

How to optimize Immunization Supply Management at different levels of the health system in Oromia Region? An implementation science research

Berhanu Fikadie Endehabtu^{1#*}, Yohannes Lakew^{2#}, Bezuayehu Tegegn³, Tekalign Morka⁴, Zeleke Abebaw Mekonnen⁵, Alemayehu Teklu⁶, Asm Shahabuddin⁷, Rajeev Gera⁸, Binyam Tilahun¹

Abstract

Background: In programs like immunization having strong supply management is important to benefit all the necessary inputs of the health system. In Ethiopia, it has been found, that vaccine availability at service delivery points is low. Moreover, the implementation barriers related to Immunization Supply Management are vague at each level of the health system.

Aim: This study aimed to explore the practice, barriers and alternative strategies related to immunization supply management in the Oromia region, west Ethiopia.

Methods: A phenomenological qualitative approach was used. The data was collected using interview guides among 27 key informants from health posts, health centers, woreda health office, regional hub and Ethiopian Pharmaceutical supply Agency from June 15 to July 10, 2020. All the audio data were independently transcribed verbatim from Amharic and Afaan Oromo languages after repeatedly listening to the records and then translated into the English. The translated transcription documents were imported into Open Code software 4.02 for the purpose of coding. The coding was performed by three experts independently. Thematic analysis was utilized for the analysis of the data.

Results: The immunization supply management practices were categorized into three themes: Vaccine forecast, vaccine request & delivery and stock management of vaccines. Organizational (lack of reviewing processes, lack of transportation, lack of refrigerators, interrupted power supply, absence of vaccine forecasting team, unavailability of performance evaluation reports and lack of electricity), technical (lack of standard ledger book and lack of vaccine requisition form) and behavioral (lack of accountability, skill gaps and negligence) barriers were the main determinants that affect vaccine availability. The alternative strategies to optimize the ISM include local data-based forecasting, direct delivery of the vaccine to health facilities, transforming the ISM through digitalization and to establish accountability.

Conclusion: This study showed that the existing immunization supply management practice is not optimal. Organizational, technical, and behavioral barriers were the identified determinants for low availability. Therefore, program managers and policymakers should emphasize addressing the identified barriers and tailoring the alternative strategies to ensure the availability of vaccines at the point of service delivery. [*Ethiop. J. Health Dev.* 2021; 35(SI-3):65-74]

Keywords: Immunization, Implementation research, Supply Management, Health system, Ethiopia

Background

In the past two decades, the government of Ethiopia has invested heavily in health system strengthening guided by its policies and strategies, resulting in significant gains in improving the health status of Ethiopians(1). As a result, the country met most of the Millennium Development Goal (MDG) targets related to child health. The coverage of immunization showed significant improvement from time to time. According to the min EDHS 2019 report, coverage for specific vaccines indicates 76% of children had received the penta1 vaccine, and 59% had received the measles vaccine. However, only 61% received the third dose of penta3, and only 43% of them were fully vaccinated, reflecting a high dropout rate of 15% and 33%, respectively(2). Even though Penta and polio vaccines are often routinely administered simultaneously, polio coverage is slightly higher than Penta coverage at 78% and 76%, respectively(2).

The Ethiopian health system is decentralized with a three-tier health care delivery system as primary, secondary, and tertiary care. The supply chain and logistic system is one of the six building blocks of the health system. Therefore, improving supply chain and logistics management is one of the strategic objectives of the Health sector transformation plan (HSTP) to deliver the right quality product, the right quantities, in the right condition to the right place and at the right time(1).

In Ethiopia, the procurement, storage and distribution of all the medical and medical-related products, including vaccines, is carried out by Ethiopian Pharmaceutical Supply Agency (EPSA)(3,4). District logistics also coordinates and manages their respective District immunization supply management and hierarchically health facilities must manage their own

^{1#*} Department of Health Informatics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar Ethiopia

^{2#} Maternal and Child Health Directorate, Ministry of Health, Addis Ababa, Ethiopia

³ Ethiopian Pharmaceutical Supply Agency, Addis Ababa, Ethiopia

⁴ Harari Regional Health Bureau, Harari, Ethiopia

⁵ Health System Strengthening Directorate, Ministry of Health, Addis Ababa, Ethiopia

⁶ Department of Pediatrics and Child Health, University of Gondar, Gondar, Ethiopia

⁷ Primary Health Care-Health Systems Strengthening Unit, UNICEF New York, USA

⁸ Immunization and Emergency Program, UNICEF, Addis Ababa, Ethiopia

Equal contributors *Corresponding author

immunization supply. Immunization supply management comprises of different critical activities, like vaccine forecasting, requesting, delivery, storage, vaccine management, monitoring and others. Vaccine forecasting and vaccine requests are made by health facilities and submitted to the district health office within a specified time. The district health office compiles all the respective health facilities data and submits it to hubs. Finally, the hubs compile and submit the request to EPSA(4)(5).

Having strong vaccine supply management is one of the strategies to ensure the availability of quality vaccines and immunization supplies for effective program delivery to achieve high immunization coverage(6)(7).

Shreds of evidence showed that Poor vaccine stock management, Vaccine supply interruptions, Delay in Shipment of supply, high wastage of Vaccines and poor forecasting are the contributing factors for the low coverage of child immunization services(8). Furthermore, even if vaccine supply chain management has received increasing attention in recent years, research has found that there is low availability of vaccine supplies at the service delivery point(9). Every country is expected to have a minimum score of 80% for stock management(10). However, findings from 2019 EVMA indicated that this criterion's score falls short of the 80% minimum score set for countries to achieve at each level of the health system (77%, 56% and 46% at national, district level and health facility level(11). In addition, according to the 2018 Service Availability and Readiness Assessment (SARA) findings, DPT, -HiB, +HepB vaccine, BCG vaccine, Rotavirus vaccine, measles vaccine, oral polio vaccine, and Pneumococcal vaccine at health facility level was on average 30%(9).

The overall theory of this research is that, understanding the existing ISM and exploring the barriers at multilevel and multi stakeholder perspectives will help for quality vaccine forecast, excellent stock management and quality vaccine request and clear context-based vaccine distribution strategies will reduce inadequate vaccine stock and in turn strengthen the overall ISM system.

However, the implementation barriers related to immunization supply management are vague at each level of the Ethiopian health system.

Therefore, the current study is envisioned to clearly explore the practice, challenges and alternative strategies related to immunization supply management in the Oromia region, west Ethiopia.

Methodology

Study design and setting:

A phenomenological study design was employed from June 15-to July 10/2020. The study was conducted at Adama Hub, at selected health centers and health posts found in Ade'a, Lume, Tiyo and Hitosa woreda, and the respective woreda health offices and EPSA.

Sample: The study group comprised of key informants from the EPSA, Adama regional HUB, woreda health office, health centers and health posts in East Shoa and Arsi zone, Oromia- regional state, West Ethiopia. The key informants were EPI focal personnel, HEWs, EPI experts, health center heads, woreda health office heads and logistics management experts.

A purposive sampling method was used to recruit participants for key-informant interviews. The number of participants interviewed was determined by information saturation. Thus, 27 participants for the key-informant interview were included in the study.

Also, a total of twenty-eight health posts, eight health centers, four woreda health offices found in East Shoa and Arsi zone, Oromia- regional state, Adama regional hub and EPSA were included for observational checklist.

Data collection tools and procedure:

Implementation was assessed according to the extent that the care providers, EPI focal personnel and Supply chain managers practiced on immunization supply management at all levels in the region. Semi-structured interview guides were used, which were prepared in English and translated to Amharic and afaan Oromo (local language of the study area) to elicit details of the data through probes. The interview guide was developed based on literatures related to the research questions. The guide was developed in a way that it captures their perception on the practice, barriers, and alternative strategies for immunization supply management. We have also used an observational checklist to assess the stock availability of vaccines.

Data collectors and supervisors were trained for two days. The data collectors were pharmacist and logistics management professionals who worked at EPSA and the supervisors were EPI experts who worked at the Ministry of health and regional health Bureau.

The data collection tool was pre-tested for relevance and understanding before the actual data collection and revision had been done accordingly. The interviews were tape-recorded and there was a designated note-taker to make sure we had summarized the ideas during the interview sessions. During interviews probing questions were forwarded to participants based on information we acquired from previous interviews and on responses that participants forwarded during interviews to explore the issues. Moreover, if discussions emerged out of order, participants were directed to the discussion point, through probing questions. Each of the key informant interviews on average took 40 minutes.

During data collection, close follow-up and supervision was done on a regular basis. The principal investigators ensured data quality assurance along with data collection supervisors. Data access was limited to those were directly working with the data. The electronic version of the documents was kept in a password-protected computer. The principal investigator was

responsible for data management and data quality assurance mechanisms throughout the research period.

Data management and analysis:

Three researchers conducted the data analysis. All the researchers were well experienced in qualitative data analysis. All the audio data was independently transcribed verbatim to Amharic and Afaan Oromo languages after repeatedly listening to the records and then translated into English. The translated transcription documents were imported into Open Code software 4.02 for the purpose of coding. The coding was performed by three researchers independently. The constructed codes were operationally defined, variations were captured. We checked the completeness and presence of sufficient data for each category. We employed a matrix for data reduction after sorting out non-essential data to answer our objectives. Interpretation and analysis were conducted using framework analysis to assess current practice, barriers and recommended alternative immunization supply management implementation strategies.

Ethical considerations:

Ethical approval for this research was obtained from the Institutional Ethical Review Board of the University of Gondar. Also, support letters were

obtained from respective bodies in the health system. Furthermore, the research participants were given comprehensive information about the objectives and procedures of the study and informed consent was obtained from each study participant. Interviews were conducted at allocated times that were convenient for the key informants to ensure their privacy and confidentiality.

Electronic and hard copy data files were securely stored in locked cabinets in a limited access area. Only the research team members had access to the data.

Result

Participants' characteristics

A total of twenty- seven key informants responded to the interviews. Of which, twenty were females. The participants' age ranges were from 26 to 39 years of age. Among the participants, thirteen were health extension workers, seven nurses, five health officers and two pharmacists. Twelve participants were diploma (level-IV training) holders, and six of the participants possess certificates (level-III in health extension program). The participants' experience ranged from 3 years to 16 years (the details are presented in table 1).

Table 1: Characteristics of study participants in Oromia region west Ethiopia, 2020

Characteristics	Frequency	
Sex	M	7
	F	20
Age	25-29	5
	30-34	11
	≥35	11
Profession	HEW	13
	Nurse	7
	Health officer	5
	Pharmacist	2
Educational status	Certificate Level- IV	7
	Diploma	12
	BSc	7
	Masters	1
Work experience	≤5 years	3
	5-10 years	7
	≥10 Years	17

Current Immunization supply management practices

The immunization supply management practices were categorized into three themes: Vaccine forecast, vaccine request & delivery and stock management of vaccines.

Forecasting practice

Majority of the study participants stated that the number of vaccine doses, diluents and syringes needed for a particular target population over a specified supply period is all about forecasting. Most of the study participants described that determining the adequate vaccine needed is crucial, because it allows us to manage the immunization programme efficiently

and effectively and, the procurement of the required immunization supply also depends on reliable vaccine forecasting. At each health system level, a vaccine forecasting team is expected to be established to forecast a reliable account of vaccines needed. However, in most health centers, district health offices, and all health posts, a vaccine forecasting team which is dedicated to conduct vaccine forecasting was not established. Due to this, in most health facilities, the forecasting activity was done by the EPI focal personnel alone.

A 28-year female clinical nurse from the health center elaborated that.

"There is not a team established and lack of teamwork and lack of commitment to do the forecasting in the group. I am the only one who is going to do the forecasting process. The other health workers were not cooperative to do the vaccine forecasting".

A 38-year female EPI focal at district health office mentioned that.

"In previous time we were participated at woreda base planning because EPI is the duty of MCH but for the last two year only the plan officer and HMIS expert were the only participants for the vaccine orientation and they are going to give orientation for the health center head and district health office at district level and they are supposed to plan together including all the offices then verified by the management team of the district health office".

In most health centers and district health offices, the annual immunization performance, annual vaccine and supplies utilization, annual dry supply utilization was not reviewed. Out of the eight health centers, only two of them calculated and reviewed the annual unopened and opened vial wastage for each vaccine.

Also, the vaccine forecast plan was not submitted timely to the respective body. Except for one health post and one health center, all health posts, health centers, and district health offices calculated their target population for immunization services.

During forecasting, Target population (the conversion factor), actual beneficiaries, vaccine wastage rate, immunization performance and actual utilization/consumption of vaccine were considered.

Mostly the district health offices and health facilities planned (forecast) their annual vaccine demand based on the target populations (the conversion factor) given by the higher level of the health system.

A 39-year-old male EPI focal from the district health office stated that;

"Vaccine forecasting can be done in different ways. There are three methods to forecast vaccines. The first one is the target population method. The second one is previous vaccine consumption ... how much did we consume vaccine in the last year, then we determine how much will be consumed for this year. The other is the number of session methods, how many sessions will be, and how many children will be vaccinated from one session. Currently, as standard, we are using the target population method."

A 39-year-old health center EPI focal complimented that;

"For vaccine forecasting, we depend on the total population and the eligible population. The total population for Oromia had been given based on the census for all the districts. We have received the total population based on the indicators give during the district base plan. Once we have the total number of the

population, we can forecast the needed amount of all types of vaccine for the year, quarter, month and weekly as well."

Many respondents mentioned that using the target population in the forecasting exercise can contribute to vaccine wastage or shortage. In addition, since the total population at a higher level of the health system is not updated every year, the target population can be lower or higher than the target population at lower level of the health system.

A 32-year-old health extension worker elaborated that;

"When we use the target population for forecasting, the actual beneficiaries can be higher or lower than what we plan; as a result, the vaccine we forecast... sometimes higher than planned and sometimes lower than planned. So, when we use actual beneficiaries, it prevents from stock out and vaccine damage. For example, there is model kebele called Hate they update their population and know how many mothers are pregnant and know their children and, they know their catchment population and will take vaccine based on the actual population."

A 29-year-old EPI expert from EPSA reported that;

"... mainly data quality is the biggest challenge, the data we get from ministry target population and consumption data is not matched and we do not have actual wastage data of our own country. We use the WHO indicative wastage rate for the calculation. These are the two basic data challenge that affects the forecasting and planning."

Vaccine Requisition and Delivery practices

Using the Vaccine Requisition Form (VRF) at the service delivery point and administrative level is one of the critical components of vaccine requisition procedures to conduct quality vaccine requisitions in standard ways. The vaccine requisition form VRF is not available at all health posts and some health centers. Almost all health posts and some health centers didn't calculate vaccine consumption using vaccine requisition forms (VRF). As a result, the monthly vaccine utilization and vaccine wastage rate status was unknown in all health posts and most health centers. Also, the monthly vaccine and dry supply consumption were not calculated across all health posts and most health centers.

Almost all health posts request vaccine and vaccine supply need orally from the health centers or district health offices, then the health center or district health office delivers the required amounts of vaccine and vaccine supplies to the health posts.

A 33-year-old Health extension worker reported that;

"The health center freezing the vaccine properly for each health post, I am going to ask the health center orally the amount of the vaccine for each antigen, including the syringe. After putting my signature, I can collect the vaccine from the health center for the specific immunization session. After the immunization

session, I can put the remaining vaccines and supplies either in cold box or fridge, vaccine carrier....."

A 34-year-old HEW complemented that.

"There is no vaccine requisition form at our health post. We [Health center personnel] have asked to submit our request, but we didn't do that. We simply request the needed amount of vaccine and vaccine supplies orally from the health centers, and the EPI focal person from the health center delivers the vaccine and vaccine supplies based on our oral request. Then we receive a vaccine using a vaccine carrier for the specific day of the vaccine, and the remaining/the extra/ vaccine at the end of the vaccination day would be returned back to the health center to minimize the wastage rate."

On the other hand, some health centers and district health offices use the vaccine requisition form to request vaccine, dry supply, and diluent.

A 28-year-old EPI focal reported that;

"I use the ledger book that contains vaccine, dry supply and diluent to record the vaccines, dry supply and diluent. I have received and distributed the health post and calculated my balance to take the ending balance for VRF. On the VRF, I consider the beginning balance, take the end balance from the ledger book, and then calculate how much I need. On the VRF, there are data elements that must be filled, and I fill the request form, get signed and go to the district health office. The district health office EPI focal person receives my request and review to resupply based on the request. Finally, I will update my balance on the ledger book."

Mainly the vaccines are collected by lower levels of the health system from respective higher levels. Health centers collected vaccines from the district health offices monthly, and health posts from health centers. Health extension workers receive a vaccine and return the remaining vaccines back to the health center to minimize the wastage rate.

A 33-year-old Health Extension worker reported that;

"The vaccine is collected from the cluster health centers by the health extension workers. No one transports the vaccine from the health center to the health post. We the HEW are the only responsible body to transport the vaccine from the health center and back to the health center after the immunization session day."

Stock management practices

It is expected that a standard vaccine ledger book be available at each level of the immunization supply system. However, we found that almost all health posts had no standard vaccine ledger book containing vaccines, dry supply, and diluent in this study.

Almost all health posts did not update their vaccine stock status during receiving, issuing, and transferring this activity. Also, none of the health posts calculated the monthly minimum and maximum vaccine stock status. In most health centers, standard vaccine ledger

books containing vaccines, dry supply and diluent are available. Only some health centers updated their vaccine stock status during receiving, issuing, and transferring. Also, few of the health centers calculated the monthly minimum and maximum vaccine stock status. Only half of the health centers used the vaccine ledger book as a source document for vaccine requisition and the ledger book was filled as per the standard.

Nearly all health posts had no refrigerators to store vaccines and diluents at service delivery points and couldn't manage their vaccine stock status. Instead, they simply request the needed vaccines, diluents and dry supplies for a single immunization session and return the remaining supplies after the session.

A 37-year-old HEW reported that;

"We receive vaccines and diluents using a vaccine carrier for the specific day of the vaccine, and the remaining/ extra vaccine at the end of the vaccination session will be returned back to the health center to minimize the wastage rate. We did this because we have not refrigerators at our health post. If we have a refrigerator, we can have appropriate stock of vaccines and get refilled monthly, and we can have vaccination service every day to the community. Also, it will minimize frequent travelling to district health offices and health centers for vaccine refill. Sometimes the EPI focal at district may not be available due to training/meeting. Due to this, we may be forced to postpone the vaccination schedule for another day which in return makes mothers go back to home without vaccinating their children."

Barriers for vaccine availability at service delivery points

Out of the respondents, most of them mentioned that they have experienced inadequate vaccine stock. The factors that contributed to the low availability of vaccines at the point of service delivery are organizational, technical, and Behavioral factors.

Organizational Factors

Lack of reviewing processes, inadequate supportive supervision, inaccessible transportation, lack of a refrigerator, interrupted power supply (electricity and/or kerosene), unestablished vaccine forecast team, and unavailability of performance evaluation reports were the organizational factors mentioned by the respondents which affect the availability of vaccines at service delivery points.

A functional refrigerator with a power supply is one of the critical inputs to increase the availability of vaccines and diluents at the point of service delivery. However, almost all key informants from health posts and health centers included in this study claimed the absence of a refrigerator at the health post level, which contributed to the unavailability of vaccines at the point of service delivery.

A 37-year-old HEW mentioned that;

"If we have a refrigerator, we can have appropriate stock of vaccine and get refilled monthly, and we can have vaccination service every day to the community."

Also, it will minimize frequent travelling to the district health office and health centers for vaccine refills. Sometimes the EPI focal at district may not be available due to training/meeting. Due to this, we may be forced to postpone the vaccination schedule for another day which in return makes mothers go back to home without vaccinating their children."

A 28-year-old EPI focal from the health center complemented that;

"Since we have many health posts under the catchment, it is difficult to prepare enough ice packs for health posts. Due to this, sometimes they [Health Extension workers] return without the vaccine, and the immunization session might be interrupted. It will be good to equip the health posts to have the minimum vaccine at the health post level."

A 34-year-old HEW also reported that;

"We collect vaccines from health center using vaccine carrier and foam pad. Then we go to the immunization site to vaccinate children on the day, and then we return the leftover vaccine on the same day. So sometimes, we may not get a vaccine on the same day. This is a challenge and increases the dropout rate due to absence of vaccine all the time at the health post; because there is no refrigerator at the health post."

Also, respondents mentioned that the target population is one factor that affects the availability of vaccines at the service delivery point. Mainly the forecasting is done based on the conversion factor given by the higher officials and which can directly affect the availability of vaccines, diluents, and dry supplies at the point of service delivery.

A39 years old Clinical Nurse reported that;

"We are forced to use the target population calculated by the conversion factor to forecast the vaccines, diluents and dry supplies. But the target population calculated by the conversion factor varies every year and from place to place and the forecasting relies on this number, which might lead to vaccine shortage or overage."

A34-year-old HEW supplemented with;

"There is a big difference between the actual population and the target population calculated by conversion factor. We reported many times about the issue, but the higher officials do not accept it. Therefore, I think it is good to forecast the vaccines based on the kebele data. We request vaccine and vaccine supplies based on the actual number of children to be vaccinated on the specific vaccination schedule. E.g. if the plan says 14 children and if the actual children are 20, I collect 20 vaccines for the specific session."

The other major challenges faced by most health extension workers included mobility (lack of transportation and long-distance).

A34-year-old HEW reported that;

"We [HEW] are the ones responsible for collecting the vaccines and dry supplies to the health post during the immunization session day. We [HEW] use public transport, and the transport access is not easy. I carry

full of vaccine carriers and can't scramble bus seats because people are very crowded to scramble bus seats. Sometimes we wait for more than six hours to get transportation. People blame me that she is out of the office today. The mothers wait for us for a long period, and they return back to home without vaccinating their children."

Also, lack of trained staff to maintain refrigerators, is mentioned as organizational factors.

Technical factors

Lack of standard ledger book and lack of vaccine requisition forms are mentioned as technical factors by the respondents, which can affect vaccine availability at point of service delivery. It is expected that standard vaccine ledger books be available at each level of the immunization supply system to update the vaccine status. Also, each service delivery unit is expected to use the vaccine requisition form to request vaccines and dry supplies. However, in this study, we found that almost all health posts had no standard vaccine ledger book to update their vaccine stock status during receiving, issuing, and transferring, as well as vaccine requisition forms to request vaccines.

A34-year-old HEW mentioned that;

"We are asked to submit our vaccine request need using requisition form. But we don't do that because the form is not available in our health post. We simply request orally the amount of vaccine we need and collect."

Behavioral

Lack of accountability skill gap and negligence are reported as individual determinants that affect the availability of vaccines at the lower level of the health system.

Alternative strategies to optimize immunization supply management

Several interventions were designed and used to ensure quality of vaccines, to ensure availability of adequate quantities of vaccines, diluent, syringes, and needles, to provide uninterrupted implementation of immunization activities, to maintain proper handling and storage conditions, to ensure adequate cold store capacity for vaccines at recommended storage temperatures and adequate dry store capacity for injection supplies. In this study, four main alternative strategies were suggested to optimize the immunization supply management at different levels of the health system in the Oromia region of Ethiopia.

Local data-based forecasting

Effective immunization supply management requires accurate vaccine forecasting or planning. The forecasting can be based upon target population, previous consumption, and number of immunizations required. The accuracy of the forecasting depends upon the quality of data used. In this study, the forecasting should be based on the actual number of children that will be vaccinated. The study participants mentioned that while forecasting, the actual data that is collected

at the community level should be used to forecast vaccines.

A 35-year-old health extension worker elaborated that; *"...there is a huge difference between the target population and the actual beneficiaries, which is difficult for the monthly monitoring of our performance. Since we implemented a community health information system, we have the total number of HH, <1year and others at the grass-root level...looking for the exact number from the kebele by updating the family data helps to have the actual number of children and mothers to be vaccinated. If the forecasting is done based on the actual number, we may not have vaccine overage or shortage at the point of service delivery and helps monitor the performance."*

A 32-year-old health extension worker also complemented that;

"When we use the target population for forecasting, the actual beneficiaries can be higher than or lower than what we plan; as a result, the vaccine... sometimes higher than planned and sometimes lower than planned. When we use actual beneficiaries, it prevents from stock out and vaccine damage. For example, there is model kebele called Hate they update their population and know how much mothers are pregnant and know their children as well and know their population and will take vaccine based on their population."

Direct Vaccine delivery to Health facilities

The vaccine delivery mechanism is crucial to ensure the availability of vaccines at the point of service delivery. The respondents mentioned that the lower-level health care providers working at the EPI units were responsible bodies to transport vaccines. Also, they reported that it is very tedious for the health workers working at EPI. Therefore, the respondents suggested that EPSA should directly deliver to the health facilities and the health center should deliver to health posts. Health extension workers also suggested that the health center should have a transportation mechanism to deliver vaccines to health posts.

A 34-year-old health extension worker reported that;

"The higher-level officials consider that health extension workers are the responsible body to collect the vaccine from the health center or district health office. They (district and health center personnel) don't worry about how we transport the vaccines. There is a severe transportation problem, and we are very much concerned about protecting vaccines from sunlight during transportation. I used my umbrella to protect the vaccine from sunlight. Sometimes we may not avail of the vaccine on time for the immunization session. The district and health centers have better transportation access and should deliver the vaccine to the health posts based on the immunization schedule."

A 29-year-old EPI focal also reported that;

"...we are travelling the vaccine from the district health offices, most of the time the travelling cost is covered by ourselves. We are using public

transportation, which may expose the vaccine for sunlight, and the quality and safety will be in question. If the vaccine is delivered directly, we will not lose our time by transporting the vaccines and will have more time for our clients."

Transforming the ISM through digitalization

In addition to the existing immunization supply management practices, digitizing the system was suggested by study participants. For this, digitalizing the documentation for forecasting, requesting, and stock management and upscale of the existing application of digital technologies are among the alternative strategies to optimize the immunization supply management to ensure the availability of vaccines at the point of service delivery.

A 37-year-old EPI focal from the district health office reported that;

"Currently vaccines are managed by EPSA, district health offices and by the lower level. The management of vaccines at the lower level has many challenges. At some health, facility vaccines are not considered as other drugs even if they are costly. They (health facilities) did not even use models 19 and 22 while receiving and issuing the vaccine. Implementing mBrana at the district health office-level helps us for proper stock management and physical inventory every month. Before preparing the request, analyze the balance using mBrana and the physical stock. If any difference is observed, the reason for the difference will be noted, and an adjustment will be made to the system. Therefore, to improve the stock management, digitizing the system and scalp up of mBrana at health centers is very important."

A 35-year-old pharmacist from HUB supplemented that;

"Using the paper-based recoding has many problems like facilities will not submit simultaneously, which is difficult to plan the routes, calculation errors, and illegibility problems. Most district health offices avoided these problems by implementing mBrana. So, implementing mBrana can improve reporting timeliness and avoid calculation errors to avail the right quantity of vaccine at the right time."

Establishing Accountability mechanisms

The immunization supply at the lower levels (Health centers and Health posts) were issued or received through vouchers, and vaccines are not auditable like other pharmaceutical commodities. They simply requested vaccines and received whatever they required and returned what was not of use to them as per their personal willingness. Therefore, there is not an accountable system designed to solve this challenge. Therefore, establishing accountability mechanisms on immunization supply systems will complement alternative solutions to mitigate the problems.

Discussion

This study found that the current immunization supply management practices are suboptimal. Barriers to vaccine availability at service delivery points in the existing immunization supply management includes

organizational barriers (lack of a reviewing process, lack of supportive supervision, lack of transportation, lack of refrigerators, interrupted power supply, absence of vaccine forecasting teams, the lack of target population based forecasting, unavailability of performance evaluation reports and untrained staff), technical (lack of standard ledger books and the lack of vaccine requisition forms) and behavioral (lack of accountability, skill gaps and negligence). The alternative strategies to optimize the immunization supply management includes conducting forecasting using the actual population at the lower level, direct delivery of vaccines by EPSA for service delivery, digitalization of the supply management system and ensuring accountability mechanisms.

This study found that the current immunization supply management practices are suboptimal to ensure vaccine availability at the point of service delivery and this affects the immunization coverage. In addition, this study showed that most of the health facilities were experiencing a shortage of stock for at least one antigen. A finding from this study is supported by other studies done in India (12). Every country is expected to have a minimum score of 80% for a composite score of effective vaccine management(10). The Service Availability and Readiness Assessment (SARA) findings of 2018 indicated that the availability of DPT, -HiB, +HepB vaccine, BCG vaccine, Rotavirus vaccine Measles vaccine, Oral polio vaccine, and Pneumococcal vaccine at a health facility level was on average 30%(9).

Findings from this study indicated that the stock management practices were suboptimal. For example, it is expected that standard vaccine ledger books be available at each level of the immunization supply system. However, we found that a significant number of health posts had no standard vaccine ledger book containing vaccines, dry supply, and diluent in this study. Also, all EPI service delivery points and administration offices are expected to update their vaccine stock status during receiving, issuing and transferring(13). But none of the health posts did this, and none of the health posts calculated the monthly minimum and maximum vaccine stock status. This can contribute to the inadequate supply of vaccines at the points of service delivery(14).

This study also found that only half of the health centers use the vaccine ledger book as a source document for vaccine requisition, and that the ledger book is not filled appropriately according to the guidelines. The time between the date of requesting vaccines, diluents and dry supplies and the date when the facilities collect them may not be as efficient as they are required to be. There may be an increase in vaccine demand that we want to respond to quickly for requests, but we may find unexpected delays in refilling. Therefore, health facilities, health posts and district health offices and hubs should always be ready to keep a minimum amount of vaccine in stock.

Nearly all health posts had no refrigerators to store vaccines and diluents at service delivery points and

could not manage their vaccine supplies. They simply requested the necessary vaccines, diluents and dry supplies for a single immunization session and returned the remaining supplies after the session. Findings from the SARA 2018 report of Ethiopia indicated that only 14% of health posts had refrigerators(9) and a study conducted in East Gojjam indicated that some health facilities had no functional refrigerators(15).

In this study, the lack of supportive supervision was mentioned as one of the determinants for unavailability of vaccines and essential dry items. This finding is supported by a study conducted at districts in India (16). So, the supportive supervision must be strengthened, by focusing on, vaccine stock, updating the stock status, vaccine handling and waste handling.

This study indicated that the forecasting process is based on the target population provided by the higher officials. This is one of the determinants that affect the availability of vaccines at point of service delivery. Vaccine forecasting based on the data collected at the grassroots level is one of the suggestions recommended by the study participants to forecast vaccines at the lower level. So, the accuracy of vaccine forecasting depends on the implementation and quality of data used(17).

This study revealed that the lack of trained staff on vaccine supply management is one of the barriers for unavailability of vaccines and dry supplies. This finding is supported by studies conducted in Ghana(18), Nigeria(19) and Ethiopia(20).

This study revealed that the vaccines are mainly collected by the facilities from higher levels either monthly or based on the immunization schedule. Sometimes the vaccines may not be available at the higher level. As a result, the immunization session might be postponed, this finding is supported by a study conducted in India(21). So, direct delivery of the vaccines to the health facilities is among the alternative strategies suggested by the study participants. Respondents mentioned that direct delivery of vaccines, diluent, and dry vaccine supplies would save healthcare providers time, which can be used to provide efficient service delivery to their patients., this finding is consistent with research conducted in relation to the topic (22,23).

Digitizing the immunization supply management is another alternative strategy recommended by the study participants. This recommendation is in line with the strategies designed by the ministry of health of Ethiopia to transform the immunization supply chain management(12,24–26).

This study provides an insight for program managers and policymakers in designing and implementing additional strategies to strengthen the immunization supply management practice based on the identified potential barriers for the availability of vaccines at the point of service delivery.

Practical Implications

Complex health system barriers to vaccine availability exist at the lower level of the health system. Designing additional strategies to address the identified potential barriers and implementing alternative strategies to strengthen the ISM practice is paramount. Direct delivery of the vaccine to health facilities will minimize the delay and ensure the availability of vaccine and vaccine-related supplies at the point of service delivery.

Transforming the immunization supply management system through digitalization and establish accountability mechanisms should be considered.

Besides, local data-based forecasting is one of the future strategies to optimize the immunization supply management of Ethiopia.

This study provides an insight for program managers and policymakers in designing and implementing additional strategies, and addressing these based on the potential identified gaps, to strengthen the ISM practice is paramount to ensure vaccine availability at points of service delivery.

Strengths and limitations of the study

This study has the following strengths and limitations. The study included a diverse sample of participants. Self-reported data could be subject to social desirability bias, and thus, participants may have exaggerated their responses.

Conclusion

This study indicated that the current immunization supply management is suboptimal to contest the immunization demand and can't ensure the availability of the required vaccines at the point of service delivery, thus affecting the immunization coverage. Lack of a reviewing process, lack of supportive supervision, lack of transportation, lack of a refrigerator, interrupted power supply, poor forecasting practices, unavailability of a performance evaluation report, lack of electricity, lack of a standard ledger book, lack of vaccine requisition forms, lack of trained staff, skill gaps and negligence were the main barriers hindering the availability of vaccines at points of service delivery.

Local data-based forecasting, direct delivery of vaccines to health facilities, and the transformation of the immunization supply management system through digitalization and the establishment of accountability mechanisms are the main strategies.

Therefore, program managers and policymakers should emphasize addressing the identified barriers and tailoring the immunization supply management strategies to ensure the availability of vaccines at the point of service delivery.

List of abbreviations

CSA: Central Statistical Agency; EDHS: Ethiopian Demographic and Health Survey; EPSA: Ethiopian Pharmaceutical Supply Agency, EPI: Expanded Program on Immunization; ISM: Immunization Supply

Management; FMOH: Federal Ministry of Health; HSTP: Health sector transformation plan; MDG: Millennium Development Goals; SARA: Service Availability and Readiness Assessment; VRF: vaccine requisition report.

Declarations***Ethical approval and consent to participate***

This research was approved by the Institutional Review Board of the University of Gondar and received ethical clearance. Besides, study permission was obtained at each level of the health system. Finally, written informed consent was obtained from each study participant.

Availability of data and materials

Data will be available upon reasonable request from the corresponding author

Competing interests

All authors approved that they have no conflict of interest

Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current Journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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