



VACCINE MANAGEMENT IN PUBLIC HEALTH FACILITIES

CASE STUDY: WAU COUNTY, WESTERN BAHR EL GHAZAL STATE

Student's Name: AGOK MALUAL AKEC AYUL, [B. PHARM]

Agok1967@gmail.com

College of Medicine and Health Sciences

School of Public Health

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By:

Student's Name: Agok Malual Akec Ayul

Student Registration Number: 220014835 agok1967@gmail.com


Supervisor: Shiferaw Mitiku [PhD], Assistant Professor of the Addis Ababa University

Co-Supervisor: Mulatedzi Makhado, MSC [MED] PHARMACY, Sefako
Makgatho Health Science University

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SUPERVISORS' APPROVAL

This research entitled with “**Vaccine management in public health facilities, case study: WAU COUNTY, Western BAHR EL GHAZAL STATE**” has been conducted by Agok Malual Akec Ayul under our supervision and submitted for evaluation and examination with our approval as University Supervisors.

1. Signature:  ----- Date: ---25 January 2022

Shiferaw Mitiku[PhD], Assistant Professor of the Addis Ababa University

2. Signature: -  Date: 26th January 2022

Mulatedzi Makhado, MSc [Med], Pharmacy, Sefako Makgatho Health Science University

DECLARATION

I, **Agok Malual Akec Ayul** hereby certify that this research entitled "**Vaccine management in public health facilities, case study: WAU COUNTY, Western Bahr El Ghazal State**" was written by myself, and has never been submitted to any other institution nor previously published in whole or in part. Every source used in this proposal has been acknowledged and cited.

Agok Malual Akec Ayul Signature: Date



24th January 2022

ABSTRACT

Background: Vaccine management is critical to maintaining vaccine potency or viability that contributes to protecting children from vaccine-preventable diseases VPD and saving their lives. The 2019 Effective Vaccine Management EVM assessment report in South Sudan found that WAU COUNTY performed poorly in nine domains of the World Health Organization WHO criteria.

General Objective: The study aims to investigate the major factors affecting vaccine management in public health facilities in Wau County, Western Bahr el Ghazal State. **Method:** The design was a cross-sectional institutional study using quantitative and Qualitative methods. The sample size was determined by census method. Variables were quantified and analysed using SPSS version - 26.

Results: Out of the five (5) types of health facility surveyed, 73% were lower-level health facilities (PHCCs and PHCUs) and 27% are higher level health facilities (Hospitals). On average, 69% of respondents knew about vaccine vial monitor VVM and 67% applied EVM correctly. However, this is less than the 80% required by WHO. Only 42% of participants adhered to WHO/MOH recommended EVM practices. The top three EVM challenges in WAU COUNTY were, Poor policy implementation amounting to 31%, lack of management support 22%, and Cold Chain Equipment CCE 17%.

Conclusion: EVM in public health facilities in WAU COUNTY, Western Bahr el Ghazal State WBeGs was inadequate. The knowledge and practice of vaccine handler on EVM was below recommended WHO Standard. There was low adherence to guidelines, and insufficient management support for EVM processes.

Recommendations: Health System Strengthening with focus to EPI is recommended at both national and subnational to improvement performance of EVM at lower levels. This entails recruitment, retention and training of Human resource, dissemination of Policy guidelines, establishing Supplies Chain Management data bases. Locally, WAU COUNTY Health Department CHD should conduct quarterly training on EVM and Monthly joint, integrated supportive by SMOH and partners to address the health facility gaps identified. They should maintain the existing cold chain equipment and infrastructure of the storage facilities as well advocate for more Cold Chain Equipment.

Keywords: effective vaccine management, WAU COUNTY, Public Health Facilities, vaccination coverage.

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ABBREVIATIONS AND ACRONYMS

BCG:	Bacillus Calmette – Guerin
BHC:	Boma Health Committee
CCE:	Cold Chain Equipment
CCEOP:	Cold Chain Equipment Optimization Programme
CCL:	Cold Chain and Logistics
CDC:	Centre for Disease Control
CHD:	County Health Department
DPT:	Diphtheria, Pertussis and Tetanus
EPI:	Expanded Programme on Immunization
EVM:	Effective Vaccine Management
EVMA:	Effective Vaccine Management Assessment
FIFO/FEFO:	First in First Out/ First Expired First Out
GAVI:	Global Alliance for vaccine Immunization
HPF:	Health Pooled Fund
HOPs:	Hospitals
HR:	Human Resource
IPV:	Inactivated Polio Vaccine
MDVP:	Multi-Dose Vial Policy
MoH:	Ministry of Health
PENTA:	Pentavalent Vaccine
PHCCs:	Primary Health Care Centres
PHCUs:	Primary Health Care Units
PPM:	Planned Preventive Maintenance
PQS:	Performance Quality Safety
SDD:	Solar Direct Drive
SIAs:	Supplementary Immunization Activities
SMoH:	State Ministry of Health

SOPs: Standard Operating Procedures
UN: United Nations
UNICEF: United Nations Children Education Fund
VPD: Vaccine Preventable Diseases
VVM: Vaccine Vial Monitor
WBeGs: Western Bahr el Ghazal State
WCBA: Women of Childbearing Age WHO: World
Health Organization

DEDICATION

I would like to dedicate this work to my wife Dr Dorothy Titus Telar for the consistent support throughout my studies and not forgetting my children Malual, Malith, Adol, Beny, Makuei and my in-laws for their encouragement.

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CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

Vaccine management is critical to saving children's lives and protecting them from vaccine-preventable diseases VPD. The South Sudan Effective Vaccine Management EVM 2019 assessment reported low performance in nine domains of World Health Organization WHO criteria in WAU COUNTY. Both the WHO and United Nation for Children Funds UNICEF in 2010 launched an initiative of EVM for countries to improve the vaccine management aiming for 80% as a target to be met to deem the country performing well in vaccine management [1];

Good vaccine handling and storage is a vital factor in preventing, and eradicating VPD [2]. This implies that incorrect handling and storage of vaccines creates a re-vaccination of several patients, hence incurring huge financial losses. Also poor storage and handling of vaccines leads to compromised vaccine potency [2]; resulting into inadequate immune responses in patients, eventually leading to less protection against VPD [3]. In Western Bahr el-Ghazal state, the 2021 estimated yearly census population projection for both men and women in WAU COUNTY alone is 279,331. Therefore, from this total estimated population, the target for women of child-bearing age [WCBA] is 69,833, and the mortality rate of children under 5 years of age is 60/1000 live births [4]

According to WHO/UNICEF annualized routine immunization data from January to May 2021 in South Sudan, coverage of Diphtheria, Pertussis and Tetanus (DPT3) was reported to be 78% [5]

Despite the improvement in immunization coverage over the years in South Sudan, it still ranks lowest in East African region as compared to Uganda and Kenya with 93% and 92% DPT3 coverage respectively[6]. Good inventory management and handling of vaccines by health workers play a significant role in improving health of community. Therefore the WHO, UNICEF, and The Global Alliance for Vaccines and Immunization [Gavi], are intensively exerting efforts in prioritizing vaccine supply improvement and country's performance through EVM [7]. The framework strategy comprises four main steps which include, consistent vaccines supply chain improvement, quality management, optimization and innovation [8],[1];

This research aims at assessing and identifying the strengths, weaknesses, and good practices in WAU COUNTY[9]. The findings of the study will be used to improve vaccine supply chain management to ensure vaccines remain potent at all stages.

1.2. Problem Statement

The immunization coverage in South Sudan has been improving in most parts of state health facilities. However, counties in Western Bahr el-Ghazal state WBeGs including Wau County has reported measles outbreak in the past five years consecutively. Well as this could be due to many factors, EVM remain questionable and maybe a contributing factor, therefore, this research aimed to investigate the effective vaccine management in Wau County, South Sudan [9].

In previous assessment as per WHO criteria, five indicators in WAU COUNTY have shown a low performance below 80% and these include; stock management, maintenance, vaccine distribution, vaccine management, information management and support functions [10]. Overall, the human resource HR capacity is poor, especially at lower level with limited capacity to utilize the available guidelines.[6].

1.3. Research Question

- ‡ What is the knowledge level of health personnel on EVM in health facilities?
- ‡ What practices are vaccine handlers implementing in relation to WHO standard criteria of effective vaccine management?
- ‡ What are the major challenges affecting vaccines management in WAU COUNTY'S health facilities?

1.4. Objective of the study

1.4.1 General Objective

The study aims to investigate the major factors affecting vaccine management in public health facilities in Wau County, Western Bahr el Ghazal State, South Sudan. Throughout the findings, close attention is paid to the process of acquisition, supply and administration of vaccine to household targets. At the end of this study, there will be a clear mirror of vaccination process and its outlook on initiatives to combat VPDs in South Sudan.

1.4.2. Specific Objective

- To assess knowledge and practices of health workers in handling vaccines in health facilities
- To assess health facilities compliance to WHO standard criteria of effective vaccine management.
- To identify major challenges affecting effectiveness of vaccines management in

WAU COUNTY

1.5. Justification of the Study

The study aimed to investigate the effective vaccine management in Wau County, South Sudan. The study was envisaged to provide information that will be utilized by State Ministry of Health MoH authorities, health Partners and other scholars for decision-making mechanism and improvement of effective vaccine management. These in turn will contribute to improvement in the quality of Expanded Programme on Immunization EPI program, including Cold chain infrastructure and equipment, Human resource, and overall supplies management.

1.6. Scope and Delimitation of the Study



The research was conducted in WAU COUNTY of Western Bahr el Ghazal state which is located about 650KM northwest of capital Juba, South Sudan.[11]. It is internationally boarding Sudan to the North, Central Africa to the West. Data from the health facilities were collected using standards WHO EVM structured questionnaires and checklist.[12]. This study has taken duration of three months from the date of approved proposal to submission of final report.

1.7. Limitation of the Study

This study does not include the comprehensive logistics process involve in the procurement and supply of vaccines and their products to local health facilities in Wau County. Since all vaccines are imported, it is understood that health authorities handle the logistical process at different levels. These levels are subject to further studies beyond the scope of this research.

Other limitation of this study includes language barrier among respondents, poor access of road to some remote health centres and insecurity.

1.8. Organization of the Thesis

This study composed of five chapters. The first chapter is an introduction which captures background of the study, problem statement, research objectives, scope of the study, the limitation of the study, significance of the study and organization of the study. The second chapter focused on relevant literature review used to help the study. Methodology of the study is presented in the third chapter and chapter four composed of results, discussion, and interpretation the fifth chapter of the study presents the summary, conclusion and recommendations as well as future research forward. Finally, reference and appendix are also presented.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.1. Theoretical Literature Review

2.1.1. Knowledge and Practices

Vaccines are sensitive biological products that can easily be destroyed if handled incorrectly. Exposure to inappropriate conditions can affect the potency of refrigerated vaccines. The loss of vaccine potency may also cause the vaccine to become more reactogenic. Vaccines require more complex handling and storage requirements due to increased temperature sensitivity and complicated immunization schedule [13]. Also, the problem is attributed to reduced vaccine potency due to failure in cold chain monitoring system [14]. A previous study indicated that there was a knowledge gap of health workers who are working on cold chain management. This required a need to improve knowledge and practice on cold chain management [15].

Cold chain management, training, supervision, a higher level of education, and year of service were significant determinants of the practice of vaccine cold chain management. The inefficient vaccine management systems, including poor stock management, poor quality of vaccine handling and storage, contribute to high wastage of vaccines.

2.1.2 Health Facilities Compliance according to WHO Standards

Centre for Disease Control CDC and the MoH South Sudan affirmed that EPI [16]. activities are considered part of an integral element in health system. As a result, the 2006 South Sudan delivery guidelines for primary health care centres PHCCs packages and hospitals HoPs were designed to provide three main immunization categories. These categories include quality immunization of children, women of childbearing age and vitamin A supplement aimed at protecting the population against vaccine preventable diseases. These can be achieved by conducting routine immunization and Supplementary Immunization Activities[SIA]s [17].

For Cold Chain system to be reliable, it needs to be certified by WHO Performance Quality Safety PQS policy and also requires consistent strong supply chain management strategy [18].

2.1.3 Challenges Affecting Vaccine Management

With increasing cost of vaccines and aggravated by Covid – 19 pandemics, there is a need to maintain optimal control of the vaccines storage capacity[19]. Countries must ensure and maintain lower stock levels, minimize waste, ensure accurate forecast of vaccines requirements and prevent equipment breakdowns. This needs a consistent, strong adherence and close monitoring standards of supply chain management. This can be achieved through integration in supply chain and complying with efficient storage and distribution of vaccines [2],[1].

The study reviewed related articles and reports from various authors within Eastern, Western, Southern Africa, Middle East, WHO and UNICEF annual reports on EVM [17], [20]. The study narratives on knowledge, practices of vaccine handlers in public health facilities in Ethiopia is almost the same like their counterparts in South Sudan [9].

2.2 Empirical Literature Review

2.2.1. Knowledge and Practices

For the case of Tolon, a rural district in Ghana it is not different from Ethiopia and South Sudan in terms of practices, thus similar to the case of WAU COUNTY [13]. In those two areas, the practice was top-down logistics where vaccines management depend largely on external factors. The beneficiary health centres do not have adequate facilities to control stock. Thus, distribution of doses affected by decisions on the logistics.

2.2.2 Health Facilities Compliance

Distribution of vaccines between and within levels of the supply chain system seeks to ensure that the transportation of vaccines and other commodities are done in an effective manner, including the correct use of passive containers [cold boxes], ‘appropriate packing practices, and maintaining transport contingency plans’ [21]; According to the vaccine transportation policy, temperature monitoring devices must be included in the transportation container.

2.2.3 Major Challenges Affecting Effectiveness of Vaccine Management

The EVM conducted identified the strengths and weakness in nine different areas of vaccine management at each level of vaccine supply chain with their corresponding recommendations to address the gaps [20,22]. The general EVM performance in Wau county recorded a decrease from 60% to 50% in 2012 and 2019 assessments respectively reflecting low immunization coverage [7, 16].

In 2019 EVMA reports had found gaps, that includes low coverage of cold chain equipment at health facility level 36% which is far below average [7]. It was recommended that Cold Chain Equipment Optimazation Programme CCEOP be extended to the lowest health facility level. This was implemented in phases in some parts of the country through supply of Solar Direct Drive SDD fridges with support from GAVI through UNICEF. This equipment were proved to be more reliable for rural area with no grid electricy.

Similar studies [13];“ KAP Vaccine” stated clearly that there is urgent need to improve knowledge and practice on cold chain management through improved supportive supervision and training. Supportive supervision and immunization coverage, evidence from India “ the internet Journal of Epidemiology 2011 Volume 9 Number2”, the study infers that supportive supervision improve immunization coverage and also serves an efficient tool to strengthen the local health system [24, 25]. Thus, Some steps have been taken to minimize cost and those issues related to supportive supervision and mentorship for vaccine handlers by allocating funds for supportive supervision to the state and CHDs through HPF. This has been achieved by introducing a joint integrated visits by all departments of health to one health facility in a single supervision trip.

In Kanja LW article title factors that affect vaccine availability in public health facilities in Nairobi city county, Kenya. The study assessed the availability of vaccine,injection accessories and associated factors in public health facilities in Nairobi City County and provided valuable data to contribute to improving health care infrastructure , stock management and vaccine distribution [26]. Therefore, there are similarities both in Kenya and South Sudan on factors affecting vaccine management. Thus, in this study emphasis will be on factors affecting EVM in Wau county which have been identified and it includes:

Policy related challenges: Agnes Semwanga Rwashana and Ddembe Wileese Williams in their article title “an Evaluation of Healthcare Policy in Immunization Coverage in

Uganda”, Immunization coverage is lowest in poor countries and among poor populations, also the paper suggested an initial model that could be used for theory building in immunization policy evaluation [27];. In WAU COUNTY and in WBeGs state there was frequent measles outbreak, and this study emphasized on EVM and thus to assesses the policy related challenges in areas such as availability and updated standards operating procedures SOPs, use of uncertified CCE as well as temperature monitoring devices. **Management support challenges:** for example trained vaccinators, training tools availability, delay or lack of payment of vaccinators.

Cold chain equipment challenges: according to Mike Brison and others in their article title: “Transforming cold chain performance and management in lower-income countries” [28]; stated that one of the common factors limiting full and equitable access to effective immunization is the existence of gaps in cold chain and logistics systems CCL Also Feyisa D [29]; article titled cold chain maintenance and vaccine stock management practices at public health centers says that cold chain maintenance is the spine of an immunization Programme. In *Woldemichael B, Bekele D, Esmael A* [14]; study title, Cold Chain status and knowledge of vaccine providers at Primary Health Care indicated that cold chain monitoring is still a major challenge in developing countries including Ethiopia. In comparison to WBeGs and particularly WAU COUNTY cold chain, there are challenges hindering the effectiveness of cold chain and logistic system and these includes few functional CCE, CCE breakdown, written planned preventive maintenance PPM and reliable power source needed to be assessed and see their contribution towards EVM in WAU COUNTY.

Training and supportive supervision challenges: In Bellary District India [25]; They form district Core Group on Routine Immunization and the paper aimed at studying the role played by supportive supervision of state and district core groups in improving immunization coverage. As such in WBeGS and WAU COUNTY, there are Boma Health Committees BHC whose function are to sensitize the community , conducting awareness sessions and give necessary advices to high authority and the stakeholders working in immunization. This research concentrated on vaccine handlers who were not trained or mentored, regular supportive supervision, identified gaps not addressed and which may have hampered the EVM in the WAU COUNTY.

Vaccines logistics management challenges: In Nigeria article written by Ojo TO and others stated that the success of national immunization program depends largely on effective logistics management of vaccine cold chain system. In their study they assessed cold chain equipment functionality, health care workers knowledge and practice of the logistics management of cold

chain system in Ile-Ife, Nigeria[30]; In this research emphasis was on factors affecting the EVM which comprised: recommended vaccine transport cold chain equipment, vaccine delivered to facility on time, FIFO/FEFO, safety boxes disposal ,open pit or incinerator.

2.3 Conceptual Framework of the study:

In this study the dependent variables are EVM status in public health facilities. The independent variable entailed the Compliance of health facility, knowledge and practice of Vaccine handlers and the Challenges.

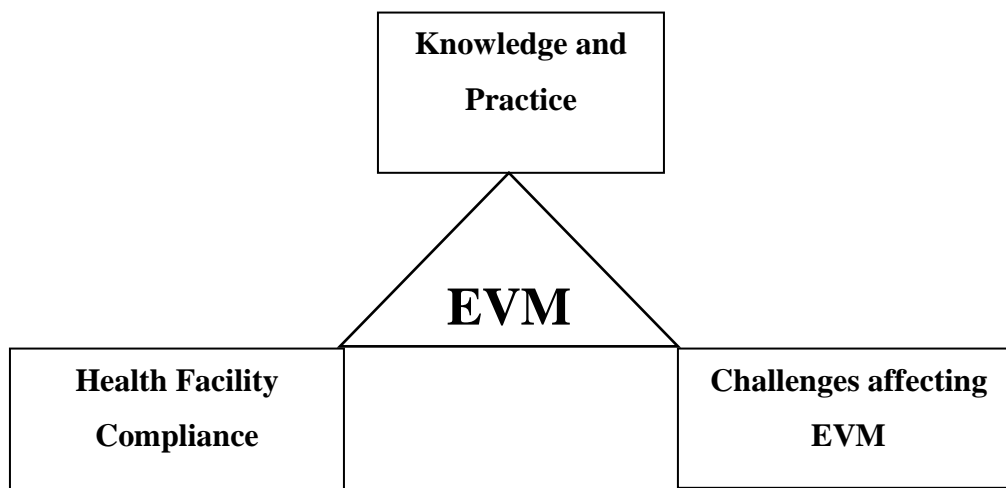


Figure 1: Conceptual Framework of EVM, Block Diagram

2.4. Identified Literature Gaps:

According to the related literatures reviewed , there were huge gaps identified despite continuous recommendations made by various authors and from previous assessment reports. For instance, in South Sudan there were three effective vaccine management assessment EVMA conducted country wide in 2012, 2015 and 2019 respectively [23]. Further literature was accessed from desk review of reports from previous annual meetings and conferences related to EPI for both national and sub-national level.

The gap of low immunization coverage was identified due to low sensitization of the communities and the care takers of the household. As such it was recommended that social mobilization

activities be stepped up by recruitment of community mobilizers at each level and availing necessary funds by stakeholders to improve on immunization handling. In Ethiopia, Wonago district, there was a low immunization coverage where only 39% of children aged 12-23 months received full vaccination according to the 2016 Ethiopia Demographic Health Survey [6].

In rural area of Ghana, specifically in Tolon district it has been found that none of the health facilities assessed met the WHO benchmark of 80% [13], implying that the vaccination in rural areas did not meet EVM framework.

CHAPTER THREE: METHOD

3.1. Research Design

This study applies institutional based cross-sectional study using qualitative and quantitative method which enables the researcher to establish factors affecting effective vaccine management in WAU COUNTY where research questionnaires and checklists was developed from WHO/IVB/05.02 version [12].

The study answers the questions to find out what has been affecting the effective management of vaccination in WAU COUNTY. Since the approach was flexible with multiple variables used to capture required information for guiding the new strategies for smooth and robust implementation of the effective vaccines management in routine immunization in WAU COUNTY which could also be used to inform future studies such as in-depth studies. The designed approach was appropriate that it was inexpensive, simple and did not require a lot of time and resources.

The collected data under the variables were anticipated to either approve or disapprove the assumptions. Quantitative and qualitative data were analysed, and SPSS Version -26 was used. Data collected were segregated by their demographic profile such as sex, age, marital status, job title, education, and experience level. Orientation and training at county and health facility level was conducted to data targets and data collectors. The research tools pre-testings' were conducted as well as field monitoring during data collections process.

3.2. Location of the study:

Data were collected from health facilities with functional cold chain in WAU COUNTY.

3.3 Target Population:

The target population were all 27 public health facilities providing immunization services in WAU COUNTY.

3.4. Sampling Size:

In 27 health facilities, where two (2) health workers responsible for vaccine handling and management were selected. Therefore, two (2) health workers in these health facilities of total of (54) were selected as sample size using census method.

3.5. Data Collection Techniques

Data collection tools were questionnaire and checklist.

3.6. Data Analysis Procedures

A complete data was cleaned, coded, edited and data analysis was carried out using SPSS Version Twenty-six V-26. The descriptive statistical results were presented in charts, figures, and tables.

3.7. Ethics Consideration

Upon approval of the research proposal, it was presented to Ethical Review Committee/ Board and Ethical Clearance was issued. Permission was sought from the head of health facilities and participants were requested to sign a consent form before interview. All data were treated with confidentiality

3.8 Validity and Reliability Test

3.8.1 Validity

Data collection tools were reviewed by the research supervisors to cross check whether the tool was clear, and language used was easy and understood as well as findings that the tools were able to capture the content of the study's objectives and free from bias.

3.8.2. Reliability Test

To find out the reliability of the proposed data collection tools, the pre- test was carried out at Wau Teaching Hospital to the study population with similar knowledge and management of vaccines.

Analysis of Scales' Reliability and Validity: To measure reliability test and internal consistency of data, most common and known statistical tools called as “Cronbach’s Alpha” coefficient method was used. This coefficient was used to measure a scale of multiquestions frequency and measure the degree of compliance between zero and one. As the coefficient draws nearer to one, Cronbach’s alpha is assumed to be very high. Tables 1. Generally, the following evaluations were made on the Cronbach alpha coefficient of researches in the social sciences:

$\alpha < 0.40$ the scale has no reliability. (Weak).

$0.41 < \alpha < 0.60$ the scale’s reliability is low. (Good).

$0.61 < \alpha < 0.80$ the scale has acceptable reliability level. (Very good).

$0.81 < \alpha < 1.00$ the scale’s reliability is very high. (Perfect).

Table 1: Statistics Reliability

Reliability Statistics	
Cronbach's Alpha	No. of Items
.759	73

CHAPTER FOUR: RESULTS, DISCUSSION AND INTREPRETATION

4. 1. Response Rate

The study had total of 54 sample size, from the distributed 54 questionnaire scripts but only 52 were collected, as one questionnaire was incomplete and one also was not submitted. A total of 52 questionnaire scripts were eventually used for analysis in SPSS V-26 and research questionnaires and checklists were developed from “WHO/IVB/05.02 version.” [12]. In this study, the five 5 and three 3 Likert scale format was used for data collection. Which the respondents were asked to tick appropriate status, strongly disagrees, disagree, uncertain, agree, and strongly agree. And yes, no idea and No.

4.2. Health Categories and Demographic Profile of the Respondents

Table 2: Health Categories and Health Workers' Job Titles

Health Levels and Health Workers Job Title Frequency[n=52]	Frequency	Percentage
Health Facilities		
PHCU	20	38
PHCC	18	35
Hospital	9	17
County Cold Chain	3	6
State Cold Chain	2	4
Job title		
Vaccinators	19	38
Nurses	13	25
Clinical Officer	15	28
Cold Chain Assistant	4	8
Others	1	2

Out of the five 5 types of health facility surveyed, 73% were lower level health facilities PHCC and PHCU and 27% are higher level health facilities Hospitals, County Cold Chain and State Cold Chain. That provided immunization services. Most of the HR 66% was vaccinators, nurse and clinical officers, aged 30 to 50 years 67%.

Table 3: Demographic Profile of Health Workers

Background characteristics	Frequency[n=52]	Frequency	Percentage
Age Group [Years]			
21-30	1	1	3
31-40	14	14	26
41-50	22	22	41
51-60	3	3	6
> 61	12	12	25
Gender			
Male	34	34	66
Female	18	18	34
Education level			
Primary	9	9	17
Secondary	22	22	43
Tertiary institution	18	18	34
Bachelor Degree	3	3	6
Marital status			
Single	11	11	22
Married	34	34	65
Widowed	4	4	7
Divorced	3	3	6
Experience			
0-2	19	19	36
2-5	1	1	2
> 5	32	32	62

Furthermore, 66% of the HR personnel were males, while female constituted 34% notably the majority of the health workers 43% had attained secondary educational level and only 34% reached Tertiary/University level. Importantly, 62% had more than five years work experience.

4.3. Knowledge and Practices of Health Workers in Handling Vaccines in Health Facilities

Table 4: Showing Participants’ Knowledge and Practices on EVM

Participants Knowledge on EVM [n=52]	Knowledgeable [%]	Unknowledgeable [%]
VVM	69	31
Availability of Vaccine	46	44
Vaccine Estimation and Ordering	85	15
Multi-dose Vial Policy [MDVP]	73	27
Temperature Monitoring	52	48
Cold Chain Equipment	77	23

Vaccine Vial Monitoring VVM: In this study about 36 (69%) of the participants knew how to read the VVM and the importance of EVM while 16 (31 %) were unable to read the VVM labelling see table 4 above. The VVM knowledge among health workers in Wau county was lower than 80% of WHO recommended requirement and much lower than 88% VVM knowledge established in South Sudan EVM assessment Study conducted in 2019 [7]. In other studies “Vaccine vial monitor availability and use in low- and middle-income countries” indicated that the majority of health workers 92% were able to read VVM labels [31].

Most participants were knowledgeable on the use and interpretation of the VVM 69%. South Sudan immunization Programme is supported by GAVI, UNICEF and WHO, thus majority of vaccine handlers at health facility and service delivery points were trained on VVM. Similarly, in other literature review, it was found that the VVM registered cumulative heat exposure on vaccines over time [31]. In Gojam zone of Ethiopia, 66.6% of vaccine handlers were trained and able to read VVM, therefore, the situation was more less the same with WAU COUNTY and all were not at WHO recommended standards..[7,15,32]. In this research, knowledge on VVM was 69% which is well above average but has not reached 80% as per WHO requirement, therefore, vaccine handlers would require more training on VVM.

Vaccine stock management: Only 29 (46%) of vaccine handlers were knowledgeable and 23 (44%) of participants were unaware of the importance of vaccine stock availability in the health facility. In this study WAU COUNTY health facilities at service delivery level performed poorly compared to other studies conducted in South Sudan 2019 and Ethiopia EVM assessment where stock management was 69% in Wau hub [7] ; and 55% in WEST SHEWA ZONE Ethiopia [33]. Therefore, in this study it is predicted that there could be vaccine stock out, low routine

immunization coverage and anticipated outbreaks of vaccine related diseases [34]. Notably, for past five years, South Sudan and WBeG state in particular reported measles outbreak almost every year[34]. Thus, vaccine handlers to be oriented and refresher trainings on restocking and how to keep vaccine requisition on time and provision of vaccine requisition vouchers at facility. **See table 4** above.

Temperature monitoring: About half 27(52%) of participants knew how to monitor and record temperature twice daily and had temperature records in their respective health facilities while 25 (48%) of respondents did not know or follow the policies and procedures of WHO recommended temperature during vaccine storage, as shown by results which are still below 80% WHO recommended standard.

The implication of this result is that there were high chances of vaccines being exposed to out of range temperatures, resulting to compromised vaccine potency and wastage, see **table 4** above.

Table 5: Scale, Mean and Standard Deviation of EVM knowledge

Item[Questions]	Scale					Mean	Standard deviation
	1	2	3	4	5		
Participant Knowledge on EVM							
VVM Prevent Heat Damaged Vaccines	7	1	8	20	16	3.71	1.304
Affect Vaccine Management Performance	9	9	4	19	10	3.29	1.460
Estimate Vaccine Requirement	6	0	2	21	23	4.06	1.243
Reduce Vaccine Wastage	1	4	8	21	17	4.00	1.029

4.4. Health Facilities Compliance to WHO Standard Criteria of Effective Vaccine Management [N= 52]

Compliance policy: On compliance to policy in HFs 22(42%) of respondents were good at practices and in policy guidelines and above half of health workers 30(58%) in WAU COUNTY health facilities did not adhere to policy and compliance, making compliance to policy below 80% minimum score required as per the WHO standards. Also, this show that vaccine handlers lack training on policy compliance, funds for dissemination of national guidelines to facility, availability of standards operating procedures [39], **.see Table 6** below.

Table 6: Showing Health Facilities Compliance to WHO Standard Criteria of EVM

Participants' Knowledge on EVM [n = 52]	Correct %	Incorrect %
Compliance	42	58
Vaccine Storage	62	38
Stock Management	69	31
Vaccine Distribution	87	13
Supportive Supervision	75	25

Vaccine storage: About 32(62%) of respondents in health facilities indicated good storage practice though it was still below 80% which is the WHO standard. This could be as a result of vaccine handlers not being motivated, insufficient training and lack of micro-plan at facility level. Other authors in Cameron, Ghana, Nigeria, Uganda and Ethiopia, reported poor vaccine storage practices by vaccine handlers which caused low immunization coverage, which is similar to the situation in WAU county [32], see **table 6** above.

4.5. Major Challenges Affecting EVM

In this study, the EVM challenges were ranked with the highest percentage considered as the most pressing challenge and the lowest percentage to be a minor challenge affecting EVM in Wau county health facilities. The pie chart indicates the three major challenges which were policy related challenges with 16(31%) and management support challenges 11(22%), shortage of cold chain equipment 9(17%), while vaccine and logistics management challenges with 8(15%) and training and supportive supervision challenges at 8(15%) both were ranked as lowest challenges respectively. see **pie chart 2** below.

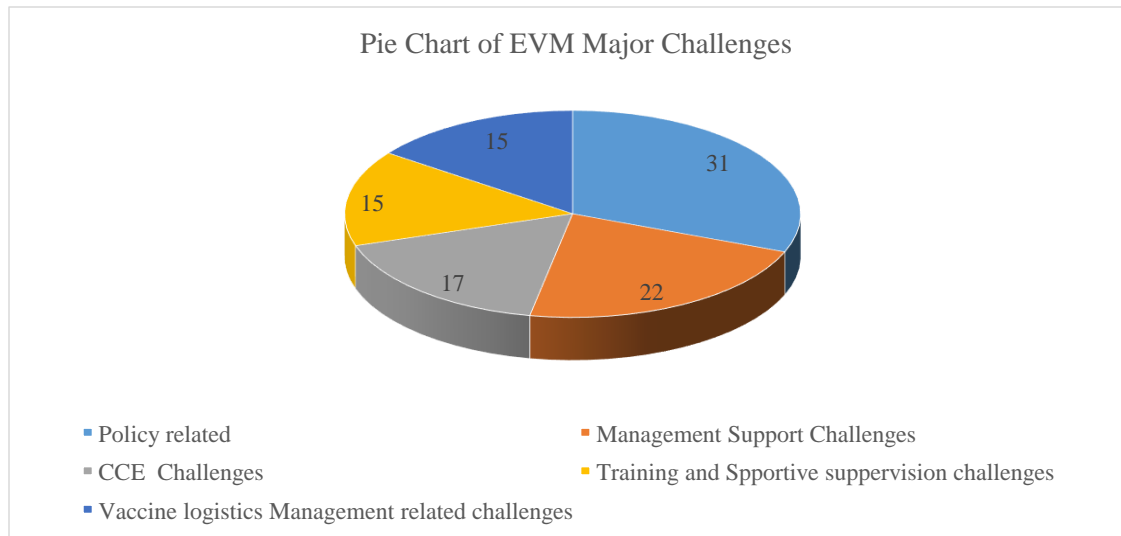


Figure 2: Pie Chart EVM Major Challenges

EVM policy related problems: In this research, 16(31%) of participants reported EVM policy related challenges in their health facilities, while in 2019 South Sudan EVM assessment policy compliance challenge was rated at 44% in EVM. Therefore, it was still a growing challenge affecting EVM; hence there is urgent need for the immunization stakeholders to build the capacity of vaccine handlers on policy compliance in WAU COUNTY. Similar studies in Cameroon show that 57% of health workers were not trained on open vial policy and low proportion of health workers having access to national guidelines and trained on use of contingency plan and in Ethiopia 42% of health workers were not complying with the policies of EVM.[15], see **Figure 2**. This research found out that 22% of challenges were related **to management support on EVM**, and yet according to the 2019 EVM South Sudan assessment in WAU Hub, management support challenges were rated at 40%, therefore there is significant improvement of about half the previous assessment in the same parameter such as training of vaccinators, vaccine handlers involvement in preparation of micro-plan at health facilities level. While in other article in Nigeria, vaccine management challenges were 61%, which is below the requirement.[15] .

In WAU COUNTY **cold chain equipment challenges** were rated by 17% and these included non-functional cold chain equipment, CCE maintenance, no reliable power source and vaccinators not oriented on how to use CCE. In this study it was clear that only some few facilities had challenges in terms of lack of functional CCE, no reliable source due to lack of generators and generators

maintenance, while in others facilities at WAU COUNTY vaccinators where not trained nor attending any orientation training on use of CCE. This compared with previous assessment conducted in South Sudan whereby it was 34%, translating to some improvement as observed. In Jimma zone Ethiopia, there were similarities specifically in CCE maintenance and no reliable power source.[7], In Wau County the majority of health facilities were using the solar panel / solar direct drive SDD which sometimes if there is no sunlight, results into insufficient power to keep vaccine cooled, see **Figure 2**.

On **vaccine logistics management challenges** 15% challenges were reported compared with 40% of previous studies in South Sudan and it means that more trainings and retraining of vaccine handlers is needed to improve on vaccine logistics management and to meet WHO recommended guidelines and to improve cold chain logistics information management. In other studies, in Nigeria 54% in logistics management was observed which is similar and even much better than the current study in the country and WAU hub EVM 2019 assessment [30].

Table 7: Item, Mean and Mean Ranking of EVM challenges

Item[Questions]	No. of Item	Mean	Mean Ranking
Policy Related Challenges	3	2.73	5 th
Management Support Related Challenges	3	3.46	4 th
Cold Chain Equipment Challenges	3	3.69	3 rd
Training and Supportive Supervision Challenges	3	3.79	1 st
Vaccine Logistics Management Related Challenges	3	3.64	2 nd

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

EVM in public health facilities in WAU COUNTY, WBeG State, South Sudan was inadequate. The knowledge and practice of health workers was found to be insufficient, there was poor adherence to policies and implementation of guidelines. Vaccine handlers in WAU COUNTY health facilities were insufficient in adhering to policies such as guidelines, standard operating procedures, motivation, emergency plans, and microplanning at the health facility level. SOPs are not used; the use of CCEs not certified by WHO affects the EVM in the institution. There was insufficient budget allocated to management support for EVM activities. Non-functional CCE, reliable power source, vaccinators were not oriented and supervised, these were factors affecting EVM in WAU COUNTY health facilities.

5.2. Recommendations:

Knowledge and Practices of Health Workers in Handling Vaccines

It is recommended that state EPI department and WAU COUNTY Health Department provides vaccine handlers with training on VVM, vaccines stock replenishment, ordering of vaccines, and maintaining safety stock at their health facility level.

Further trainings for health workers that are recommended are: keeping vaccines at the recommended temperature range (2 to 8 degree Celsius), monitoring and recording temperature twice daily as per WHO standards guidelines as well as provision of temperature monitoring tools in their stores facility.

It is also recommended that our Ministry of Health engage UNICEF and other implementing partners to provide necessary financial package for health workers and to encourage the vaccine handlers to stay in service delivery points.

Health Facilities Compliance on WHO Standard Criteria of EVM:

The study found out those vaccine handlers in HFs of WAU COUNTY lacked training capacity on policy compliance and thus, the National Ministry of Health MOH and State Ministry of Health

should provide training tools, guidelines such as standard operating procedures SOPs, good storage practice, motivation package and micro plan at health facility level.

Identified Major Challenges Affecting Effectiveness of Vaccines Management in WAU COUNTY:

Several challenges affecting the effectiveness of vaccines management at Wau County were identified during the study period namely: lack of training on vaccine vial open policy, few health workers having access to national EPI guidelines, lack of contingency plans, shortage of CCE and temperature monitoring devices and lack of staff involvement in micro plan preparations. It is therefore recommended that Ministry of Health address identified challenges which will help health care workers in rendering their services efficiently.

5.3. Study Limitations and Future Research Forward

The limitations of the research were the language barrier which made it difficult to interact with some of the participants., One health center could not be assessed as access to the facility was not granted due to security issues at the time of visit. The research did not cover areas of managing vaccine wastage and availability of cold chain equipment which could be explored further in future

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APPENDIX 1: ETHICAL APPROVAL

1.1 Ethical Approval

REPUBLIC OF SOUTH SUDAN



Ministry of Health, Research Ethics Review Board (MOH-RERB), Juba.

RERB NO:37 /07/2021- MOH/RERB/ A38//2021

Date: 12th July 2021

Principal Investigator (PI): Agok Malual Akec Ayul, University of Rwanda

Supervisor: Shiferaw Mitiku, PhD, Ass. Prof. Addis Ababa University

Research Approval Letter

Dear All:

Sub: "Vaccine management in public health facilities: case study, Wau county, Western Bahr el-Ghazal"

This is in response to the request for authorization of the study **Vaccine management in public health facilities: case study, Wau county, South Sudan**. As part of vaccine management and response to the public health problems in South Sudan.

The Ministry of Health Research Ethics Review Board at its A.15th meeting held on 9th August 2021 reviewed your research proposal and has given a favorable ethical opinion for implementation.

The approval was based on the quality of your application form, protocol and supporting documents that complied with the conditions and principles established by the International and national guidelines for carrying out research involving humans as research participants.

This approval shall be valid until 22nd/10/2021. In this regard, you are expected to commence implementation of this research. Please note that the annual report and the request for renewal, should be submitted to the MOH-RERB one month before the expiry of the approval time. The progress report should not exceed five pages.

In addition, any serious problem related to implementation of this research protocol should be promptly reported to the MOH-RERB, and any changes to the protocol should not be implemented without the MOH-RERB approval except in instances where such changes are necessary to eliminate or prevent an immediate hazard to the research participants. I wish you all the best in implementing this research.

Amanya Jacob Kasio Iboyi, MPH

#. Deputy Director Research-MOH, Juba

#. Deputy Chairperson MOH-RERB/Juba



1.2. Request Research for Data Collection

06/08/2021

Juba, South Sudan

To James Ambrose
Director General
State Ministry of Health, Western Bahr el Ghazal State, Wau

Subject: Request Research for Data Collection in WAU County's Public Health Facilities

I am conducting a Research title: **Vaccine Management in Public Health Facilities, WAU County, Western Bahr el Ghazal** for the Master's Degree of Health Supply Chain Management in East Africa Community Regional Center of Excellence for Vaccine, Immunization and Health Supply Chain Management, University of Rwanda, Kigali, Rwanda.

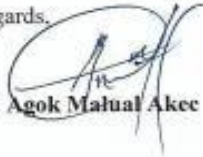
Therefore, I am requesting your esteem office to grand me approval for research data collection in public health facilities at ^{Wau} County starting from August 15, 2021 to October 15th, 2021.

Your approval will be highly appreciated.

Thanks.

Regards,

Dr. Agok Malual Akec



To whom it may concern
Approved for necessary
action - please provide
all supporting documents.



12/08/2021

APPENDIX 2: CONCERN FORM

2.1 Concern Form


I ----- hereby agree to participate in the research project entitled Vaccine Management in Public Health Facilities, case study WAU COUNTY, Western Bahr El Ghazal State-South Sudan, conducted by researcher **Mr. Agok Malual Akec Ayul**. The purpose and content of the study were explained to me and I was also given the opportunity to ask questions about this study and I acknowledge that they were answered satisfactorily. I understand the general objectives, risks and methods of this study.

I also understand and give my consent to participate in the research project according to the following terms and conditions that;

- The research may not directly benefit me
 - My participation is completely voluntary
 - I have the right to withdraw from the research at any time without any consequences for me
 - There are no risks, in case of discomfort or uneasiness I have every right not to answer questions
 - Who I should contact in case of any complaints about the study or the conduct of the researcher
 - I am able to request a copy of the research results and reports
 - My personal data and any other information will be kept strictly confidential and used only for the research purpose
- Name of Participant Signature:

Date:

Name of Researcher: Agok Malual Akec Ayul

Signature: 


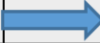





Date

APPENDIX 3: RESEARCH BUDGET AND TIMELINE

3.1 Research Budget

S/No	Descriptions	Qty	Freq. [Month]	Unit USD	Total USD
A	Personnel				
1	Principal investigator	1	3	200	600
2	Co-investigators	2	3	100	600
3	Data manager	1	3	50	150
4	Office assistant	1	3	25	75
5	Drivers	2	3	20	120
6	Air tickets	2	1	200	400
7	2 vehicles to be hired	2	3	100	600
8	3 motorbikes	3	3	100	900
B	Materials & Supplies				
10	Stationaries	1	2	200	400
11	Printing costs	1	2	250	500
12	Photocopying cost	1	2	300	600
13	Result dissemination	1	1	100	100
14	DSA	3	2	200	1,200
16	Others Costs	1	2	280	560
Grand Total					6,805

3.2 Timeline

S/No	Activities	July	August	September		October			Deliverables
		20 th	20th	20th	30th	10th	15th	25th	
1	Final proposal ready for submission to Ethical Committee								Research Protocol [data collection tools]
2	Getting Approval of Ethical								Ethical approval
3	Data Collection								Data set
4	Data Analysis								Results and interpretation
5	Writing Dissertation								A complete dissertation
6	Submission of a Dissertation and a Draft Manuscript								A final copy of a dissertation and a draft Manuscript
7	Defence								Power Point presentation

APPENDIX 4: DATA COLLECTION TOOLS

4.1 Questionnaire Form:

Are used to estimate vaccine requirement

Part One: Health Facility Information						
1. Name: _____ 2. Level of health facility: _____						
3. Location: _____						
Part two: Demographic Information						
4. Age _____ [years] 5. Sex <input type="checkbox"/> Male <input type="checkbox"/> Female						
6. Marital Status: <input type="checkbox"/> Married <input type="checkbox"/> Single <input type="checkbox"/> Divorced <input type="checkbox"/> Widowed						
7. Level of education <input type="checkbox"/> Primary <input type="checkbox"/> Secondary <input type="checkbox"/> Tertiary Institution <input type="checkbox"/> Vocational Training <input type="checkbox"/> Bachelor Degree <input type="checkbox"/> Masters and above						
8. Current position/job <input type="checkbox"/> Nurse/Midwife <input type="checkbox"/> Clinical Officer <input type="checkbox"/> Cold Chain Manager <input type="checkbox"/> Cold Chain assistant <input type="checkbox"/> Vaccinator <input type="checkbox"/> Others [Specify].....						
9. Years of Experience EPI department? a]. 0-2 Years <input type="checkbox"/> b]. 2-5 years <input type="checkbox"/> c]. 5 years and above <input type="checkbox"/>						
Part Three: Participant Knowledge on Effective Vaccine Management						
Please indicate your level of agreement using a tick mark [√] with given 5-point Liker scale where 1 = Strongly Disagree, 2= Disagree, 3=Uncertain, 4=Agree, 5= Strongly Agree.						
S/N	Items	Scale				
	Participant Knowledge on EVM	1	2	3	4	5
1	<p>The purpose of Vaccine Vial Monitor [VVM] policy is to:</p> <p>Prevent heat-damaged vaccine from being administered,</p>					

2	Availability of adequate quantity of vaccines is one of the factors that affects vaccine management performance					
3	Target population and Previous consumption					
4	Multi Dose Vial Policy and Vaccine Vail Monitor [VVM] help to reduce vaccine wastage					
5	Fridge-tag should be placed in each vaccine refrigerator on the shelf where there are Freeze sensitive and heat sensitive vaccines					
6	Domestic refrigerators are not qualified for vaccine storage as per WHO Standards					
7	Oral Polio Vaccine [OPV] in South Sudan is a freeze sensitive vaccine					
8	The objectives of the Continuous temperature monitoring is to ensure the quality of vaccines and minimize vaccine wastage					
9	Reconstituted Freeze Dried Vaccines should be discarded after six hours or at the end of the session whichever comes first					
10	In an event of vaccine stock out, the vaccinator may use Expired, Discard point VVM, freeze indication vaccines to immunize.					
11	Frequent and unnecessary opening of vaccine refrigerator can expose vaccines to damage by heat					

4.2 Checklist

Part Nine : Major challenges affecting effectiveness of vaccines management Please indicate your level of agreement using a tick mark [√] with given 5-point Liker scale where 1 = Strongly Disagree, 2= Disagree, 3=Uncertain, 4=Agree, 5= Strongly Agree.

Part Nine	Items	Scale				
		1	2	3	4	5
A	Challenge A: Policy related Challenges					
1	Temperature monitoring devices are not used in the facility as a result it affects the effectiveness of vaccines management					
2	SOPs are not used to guide vaccine handlers at all time, as a result it affects the effectiveness of vaccines management					
3	Cold chain equipment used in the Health Facility are not certified by WHO, as a result it affects the effectiveness of					
4	vaccines managementTemperature of +2 degrees to +8 degrees Celsius is not used to keep vaccines as a result it affects the effectiveness of vaccines management					
B	Challenge B: Management Support related challenges					
1	Lack of trainings of Vaccinators at the health facility level affects the effectiveness of vaccines management					
2	Failing to provide Training tools and documents in the most understood language affects the effectiveness of vaccines management					
3	Delay or lack of payment of vaccinators affects the effectiveness in work					
4	Vaccine handlers do not participate in Micro plan development and periodic review meetings as a result it affects the effectiveness of vaccines management					

C	Challenge C: Cold Chain Equipment Challenges	1	2	3	4	5
1	Health Facility has no functional Cold Chain Equipment; as a result, it affects the effectiveness of vaccines management.					
2	Cold Chain equipment breakdowns are not reported in time to supervisors/concerned authority as a result it affects the effectiveness of vaccines management					
3	Temperature records are not updated regularly by vaccinator as a result it affects the effectiveness of vaccines management					
4	Health Facility uses Equipment with no reliable power source like Solar Direct Drive [SDD], as a result it affects the effectiveness of vaccines management					
5	Vaccinators are not oriented and mentored on how to use the cold chain equipment as a result it affects the effectiveness of vaccines management					
D	Challenge D: Training and Supportive Supervision Challenges	1	2	3	4	5
1	Vaccine handlers are not trained/ mentored on vaccine management, as a result it affects the effectiveness of vaccines management					
2	Lack of regular supportive supervision on Immunization Programme at the Health Facility affects the effectiveness of vaccines management					
3	Failing to address identified gaps from supportive supervision and feedback received affects the effectiveness of vaccines management					

E	Challenge E: Vaccine Logistics Management related Challenges	1	2	3	4	5
1	Vaccines are not transported in the recommended cold chain equipment [Cold Box, Cool Ice Pack, Refrigerated Trucks] as a result it affects the effectiveness of vaccines management					
2	Temperature Monitoring devices are used during the transportation of vaccines to health facilities					
3	Failing to deliver vaccines to the facility on time to avoid stock out affects the effectiveness of vaccines management					
4	Vaccine requisition and issuing vouchers are not available at the facility as a result it affects the effectiveness of vaccines management					
5	Monthly vaccine inventory is not conducted at the health facility, as a result it affects the effectiveness of vaccines management					
6	Vaccine Flow of First In First Out [FIFO]/ First Expiry First Out [FEFO] principle is not being used in the health facility, as a result it affects the effectiveness of vaccines management					
7	Safety Boxes are not used in disposal of sharp immunization objects like needles and syringes as a result it affects the effectiveness of vaccines management					
8	Open Pit or Incinerators are not used in the disposal of waste products as a result it affects the effectiveness of vaccines management					

Please mention any other factors that would highly affects the effectiveness of vaccines management in your Health facility_____

Thanks.