knowledge. This is due to the fact that long service also paves way for the individual to learn. This was a strong predictor of knowledge in a study according to Najwa and Minhat (2016). These findings were also in line with Ademuyiwa (2014) where knowledge had a relationship with experience at the work setting. A study conducted in Malaysia also indicated that majority of general practitioners in public health had adequate knowledge about cold chain management (Azira et al., 2013). This may be due to the fact that they have had a higher education in public health where vaccine cold chain management is not left out. Although these general practitioners had knowledge about cold chain management, less than twenty percent had knowledge on the shake test. This knowledge differences can contribute to vaccine distribution disparities which can affect the nature of vaccines that are used for immunization activities.

In Africa, the maintenance of the cold chain system has become a challenging issue for the public health community but the vaccine cold chain system cannot be left out. It cannot be neglected because it is essential in the

delivery of potent vaccines which are expected to yield a wider coverage. In Ethiopia, Bezunesh, Berhane and Bisrat (2013) found out that sixty-five percent of the respondents had some knowledge on cold chain management. The study indicated that professional qualification and years in service had influence on knowledge. This shows that an individual with a higher qualification is more likely to have adequate knowledge on cold chain management than a counterpart with a lower qualification. Also, the number of years an individual spends at the workplace especially in immunization setting can also be an avenue for knowledge creation (Bezunesh et al., 2013).

According to Mavimbe and Gunner (2007), sixty-one percent of health workers did not know the effects of freezing on DPT vaccine. This can contribute to the destruction of this type of vaccine as a result of inadequate knowledge on vaccine cold chain management. In addition, it was also revealed that forty-eight percent of health workers did not know the temperature range of the vaccine. This might have contributed to their poor knowledge background on freezing (DPT) in that study. This finding also indicated that ninety-one percent of the respondents do not have knowledge on the shake test (a test to indicate whether freeze sensitive vaccines are frozen). This study also indicated that sixty percent of the staff had no in-service training. This might have contributed to the inadequate knowledge on cold chain including the shake test. The results from a study conducted by Bezunesh et al. (2013) indicated that a few of the health workers knew of the shake test. This study also indicated that the health workers do not have adequate knowledge.

In Kenya, a study conducted by Bakari (2015) indicated that most of the respondents had knowledge on the definition of cold chain but this knowledge

could not be transformed into practice. This shows that knowledge does not mean practice, hence the need for this study to be carried out. In Uganda, Namuhaywa (2013) also indicated that a cross section of the health staff had some degree of knowledge on cold chain management but none of them had knowledge on the shake test. Again, midwives and nurses were not having enough knowledge about cold chain management although they were the facility heads for Expanded Programme on Immunization (EPI). In addition to these, all the respondents were not having knowledge on the shake test and freeze watch. This implies that vaccines could be exposed to temperatures above their thermo-tolerance level which could affect the quality of vaccines that were used for EPI activities. In another study conducted by Yauba et al. (2018), about sixty-five percent of the respondents were aware of the risk associated with the exposure of vaccines to low temperatures (cold temperatures). This finding was still not the best because the others who were not aware of the dangers associated with extreme heat and freezing could undermine the potency and strength of the vaccines so far as cold chain is concerned.

The study further indicated that forty-nine percent of the respondents were aware of the necessary measures to take when the vaccines freeze. The study reported that previous training had not been organized for the staff, which could also play a role in the study findings. Although previous training had not been carried out, their basic background information could have been used as a guide to monitor the vaccine temperature. This study has shown that some health workers are still deficient in vaccine management as a result of inadequate training and knowledge gap which can affect cold chain management (Yauba et al., 2018).

Najwa and Minhat (2016) also indicated that the number of years an individual has served also has an effect on the knowledge of cold chain management practices. This finding was different from Bakari (2015) who realized there was no association between the number of years an individual has served and his or her cold chain management output. With respect to Najwa and Minhat (2016), history of training of health workers is also likely to influence their knowledge since in their study, most of the participants had not often received a technical training in the form of a workshop for the respondents at that time. Those who attended training on cold chain management are 3.3 times more likely to perform better in cold chain management as compared to those who hardly attend training. Similar results were also discovered by another researchers Gopal-Krishnan et al., 2014, Yakum et al., 2015, Widsanugorn et al., 2011, Bankole et al., 2010 (as cited in Najwa & Minhat, 2016). But the most unfortunate aspect of the study is that health care practioners in private facilities are not trained on cold chain management, with the reason being that it can be managed by a cross section of them. To have the chance to attend the training depends on the employer's own interest and perception of cold chain management. The trainings of the staff at the facility are mostly done by the public sector and pharmaceutical companies that have that willingly interest to private and public health facilities, which may be due to supply of products to the health facilities (Najwa & Minhat, 2016).

The training mostly covers areas such as the ability to recognize types of vaccines that are mostly sensitive to the challenging impact that heating and freezing has on vaccines, monitoring and recording the temperature of the refrigerator in which vaccines are stored, appropriate placement of refrigerator

at the health facility and getting the understanding of the recommended protocol for the handling of vaccines during unexpected events. Another predictor of good knowledge in this same study was monthly income and level of education (Najwa & Minhat, 2016). According to Greenstone and Looney (2016), cited in Najwa and Minhat (2016), a person who receives a higher income is likely to have a higher educational level. This can be a factor to influence cold chain knowledge.

The study also indicated a correlation between positive attitude and good knowledge. It revealed that health practitioners who had a decent perception on the values on ensuring appropriate cold chain management are 5.8 times more likely to have more knowledge as compared to health practitioners with a negative attitude (Najwa & Minhat, 2016). This association was also found by Awan and Islam (2015) who indicated that job performance and job satisfaction are equally connected to good attitude and job satisfaction which is likely to influence knowledge indirectly at the workplace through the process of learning (Najwa & Minhat, 2016).

The effects of freezing is equally as harmful as the exposure of a vaccine to heat. Due to this, freeze sensitive vaccines such as Diphtheria Pertussis Tetanus (DPT) Hep/Heb, Diphtheria Tetanus (TD), Tetanus Toxioid (TT) and hepatitis B vaccines are not to be frozen. To determine whether the vaccines are frozen, one needs to conduct the shake test (Makulu, 2012). In terms of knowledge, health practitioners should also have a background about the nature of the equipment and demonstrate the ability to use such equipment. Another study by Bankole et al. (2010) indicated that health workers have inadequate knowledge about the vaccine vail monitor (VVM) indicator. This can affect

vaccine usage and wastage since they cannot read and interpret to deem it fit for vaccination or not. The WHO has indicated that VVM in the third and fourth stage should not be used. They also found out that ongoing monitoring and tutoring also improve the knowledge and attitude of health workers in the area of cold chain management (Bankole et al., 2010).

In Ghana, according to the Effective Vaccine Management (EVM) assessment review, it was discovered that inadequate training, lack of continuous temperature monitoring devices, knowledge gap in the management of vaccines especially in shake test, conditioning of ice packs and stock management were some of the challenges to the Expanded Programme on Immunization (Diamenu et al., 2015). Therefore, Expanded Programme on Immunization Officers at the national, regional and district levels need to factor knowledge gap into their thematic plans for vaccine management. If not, vaccination activities could be halted.

What is the Attitude of Health Practitioners towards Cold Chain Management?

The subject of vaccine purchase, how it is stored, transported and delivered to the recipient, and issues such as knowledge, attitude and practices of health workers play a vital role to the achievement or failure of immunization program (Swarnkar et al., 2016). For every cold chain management system to be successful, it demands the presence of health workers who have a positive attitude towards the management of cold chain. Azira et al. (2013) indicated that the attitude of general practitioners towards cold chain management was poor per the findings from their study. This was due to the fact that majority of the practitioners had a poor attitude towards cold chain management. Cold chain management cannot be in good shape if health practitioners do not have a good

attitude since positive attitude is very vital to the management of vaccines. According to Najwa and Minhat (2016), positive attitude was a good predictor of knowledge on maintaining vaccine cold chain management. This was high in Health Assistants practicing in private health facilities. Mallik et al. (2011) indicated that facilities hardly record power failures but this was not so in a study by Krishnappa et al. (2014). This difference in results was due to the fact that a cross section of the vaccine handlers recorded power failure where one of the reasons was associated with the attitude of the staff.

In Nigeria, West Africa, the findings of Ogboghodo et al. (2018) also showed that the participants had a positive attitude towards cold chain management. Again, Nwankwo et al. (2018) also indicated that two-thirds of the participants had positive attitude towards cold chain management.

What is the Association between Attitude and Knowledge on Cold Chain Management?

A Malaysian study conducted by Shinde and Guruv (2019) concluded that there was only moderately positive correlation between knowledge and attitude scores of people in cold chain management. In a study in Indonesia, it was found that there was a weak positive correlation between attitude and the number of new and old cases of diarrhoea (Sofia, Dimiati, & Putri, 2017). In assessing association between knowledge, attitude and practice on cardiovascular disease among women in Kelatan, Malaysia, Yahya, Muhamad, & Yusoff (2012) found that the association between knowledge and attitude was statistically significant. A study from Sultan (Suparmi, Desantri, Cahyono, 2015) indicated that there was no vital disparity ($p > 0.05$) between knowledge concerning food colorants and attitude so far as colorants used in food was concerned. In Ghana Boakye, Quartey, Baidoo and Ahenkorah (2018) found

that there was no relationship between knowledge and attitude of physiotherapist towards health promotion(p=0.097).

To What Extent do Health Facilities support Correct Cold Chain Management?

For every immunization activity to achieve its intended purpose, it depends on distribution of quality vaccines which are managed through appropriate cold chain system. Vaccines easily lose their potency when they are exposed to temperatures above their tolerance level. This makes vaccination activities useless (WHO Regional Office for Africa, 2009). Vaccines have come a long way to prevent diseases and deaths, especially, in children under 59 months. This achievement was also attributable to a reliable cold chain management system, because without efficient cold chain system, vaccination activities cannot be achieved. In the year 2011, millions of doses of vaccines were wasted in five different countries as a result of improper cold chain management (WHO, 2014). The Centers for Disease Control and Prevention has also estimated that each year, over three hundred million pounds of vaccines are wasted as a result of cold chain malfunction or failure Praveen, 2015 (cited in Ogboghodo et al., 2017). This can affect the safety of vaccines and also increase the side effects of the vaccines (Dairo & Ozimete, 2016). Again, this also contributes to shortage which adds to the cost of purchasing vaccines. This cold chain failure also has a link with the ability of health workers to manage the cold chain and follow diligent procedures for vaccine management (Ogboghodo et al., 2017).

The health workers are the intermediate people between the vaccine and the recipient in the community, but if they are not trained or supervised, they would do otherwise to affect the cold chain system. Also, refrigerators

which are intended to be used for vaccine storage are used to store other things which interfere with cold chain practices. This indicates that cold chain management practices are sometimes not being followed by health workers (Ogboghodo et al., 2017). Vaccines need to be monitored at specific times at least twice daily so that their potency can be ensured. Damage from accidental freezing can cause damage to freezing sensitive vaccine such as diphtheria, pertussis, tetanus, Hemophilus influenza type B and hepatitis B (DPT/ HIB/HEP). Again, when vaccines are monitored according to standard protocols, it also prevents vaccine wastage which serves as a gateway to increase vaccine supply as well as immunization coverage. Therefore, appropriate management of the cold chain system is very important to vaccination activities (African Medical & Research Foundation, 2007). Although adherence to cold chain management is key to public health, some health facilities do not adhere to cold chain management practices (WHO/ UNICEF, 2016), Oyefolu et al. (2007) cited in (Dairo & Ozimete, 2016). This non-adherence results in additional debt to countries and donors who support vaccination activities.

The management of vaccines do not depend on infrastructure alone but obedience to standards that are set for the management of vaccines, but adherence to guidelines in the everyday practice of cold chain is poor. This may be due to inadequate knowledge, inadequate training and types of physicians. Vaccines should not be stored with items that are not vaccines in nature. They must be stored on trays with spaces in between to permit circulation. They must be stored away from the refrigerator plate and the refrigerator itself should be

about 40 centimeters away from the wall. The refrigerator must be far from direct sunlight and any form of heat (Azira et al., 2013).

Bankole et al. (2010) also found that majority of the facilities they studied had cold chain equipment but most of the refrigerators had problems with the non-existence of a power supply. Another practice which was contrary to vaccine storage was the sharing of chemicals and drugs that are used to work at the laboratory with the vaccine refrigerator. Most of the vaccines were in VVM stage four, which may be due to the mechanical breakdown of refrigerators. In terms of the use of thermometers for monitoring the temperature of vaccines, only a few refrigerators were assigned with thermometers. Beside this, most of the fridges did not have temperature monitoring charts on top of it. There was a change in the findings during another visit, which was due to the fact that during the first visit, there was a training and majority of those health workers participated in the study.

Krishnappa et al. (2014) also indicated that majority of the facilities had at least one icelined refrigerator and a deep freezer. The study also considered the availability and maintenance of cold chain equipment. There were good storage facilities in 12 out of the 33 facilities that were studied. Again, functional thermometers were also available to monitor the temperature of the refrigerator with about 71% of the facilities having the temperature of the vaccines within the recommended range. One of the health facilities also stored vaccines purposely in domestic refrigerators out of the twenty-seven facilities with domestic freezers. Most of the facilities had located the refrigerator (Ice Lined Refrigerators (ILR) and Deep Freezers (DF) at least at a range of 10cm from the wall which was also positioned on a wooden stand. Out of the 34 ILR,

28 had do's and don'ts as required by standard cold chain management. Only 13 out of the ILR had their electric plugs secured (Krishnappa et al. 2014).

The brands of ILR that were used at the facility included Haier Company while the DFs were of Blue Star, West Frost, UNICEF supplied, and Cold Cell models. Although the facilities had ILR, 10 of them were keeping Tetanus Toxiod in domestic refrigerators. All the facilities used DF for the storing of icepacks excluding one facility that had converted theirs to store vaccines. It was only in ten DFs that the facility had stored ice-packs in a criss-cross way as expected by the recommended standard. All the cold boxes were in good shape but only one facility had a cold box intended specifically for emergencies like power failure and transfer of vaccines. The facilities also had enough quantity of vaccine carriers and ice packs per the standard required for poliomyelitis micro plan for mass vaccination (Krishnappa et al., 2014).

This study also assessed the storage of vaccines based on their level of thermo sensitivity. They were assessed as BCG and Measles in the lower basket, T- series vaccine and Hepatitis B at the same level in the right basket and (3) diluents, returned partially used and unused vials in upper left basket. For the sake of proper analysis and scoring, if all the three were correctly stored, it was considered as good practice; if two were correctly stored, it was graded as fair practice and if only one code was practiced, it was graded poor practice (Krishnappa et al., 2014). Accordingly, at the time of visit, only 35% of the centers followed well. The study indicated that a few of the facilities followed the recommended guideline for vaccine storage. Only a few of the facilities (31%) had baskets in the ILRs. Diluents, on the other hand, were not stored as recommended: a small percentage of the facilities stored diluents in the ILRs.

The centers also stored food or other medicines in the fridge. A similar result was also reported by other researchers (Makulu, 2012; Mavimbe & Gunner, 2007). In another study, it was found that vaccines are not stored with other items in the refrigerator. Again, temperature monitoring charts are placed on all the refrigerators (Al-Hajri et al., 2015). The refrigerators were also placed away from direct sunlight (Krishnappa et al., 2014).

Majority of the facilities had functional thermometers but 15 centers positioned the thermometer correctly in the ILR. There was a plan for documentation of temperature monitoring and measures to be taken in case of power failure (38%). On the part of personnel for handling cold chain management staff nurses, laboratory technicians and pharmacist were used but seven of the facilities did not have a staff assigned for the management of vaccines (Krishnappa et al., 2014).

What are the Challenges with Cold Chain Management?

Providing an appropriate means to refrigerate vaccines at the health facility is important to cold chain management (Burstein et al., 2013) but a lot of vaccine supply chains that are ran by the government are still being challenged by the management of the introduction of newer vaccines which are also more expensive. Keeping the quality of the vaccine throughout the period of supply means to make sure vaccines are also at sites where vaccines are to be delivered. There are also problems with how to raise funds to increase the grade of materials when there is the need for it. Others are also challenged with the presence of people who are skilled to handle the vaccine supply system and maintain the pace with new policies, very good practices that are also evolving and advancement in technology that are in line with the supply of vaccines. In

view of this, some governments are looking for alternatives to the system where governments take responsibility for the vaccine supply. Some governmental systems are delegating the maintenance responsibilities to others (PATH & WHO, 2012). All these points that are raised by these two big organizations put the management of vaccine at a risk, which could be very fatal if these issues are not addressed.

The management of the cold chain system is still an area of susceptibility to the countries immunization activities and the practice of cold chain in the office as well especially in countries that are not really developed who also have tropical climates. Above everything, health workers involved in primary health care should have adequate knowledge about the management of the cold chain. Activity reports from developing countries indicate that health workers are interested in the achievement of vaccination coverages at the expense of the quality of the vaccines that are to be administered (Samant et al., 2007; Bankole et al., 2010; Berhane, & Demissie, 2000), cited in (Rao et al., 2012). Vaccines losing their potency or suboptimal seroconversion were linked to poor storage or during transportation. This indicates that poor vaccines storage or the movement of vaccine from one end point to the other in a poor manner poses a challenge to the cold chain system (Rao et al., 2012).

The ability to maintain a very good cold chain management system aids in the improvement of vaccine safety and efficacy. It also contributes to an increase in the immunization coverage. Although this maintenance of the cold chain is very essential to health services delivery, the cold chain management system is faced with a lot of challenges which could be in the form of equipment or personnel. Among some of the challenges that were facing the cold chain

system is knowledge of the health personnel involved in cold chain management (Najwa & Minhat, 2016).

The practices of health personal concerning the management of the cold chain is very important. Therefore, health workers are expected to have at least fair knowledge in cold chain management. Poor handling of vaccines through inadequate storage and poor knowledge in some fields are also contributing factors to cold chain management. This technical issue has the tendency to influence the outcome of vaccine usage wrongly (Rao et al., 2012). Other issues that are of cost and concern to the cold chain management system are routine control and temperature monitoring, safety, over freezing, engagement of compounds that are not environmental. The World Health Organization has established a standard level or criteria for the management of vaccine cold chain at each level of the chain to maintain the potency of the vaccines, but it is not easy to achieve the expected results due to infrastructure related problems and pressure from the workload (Mavimbe & Gunner, 2007). In another study, vaccines were stored in the same refrigerator with non-vaccines (Ameen et al., 2016; Dairo & Ozimete, 2016; Maglasang et al., 2018; Mavimbe & Gunner 2007; Pillay, 2014; Woldemicheal et al., 2018; Yassin et al., 2019).

This poses a challenge to the cold chain system since this space occupation by other medical products can compete with the vaccines for temperature maintenance (Rao et al., 2012). Technically, vaccines are not to be stored in the same medium with other medical preparations. Another study also indicated that some of the facilities do not have cold chain equipment that can be used for vaccine transfer (Bachani & Bansal, 1990). Although this finding

may be very old, it is not different from what was stated by Mavimbe and Gunner (2007).

This may be attributable to a skill acquisition challenge. Adherence to cold chain management is also a challenge which may have a relationship with the attitude of general health practitioners (Azira et al., 2013). Inadequate training for staff has also made the cold chain management more vulnerable, which can have an effect on immunization coverages. All these factors could not be a challenge alone but a reason for the limited knowledge towards cold chain management. A study conducted in South Africa also indicated that the maintenance of the vaccine potency is one of the challenges of the Expanded Programme on immunization (Pillay, 2014).

Ashok et al. (2017) also indicated differences in population settlement, lack of performance management systems, service delivery type, greater demand for cold chain structurally, weak temperature control, nonfunctional equipment, inadequate storage capacity, poor use of financial and human resources for successful cold chain implementation.

In Ghana, the Expanded Programme on Immunization is challenged with poor cold chain maintenance. According to the Effective Vaccine Management Assessment (2010) which was carried in all the regions in Ghana, the evaluation report indicated that the capacity of cold chain activities at the national level was adequate for both positive and negative storage but there was a disparity at the regional and district levels which was basically due to inadequate cold chain storage capacity. Although mechanisms have been put in place to fortify the RED strategy in every district, the EPI is still facing some challenges, some of the challenges are insufficient items for routine outreach

in the hard to reach areas, inadequate personnel, deprived maintenance of the cold chain system, inadequate supervision from the advanced levels , and poor surveillance systems in majority of the regions for diseases that are vaccine preventable (MOH/GHS, 2011). All these have a negative effect on the cold chain system.

Conceptual Framework

This thesis was based on the social cognitive theory (SCT) and the theory of planned behaviour (TPB) and how they will influence the knowledge, attitude and practice of cold chain management among health practitioners. The aspects of the theories reviewed which were considered for the study were of knowledge which was borrowed from behavioural capability, construct of the SCT. This was due to the fact that an individual should know what to do and how to do it as one of the measures to carry out a particular behaviour. The experiences that the person would also gather through reciprocal determinism and modelling through observation were also selected from the SCT in designing the conceptual framework. The attitude component was also built and adopted from TPB.

The motivational aspect was also derived from behavioural intentions which is also a construct of the TPB. The belief was also developed from subjective norms – a tenet of the TPB. The framework on practice was also developed based on an interwoven relationship between the constructs of both SCT and TPB where applicable. As depicted in the diagram for a health practitioner to manage the cold chain system appropriately (see Figure 2), it depends upon the interaction between knowledge, attitude and practice. The

correlation between these variables in achieving proper cold chain management is explained below:

Health practitioner's knowledge on cold chain management depends on being aware and the experience the individual has on the job. Through training workshops, sensitization or reviews, that is internal or external, the individual acquires basic information on cold chain management. This information helps to influence the person's behaviour which would aid him/her to manage cold chain as expected. This is because the refresher training would help to clear previous mistakes and create an avenue for new ideas to mould and shape cold chain management. Another important factor in acquiring knowledge is through experience. As people carry out their day to day activities on the job, they create a sense of familiarity between the equipment they work with and the rules and regulations governing the body of practice which aids them to improve upon their skills which is likely to influence their performance on the job. Experience leads to mastery of the job. The number of years an individual has served on the job also has an association with experience which has an impact on knowledge acquisition, because the person would be exposed to a number of in-service training on new ideas and technologies that have evolved throughout the period, also through observation. Due to these number of years, the person also gathers some form of learning behaviours about cold chain management which is likely to also impact the person positively so far as knowledge is concerned.

Attitude plays an important role in cold chain management: the attitude of an individual is likely to change when the person is knowledgeable and motivated within (intrinsic) or outside (extrinsic). A person who feels within him/herself that appropriate cold chain management is a "must do" would do

everything humanly possible to accurately survive the cold chain system without depending on external instructions. Again, when the office and Program Officers also appreciate the worth and dignity of the health practitioners by using inspiration and motivating words, it would encourage the practitioner to have a positive attitude towards cold chain management. The opposite is when the individual is not motivated due to the circumstances the person finds himself or herself in, which also leads to negative attitude towards cold chain management. Although motivation is a factor to influence attitude, self-efficacy (the self-reliance that a person can implement a precise conduct under a range of situations) is very vital to attitudinal change and development in the area of cold chain management. When Health Practitioners feel the need to monitor vaccines appropriately irrespective of the situation, they find themselves and it also goes a long way to impact the cold chain system positively.

The spirit of self-reliance also helps the practitioners to be passionate about what they do, no matter how poor the system may be. The results possible to happen from carrying out the behaviour (outcome expectancy) also plays a pivotal role in shaping the individuals behaviour towards cold chain management; that is vaccines are delicate biological preparations which are more likely to be destroyed when exposed to certain temperatures (freezing or heating). So, when the practitioner considers these factors, it would trigger the mind to have a change of thinking which is more likely to influence the attitude because of the repercussions associated with the vaccine wastage. Secondly, when the vaccines are also wasted, the Officer would be held responsible for the waste. So, to avoid all those queries which may lead to a suspension, that health practitioner would develop a positive attitude manage the cold chain

properly. Belief about cold chain management also has a connection with how an individual manages the cold chain system. Health Practitioners who have a strong feeling that vaccines must be managed correctly would do so. In addition, those who also believe that poor cold chain management would alter the safety of the vaccines would also put in all means to handle the vaccines.

The management of cold chain does not depend on the knowledge and attitude alone although they have the ability to influence the practice of cold chain management. The environment in which the health practitioner is working also plays a vital role. When the person is working in an environment which is very supportive in terms of skilled and motivated staff, functionable and reliable equipment including efficient distribution of resources, that health practitioner is likely to perform better. Again, all the variables under the knowledge and the attitude also have a link with the environment: if the environment is not conducive, it serves as a barrier for practice which would affect the cold chain negatively. For instance, inadequate power supply would affect cold chain outcome. In addition, other external factors like poor road network would even affect distribution of equipment and monitoring and supervision in cold chain management sites. Furthermore, if national and regional levels do not support cold chain management, the facilities in the district would suffer, which would also affect the management of vaccines.

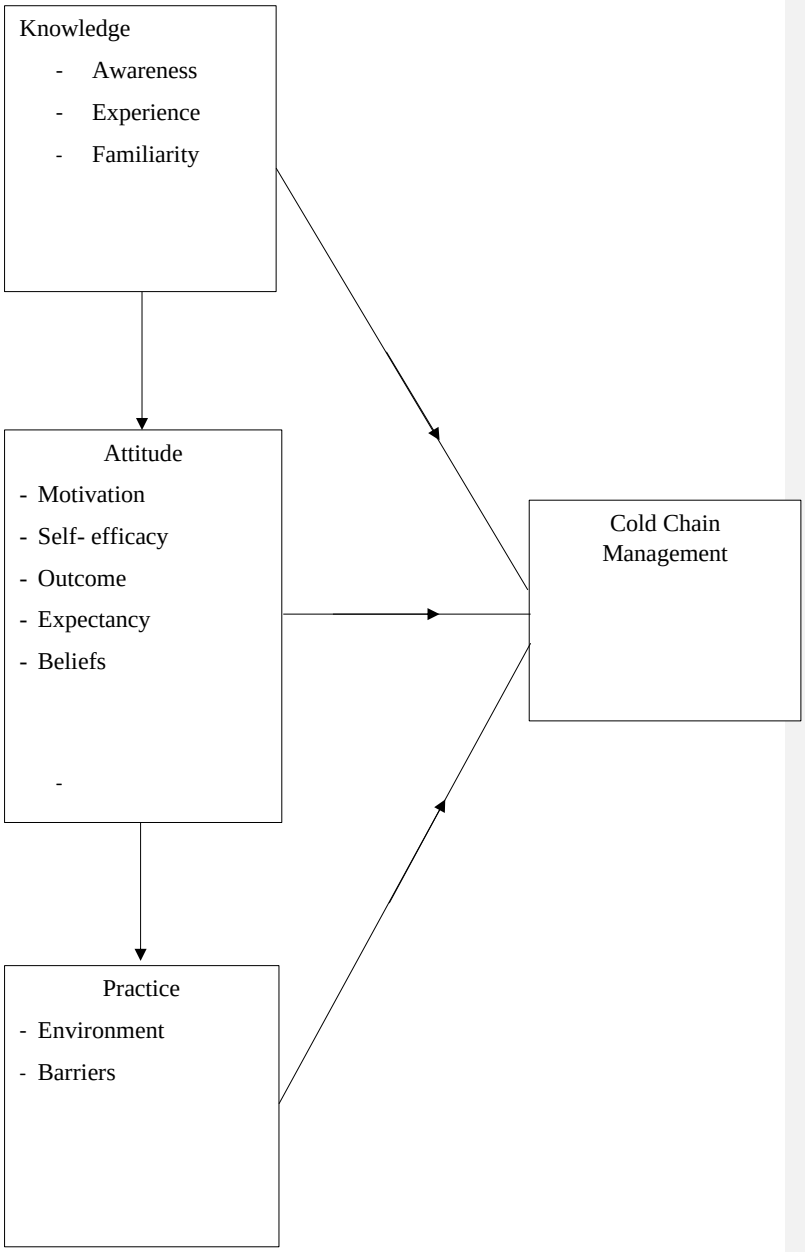

Figure 2: Conceptual Framework (Social Cognitive Theory, 1960; Theory of Planned Behaviour, 1985).

CHAPTER THREE

RESEARCH METHODS

The purpose of the study was to assess the knowledge, attitude and practice of cold chain management among health practitioners in the Sekyere Central District. This chapter consists of the research methods that were employed to conduct the study. It gives special emphasis to the research design, study area, population, sampling procedure, data collection instruments, data collection procedures, data processing and analysis.

Research Design

The study employed a mixed method study design. A mixed method is a combination of both quantitative and qualitative approaches to research. It helps to get an in-depth information about the situation under study (Creswell & Zhang, 2012; Wisdom, Cavaleri, & Green 2012, as cited in Zakpa, Simpson, Hiott, Langston, Fakhry, & Ford, 2013). A mixed method also assists the researcher to explore the phenomenon from diverse perspectives as a means to discover more. In view of this, the study employed the concurrent embedded strategy: this strategy gives varied views that portray an inclusive evaluation of the issue at hand. The mixed method has been used in several studies in health and health behaviour (Lindsay – Smith, Eime, O'Sullivan, Harvey, & van Uffelen, 2019; Niederberger & Keller, 2018; Namuhaywa, 2013; Zakpa et al., 2013: Bakari, 2015). The design is appropraite in understanding the knowledge, attitude and practice of cold chain management.

Study Area

The study was conducted in the Sekyere Central District which is one of the 30 administrative districts in the Ashanti Region of Ghana. The district was

designed based on a legislative Instrument (LI) 1992 in 2008 from the previous Sekyere West District. The founding of the district was as a result of the rapid population growth and the need to also extend development activities to other parts of the district. The total population of the district based on the 2010 population census is 71,232, representing 1.5%. The population has a sex ration of 49.5 males to 50.5 females. The total fertility rate for the district is 4.0 with a general fertility of 118 births per 1000 women aged 15- 49 years, which is the second highest for the Ashanti Region. The crude death rate for the district is 7.65 per 1000. The district has a household population of 71,232 with a total of 4902 households. The rest of the district characteristics are discussed as follows (Population and Housing Census, 2010).

Geographically, the district is located in the northern part of Ashanti Region. It shares boundaries with Mampong Municipal, Atebubu district, Sekyere East, Sekyere South and Ejura Sekeyere Odumasi. It has a land size of 1,631.1 square kilometers, where it can be located within the longitudes of 0.05 ° and 1.30 ° West and latitudes 6.55° and 7.30° degrees North. It is made up of about 150 communities where majority (70%) of these settlements are found in rural areas which mostly play a host to the Afram plains communities (Population and Housing Census, 2010).

The major means of movement from one community to the other is by the use of vehicles, bicycles and motorbikes. There are tarred and non-tarred roads in the district. Some of the communities in the remote areas are sometimes difficult to reach, especially during the raining seasons. This interferes with economic activities and other activities during that point in time. The poor road network in some of the areas also interferes with the transportation of patients

from a remote community to the nearest health facility. Those around the Afram plain sometimes use canoes to travel to nearby communities (District Health Administration, 2019).

There are a sizable number of primary and Junior High Schools in the district that cater for the educational needs of the children in the district. There are three Senior High Schools in the district (Population and Housing Census, 2010).

There is a District Health Management Team (DHMT) that collaborates with the sub-district heads and other sectors such as the Assembly, traditional leaders and other community opinion leaders to spearhead health activities in the district. At the district level, we have the nutrition unit which champions nutrition and diet related activities in the district. Again, there is the disease control unit which also sees to the implementation of Expanded Programme on Immunization activities as well as disease surveillance and the prevention of communicable diseases. There is also the reproductive health unit that runs maternal and child health activities (District Health Administration, 2019).

The data management unit which is also referred to as the health information unit also sees to the technical management of health data from both clinical and non-clinical activities where these data are used as the basics for planning. To achieve very good results, the study was grouped into five sub-districts. At the sub-district level, there are sub-district heads mostly Medical Assistants and Midwives who also collaborate with the sub-district staff who are mostly Disease Control Officers, Field Technicians, Community Health Nurses and Midwives to coordinate and implement health service activities at this level. But there is other category of staff such as health aides who also assist

in minor activities. The sub-districts implement both clinical and non-clinical activities such as treatment of ailments and minor surgeries, vaccination, child welfare clinic among a host of health services. The district has a couple of health centers and Community Based Health Planning and Services (CHPS) zones but there is no hospital, so extreme cases are referred to the Mampong Municipal Hospital. There are a number of chemical sellers in the district where people buy over the counter drugs as first aid. In terms of disease incidence, malaria remains the topmost condition of the district. The district benefited from the nationwide distribution of Bednet as a means to combat malaria. The district also partakes in the annual child health celebration week where children are given a particular health intervention during that week to promote their health (District Health Administration, 2019).

Population

The study population consisted of 129 health practitioners who were working in the Sekyere Central District (District Health Administration, 2018). The participants were selected from five sub-districts, namely; Nsuta, Kwamang, Birem, Oku and Asubuasu where they were currently serving in various health facilities with cold chain sites. The participants included Community Health Nurses/Nurse Assistant Preventive, Nurse Assistant Clinical, Enrolled Nurses, Field Technicians, Registered Community Health Nurses, Midwives and Medical Assistants. Their ages ranged from 24 years to 59 years. Most of the participants had certificate from the various Ministry of Health (MOH) training institutions and some few ones with diploma or a university degree. The study excluded health practitioners who were on study leave, as well as laboratory technicians, dispensary technicians. The participants

were selected from governmental and non- governmental health facilities in the hard and non- hard to reach parts of the district. Only health facilities that were designated as cold chain management sites were considered for the extent to which these facilities support correct cold chain management and not every health facility in general.

This population is justifiable for the study because they are working with vaccines at different levels of health care and for that matter are expected to have a certain knowledge level in cold chain management so that vaccines would be safe for human use. In all, 86 health practitioners actually participated in the study.

Forty-three percent (n= 37) of the population for this study were from Nsuta, 30.2% (n= 26) were from Kwamang, 10.5%(n=9) were from Birem,14% (n=12) were from Oku, whilst 2.3(n= 2) were from Asubuasu. Majority of the respondents 51.2%(n= 44) were Community Health Nurses (Nurse Assistant Preventive), 23.2%(n=20) were Nurse Assistant clinical/ Enrolled Nurse, 9.3 % (n=8) were Registered Nurse, 9.3% (n= 8) were Midwives, 3.5%(n= 3), Field Technician ,1.2%(n= 1), Registered Community Health Nurse, 1.2(n=1), Public Health Officer, 1.2%(n=1), majority of the respondents 43% (n=37) were within the age bracket of 28- 31. With respect to gender 39.5(34) were males whilst 60.5% (52) were females.

Most of the respondents were certificate holders 75.6%(n= 65), diploma 18.6%(n= 16) and Degree 5.8%(n= 5), 52.3%(n= 45) have less than 5 years of service in the Ghana Health Service, 44.2%(n=38) have also served for 5-10 years , 2.3%(n= 2) have served for 11-15 years , and 1.2% (n= 1) , have served for 16 years and above. With respect to years of service in cold chain

management 61.6% (n= 53) have spent less than 5 years, 37.2% (n= 32) have spent 5-10 years, 1.2(n=1) has spent 11- 15 years. The findings from the number of years the participants have spent in administering vaccines indicated that 61.6% (n= 53) have spent less than 5 years administering vaccines, 37.2% (n= 32) have spent 5-10 years, 1.2(n=1) has spent 11- 15 years.

For the qualitative aspect of the study, four of the key informants were drawn from Nsuta subdistricts (District Health Administration - two, Nsuta RCH – one, Amoamang/ Ankapong - one), two were from Kwamang and two from Birem subdistricts respectively, two participants were also drawn from Oku and another one from Asubuasu subdistricts respectively. Key informants were made up of two Public Health Officers, one Field Technician, and eight Community Health Nurses. Two of the key informants were females while the other nine were males. Two were degree holders whilst the rest, nine were certificate holders. The minimum age was 25 and the highest age 35. The study discovered that three of the respondents have spent less than five years in the Ghana Health Service, six have spent between five to 10 years, and two have spent 11 to 15 years. Their background in cold chain management revealed that seven have spent less than five years in cold chain management, four have spent between five to 10 years. In terms of vaccine administration six have less than five years' experience in vaccine administration, five have between five to 10 years in vaccine administering.

The census method was used for the quantitative aspect of the study. This is because census method denotes a complete involvement of the people in the universe. A universe can be a place, group of people or a specific locality through which we collect the data. Census was used for the study because the

health practitioners in the district were few and for that matter the study considered all health practitioners for the study (Kothari, 2013). Under this method, extensive knowledge on the problem is possible since it covers every one within the population. This method also provides a higher degree of accuracy. It also provides an avenue for diverse units. However, the census method is expensive in terms of money, time and energy and it is not applicable in some instances (Farooq, 2013).

Sampling Procedure

For the quantitative aspect of the study, the participants were drawn from all the 12 cold chain sites in the five sub-districts through census (86 participants).To conduct the census study, a detailed profile of the health practitioners that qualified for the study and the various cold chain sites to be assessed for the extent to which facilities support appropraite cold chain management were retrieved from the district health directorate, which informed the decision to consider all eligible participants and cold chain sites in the inclusion criteria since the total staff strength as well as the cold chain facilities were small. Purposive sampling was employed to select 11 health practitioners for the key informant interview. According to Creswell (2009), 5-25 participants were sufficient for data saturation. In this design, I purposefully selected the participants for the study. Again, data saturation was also reached after interviewing the 11th participant. This was due to the fact that no extra data was being discovered, which permitted the research to terminate the interview since equivalent illustrations were informed repeatedly. Also, the data collected was also adequate to duplicate the study (O'Reilly & Parker, 2012) and from the point of view of Guest et al. (2006), six interviews are even enough

depending on the sample size and to Burmeister and Aitken (2012), the numbers do not matter but the quality of the information gathered and the constituents of the sample size. This design can also give results which are reliable (Kothari, 2013). In addition, the small group of health practitioners who are selected would be a characteristic of the large population. One of the disadvantages of this method is that there can be bias since the researcher would select those who are capable of meeting his or her interest (Mustafa, 2014).

Data Collection Instruments

The instruments were developed based on the experiences gathered from literature (Joshi, Tharkar, & Sign 2007, Bankole et al., 2010; Azira et al., 2013; Krishnappa et al., 2014; Pillay, 2014; Khan, Sarriff, Khan, & Mallhi, 2014: Khan et al., 2015; Memon, Shaikh, Shaikh, Fahim, Mumtaz, & Ahmed, 2015; Yakum et al., 2015; Ogboghodo et al., 2017; Billah et al., 2017; Nwankwo et al., 2018) and practical experience from the Policy Guidelines on Immunization for Ghana (MOH, 2016). The data collection instruments have been categorized into three. These are;

1. a structured questionnaire, (Appendix A)
2. observation guide, (Appendix B) and
3. a semi – structured interview guide, (Appendix C).

The first part of the questionnaire focused on the background characteristics of the respondents. It consisted of nine items which cover basic demographic variables such as sub-district, current place of work, professional category, gender, age, sex, educational background, number of years the person has served in the Ghana Health Service or a health facility, years of experience

in cold chain management and the number of years spent in the administration of vaccines.

To assess the level of knowledge of respondents on cold chain management, a structured questionnaire was used for that purpose. The questionnaire consisted of 20 items. The respondents were required to respond to the items on cold chain management questions by answering either "Yes" or "No'' to the questions.

The structured questionnaire is appropriate for the study since it provides a guide in a sequential order for the responses to the various questions. Structured questionnaire can easily be measured as compared to a non-structured one. (Kothari, 2013). It is easy and quick to answer. Again, the findings can also be inferred to create pragmatic accounts that can help in decision making. Also, in using a structured questionnaire, the questions are quite easy to measure, which sees to it that the results can be used quantitatively (DeFranzo, 2014). It can cover a large number of respondents at a point in time (Guest, 2019). Although the structured questionnaire is appropriate, it has some disadvantages. Some of the disadvantages are that the respondent is pushed to select alternative answers which may compromise the actual results of the entire group. The questions cannot also account for the differences in attitude, values and opinions of the respondents (MBA Skool Team, 2019). This type of instrument can also create a medium for a researcher to influence results willingly or unwilling that may affect measurement outcome.

The questionnaire also covered items on the attitude of health professionals towards cold chain management. Respondents were required to either agree or

disagree to the statements on the attitude subscale. This subscale consisted of ten items.

In order to ensure content validity of the structured questionnaire, samples of the questionnaire were given to experts for corrections to be made. The study supervisors also inspected the data collection instruments for the final modifications and endorsement. The study was pretested with 40 health practitioners at Mampong Municipal area. This was due to the fact that Mampong Municipal shares similar characteristics with the chosen district. The main reason was to detect errors, inclusion biases and language ambiguities that may serve as a barrier to the free flow of information. To determine the reliability coeffient of the questionnaire, Kuder-Richardson (KR-20) coefficient which is used to measure dichotomous (binary) data was used. The reliability coefficient of the subscales under the various data collection instrument was measured independently for each sub scale in order to assess the individual coefficient of each subscale. A reliability coefficient of 0.7 or more for each subscale was considered acceptable, because according to Taber (2018), the values for reliability irrespective of the range does not really matter. The reliability of the various subscales was 0.761 for knowledge subscales, 0.723 for attitude subscales, 0.742 for practice subscale.

On the level of cold chain management practices, a structured observation guide was used for the study. The observation guide consisted of 50 items. These items were further grouped under three main headings; policies, procedures and guidelines, quality of vaccine care and equipment. The policies, procedures and guidelines consisted of 14 items, quality of vaccine care comprised 23 items, and equipment consisted of 13 items.

A key informant interview with some selected staff was conducted to answer the question on challenges facing cold chain management in the district. The interview guide consisted of 13 probing items that were geared towards the challenges of cold chain management among health practitioners. A semi-structured interview guide was developed which created an opportunity for key people to express their views on the phenomenon which provided in depth information about the situation.

The interview guide helped the researcher to know how to ask questions, the order or the sequence, how to present the questions and how to pose follow up questions. The interview guide also enables the clarification of point where necessary so that the right information would be sought and if possible, identify the factors that are contributing to the problem. It also increases the knowledge of the interviewer. The interview guide also has some form of weakness that may also affect the study: some of the weaknesses are interviewers may understand and transcribe interviews in different ways that are quite different from the respondent's view (Kumar, 1989).

The study was subjected to the following guiding principles in order to achieve trustworthiness; credibility, dependability, confirmability and transferability. Credibility is the assurance that can be positioned in the reality of the study findings. It indicates whether the findings from the study epitomises the view of the respondents as correlated with the actual data (Forero et al., 2018; Korstjens & Moser, 2017). Credibility was ensured by familiarizing with the setting and was able to identify people who could give more credible information on the topic and not just any member of staff. Those selected also have diverse field experiences which also made them qualify for the key

informant interview so far as their field of work was concerned. Key informants were asked several questions that had a link with the topic, where they backed their responses with illustrations. The data was not collected in a haste there was prolonged encounter with the participants because the key informants were given ample time to express themselves so far as each question was concerned. The researcher asked probing questions as a means to gather more data. There was a sequential linkage where the questions were asked in a coherent manner to aid in data collection and key points were also noted down as the key informants also responded to the interview. The data was analyzed by the researcher. The information was also shown to the participants for their views. The transcribed information was coded and interpreted in such a manner that it was not traceable to a particular informant.

Dependability denotes the reliability from the positivist point of view. It certifies reliability of the data collected as well as the explanation of the data in respect of the study findings (Collier–Reed, Ingerman, Berglund, 2009). Dependability was also ensured by testing the data collection instrument at Mampong Municipal where it was modified for data collection. Records of the various stages were kept to maintain an audit trail (Korstjens & Moser, 2017).

Confirmability seeks to ensure that the data represents the views of the participants and not that of the researcher (Lincoln & Guba, 1985; Polit & Beck, 2012) cited in Elo et al., 2014). To ensure confirmability, the transcribed data was read to the participants to find out from them if it represents what they indicated. Again, the analysed data was shown to two people who are skilled in qualitative data management where the original data from the field, codes, transcribed data, themes and sub-themes were also inspected. The link between

the themes, sub-themes and degree of representation in the analysis was also evaluated. Again, all salient points were also checked sequentially to assess the level of legitimacy to the study. This tracking was to ensure that all the data gathered was rooted in the views of the key informants, and also to approve that the most appropraite results which would not misrepresent the view of the informants was arrived at.

Transferability specifies the extent to which the findings of a qualitative study can be transferred to other locations with other participants (Korstjens, & Moser, 2017). Transferability was ensured by providing a vivid description of the research setting where a descriptive background of the key informants were provided and the processes that were involved in the key informant interview as well as the findings were also stated. The findings would be applicable to the Sekyere Central District only.

Data Collection Procedures

An ethical clearance (UCCIRB/CES/2019/01) (Appendix I) was obtained from the Institutional Review Board of the University of Cape Coast through the Head of Department for the Department of Health, Physical Education and Recreation. The consent of the participants was obtained before engaging them in the study. Again, a letter of introduction was sent to the District Director of Health Services for the study area to negotiate access to the study sites.

On the aspect of questionnaire administration, during the scheduled date, I visited the study sites to conduct the study. At each site, the content of the study was explained to the staff, where the staff who willingly opted for the study was engaged. In addition, confidentiality and privacy were also ensured

especially with the questionnaires. The identity of the respondents was not indicated on the questionnaire.

To collect the data on the knowledge of health practitioners on cold chain management, the items were read one after the other to the participants so that the respondent would indicate the option (either Yes or No) which is more appropriate to a particular item for me to record.

To assess the attitude of health practitioners (participants) on cold chain management, a number of items were read in a sequential order to the participants for them to specify whether they agree or disagree: the responses were indicated as such on the questionnaire.

A covert type of observation - a method of observation where those who are studied are not aware that they are being studied was used to gather data on the extent to which facilities support correct cold chain management. Observation is the process of noticing things around us. A day each was spent at all the cold chain sites to observe their cold chain management practices. An observation schedule was developed and used for that purpose.

The researcher decided on what to observe with each item on the guide - policies, procedures and guidelines, quality of vaccine, equipment and take field notes and write findings (Kawulich, 2005). Again, the schedule also has a tabulated column for “Yes” or “No” for the researcher to indicate the outcome of the observation so far as each item observed is concerned. Eight items were adopted from Pillay (2014). The questions were; Are all the staff trained to follow policies, procedures and guideline that ensure compliance for cold chain management, are contingency plans in place for problems with equipments, is there evidence of filling in of stock cards for vaccine storage, is vaccine wastage

managed according to policy, does the facility manage waste vaccines according to policy, is evidence of vaccine wastage report available to make operational changes, is there evidence of records in case of recall/ batch numbers for vaccines, is the refrigerator technically appropriate to store vaccines, Does the refrigerator have a lock and key, is/are the cold boxes in a good condition.

The researcher used a key informant interview guide to explore the challenges to cold chain management in the Sekyere Central District. This key informant interview was conducted for some of the core people involved in cold chain management where it was recorded manually and electronically (digital recorder) and transcribed later for analysis and interpretation. The participants were informed of the recording so far as ethical issues were concerned. The interviews took place at a time and place convenient to the participants. Each interview section took approximately 30-45 minutes. The participants were made to participate in the study voluntarily without the use of anything in cash or in kind. The respondents also gave the free will to terminate the study if they wish to do so at any point in time during the data collection period. Finally, the data collected from the participants was used only for the purpose it was intended.

Data Processing and Analysis

The raw quantitative data were screened for completeness and codified. The data were organized with Statistical Package for Social Sciences (SPSS) version 20.0.

Research question one- What is the level of knowledge of health practitioners on cold chain management? The data was analysed using frequencies and

percentages. Knowledge level score ranged from 0-20 and each correct response yielded a mark. An incorrect response yielded zero score. The maximum score that can be achieved is 20 and the lowest is 5. The scores were grouped as 0- 5 (poor), 11-13.9(fair) and 14-20 as good. The scores for the knowledge category were converted to percentages and grouped as poor (0-50%), fair (51-69%) and good (70% and above). This analysis was adapted from (Khan et al., 2014; Memon et al., 2015).

To address the question - what is the attitude of health practitioners towards cold chain management? A positive response had a score of 1 for "agree" and a score of 0 for "disagree". Reverse coding technique was used for negatively worded statements. These scores were entered into the SPSS template and processed. To determine the attitude, the scale was measured within a range of 0 to 10, with the highest score as 10 and the lowest score being 0. That is, a response was considered to be positive if it corresponds to the right behaviour a person is expected to demonstrate so far as response to that attitude item is concerned. A negative attitude was a product of a response that does not correspond to the right attitude the person is supposed to portray so far as that attitude item is concerned.

The scores for the attitude category were converted to percentages and grouped as poor (0-50%), fair (51-69%) and good (70% and above). This scoring system was adapted from Khan et al. (2014), Memon et al. (2015), and Nwankwo et al. (2018). The data was analysed using frequencies and percentages.

To answer the question - What is the association between attitude and knowledge on cold chain management? Pearson chi-square was used to examine

the association amongst knowledge and attitude (x^2). For the values to be recognized as statistically significant, findings with a p value of less than 0.05 were acknowledged.

To answer the question – To what extent do facilities in Sekyere Central District support correct cold chain management? all the items on the observational guide were summarized using frequencies and percentages, where the responses to the various items that indicate the extent to which facilities support correct cold chain management were highlighted for discussion. This was adopted from Ansong et al. (2018). The final part of the analysis is on the challenges facing cold chain management.

To analyse question five - what are the challenges with cold chain management in the Sekyere Central District? - thematic analysis based on Braun and Clarke (2006) was used. This type of analysis permits an available and theoretical-flexible method to analysing qualitative data. It consists of six phases of analysis; these are familiarizing oneself with the data so that the individual can have control in making a meaning out of the data collected. At this phase, the data collected was read indeptly in order to have explicit knowledge about the data. The exact meaning of the words that were recorded in the data as well as the pattern were also found. Again, there was coding and transcription of the audio recording. The second phase of the analysis was on generating initial codes. Coloured pens and highlighters were used to indicate relevant patterns that were applicable to the data analysis. All the real data derived from the interview were also codified and then organized with each code.

The searching for themes is the third phase of the thematic analysis. At this level, diverse codes were sorted into possible themes. In addition to this, all the necessary coded excerpts (extracts) within the recognized themes were assembled and added all together to form an overarching theme. The links between the codes, themes and the diverse levels of themes were also considered. The final part of this phase is to conclude with a collection of main themes, minor (sub) themes and all extracts of data that have been coded in relation to them.

The fourth phase was on reviewing the themes. Here, the themes were refined. This phase consists of two levels. At the first level, all the coded excerpts for the individual themes were read, reviewed and inspected to assess if they made up a clear pattern. Once everything was in order, the next sub phase (second level) which sought to check the validity of the individual themes in relation to the set of data gathered was conducted.

The fifth stage is redefining and naming theme. At this phase, the themes that were to be presented for the analysis were outlined and additionally enhanced. The final stage is on finally producing report. The data was analysed, and made into complete summary which was a clear, reasonable and non-repetitive write up of the data collected from the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

The purpose of the study was to assess the knowledge, attitude and practice of cold chain management among health Practitioners in the Sekyere Central District of Ghana. This chapter is a description of the results and discussions from the study. The study used a mixed method approach. First, a census was conducted involving 86 participants (34 males and 52 females) who were mostly health practitioners from 5 sub-districts with 12 cold chain sites with a 66.7% response rate. The sub-districts were made up of both remote and non-remote cold chain sites.

A qualitative approach was used to explore the challenges with cold chain management. Eleven people were involved in the qualitative study. They were selected due to the fact that they were focal persons for cold chain management and others also had an insight into cold chain activities at the sub-district level. This study design was employed because it aids to get an in-depth information from the topic under study. The quantitative data was organized with SPSS version 20.0 and analyzed using descriptive statistics while the qualitative data was transcribed from a key informant interview, converted to themes and sub-themes which were further discussed with supporting quotes from the respondents. The rest of the chapter is discussed in line with the research questions.

Research Question 1: What is the level of knowledge of health practitioners in the Sekyere Central District on cold chain management?

Table 1: Background Characteristics of Respondents, (N=86)

Variable	*Frequency*	*Percentage (%)*
Subdistrict		
Nsuta	37	43.0
Kwamang	26	30.2
Birem	9	10.5
Oku	12	14.0
Asubuasu	2	2.3
Current Place of work		
Oku Catholic Clinic	11	12.8
Asubuasu/Amoaman/Jeduako	12	13.9
Nsuta RCH/Health Center	16	18.6
Kwamang Health Center	14	16.3
Beposo Health Center	8	9.3
Adutwam/DHA/Nkudja/Abesua	4	4.7
Aframso/Jetiase	6	7.0
Atonsu/Birem/Kyebi	15	17.4
Category of Staff		
Community Health Nurse/Nurse	44	51.2
Assistant Preventive		
Nurse Assistant Clinical	5	5.8
Enrolled Nurse	15	17.4
Field Technician	1	1.2
Disease Control Officer	0	0
Nutrition Officer	0	0
Health Information Officer	0	0
Registered Community Health Nurse	1	1.2
Registered Nurse/SRN	8	9.3
Midwife	8	9.3
Public Health Nurse	0	0
Public Health Officer	1	1.2
Medical Assistant	3	3.5
Age of Respondents		
24-27	23	26.7
28-31	37	43.0
32-35	22	25.6
36-39	2	2.3
40-43	1	1.2
44-47	1	1.2

Source: Field Survey, Sekyere Central District (2019)

Table 1, Continued

Variable	Frequency	Percentage (%)
Gender		
Male	34	39.5
Female	52	60.5
Educational level		
Certificate	65	75.6
Diploma	16	18.6
Degree	5	5.8
Masters	0	0
Years Served in Ghana Health Service		
Less than 5 years	45	52.3
5-10 years	38	44.2
11-15 years	2	2.3
16 years and above	1	1.2
Years of Experience in Cold Chain Management		
Less than 5 years	53	61.6
5-10 years	32	37.2
11-15 years	1	1.2
16 years and above	0	0
Years spent in administering vaccines		
Less than 5 years	53	61.6
5-10 years	32	37.2
11-15 years	1	1.2
16 years and above	0	0

Source: Field Survey, Sekyere Central District (2019)

As depicted in (Table 1), 43% of the participants(n=37) were drawn from the Nsuta subdistrict, 51.2% (n= 44) were also Community Health Nurses/ Nurse Assistant Preventive, the age distribution of the participants also revealed that 43% (n=37) of the participants were between the age interval of 28-31,60.5%(n=52%) were females, as much as 75.6 % (n= 65) were certificate holders, whilst 52.3%(n=45) had served for less than 5 years in the Ghana Health Service. With respective to the years of experience in cold chain management, an average representation, 61.6% (n= 53) had less than five years experience in cold chain management as well as years spent in administering vaccines.

Table 2: Descriptive Statistics on Level of Knowledge on cold chain management

Variable	Frequency	Percentage (100%)
Vaccines can be stored at any temperature		
Yes	2	2.3
No	84	97.3
Temperature for the storage of vaccines in a coldbox is the same as that of the vaccine carrier		
No	36	41.9
Yes	50	58.1
All vaccines shall be stored at +2 C to + 8 C except oral Poliomyelitis		
Yes	46	53.5
No	40	46.5
Poliomyelitis and Measles can be destroyed by freezing		
Yes	56	65.1
No	30	34.9
DPT/Hep/Hep can also be destroyed by freezing		
Yes	27	31.4
No	59	68.6
Vaccines can be destroyed by heat		
Yes	3	3.5
No	83	96.5
VVM stage 3 and 4 of the vaccine can be used		
Yes	15	17.4
No	71	82.6
Vaccine Transfer (fridge, coldbox or vaccine carrier) is required if power failure is more than 24 hours		
Yes	14	16.3
No	72	83.7
Storage of diluent before vaccination session		
Yes	10	11.6
No	76	88.4
All WHO prequalified multi-dose vails of vaccines		
No	18	20.9
Yes	68	79.1
Meeting all four criteria (kept and use for 24 days)		
Yes	45	52.3
No	41	47.7

Table 2, Continued

Variable	Frequency	Percentage (100%)
Fridge tags monitors temperature for 6 weeks		
Yes	29	33.7
No	57	66.3
Coldbox can store vaccines for 2 weeks in case of emergency		
Yes	59	68.6
No	27	31.4
Ices packs should be conditioned before immunization		
Yes	3	3.5
No	83	96.5
Duration for conditioning icepacks (5 to 10 minutes)		
Yes	74	86
No	12	14
Vaccines can be placed at refrigerator		
Yes	66	76.7
No	20	23.3
Temperature recording on temperature chart not required		
Yes	12	14
No	74	74
At the facility level when vaccines get frozen it should be Discarded		
Yes	58	67.4
No	28	32.6
Poliomyelitis vaccine can be used for shake test		
Yes	55	64
No	31	36
DPT/HIB/HEpB vaccine can be used for the shake test		
Yes	73	84.9
No	13	15.1
Total	86	100.0

Source: Field Survey, Sekyere Central District (2019)

The (Table 2), shows the descriptive analysis of the items that were used to assess the level of knowledge of the participants on cold chain management.

Research Question 1: What is the Level of Knowledge of Health Practitioners in the Sekyere Central District on Cold Chain Management?

Table 3: Level of Knowledge on cold chain management, (N=86)

Score	Frequency	Percentage (100%)
Poor	4	4.7
Fair	23	26.7
Good	59	68.6
Total	86	100.0

Source: Field Survey, Sekyere Central District (2019)

This research question sought to assess the level of knowledge of health practitioners in the Sekyere Central District on cold chain management. Table 3 indicates that 4.7% (n= 4) of the participants had poor level of knowledge on cold chain management, while 68.6% (n= 59) also had good level of knowledge on cold chain management. A possible explanation of this could be that the district organized a refresher training for a section of the staff on cold chain management as part of the supplemental immunization activity (SIA). Again, majority 51.2% (n=44) of the staff were Community Health Nurses (CHNs) who also work with vaccines constantly. This finding is quite similar to a prospective cross- sectional study conducted in Ghana by Ansong et al. (2018) where 88.18% of the participants knew that it was a requirement for the temperature of the vaccine to be recorded twice a day. The similarity between these two studies may be due to the fact that most of the participants were CHNs, thus 83.64% in Ansong et al. (2018)

Comparatively, the findings from a cross-sectional study in Malaysia by Azira et al. (2013) indicated that 78.7% of the respondents had adequate knowledge on cold chain management. Although the finding of this study is

consistent with that of Azira et al. (2013), the respondents involved in Azira et al.'s study had a higher percentage 78.7% score regarding knowledge. This may be due to the fact that most of the respondents were not certificate holders as discovered in this study.

Again, the study was done in Malaysia where the respondents might have had access to a lot of materials to influence their knowledge on cold chain management as compared to this one which was conducted in Ghana where some of the facilities do not have access to the internet or policy guidelines on cold chain management. Another reason could be that the population sample was general practitioners as compared to this current study that did not recruit such caliber of practitioners.

This study indicated that 68.6%(n=59) of the participants had good knowledge on cold chain management. This result is consistent with the findings of a descriptive interview study in Turkey (Efe et al., 2008) where most of the participants had adequate knowledge concerning the cold chain. The differences in this results may be due to the fact that most of the participants (76.5%) in the Turkish study had more than 10 years experience in cold chain as compared to this present study. The similarity between these studies is that midwives in primary care facilities were involved in both studies. This study is also similar to an institutional based cross-sectional study in Ethiopia (Bezunesh et al., 2013) that also recorded a satisfactory level of knowledge (65%). Comparatively, the findings from this study is not different from a cross sectional study that employed both quantitative and qualitative data collection methods in Uganda (Namuhaywa et al., 2013), in the previous findings 86% of the respondents had knowledge about the vaccine vail monitor items. In India,

Krishnappa et al. (2014) found that the overall knowledge of the participants concerning some cold chain practices was satisfactory apart from ice pack conditioning and temperature of deep freezers.

Other cross-sectional studies from Pakistan that is (Buledi et al., 2017; Khan et al., 2015) have also discovered similar related findings. Another consistency also exists between this study and an institution based cross-sectional study in Ethiopia (Woldemicheal et al., 2018), the Ethiopian study recorded 54.6% as compared to this study. Another study from Ethiopia (Yassin et al., 2019) also recorded that 51.3% of the participants had satisfactory knowledge about cold chain. The similarity between both studies is that a knowledge gap still exists on cold chain management in some African countries although certain satisfactory scores were reported. Although this study drawn some consistencies with some previous studies, the results is inconsistent with that of (Ogboghodo et al., 2018; Naik et al., 2013) since majority of the respondents had poor knowledge in that study. Again it is also not consistent with a descriptive cross-sectional study that took place in Nigerian by Ogboghodo et al. (2018) where 64.0% of the participants had poor knowledge on cold chain management.

The previous study involved 39.8% community health extension workers (CHEWS) who may not be more knowledgeable in vaccine cold chain as compared to this present study that did not use such participants. Again 8.2% of the participants in Ogboghodo et al. had served for less than one year but this current study did not use such participants. Although this study recorded good level of knowledge on cold chain management Naik et al. (2013) concluded in a cross-sectional study in Western India that the knowledge level of the

participants was unsatisfactory, irrespective of the fact that most of the participants knew VVM and its correct interpretations.

As part of the effective vaccine management assessment review in Ghana, Diamenu et al. (2015) indicated that knowledge gap continues to be a challenge to cold chain management but this to some extent is true , because in this current study a gap still exists that needs to be filled, 31.4%(n=27) did not have good level of knowledge .This gap is related to the findings of a cross-sectional study in Mozambique (Mavimbe & Gunner, 2007). It implies that some of the staff, if not all, should be educated on cold chain management; because health practitioners need to have adequate knowledge on cold chain management if not there would be vaccine induced diseases (Mavimbe & Gunner, 2007). Again, the leadership of the district should also add training and workshops on cold chain management to update the staff and cover all the staff as part of the task sharing policy. Again, the implications of this finding is that the participants may perform better if the necessary logistics and equipment for cold chain management are available in the district since they have good knowledge on cold chain management.

Table 4: Descriptive statistics on the attitude of health practitioners in the Sekyere Central District towards Cold Chain Management, (N=86)

Variable	Frequency	Percentage (%)
I monitor the temperature of the vaccine twice daily including holidays		
Agree	78	90.7
Disagree	8	9.3
Is mandatory for me to record the temperature of the vaccine on the temperature monitoring chart		
Agree	81	94.2
Disagree	5	5.8
I defrost refrigerators when the need arises		

Table 4, Continued

Agree	66	76.7
Disagree	20	23.3
I seldomly clean cold chain equipments weekly		
Agree	65	75.6
Disagree	21	24.4
I put icepacks in the freezer in case of power failure		
Agree	60	69.8
Disagree	26	30.2
If a refrigerator is opened more than three times it will not affect the potency of the vaccines		
Agree	30	34.9
Disagree	56	65.1
I store vaccines in a dedicated refrigerator		
Agree	67	77.9
Disagree	19	22.1
I do shake test to determine the potency of some vaccines		
Agree	62	72.1
Disagree	24	27.9
I think the potency of vaccines can be maintained if medicine and specimen are put together		
Agree	23	26.7
Disagree	63	73.3
Special thermometer is not required to measure internal refrigerator temperature		
Agree	20	23.3
Disagree	66	76.7

Source: Field Survey, Sekyere Central District (2019)

This research question sought to assess the attitude of healthcare practitioners in the Sekyere Central District towards cold chain management. Table 2 indicates that 10.5% (n=9) of the respondents had a poor attitude towards cold chain management whilst 67.4% (n=58) had a good attitude, meaning they had a positive attitude towards cold chain management. The possible implication for this result may be due to the fact that most of the participants have served for about five years in the district where they may be passionate about cold chain management. Additionally, they are also involved

in maternal and child health activities in which the use of potent vaccines to prevent diseases is one of the ultimate interventions in maternal and child health.

This study reported that 67.4% (n=58) of the participants had a good attitude towards cold chain management. This is consistent with a cross-sectional study in Nigeria by Nwankwo et al. (2018) as well as another finding from Pakistan thus Khan et al. (2015), and a Nigerian study by Ogboghodo et al. (2018) but inconsistent with findings of Azira et al. (2013) in Malaysia. The inconsistencies may be due to the level of supervision, leadership qualities, policy implementation and the facilities available that may support or stress health practitioners on cold chain practice as well as the variations in the study areas. The implication for the study is that the health system should continue to put in more mechanisms to encourage health practitioners to have a sense of affection for cold chain management.

Research Question 2: What is the attitude of health practitioners in the Sekyere Central District towards cold chain management?

Table 5: Attitude of health practitioners towards cold chain management (N= 86)

Attitude	Frequency	Percentage (%)
Poor	9	10.5
Fair	19	22.1
Good	58	67.4
Total	86	100.00

Source: Field Survey, Sekyere Central District (2019)

Research Question 3: What is the Association between Attitude and Knowledge?

The study indicated that there was a weak association between knowledge and attitude, but this association was weak positive. This is quite similar to that of Sofia et al., 2017.This implies that knowledge would not always lead to a change in attitude.

Table 6: Association between Knowledge and Attitude towards Cold Chain Management

	Value	Df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)		
				Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pearson Chi-Square	3.814[a]	4	.432	.402[b]	.392	.411
Likelihood Ratio	4.025	4	.403	.457[b]	.447	.466
Fisher's Exact Test	3.551			.409[b]	.399	.418
Linear-by-Linear Association	.845[c]	1	.358	.390[b]	.381	.400
N of Valid Cases	86					

Source: Field Survey, Sekyere Central District (2019)

Research Question 4: To what extent do facilities in the Sekyere Central District support correct cold chain management?

This research question sought to identify extent facilities in the Sekyere Central District support correct cold chain management in the Sekyere Central District. The (Table 5) indicates extent facilities in the Sekyere Central District support correct cold chain management. Two (n=4%) out of the 50 items were not applicable as at the time of the study, leaving 48 applicable items. The results revealed that nine items (20.8%) out of the 48 items on cold chain management were supported by the facilities whilst 79.2% (n=38) did not

support correct cold chain management. These are; 66.7%(n=8) of the facilities had records in case of recall, this finding is contrary to that of a quantitative descriptive study in South Africa (Pillay, 2014) where all the facilities (100%) did not have an evidence of recall/batch numbers of vaccines. This may be due to the fact that the vaccines history is mostly recorded in the child health records booklet.

The similarity between the two studies is that data management on vaccine is still a problem for some health facilities. The implication for this study is that it would be difficult to trace the details of vaccines in case of emergency which can affect the credibility of vaccines used at the various vaccination sites. The study also found that 83.3%(n=10) of the facilities had trained all the staff on cold chain management, this result is quite related to that of a Nigerian descriptive cross-sectional study (Ogboghodo et al., 2017) which specified that 70.8% of the participants had received training on cold chain management. The implication for the study is that it creates a formidable atmosphere for health practitioners to acquire knowledge on cold chain management with regards to vaccine storage (Ogboghodo et al., 2017), most of the facilities 91.7% (n=11) had refrigerators to store vaccines, this is consistent with Ogboghodo et al. (2017) that indicated 92.7% coverage on functional vaccine refrigerator. A similar documentation has been made in a descriptive cross-sectional study in Cameroun (Yakum et al., 2015) that documented 81.5%. Despite the fact that most of the facilities have refrigerators, the facility that does not have the refrigerator is likely to be challenged because infrastructural capacity has an association with performance at the workplace (Chandrasekar, 2011). Ideally, all the facilities should have adequate number of

functional refrigerators for vaccine storage depending upon the terrain. On the part of the technical appropriateness (size, type, functionality, icepack compartment) of the refrigerators that were available for vaccine storage it found that 58.3% (n=7) of the facilities had technically appropraite refrigerators. Comparatively an Indian study, Krishnappa et al. (2014) reported 91% for the cold chain status of icelined refrigerators (ILR) and 46.9% for deep freezers (DF). This finding is quite similar to that of a cross-sectional study that was conducted in Cameroun by Ateudjieu et al. (2013), this may be due to the fact that vaccines cannot be stored in any refrigerator. The implication of the results for this study is that 41.7% (n=5) of the refrigerators may not be functioning very well for cold chain activities, but the facilities are managing its use.

As much as 66.7% (n=8) of the facilities had functional fridge tags. This current result is lower than the findings 87.5% of Yassin et al., (2019) as part of an institution-based cross-sectional study in Ethiopia. The differences may be due to resource availabilty and distribution in both countries at the time of the study. This implies that the availability of cold chain resources varies from one geographical region to the other. Recording of vaccine temperature is very vital in cold chain management, as much as 75% (n=9) of the facilities had records on the 30 days(daily) temperature recording sheet, but half of the facilities 50% (n=50) monitored the temperature of the vaccine twice daily. This has shown that 50% of the facilities do not comply with the protocols for vaccine storage, reasonably this coverage is lower than the results of an institution based cross-sectional study in Ethiopia (Yassin et al., 2019) who respectively reported 100% on availability of daily temperature records and 85.7% on temperature records twice daily. Any similarity in both studies may be due to the fact that

temperature monitoring devices are supplied from the national level to health facilities so if the means is not available facilities would not be able to record on the temperature recording sheet. The differences may be due to the fact that some of the facilities 33.3(n=4) were not having fridge tags in this present study. The implication for this study is that the potency of 50% of the vaccines in the district may be at risk because temperature variations may not be noticed.

Preferably, all cold chain refrigerators at the district level are to maintain a temperature of + 2 °C to + 8°C as the optimal temperature range for the storage of vaccines at the district and subdistrict level. It was observed that 41.7% (n=5) of the facilities keep the vaccines within the appropriate range (+ 2 °C to + 8°C). This was due to the fact that some of the fridge tags and refrigerators were not functioning properly, which made reading of the temperature a bit challenging. This finding is consistent with the results of Maglasang et al. (2018) but inconsistent with Mugharbel and Al-Wakeel (2009), Krishnappa et al. (2014), and Yassin et al. (2019) who recorded higher values. Mavimbe and Gunner (2007) also indicated that some of the facilities had a normal temperature reading.

The implication of this finding is that most of the vaccines from this district may be exposed to serious temperature challenges which are likely to reduce vaccination outcomes. The probability that a vaccine derived medical condition may arise from the district is 58.3% higher as few of the facilities store the vaccines according to the right temperature per the WHO and Ghana Health Service vaccine storage and handling protocol. The cardinal factor is that the district is challenged with cold chain management practices apparatus where some of the facilities do not have access to repairs and functional equipment.

The study also found that 66.7%(n=8) of the facilities had vaccines in good condition, this does not mean the rest (33.3%) were expired or VVM readings were not in line with standard protocols but (VVM labels, vaccine information on the vails such as batch number, expiry, batch/lot, vaccine type were peeled off or soaked and some of the vaccines looked partly cloudy). The implication is that vaccinators may not know the status of the vaccines that they are using to vaccinate the eligible target. The study found that 83.3% (n=10) of the facilities had enough temperature (additional copies) of monitoring charts that can be used for the rest of the year. However certain incorrect activities were also discovered, thus the study found that 91.7% (n=11) of the facilities do not have policies and guidelines on cold chain management practices. This finding is consistent with that of Pillay (2014) but inconsistent with that of Mavimbe and Gunner (2007), Yakum et al. (2015), and Yassin et al. (2019). The variations may be due to the fact that manuals and guidelines on cold chain are mostly supplied by the regional level to the district level so if the means of distribution is not available facilities may not have them.

The implication is that majority of the facilities would not have the means of reference in case of consultation or emergency and would have to depend on what they already know, which may not really provide the solution needed. Again, some of the facilities are in remote areas where there is poor tele-communication network so the absence of these policies, procedures and guidelines will greatly affect cold chain management.

Table 7: Extent to which Facilities support Cold Chain Management, (N=12)

Variable	*Frequency (%)*	
Does the facility have policies and guidelines on cold chain management practices?	Yes (%)	No (%)
	1(8.3)	11(91.7)
Evidence of policies, procedures and guidelines for cold chain management at this facility	1(8.3)	11(91.7)
Are all the staff trained to follow policies, procedures and guidelines that ensure compliance for cold chain management?	1(8.3)	11(91.7)
Does the facility have a vaccine ledger book?	2(16.7%)	10(83.3)
Does the facility have a cold chain inventory book or guide?	2(16.7%)	10(83.3)
Are contingency plans in place with equipment?	0	12(100%)
Does the facility have an emergency power supply?	1(8.3)	11(91.7)
Is there evidence of filling in stock cards for vaccine storage?	0	12(100%)
Is vaccine wastage managed according to policy?	0	12(100)
Is evidence of vaccine wastage report available to make operational changes?	0	12(100)
Is there evidence of records in case of recall/batch numbers?	8(66.7)	4(33.3)
Has the district trained staff on cold chain management?	10(83.3)	2(16.7%)
District level supportive supervision and monitoring	0	12(100%)
Does the facility have a trained Officer purposely in charge of cold chain management?	2(16.7%)	10(83.3)
Does the facility have a refrigerator for storing vaccines?	11(91.7)	1(8.3)
Is the refrigerator technically appropriate to store vaccines (size, type, functionality, icepack compartment)?	7(63.6)	5(41.6)
Is the distance from the refrigerator to the wall technically appropriate?	1(8.3)	11(91.7)
Does the refrigerator have a lock and key?	1(8.3)	11(91.7)
Does the refrigerator have a functional thermometer?	1(8.3)	11(91.7)
Functional fridge tag (if no functional thermometer)	8(66.7)	4(33.3)
Position of thermometer correctly placed in fridge	1(100%)	0
Absence of refrigerator (cold box Fridge Tag /Thermometer) Not applicable)	-	-
Does facility monitor temperature twice daily?	6(50)	6(50)
Is Temperature within appropriate range? (+2 °C – +8 °C)	5(41.7)	7(58.3)
Records (30 days monthly temperature chart)	9(75)	3(25)

Source: Field Survey, Sekyere Central District (2019)

Table 7, continued

Variable	Frequency (%)	
Three months reading (twice daily each day)	4(33.3)	8(66.7)
Level of records availability	4(33.3)	8(66.7)
Vaccines arranged in coldbox (Not Applicable)	0	0
Vaccines correctly arranged in refrigerator	2(16.7)	10(83.3)
Diluents correctly stored in refrigerator	4(33.3)	8(66.7)
Are vaccines overstocked?	7(58.3)	5(41.7)
Space in between vaccines	1(8.3)	11(83.3)
Presence of food in refrigerator	0	12(100)
Presence of water in refrigerator	0	12(100)
Presence of medical item or biological(non-vaccine) in refrigerator	8(66.7)	4(33.3)
Does the facility have enough thermometer for every outreach?	0	12(100)
Does the facility have enough functional refrigerators?	0	12(100)
Does the facility have enough cold boxes?	5(41.6)	7(58.3)
Is/are the cold boxes in good condition?	4(80)	1(20)
Does the facility have enough vaccine carriers?	0	12
Are the vaccines in good condition?	8(66.7)	4(33.3)
Do all the vaccine carriers have foam pads?	15(39.5)	23(60.5)
Does the facility have enough thermometers or fridge tags?	0	12(100)
Are all the available thermometers or fridge tags functional?	5(41.7)	7(58.3)
Does the facility have enough icepacks?	1(8.3)	11(91.7)
Does the facility have a deep freezer for storing icepacks?	1(8.3)	11(91.7)
Does the facility have enough temperature monitoring charts?	10(83.3)	2(16.7)
Is there enough equipment for emergency?	0	12(100)
Does the facility have a room purposely for cold chain equipments?	5(41.7)	7(58.3)

Source: Sekyere Central District (2019)

Contingency plan helps facilities to identify resources in order to put in measures to curtail risk in the near future (Philips, 2018). This practice is under normal circumstances expected to be applied in all health facilities that are handling the vaccine cold chain. But this observation discovered that all the facilities 100%(n=12) did not have a contingency plan in place for equipment. This may be due to the fact that, cold chain issues may not be equated to situations that are likely to result in medical emergencies, which are likely to result in fatalities. This current observation is similar to a study in South Africa

(Pillay, 2014) and a Tanzanian study (Ringo et al., 2017), but quite inconsistent with that of Maglasang et al. (2018). This indicates that plans for emergencies are not really an area of concern for a cross section of facilities in the African sub region; perhaps, they need to wait for the risk or crisis to happen before it is given the needed attention which does not work well for cold chain management. This implies during cold chain breakdown; volumes of vaccines can be wasted due to unpreparedness. Also, the ability to also contain any risk of cold management is also compromised. Lastly, the district may not be able to establish more vaccination points during outbreaks.

The role of emergency power (alternative) supply is very crucial to cold chain management; therefore, facilities managing the vaccines are expected to have alternative power supply because vaccines are delicate biological substances that are highly vulnerable to temperature alterations, especially during power outages.

The study observed that only 8.3% (n=1) had emergency power supply, thus 91.7% (n=11) did not have. The possible reason could be that the facilities have not budgeted for one. The Ghana Health Service also does not supply generators to cold chain sites but may encourage alternative source of power such as gas. This finding is consistent with a cross sectional study in the Philippines (Maglasang et al., 2018) where majority of the facilities 72.7% were not having accessible generators. This consistency may be due to the fact that alternative power supply challenges may be a global issue. The implication of this observation is that the entire districtwide cold chain management system is at risk, because the chemical nature of vaccines can be destroyed easily during power outages, especially, in the remotest part of the district which cannot easily

alternate due to transport challenges. This outcome can lead to vaccine induced medical conditions, wastage or false immunity.

Ideally, each cold chain facility is expected to have a technical person to handle the cold chain system. The study observed that majority of the sites 83.3% (n=10) did not have a trained officer (Disease Control or Field Technician) purposely designated for cold chain management, but Community Health Nurses (CHNs) were mostly the focal persons in the facilities since the district is short of this category of staff. This finding is to some extent consistent with Murgabel and Al- Wakeel (2009) in Saudi Arabia, but inconsistent with a Nigerian study (Ameen et al., 2016) but the later did not indicate the background of the designated officers. The implication for this study is that challenging cold chain issues cannot be solved by most of the focal persons since they had to wait for the technical staff from the district level to attend to such issues. The operation of certain cold chain gadgets such as the fridge tag and temperature regulation of refrigerators will be a problem for most of the staff.

In cold chain management, vaccines are to be monitored twice daily. This is to ensure that the optimal temperatures for vaccines are achieved and compared. Twice monitoring of the vaccines also helps to identify faults in time for the exact amendments to be made. The study found that half of the facilities 50.0% (n=50) did not monitor the temperature of the vaccine twice daily. The possible reason could be that almost half of the facilities do not have stable or temperature monitoring devices which may not influence some of the staff to even monitor the temperature. This finding is consistent with Yassin et al. (2019), and (Mugharbel & Al-Wakeel, 2009) but quite inconsistent with the results of Pillay (2014) and Ameen et al. (2016). This similarities and

differences may be due to the availability of resources and the level of commitment to temperature monitoring on the part of the participants. The implication for the study is that some facilities in rural Ghana are not practising cold chain management within the WHO and Ghana Health Service standard protocol for the management of vaccines.

Technically, it is insupportive to store vaccines together with medical or biological (non-vaccines) items in the vaccine refrigerator. It was also shown that 66.7% (n=8) of the facilities stored medical or biological items in the refrigerator. The possible reason could be due to the fact that most of the health facilities in the study area do not have refrigerators for the storage of medicals and other biological items. This finding is related to that of (Mavimbe & Gunner, 2007; Pillay, 2014; Ameen et al., 2016; Maglasang et al., 2018; Woldemicheal et al., 2018; Yassin et al., 2019) and a cross-sectional study in Nigeria (Dairo & Ozimete, 2016). This consistency may be attributed to the fact that most health practitioners are always interested in preserving medical products as part of life saving skills and the only means at the sub-district level is to store them in the vaccine refrigerator. Again, some health practitioners may not see anything wrong with keeping the two together.

The temperature for vaccines during transportation and outreach should be within the standard temperature range of +2 °C to + 8° C. It takes the ability of thermometers to detect whether the temperatures are within this range or not, so ideally there should be thermometers for every outrage. However, it was observed that all the facilities 100% (n=12) did not have enough thermometers (at least one thermometer at a session) for outreach points. The possible explanation could be due to the fact that the district is short of spare temperature

monitoring devices, especially fridge tags which have come to replace the analog thermometers. Again, the fridge tags are also supplied at the regional level where the district does not have control. The implication for the study is that vaccinators may not know the temperature status of the vaccines during outreach which is not the best of practice.

The key findings from the study indicated that insupportive cold chain activities were going on in the district, due to the fact that health practitioners do not have access to the necessary equipments (out dated equipments, inadequate functional refrigerators, coldboxes, icepacks, fridge tags) and logistics to work with. Additionally, certain outlier practices were also discovered during the observation, in two facilities (Aframso and Birim) because vaccines were stored in undesignated (home) refrigerators. These facilities had problems with their refrigerators, and again distance and transportation were a big challenge to them. It was observed that none vaccines were stored in some of the refrigerators.

Table 8: Background Characteristics of Key Informants, (N=12)

Variable	Frequency	Percentage (%)
Subdistrict		
Nsuta	4	36.4
Kwamang	2	18.2
Birim	2	18.2
Oku	2	18.2
Asubuasu	1	9.1
Facility of work		
District Health Directorate	2	18.2
Nsuta RCH	1	9.1
Amoamang Ankapong	1	9.1
Kwamang Health Center	2	18.2
Aframso	1	9.1
Birim Health Center	1	9.1
Oku Catholic Clinic	2	18.2
Asubuasu	1	9.1
Gender		

Table 8, continued

Male	9	81.8
Female	2	18.2
Educational Background		
Certificate	8	72.7
Diploma	1	9.1
Degree	2	18.2
Masters	0	0.0
Years Served in the Ghana Health Service		
Less than 5 years	2	18.2
5-10 years	7	63.6
11- 15 years	2	18.2
16 years and above	0	0.0
Experience in cold chain management		
Less than 5 years	2	18.2
5-10 years	7	63.6
11- 15 years	2	18.2
16 years and above	0	0.0

Source: Sekyere Central District (2019)

The (Table 6) shows that nine of the key informants were males whilst two were females with diverse experience in the GHS and cold chain management.

Research Question 5: What are the challenges to cold chain management practices in the Sekyere Central District?

This research question sought to explore the challenges of cold chain management practices in the Sekyere Central District. The major findings are categorized into three themes; these are state of constant pressure, irregularities in temperature and delays in reaching the underserved communities.

1. **State of constant pressure and stress**

This theme denotes the continuous pressures that are constantly placed on the healthcare providers due to the lack of control on external factors such as no electricity or power source, erratic power fluctuations, inadequate equipment, lack of alternative source of power/energy, and poor maintenance of faulty equipment for the management of cold chain in the district.

Electricity or power source

Electricity plays a vital role in vaccine care where its absence would be fatal for vaccine health, but this study discovered that some of the facilities are challenged with electricity issues. In reference to this, the participants expressed themselves with varied views.

> *Some of the facilities in the district are not connected to the national grid, again solar is also expensive, so if they are even given a fridge, they would not have electricity to power it (CTB).*

Finally, ASUB also indicated that*;*

> *when there is no power or electricity, it affects the cold chain management system.*

Erratic power fluctuation

Power fluctuations have a lot of effects on cold chain management since they lead to power failure. Again, power failure also alters the temperature of the vaccines, which comes with a lot of effect for the management of the cold chain system. In view of this, the key informants also informed that;

> *At the moment in my facility the power system is disturbing due to the on and off (BOY).*

In addition to this, AMAK also voiced that;

> *Power problem because the facility can experience light off for about two days and due to this you can't determine if a vaccine is in the right condition or not.*

Inadequate Equipment

One of the elements of the cold chain system is efficient and reliable equipment. Equipment are the first point of storage in cold chain management. Their absence creates a lot of challenges for cold chain management. This study identified inadequate equipment as one of the major challenges to cold chain management. In this regard, participants expressed themselves through the following supporting quotes.

> *The management of cold chain is dependent upon resources (equipments and logistics). So, the main factors that are challenging to cold chain management are none availability of cold chain equipments, due to this staff have to travel to other health facilities for vaccines which comes with a lot of implications (CTB).*

Another participant, AMAK also said;

> *We don't have a cold box, because we don't even have a cold box, just the vaccine carrier, maybe you have about almost 200 vaccine vails inside this (mini refrigerator) you cannot store most of the vaccines inside the vaccine carrier, because you only have well-conditioned ice packs, is about six and six cannot maintain vails about almost 300 or so.*

Additionally, AB also indicated that;

> *Basically, is the fridge and inadequate properly functioning thermometers.*

FEM also confirmed that;

> *There is a big problem with their fridge due to instability so they have to cool ice packs and support the fridge with them before they use it.*

Lack of alternative power supply

In cold chain management, alternative power supply is very instrumental, but the case was different in this result. The study discovered that lack of alternative power supply was also a challenge to cold chain management. This was also indicated by the key informants with some quotes.

AMAK specified that;

> *there is no power supply or generator. In another jurisdiction*

MAL also indicated that;

> *the facility does not have a plant or generator that can support the cold chain system as expected so is a challenge.*
> *Poor maintenance of faulty equipments*

The efficiency of every machine depends on maintenance, so if maintenance is not at its best, it reduces overall performance: such is the nature of the cold chain system. In vaccine management, faulty equipment would lead to vaccine wastage and to some extent false immunity. As part of this, an informant (BOY) indicated that;

When the fridge gets spoilt sometimes sending it for repairs is a problem as well as the time for us to also receive it and all those things.

2. Irregularities in temperature

This theme illustrates the healthcare malpractices that threaten the temperature regulation of vaccines. They include practices such as keeping non-vaccine related items such as food in the vaccine refrigerator, poor charting of the vaccine temperature, tampering with the vaccine vail monitors, etc. These challenges were explained this way.

SFD indicated that;

putting things in the fridge and irregular charting of the fridge and this was also not different from what BE said;

water and drinks. Another staff also mentioned that: I think we have attitudinal conditions of the staffs how they handle the vaccine.

A respondent also indicated that;

*The mishandling of the vaccine by some of the staff too at times to check on the VVM to see whether the vaccine is potent or not because we have been mishandling it you get some of the vaccines with their seal on it been peeled off, you can't even identify the vaccine whether it is in its first stage or second stage (**MAL**).*

3. Delays in reaching the underserved community

This theme described the transportation challenges practitioners face in getting potent vaccines from their source to the targeted community or users. This quote explained the heading in detail.

> *They transport the items to nearby facilities before subdistrict staff also commute to such facilities for their vaccine stock which also has an influence on the cold chain system, again public transport is also used to transport ice packs to subdistricts without electricity; CTB*

Another informant (ASUB) also indicated that*;*

> *they have to travel to another facility for vaccines and keep it for the next day before they send it to the outreach session.*

State of Constant Pressure and Stress

The cold chain should be managed in such a way that there will be smooth running of the cold chain system. When any form of pressure, whether internal or external, is exerted on the administrative capacity of the cold chain system, it leads to poor performance which affects the vaccine cold chain and herd immunity at large. The study discovered that absence of electricity or power source was a major challenge to cold chain management. This is due to the fact that some of the facilities do not have electricity or a source of power such as gas or kerosene. This is quite different from the findings of Ateudjieu et al. (2013) and Ogboghodo et al. (2017) where majority of the facilities had access to power supply but the later reported of unstable power supply.

The inability of electricity or source of power in a facility simply implies that refrigerators that depend on electrical power will not be operational within

such areas, which could have a lot of repercussions for vaccination, especially when it comes to the vaccination of the vulnerable groups (children under 59 months and pregnant women). This situation also creates a platform for compromise or inappropriate innovation, which may push the staff to store vaccines under inappropriate conditions because the main current behind the storage is missing. Also, the absence of a source of power would also put too much pressure on vaccine storage facilities since there is no gas or kerosene stove and stress on the staff.

Additionally, to this, the staff may gradually lose their skill on vaccine handling with respect to certain models of refrigerators because it kills their ability to learn on the job, and for that matter they may not be perfect in certain aspects of the cold chain management. It can even affect their ability to read fridge tags since they cannot even collect samples because vaccines are mostly stored elsewhere for routine collection and dispatch to vaccination sites.

Another theme that emerged was erratic power fluctuations. This finding is consistent with Ogboghodo et al. (2017). Ateudjieu at al. (2013) indicated that only 7 facilities out of 34 had access to permanent power supply. Power outages could lead to changes in temperature which can affect the molecular nature of the vaccines. The longer the duration of the power fluctuation, the higher the chances of the vaccines losing their potency. Power fluctuations can also destroy certain refrigerators depending upon their capacity to stabilize power flow. When this happens, volumes of vaccine can be destroyed, especially heat sensitive ones.

The study also found out that inadequate equipment was also a contributing factor to the challenges of cold chain management. If cold chain

equipment are not available, vaccines are going to suffer and the targeted populations may be at risk of being vaccinated with inefficacious vaccines. This was reported by Mavimbe and Gunner (2007), and a similar finding was also reported by Ateudjieu et al. (2013). But this finding is not consistent with Ogboghodo et al. (2018). Although there were methodological variations in the previous and this present study, equipment inadequacy is still a challenge to today's cold chain management. This current finding is also partly related to that of Bogale et al. (2019) who stated that some of the facilities were not having refrigerators

The next point in relation to this sub heading was lack of alternative power source of power/energy. This finding is not similar to that of Yassin et al. (2019) who reported that most of the facilities had available generator/solar. In Sow, et al. (2018), it was also revealed that facilities had backup gas bottles to support cold chain management in case of power failure.

It is expected under optimal conditions that every facility that stores vaccine would get a standby generator or an alternative power supply, but per this study, findings were different. Most of the facilities do not have alternative power supply and they have to depend on the District Health Administration (DHA) which is the central point for assistance. The implication is that facilities may be tempted to buy "ice block" from town to store the vaccines, especially, during long outreach hours. This ice blocks would melt the vaccine vail monitors, preventing the vaccinators from identifying the quality of the vaccine. The final point under this sub heading was on poor maintenance of faulty equipment for the storage of cold chain equipments.

The equipment which are the pivot of cold chain management need to be maintained as quickly as possible so that the vaccine cold chain would be in order. When maintenance is delayed, vaccine potency also suffers meaning efficacious vaccines are less likely to be used at the immunization centers and the final effect would be vaccine induced or derived diseases. In addition, there can be out breaks because expected recipients received inefficacious vaccines.

Again, the distance from the DHA to the communities is very far and the means of transportation to some extent is also not easy. Due to this, the facilities would be tempted to leave the vaccines to their fate or use ice blocks from generator operators in town. Using ices blocks dissolves the VVM of the vaccines, peel them off, which renders the vaccines empty to VVM reading. The next sub heading is on irregularities in temperature.

Irregularities in Temperature Maintenance

Temperature maintenance through vaccine inspection in the morning and evening is very important. This is due to the fact that the potency capacity of vaccines is attained through a certain optimal temperature range, where any alteration in temperature would render the vaccines inactive.

The study reported that there is irregular charting of the refrigerators. This result is different from Yassin et al. (2019) where most of the facilities recorded the temperature twice daily. This indicates that faults cannot be detected on time, especially when outreaches have ceased at the end of the month.

Again, when vaccines are not monitored, wastage can also take the district by surprise due to poor contact with the refrigerator. This is due to the fact that any rise in temperature or decrease in temperature is likely to affect

one type of vaccine or the other as a result of their sensitivity to temperature discrepancies. Due to this, the neutral point is the optimal temperature of + 2° C to + 8 °C which needs to be maintained through appropriate monitoring and temperature regulation.

Another result with this sub heading was putting food in the vaccine refrigerator. This was also detected by Ameen et al. (2014), Pillay (2014), Dairo and Ozimete (2016), and Maglasang et al. (2018). The introduction of food into the refrigerator introduces heat into the fridge, since the food reduces the temperature regulation of the fridge (it dilutes the temperature from a cooler medium to a warming one).

When it happens this way, it affects the potency of the vaccines. Again, the food can also contaminate the vaccines by gradually leaving residue in the fridge. Also, the aroma of the food can also diffuse into the vaccines, adding up to the contamination process.

The study also discovered tampering with the vaccine by some of the staff as a major challenge, because the seals peel of making the vaccine vail monitors (VVM) unreadable to the staff. So, identifying the stage of the vaccine to compare with utilization becomes difficult.

Delays in Reaching the Underserved Communities

Due to inadequate cold chain logistics in the district, facilities need to depend on other facilities for the needed assistance, which also interferes with vaccination activities. The study found out that informants were challenged with transportation issues. A similar report was also indicated by Kitamura et al. (2018). Also, the cost of transporting vaccines from one facility to the other has rippling effect on the cold chain because if that facility is having a problem with

vaccine management, it would also affect the vaccination power of the ones the practitioner collected.

Again, due to this situation, staff would be forced to keep vaccines in vaccine carriers for more than a day without changing icepacks. Furthermore, diluents, on the other hand, would not be stored a day prior to vaccination and would be reconstituted just like that which can also cause thermo shock to vaccines.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of the study was to assess the knowledge, attitude and practice of cold chain management among health practitioners in the Sekyere Central District. The previous chapter assessed the results and the discussions that were derived from the study, but this particular chapter focuses on the summary, conclusions and recommendations from the study.

Summary

The study assessed the knowledge, attitude and practice of cold chain management among health practitioners in the Sekyere Central District of Ghana. A mixed method was employed, where 86 participants, mainly health practitioners, consisting of 34 males and 52 females were selected for the knowledge and attitude aspect of the study: all these participants were recruited from both remote and non-remote parts of the district and they responded to a questionnaire on knowledge and attitude to cold chain management. The extent to which facilities support correct cold chain management was also conducted through an observational study in 12 cold chain sites which were also purposively selected. To assess the challenges on cold chain management, a key informant interview was carried out with 11 health practitioners from both remote and non-remote cold chain sites. Ethical clearance was sought from the Institutional Review Board of the University of Cape Coast. To analyze research questions one, two and three, descriptive statics was employed where the responses were converted to frequencies and their respective percentages. Thematic analysis was used to analyze the fourth research question, where it was broken down into themes and sub-themes for appropriate discussion.

The major findings from the study include:

1. The level of knowledge on cold chain management was good (68.6%).
2. The attitude of health practitioners towards cold chain management was also good (67.4%).
3. There was a weak positive association between attitude and knowledge on cold chain management.
4. The district was involved in a lot of insupportive cold chain management activities.
    a. storage of non-vaccines in refrigerator (66.7%)
    b. inadequate monitoring of vaccine temperature (50%)
    c. inadequate temperature range for vaccine storage (41.7%)
    d. Few facilities arranged vaccines correctly (16.7%).
    e. inadequate emergency power supply (8.3%)
    f. non availability of contingency plan (100%)
5. The major challenges identified were poor cold chain infrastructure such as;
    a. state of constant pressure and stress
    b. electricity or power failure
    c. delays in reaching the underserved communities

Conclusions

The study assessed the knowledge, attitude and practice of cold chain management among health practitioners in the Sekyere Central District. The findings indicated that knowledge and attitude towards cold chain management were good. Although the district recorded good results for knowledge and attitude, the association between knowledge and attitude towards cold chain

management was weak, the extent to which the facilities support cold chain management was poor which has demonstrated that these variables are not the only determinants of cold chain management.

The district is woefully challenged with cold chain infrastructure coupled with poor transport system. The movement of vaccines from place to place before and after vaccination also creates a problem for the vaccine where potency can be lost. Again, if equipment that are the first priority of the scale of cold chain preference are not available, the cold chain would not be functioning properly and vaccines would not meet the requirement for protection and the rippling effect could be vaccine induced diseases or the circulation of vaccine induced pathogenic organisms.

Recommendations

The study has clearly demonstrated that the management of the vaccine cold chain in the Sekyere Central District of Ghana is not in the best of public health interest because the district is technically challenged with a lot of the cardinal requirements for cold chain management. Based on the findings of the study, the following recommendations can be made:

Level of knowledge on cold chain management

The District Health Directorate should;

1. train the rest of the participants 31.4% as a means to improve their level of knowledge on cold chain management, because vaccine cold chain is about the health of the populace especially children under 59 months and pregnant women so any deficit in knowledge has repercussions for cold chain management and vaccination activities in the district.

2. Cold chain management should be incorporated into workshops that are organized in the district for health practitioners since education is an influential device for knowledge attainment and enhancement. This would help to create a skilled category of health practitioners who are competent enough to handle vaccines related to the Expanded Programme on Immunization (EPI)

Attitude towards cold chain management

3. Although the attitude was good(positive), the others 32.6% should be trained to improve their attitude towards cold chain management respectively, because trainings can be used as avenues for capacity building which can also boost an individual's confidence level and self-reliance to perform a task.
4. Facility heads should use rewards, motivation and punishment as a means of enforcement to gradually improve the attitude of health practitioners towards cold chain management.
5. The need for general attitudinal change towards cold chain management should also be emphasized during subdistrict, district and regional workshops and other health programmes.

Association between knowledge and attitude towards cold chain management

7. Since knowledge acquisition does not always lead to change in attitude or vice versa, continuous training and enforcement of protocols for the management of cold chain must be enhanced so that health practitioners would demonstrate a causal relationship between knowledge and attitude towards cold chain management.

Extent to which facilities in the Sekyere Central District support correct cold chain management practices.

The District Health Directorate should collaborate with the Regional Health Directorate to:

8. deliver educational resources on cold chain management such as manuals and guidelines, vaccine ledger/ inventory books to cold chain sites and their allied facilities.
9. monitor and supervise cold chain facilities with emphasis on temperature monitoring of vaccines.
10. Create a cold chain management contingency plan for the district

Challenges on cold chain management

The District Health Directorate in collaboration with the Regional Health Directorate should:

11. supply equipments and alternative source of energy to cold chain facilities especially those in underserved communities.
12. maintain faulty equipments as quickly as possible.
13. team up with the District Assembly to extend electricity to deprived facilities.
14. join forces with the District Assembly and secondary schools in the district so that their vehicles can be used to transport vaccines when the need be.
15. Lobbying with stakeholders to get additional vehicles and motorbikes for the district.
16. enforce the monitoring of vaccines twice daily and creation of contingency plans.

17. educate staff to develop a sense of respect for vaccine health and ethics by refraining from putting non-vaccines in the refrigerator.
18. Provide separate refrigerators for the storage of medical items and non-medical items at the health facility level so that vaccine refrigerators would be independent.

Suggestions for Further Research

As part of the measures to expand the activities of cold chain management in the district, these topics can be considered for further research.

1. further studies on the association between the knowledge and practice, attitude and practice of cold chain management in the Sekyere Central District.
2. Geospatial distribution of cold chain infrastructure and its impact on cold chain management.
3. The efficacy of vaccines at outreach centers as compared to their storage sites.
4. The availability of cold chain equipment and its impact on vaccine management.
5. The ability of health practitioners to use the fridge tag.

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APPENDIX A

QUESTIONNAIRE ON COLD CHAIN MANAGEMENT

INSTRUCTION

BACKGROUND CHARACTERISTICS OF RESPONDENTS

Please indicate the correct response by ticking [√] or writing in the space provided.

1. Which subdistrict do you work? (Please tick the subdistrict which is applicable to you)

A. Nsuta [ ]

B. Kwamang [ ]

C. Birem [ ]

D. Oku [ ]

E. Asuboasu [ ]

2. What is your current place of work? (Please kindly indicate)

……

3. What category of health staff are you? (Please kindly tick [√]

A. Community Health Nurse (Nurse Assistant Preventive) [ ]

B. Nurse Assistant Clinical [ ]

C. Enrolled Nurse [ ]

D. Field Technician [ ]

E. Disease Control Officer [ ]

F. Nutrition Officer [ ]

G. Health Information Officer [ ]

H. Registered Community Health Nurse [ ]

I. Registered Nurse/ SRN [ ]

J. Midwife [ ]

K. Public Health Nurse [ ]

L. Public Health Officer [ ]

M. Medical Assistant [ ]

4. How old are you?.....

5. What is your gender?

a. Male [ ]

b. Female [ ]

6. What is your educational background?

a. Certificate [ ]

b. Diploma [ ]

c. Degree [ ]

d. Masters [ ]

7. How many years have you served in the Ghana Health Service?

a. Less than 5 years [ ]

b. 5 – 10 years [ ]

c. 11 – 15 years [ ]

d. 16 years and above [ ]

8. How many years of experience do you have in cold chain management?

a. Less than 5 years [ ]

b. 5- 10 years [ ]

c. 11 – 15 years [ ]

d. 16 years and above [ ]

9. How many years have you spent in administering vaccines?

a. Less than 5 years [ ]

b. 5- 10 years [ ]

c. 11 – 15 years [ ]

d. 16 years and above [ ]

KNOWLEDGE ON COLD CHAIN MANAGEMENT

Instruction: Please kindly indicate the appropraite response by ticking [√] either "**YES**" or "**NO**"

Statement	**Yes**	**No**
Vaccines can be stored at any temperature		
The temperature for the storage of vaccines in a cold box is the same as that of vaccine carrier.		
All vaccines shall be stored at +2ºC to + 8º C at all levels except oral Poliomyelitis vaccines.		
Poliomyelitis and measles can be destroyed by freezing		
DPT/Hep/Heb can also be destroyed by freezing		
Vaccines can be destroyed by heat		
Vaccine Vail Monitor(VVM) stage 3 and 4 of the vaccine can be used		
Transfer of vaccine to another refrigerator, cold box or vaccine carrier is required if power failure is more than 24 hours		
Diluent can be stored at +2ºC to + 8º C for at least a day before vaccination session if cold space is inadequate		

All WHO-prequalified multi-dose vails of vaccines should be discarded at the end of the immunization session or within six hours of opening unless the vaccine meets all four criteria		
If the vaccine meets all four criteria the opened vail can be kept and used for up to 24 days after opening		
Fridge/Freeze tag monitors the temperature of the refrigerator for 6 weeks		
The cold box can store vaccines for 2 weeks in case of emergency		
Ice packs should be conditioned before using for an immunization session		
Conditioning of ice packs should take about 5 to 10 minutes		
Vaccines can be placed at refrigerator door		
Recording of temperature on the temperature chart is not required		
At the facility level when vaccines get frozen it should be discarded		
Poliomyelitis vaccine can be used for shake test		
DPT/HIB/Hep B vaccine can be used for the shake test		

ATTITUDE TOWARDS COLD CHAIN MANAGEMENT PRACTICE

Instruction: Please kindly indicate the appropriate response by ticking [√] either "**Agree**" or "**Disagree**"

Statement	**Agree**	**Disagree**
I monitor the temperature of the vaccine twice daily including holidays.		
Is mandatory for me to record the temperature of the vaccine on the temperature monitoring chart even if the facility has a fridge tag.		
I defrost refrigerators when the need arises		
I seldomly clean cold chain equipments weekly		
I Put icepacks in the freezer in case of power failure		
If a refrigerator is opened more than three times it will not affect the potency of the vaccines.		
I store vaccines in a dedicated refrigerator		
I do shake test to determine the potency of some vaccines		
I think the potency of vaccines can be maintained if medicine and specimen are put together in the refrigerator.		
Special thermometer is not required to measure internal refrigerator temperature		

Thank you for taking the time to respond to the questionnaire

APPENDIX B

OBSERVATIONAL GUIDE SCHEDULE ON COLD CHAIN MANAGEMENT PRACTICES

NAME OF FACILITY

……..

Instruction: Please kindly indicate the appropraite response by ticking [√]

either

"**YES**" or "**NO**"

STATEMENT	**YES**	**NO**
Does the facility have policies, procedures and guidelines on cold chain management practices?		
Evidence of Policies, procedures and guidelines for cold chain management at this facility a. All three available b. Two available **c.** One available		
Are all the staff trained to follow policies, procedures and guidelines that ensure compliance for cold chain management?		
Does the facility have a vaccine ledger book? a. Available b. Not Available		
Does the facility have a cold chain inventory book or guide? a. Available b. Not Available		
Are contingency plans in place for problems with equipments?		
Does the facility has an emergency power supply		
Is there evidence of filling in of stock cards for vaccine storage?		
Is vaccine wastage managed according to policy?		

Is evidence of vaccine wastage report available to make operational changes?		
Is there evidence of records in case of recall/batch numbers for vaccines?		
Has the district trained staff on cold chain management?		
Has the district level paid a supportive supervision and monitoring visit to the facility?		
Does the facility have a trained Officer in charge of cold chain management?		

QUALITY OF VACCINE CARE

STATEMENT	**YES**	**NO**
Does the facility has a refrigerator for storing vaccines?		
Is the refrigerator technically appropraite to store vaccines?		
Is the distance from the refrigerator to the wall technically appropraite?		
Does the refrigerator has a lock and key?		
Does the refrigerator have functional thermometer?		
If the facility does not have a functional thermometer do you have the fridge tag?		
Is the position of the thermometer correctly placed in the refrigerator?		
In the absence of a refrigerator is there a working thermometer/ fridge tag in the cold box/ vaccine carrier?		
Does the facility monitor the temperature of the vaccine daily?		

Is the temperature within the appropraite range (+2°C to + 8 °C)?		
Is there a record of the 30 days monthly temperature monitoring chart?		
Does the temperature monitoring charts (for the last three months) cover the readings(twice) for each day?		
a. Records available for everyday for last three months b. Records available but not for everyday for the last three months c. Records not available		
Are vaccines arranged in cold box if refrigerator is not available?		
Vaccines correctly stored in refrigerator (Order of sensitivity)		
Are diluents correctly stored in refrigerator?		
Does the vaccine stock tally with the diluents in the refrigerator?		
Are vaccines overstocked?		
Space in between vaccines		
Presence of food in refrigerator		
Presence of water in refrigerator		
Presence of medical items or biologicals (non vaccines) in refrigerator		
Does the facility have enough thermometers for every outreach?		

EQUIPMENT

ITEM	YES	NO
Does the facility have enough functional refrigerators?		
Does the facility have enough cold boxes?		
Is/are the cold box(es) in a good condition?		
Does the facility have enough vaccine carriers?		
Are the vaccine carriers in good condition?		
Do all the vaccine carriers have foam pads?		
Does the facility have enough thermometers or fridge tags?		
Are all the available thermometers or fridge tags functional?		
Does the facility have enough icepacks?		
Does the facility have a deep freezer for storing icepacks		
Does the facility have enough temperature monitoring charts?		
Are there enough equipment for emergency?		
Does the facility have a room purposely for storing cold chain equipment?		

APPENDIX C

CHALLENGES TO COLD CHAIN MANAGEMENT IN THE DISTRICT

INTERVIEW GUIDE FOR KEY INFORMANTS ON CHALLENGES TO COLD CHAIN MANAGEMENT

BACKGROUND CHARACTERISTICS OF RESPONDENTS

Please indicate the correct response by ticking [√] or writing in the space provided.

1. Which subdistrict do you work? (Please tick the subdistrict which is applicable to you)

A. Nsuta [ ]

B. Kwamang [ ]

C. Birim [ ]

D. Oku [ ]

E. Asubuasu [ ]

2. Which facility do you work?……..

3. Which category of staff are you? ……

4. How old are you?.....

5. What is your gender?

a. Male [ ]

b. Female [ ]

6. What is your educational background?

a. Certificate [ ]

b. Diploma [ ]

c. Degree [ ]

d. Masters [ ]

7. How many years have you served in the Ghana Health Service?

a. Less than 5 years [ ]

b. 5 – 10 years [ ]

c. 11 – 15 years [ ]

d. 16 years and above [ ]

8. How many years of experience do you have in cold chain management?

a. Less than 5 years [ ]

b. 5- 10 years [ ]

c. 11 – 15 years [ ]

d. 16 years and above [ ]

9. How many years have you spent in administering vaccines?

e. Less than 5 years [ ]

a. 5- 10 years [ ]

b. 11 – 15 years [ ]

c. 16 years and above [ ]

1. In your opinion what are some of the factors that may pose a challenge to cold chain management at the facility level?
2. In relation to your previous response what is the most important factor or factors that is/are more challenging to the cold chain management system?……
3. How does this factor or factors affect the cold chain management system?……
4. What measures are put in place to address this factor or factors to suit appropraite cold chain management?…… ……

5. How do you apply these measures to solve cold chain problem?

   …….

6. What opportunities are available in the district for health practitioners to update themselves on cold chain management?.....

   ……..

7. In your opinion, is there a need to improve the continuing professional development of health practitioners on cold chain management?

   ……

8. If yes, what steps could be taken to improve continuing professional development in cold chain management?
9. In general, do you think the infrastructure for cold chain management are sufficient in quantity and quality?.....
10. Kindly explain your response

    ……

11. What is your opinion of the quantity of staff that are managing the cold chain system?.....
12. What is your opinion of the quality of the staff who are managing the cold chain system?

    …….

13. In your view what steps should be taken to ensure the availability of sufficient number of skilled staff to manage the cold chain system at the facility……..…….....

APPENDIX D

INTRODUCTORY LETTER

UNIVERSITY OF CAPE COAST
CAPE COAST, GHANA
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF HEALTH, PHYSICAL EDUCATION & RECREATION

TELEPHONE: +233 - (0)206610931 / (0)543021384 / (0)268392819
TELEX: 2552, UCC, GH.
EMAIL: hper@ucc.edu.gh
Cables & Telegrams: UNIVERSITY, CAPE COAST

Our Ref: **ED/MHE/16/0004/**

10th December, 2018

TO WHOM IT MAY CONCERN

INTRODUCTORY LETTER: MS. ANTHONIETTE ASAMOAH (ED/MHE/16/0004)

The bearer of this letter is an MPhil (Health Education) student of the Department of Health, Physical Education and Recreation in the University of Cape Coast. She is working on her thesis and wants to pre-test her questionnaire on the topic: **Knowledge, Attitude and Practice of Cold Chain Management among Health Practitioners in the Sekyere Central District**.

The data will be used for academic purposes only and be assured that the information collected will be treated with utmost confidentiality.

We would therefore be very grateful if she is given the assistance she needs from your outfit.

We count on your usual co-operation.

Thank you.

Dr. Daniel Apaak
HEAD

DEPT. OF HEALTH, PHYSICAL EDUCATION & RECREATION
UNIVERSITY OF CAPE COAST
CAPE COAST

APPENDIX E

INTRODUCTORY LETTER

and the date of this letter should be quoted

My Ref. No: MHD/MA/PF/74
Your Ref. No:
Tel. 0208158730
Fax :

E-mail: mampong mhd@yahoo.com

Municipal Health Directorate
P. O. BOX 424
Mampong – Ashanti

11th December 2018

THE MEDICAL SUPERINTENDENT
MAMPONG GOVERNMENT HOSPITAL
MAMPONG

ALL HEADS
HEALTH FACILITIES
SUB-DISTRICTS
MAMPONG - ASHANTI

INTRODUCTORY

MS. ANTHONIETTE ASAMOAH (ED.MH.16.0004

The bears of this letter are an MPHil (Health Education) student of the Department of Physical Education and Recreation in the University of Cape Coast.

She is working on her thesis and wants to pretest her questionnaire on the Topic: **Knowledge, Attitude and Practice of Cold Chain Management among Health Practitioners in the Municipal**.

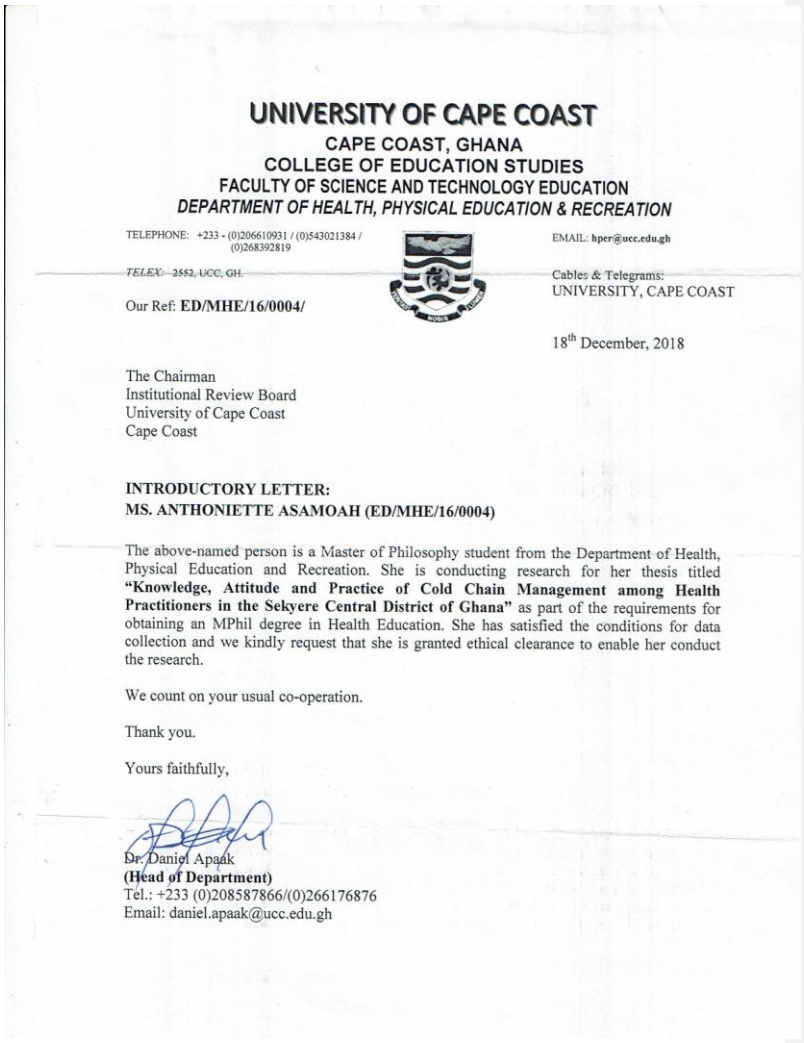
I therefore write to recommend your assistance her in administering the questionnaires.

Thank you.

MR. JACOB AMOA
MUNICIPAL DIRECTOR OF HEALTH SERVICES

APPENDIX F

INTRODUCTORY LETTER



UNIVERSITY OF CAPE COAST
CAPE COAST, GHANA
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF HEALTH, PHYSICAL EDUCATION & RECREATION

TELEPHONE: +233 - (0)206610931 / (0)543021384 / (0)268392819
TELEX: 2552, UCC, GH.
EMAIL: hper@ucc.edu.gh
Cables & Telegrams: UNIVERSITY, CAPE COAST

Our Ref: **ED/MHE/16/0004/**

18th December, 2018

The Chairman
Institutional Review Board
University of Cape Coast
Cape Coast

INTRODUCTORY LETTER:
MS. ANTHONIETTE ASAMOAH (ED/MHE/16/0004)

The above-named person is a Master of Philosophy student from the Department of Health, Physical Education and Recreation. She is conducting research for her thesis titled **"Knowledge, Attitude and Practice of Cold Chain Management among Health Practitioners in the Sekyere Central District of Ghana"** as part of the requirements for obtaining an MPhil degree in Health Education. She has satisfied the conditions for data collection and we kindly request that she is granted ethical clearance to enable her conduct the research.

We count on your usual co-operation.

Thank you.

Yours faithfully,

Dr. Daniel Apaak
(Head of Department)
Tel.: +233 (0)208587866/(0)266176876
Email: daniel.apaak@ucc.edu.gh

APPENDIX G

INTRODUCTORY LETTER

UNIVERSITY OF CAPE COAST
CAPE COAST, GHANA
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF HEALTH, PHYSICAL EDUCATION & RECREATION

TELEPHONE: +233 - (0)206610931 / (0)543021384 / (0)268392819
TELEX: 2552, UCC, GH.
EMAIL: hper@ucc.edu.gh
Cables & Telegrams: UNIVERSITY, CAPE COAST

Our Ref: **ED/MHE/16/0004/**

20th December, 2018

The District Director of Health Services
District Health Administration
Sekyere Central District
Ashanti Region

Dear Sir/Madam,

INTRODUCTORY LETTER:
MS. ANTHONIETTE ASAMOAH (ED/MHE/16/0004)

The above named person is a student of the Department of Health, Physical Education and Recreation of the University of Cape Coast. She is pursuing a Master of Philosophy degree in Health Education. In partial fulfilment of the requirements for the programme, she is conducting a research for her thesis titled **"Knowledge, Attitude and Practice of Cold Chain Management among Health Practitioners in the Sekyere Central District of Ghana"**.

We would be very grateful if she is granted the opportunity to conduct her research in your district health facilities and also provide her with the information needed from your outfit. The data will be used for academic purposes only and be assured that the information collected will be treated with utmost confidentiality.

We count on your usual co-operation.

Thank you.

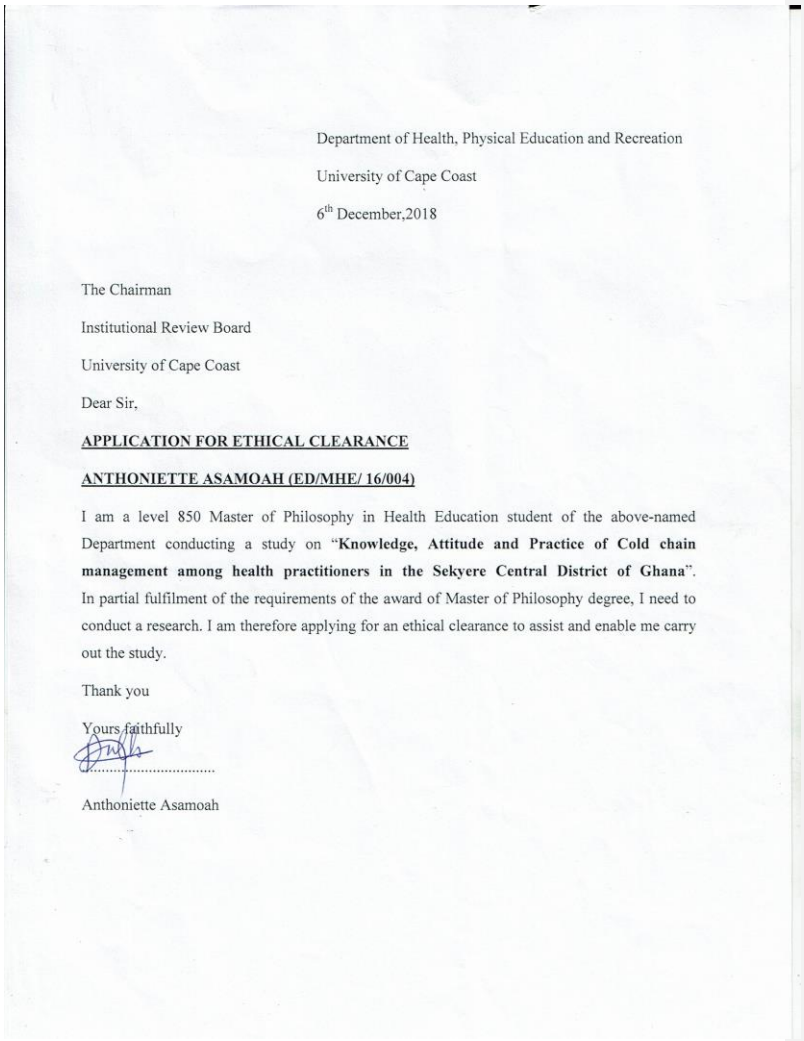
Yours faithfully,

Daniel Apaak (Ph.D)
(Head of Department)
Tel.: +233 (0)208587866
Email: daniel.apaak@ucc.edu.gh

DEPT. OF HEALTH, PHYSICAL EDUCATION & RECREATION UNIVERSITY OF CAPE CO...

APPENDIX H

APPLICATION FOR ETHICAL CLEARANCE



Department of Health, Physical Education and Recreation

University of Cape Coast

6th December,2018

The Chairman

Institutional Review Board

University of Cape Coast

Dear Sir,

APPLICATION FOR ETHICAL CLEARANCE

ANTHONIETTE ASAMOAH (ED/MHE/ 16/004)

I am a level 850 Master of Philosophy in Health Education student of the above-named Department conducting a study on "**Knowledge, Attitude and Practice of Cold chain management among health practitioners in the Sekyere Central District of Ghana**". In partial fulfilment of the requirements of the award of Master of Philosophy degree, I need to conduct a research. I am therefore applying for an ethical clearance to assist and enable me carry out the study.

Thank you

Yours faithfully

.....

Anthoniette Asamoah

APPENDIX I

ETHICAL CLEARANCE

UNIVERSITY OF CAPE COAST

INSTITUTIONAL REVIEW BOARD SECRETARIAT

TEL: 0558093143 / 0508878309/ 0244207814
E-MAIL: irb@ucc.edu.gh
C/O Directorate of Research, Innovation and Consultancy

OUR REF: UCC/IRB/A/2016/527
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0009096

25TH MARCH, 2019

Ms. Anthoniette Asamoah
Department of Health, Physical Education and Recreation
University of Cape Coast

Dear Ms. Asamoah,

ETHICAL CLEARANCE –ID: (UCCIRB/CES/2019/01)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted **Provisional Approval** for the implementation of your research protocol titled **Knowledge Attitude and Practices of Cold Chain Management among Health Practitioners.** This approval requires that you submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

Please note that any modification of the project must be submitted to the UCCIRB for review and approval before its implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

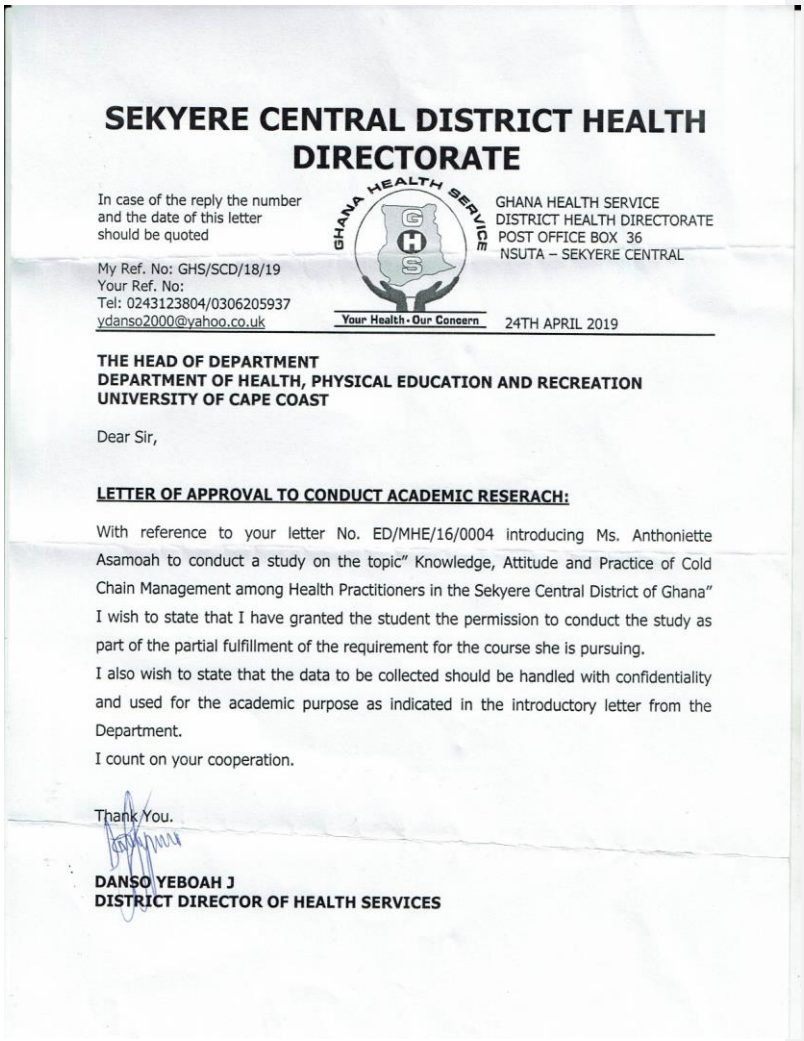
Yours faithfully,

Samuel Asiedu Owusu, PhD
UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST

APPENDIX J

APPROVAL LETTER



SEKYERE CENTRAL DISTRICT HEALTH DIRECTORATE

In case of the reply the number and the date of this letter should be quoted

My Ref. No: GHS/SCD/18/19
Your Ref. No:
Tel: 0243123804/0306205937
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GHANA HEALTH SERVICE
DISTRICT HEALTH DIRECTORATE
POST OFFICE BOX 36
NSUTA – SEKYERE CENTRAL

Your Health · Our Concern

24TH APRIL 2019

THE HEAD OF DEPARTMENT
DEPARTMENT OF HEALTH, PHYSICAL EDUCATION AND RECREATION
UNIVERSITY OF CAPE COAST

Dear Sir,

LETTER OF APPROVAL TO CONDUCT ACADEMIC RESERACH:

With reference to your letter No. ED/MHE/16/0004 introducing Ms. Anthoniette Asamoah to conduct a study on the topic" Knowledge, Attitude and Practice of Cold Chain Management among Health Practitioners in the Sekyere Central District of Ghana" I wish to state that I have granted the student the permission to conduct the study as part of the partial fulfillment of the requirement for the course she is pursuing.

I also wish to state that the data to be collected should be handled with confidentiality and used for the academic purpose as indicated in the introductory letter from the Department.

I count on your cooperation.

Thank You.

DANSO YEBOAH J
DISTRICT DIRECTOR OF HEALTH SERVICES