Original article

Cold chain management: Knowledge and practices in primary health care facilities in Niassa, Mozambique

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Abstract

Background: To maintain vaccines perfectly conserved from its manufacture through administration requires an adequate could chain infrastructure. At the end of the chain, primary health care providers must have adequate knowledge to manage the cold chain.

Objective: The study describes an observed audit of the Expanded Program on Immunization (EPI) in Niassa province of Mozambique.

Methods: Data collection methods included questionnaires, observations and document analysis in 44 health facilities, 12 of which in district capitals, and the remaining 32 in peripheral health facilities in Niassa province.

Findings: The results show that the principal explanatory variable for the inadequacies of the system was the location of the health facility as health workers in the peripheral health facilities were in general less educated, had less work experience and their knowledge of cold chain was not as per required levels to support effective cold chain management.

Conclusions: The study strongly indicates the need to improve and integrate the knowledge and practices on cold chain management, especially to the peripheral level workers, by providing them with adequate training and supervision, and demonstrating how that can be effectively integrated with practice. [*Ethiop.J.Health Dev.* 2007;21(2):130-135]

Introduction

To maintain vaccines perfectly conserved from its manufacture through administration requires an adequate cold chain infrastructure, compliance to standards and effective management. At the end of the chain, primary health care providers must have adequate knowledge to manage the cold chain (1-3). To improve management, the World Health Organization (WHO) has created a set of practice guidelines for different service levels, which include immunization techniques, vaccine monitoring, cold chain management and reporting systems (3). For example, for the cold chain, these guidelines recommend: the vaccine storage in remote sites should be maintained in the temperature range of 2-8^{o}C, the use of minimum/maximum thermometers, temperature charts and the shake test (3,4). However, these guidelines are often practically quite difficult to implement in field situations due to various factors like infrastructure problems and work load pressures (5-10).

In Mozambique, the Expanded Program on Immunization (EPI) started in 1979 following a national immunization campaign aiming at smallpox eradication. For many years, EPI was characterized by donor dependence and vertical delivery structure. More recently, an abrupt break in donor support has made the Ministry of Health (MOH) to try and integrate EPI into the primary health care services in order to more effectively institutionalize the program (11). Limited human resource capacity has let the MOH to adopt a strategy where basic and elementary level personnel, major workforce at the most remote heal facilities, administer the EPI. Most of them had to cope with these newly assigned jobs without adequate training such as in cold chain management (12). This often contributes to the challenge of adhering to the WHO guidelines and standards for cold chain management.

Paradoxically while Mozambique has reported high immunization coverage rates (in some provinces above 100%), simultaneously however, there have also been reports of epidemics concerning vaccine preventable diseases (13-15). This paradox points to problems in the cold chain, from how it is managed, to how the reporting on service delivery or epidemics take place. We argue that gaps in knowledge between vaccine handling and conservation and their actual practices contribute to this paradox.

The focus of this paper is therefore to assess the knowledge and the practices of primary health care providers regarding cold chain management in one province of Mozambique (Niassa) in order to understand to what extent this gap in cold chain management can be a contributing factor to the paradox between high immunization coverage rates and the appearance of epidemics.

This study is part of an ongoing research initiative of the Health Information Systems Program (HISP) and as part the PhD studies of the first author. HISP is a joint collaborative project of the University of Oslo in Norway, the Eduardo Mondlane University (UEM) in Mozambique and South Africa (16, 17). Niassa was

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chosen because it is designated by the MOH as one of the pilot sites for the HISP implementation.

Methods

The study was conducted from January to March 2003 in Niassa, a northern province of Mozambique, which covers an area of approximately 129,000 km^2 and has a population of around 900,000 (18). Niassa is administratively divided into 16 health districts (including two towns that are considered as districts), all of which are managed by Paramedical staff. The typical health district in Niassa province has a main health facility at the district capital which, serves the catchment population of the district capital, and also acts as a referral facility for satellite health facilities which serve the rest of the district.

Routine vaccination is provided in Niassa through 63 fixed health facilities and also various outreach services. The cold chain is composed of one provincial depot, 16 district depots, and the health facilities fridges (19). The provincial depot stores vaccines for the whole province, and is responsible to distribute them to the different district directorates who then supply them to the various health facilities in their respective districts.

Provincial health staff carries out supervision visits to assess the functionality of the district level, while the district health office staff supervises the peripheral health facilities. Supervision visits (at all levels) takes place in an integrated manner, composed of program managers from the different health programs such as, pharmacy, maternal and child health, EPI and curative care. At the facility level, supervision visits last one or two days and the findings are recorded in a log book, where the supervisors note the common weaknesses and strengths of the health worker. The log book is intended to provide a basis for information recall by the health worker at the facility level, as well as a means for the supervisor to evaluate their performance, and take corrective measures. This study was approved by the Eduardo Mondlane University Research Committee.

For a better understanding of the health workers background, it is important to define some of the terminology used. By elementary level, it is understood as the staff that has completed 7 years of secondary school and one year of training on basic health care in a MOH institution. This group is selected directly from the community. The basic level consists of those with 10 years of secondary school education, and then the MOH provides further 18 to 20 months training on health care delivery in specific training schools run by the MOH (20).

The accessibility to districts and health service, the population distribution and the road infrastructure (poor), varies between the different geographical areas of the province. For example, during the rainy season when we carried out the study, accessibility was often limited to some districts and health facilities. To gain a provincial overview in the research, the issue of accessibility and geographical location were considered. Therefore, the 16 districts were stratified into tow groups: accessible with difficulty (3) and accessible (13). Using simple random sampling, we selected two out of three districts from the difficult-to access group, and 10 out of 13 from the accessible group. All health facilities providing immunization services in these districts were further included. From the total of 63 fixed health facilities providing immunization services, 44 were included (12/16 in district capitals and 32/47 outside).

Also, to be able to gain a more representative picture of the observations we thus selected one district from each of the four geographical regions. The northern district had only 1 fixed health facilities, while the eastern 2. The southern district had 4 fixed health facilities and the western 2. The sample thus included a total of 4 district depots and 9 fixed health facilities.

Both quantitative and qualitative approach to data collection has been used in this study. Quantitative data was collected using a questionnaire with both open and close ended questions, administered by the first author to the health workers responsible for EPI in each health facility. The questionnaires included questions on background information of the respondents and more specific ones related to knowledge regarding management of the cold chain including the recommended storage temperature range, the shake test and the effects of freezing DTP+HepB (diphtheria, tetanus, pertussis and hepatitis B) vaccines. It also included questions related to pre-service training in vaccine storage and handling, the presence (or not) of a procedures manual, and practices around feedback and supervision.

Qualitative data consisted of empirical observation of practices such as, the opening and closing the fridge, the presence of temperature charts, the reading of thermometers and the presence of other products than vaccines in the fridge. As the logbook constitutes a valuable source of information, it was carefully and empirically studied to identify issues related to information on cold chain management.

To assess vaccine distribution from the district to the health facility, the vaccine distribution and routine reports at the district level were reviewed by comparing the activities performed and the amount of vaccines physically received by the health facility. District depots located in the main health facility, were also observed to try and understand could chain practices at this level.

Quantitative data collected through the questionnaires were entered in a computer database, using as interface Epidata version 3.0 (The EpiData Association), and later converted into SPSS version 11 format (SPSS Inc.). Data were analyzed using descriptive statistics by computing frequencies and running cross-tabulations across the different variables, for example, comparing the location of the health facility (district capital or peripheral health facility) and the years of service to variables relating to knowledge about the cold chain.

Qualitative data were recorded as notes on hard copy and later entered in a world processor, where they were complied and categorized to reflect how the health workers are maintaining vaccine quality, for example, following recommended practice procedures. These are presented as "mini case studies" in the results section to help highlight the most critical findings. Information collected from the supervision log books was used as a basis to check if the entries in them related to cold chain storage (for example, how vaccines are stored) and handling (for example, if the temperature of the thermometers has been evaluated) were adequately addressed during the supervision visits.

Related to the distribution of vaccines, the average consumption for the past six months was calculated from the health facility reports and compared to the vaccine requests and distribution reports obtained from the district capitals. This comparison helped to understand how the process of vaccine distribution between the district depot and the facility took place.

Taking into consideration the analysis per location of the health facility, we found that the two districts with difficult accessibility were providing immunization activities only in the main health facility at the district headquarters. For that reason, an analysis per location was not considered.

Results

The study included 44 health workers from district capital (12) and peripheral (32) health facilities. 21 (48%) and 23 (52%) of the respondents were respectively elementary and basic level educated workers. More typically, workers had between 2 to 5 years (32%) of service in EPI and the newly assigned (23%) staff were located in peripheral health facilities (please see Table 1).

Table 1: **Overview of the study population, Niassa 2003**

	Frequency (n=44)		District (n=12)	Capital	Periphery (n=32)	
Level of Education						
Elementary	21	48%	4	33%	17	53%
Basic	23	52%	8	67%	15	47%
Years of Service						
< 1 year	10	23%	0	0%	10	31%
1-2 years	4	9%	1	8%	3	9%
2-5 years	14	32%	3	25%	11	34%
5-10 years	12	27%	6	50%	6	19%
>10 years	4	9%	2	17%	2	6%

Sixty one percent of respondents knew that freezing DPT+HepB vaccine causes it to lose potency (Table 2). Most of the health workers from the district capital knew this condition (92%), whereas only 50% of those from the peripheral facilities were aware of this. The recommended temperature range for vaccine storage was known by 52% of the respondents (67% in the district capital and 47% in the periphery) and the shake test was known by only four respondents.

Table 2: **Knowledge of vaccine storage and handling in Niassa Province, 2003**

	Frequency (n=44)		District (n=12)	Capital	Periphery (n=32)	
Effect of Freezing DTP						
Yes	27	61%	11	92%	16	50%
No	17	39%	1	8%	16	50%
Temperature Range						
Knows	23	52%	8	67%	16	47%
Don't Know	21	48%	4	33%	15	53%
Shake Test						
Knows	4	9%	2	17%	2	6%
Don't Know	40	91%	10	83%	30	94%

Approximately, 60% of the health workers had no pre-service training in vaccine storage and handling (see Table 3). Pre-service training was more common in the district capital workers (100%) compared to those in the periphery (19%). Forty three percent of the respondents had an EPI manual, 58% of which were in the district capital and 38% in the periphery (Table 3).

Feedback from the province to the district and from there to the health facility was based on monthly, quarterly and yearly reports. We found that in practice, feedback seldom occurred (only 32%), and 70% of the respondents had experienced some form of supervision (Table 3). Feedback was more common in the district capital (42%), whereas supervision was more frequent in the peripheral health facilities (75%). Supervision was seen by the health workers at the facility level as an opportunity to discuss their difficulties, to learn and to improve data analysis skills.

Table 3: **Pre-service training, feedback and supervision of health staff in Niassa Province, 2003**

	Frequency (n=44)		District Capital (n=12)		Periphery (n=32)	
Pre-Service Training						
Yes	18	41%	12	100%	6	19%
No	26	59%	0	0%	26	81%
Have EPI Manual						
Yes	19	43%	7	58%	12	39%
No	25	57%	5	42%	20	63%
Feedback						
Yes	14	32%	5	42%	9	28%
No	30	68%	7	58%	23	72%
Supervision						
Yes	31	70%	7	58%	24	75%
No	13	30%	5	42%	8	25%

Practices on cold chain management

The findings of this section are summarized in table 4. In one peripheral health facility, a midwife with elementary level education was found to be performing EPI activities. On the top of the fridge, there were temperature charts. In preparation for the immunization session, the health worker opened the fridge and removed the vaccines without looking at the thermometer reading. We immediately checked the temperature inside the fridge and it was -1^{o}C. Probing further into the problem, we found that the health worker did not know the effect of freezing on DPT+HepB vaccine or the use of the shake test. She did not have pre-service training in vaccine storage and handling but, had experienced two in-service training sessions followed by few supervision visits. On examining the supervision log book, no information was found related to vaccine storage and handling, either reporting problems or suggestions for improvements.

Table 4: **Summary of the observations in cold chain management in Niassa Province, 2003**

	Facilities (n=9)	Districts (n=4)
Level of education		
Elementary	7	0
Basic	2	2
Medium	0	2
Temperature Charts		
Yes	9	4
No	0	0
Reading Thermometer before immunization		
Yes	3	-
No	6	-
Supervision information on cold chain		
Yes	0	0
No	9	4
Temperature in the Fridge		
High	4	1
Normal	2	2
Low	3	1
Other products than vaccines in the fridge		
Yes	3	1
No	6	3

In one district depot, the fridge was managed by a health worker with basic level education who had been working with EPI for more than 10 years. The temperature in the district depot fridge was -5°C. After some discussion, we found that the last in-service training session on vaccine storage and handling had taken place five years ago, and that had not included the shake test. There was no information in the supervision log book regarding vaccine storage and handling.

In another district depot, we found that the fridge was shared between the EPI, the laboratory and the maternity sections. Besides vaccines, we found other products, including oxytocin and laboratory reagents in the fridge. We also observed that, with the intense work load of the laboratory, the fridge was constantly being opened and closed. The temperature reading was +18°C, much above that required for vaccine storage.

In two entire health districts, we could not find a single manual on cold chain procedures. In others, a quick guide (3 pages) produced by John Snow Incorporated was posted on the wall. The guide explained how to store vaccines, how to look at the polio vaccine vial monitor, and how to calculate the needed supply for the following month. Although we observed that about one third of the health facilities had this quick 3-page guide, the health workers had difficulty in correctly estimating vaccine orders. For example, one health facility requested and received 300 doses of measles vaccine for a specific month, while their usage, as inferred through an analysis of their periodic reports, indicated a consumption of a monthly average of 60 doses over the last 6 months.

Discussion

This study has shown that inadequate knowledge and practices exist regarding cold chain management in primary health care facilities in Niassa province, Mozambique. A common feature analyzed was that health staff at the district capital had a better knowledge than those working in the periphery. Nonetheless, apparently the staff at the district level failed to highlight knowledge of cold chain management issues during their supervision visits to peripheral health facilities.

The poor knowledge, for example, about the effect of freezing DPT+HepB vaccine, the shake test, the correct storage temperature range, and the observed inadequate vaccine storage practices, potentially adversely affected the quality of the administered vaccines opening spaces for epidemics due to vaccine preventable diseases. For example, one district depot where vaccines were stored at freezing temperatures, supplied nine peripheral health facilities. They had reported a whooping cough epidemic in 2001 while paradoxically simultaneously reporting a DPT coverage rate of over 100% (14, 21).

The study also revealed that training in cold chain management was weak and unevenly distributed between district capitals (more common) and the periphery (less common).Despite the fact that health staff in the district capitals benefited in having more in-service training sessions, there still was a knowledge and practice gaps in vaccine storage and handling within this group.

Shortage of manuals constituted another important finding of our study. Budget constraints have prevented the production of the new manual needed since the introduction of Hepatitis B vaccine EPI in June 2001 (11). As an interim measure, a three page guideline was produced, but was unevenly distributed amongst the health facilities contributing further to the knowledge and practice gaps in cold chain management.

Ideally, the fridge containing vaccines should not be used to store other products. However, our study showed that vaccines were sharing space with laboratory reagents and drugs and consequently it was difficult to maintain the required temperature ranges. This constraint has also been reported by some other studies in the context of cold chain management (8, 22, 23).

This article has focused on the knowledge and practices gaps in cold chain management in remote areas of Mozambique and highlights the ensuing challenges to implementing the EPI effectively. Key constraints identified include gaps in the knowledge about the management of the cold chain. The importance of training is the main finding and should be prioritized for the health staff, especially those at the most remote sites. Our finding corroborates with similar studies that have shown weaknesses in cold chain management of health workers in remote health facilities (5, 24). We therefore recommend continuous training and supportive supervision as the key measures to address the findings of this study.

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