

Cold Chain Status and Knowledge of Vaccine Providers at Primary Health Care of Units Bale Zone, Southeast Ethiopia: Cross-sectional Study

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Received date: October 29, 2017; Accepted date: February 12, 2018; Published date: February 16, 2018

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Abstract

Background: Despite of long history of Expand program of immunization service delivery and most countries in the world achieved immunization coverage of around 90% for DPT3 in 2010, still there is child mortality attributed to vaccine preventable disease which accounts 29% of world-wide. This problem is attributed to reduced vaccine potency due to failure in cold chain monitoring system. Cold chain monitoring is still a major challenge in developing countries including Ethiopia. The aim of this study was to assess cold chain status and knowledge of vaccine providers at primary health care units.

Methods: Institution based cross-sectional study design employed among 183 randomly selected primary health care units of Bale Zone, Southeast Ethiopia in November 2015. Data were collected by using observational checklist and interviewer administered questionnaire for vaccine providers. The data were entered into Epi-data 3.1 versions and transferred to SPSS version 21 for analysis. Descriptive analysis was used.

Results: Among 189 health facilities selected, 183 (96.83%) health facilities were visited during the period of data collection of which majority 146 (79.8%) were health posts. Only 56 (30.6%) health facilities had refrigerator. During data collection, out of 35 functional refrigerators, 20 (57.1%) had national cold chain monitoring guideline and only 14 (40%) were properly store vaccines. In 29 (82.86%) refrigerators thermometer showed temperature readings within the standard range (2°C-8°C). About 124 (67.8%) vaccine providers were responded correctly the recommended range of temperature for storage vaccine.

Conclusions: In general the study indicated that there were gap in maintaining cold chain system and improper storage of vaccine were observed at study area, which compromise the potency of the vaccines and quality of the immunization services. Hence, regular supportive supervision, training and distribution of at least one refrigerator per health facility with adequate kerosene provided with the concerned body to maintain the system.

Keywords: Cold chain; Vaccine providers; Knowledge; Primary health care units

Introduction

Cold chain is a system to transport and store vaccine in order to ensure immunization potency [1] because vaccines are sensitive biological products which may become less effective, or even destroyed, when exposed to temperature outside the recommended range which is 2.8°C [2]. Any loss of potency in a vaccine is permanent and irreversible. Immunization is the most precious gift that a health care worker can give to a woman and child. In order to address vaccine preventable disease worldwide, the WHO launched the expanded program of immunization (EPI) in 1974 with the goal of ensuring that every child would be protected against Vaccine Preventable Diseases (VPDs) [3]. Despite of the long history of EPI service delivery, still there is child mortality attributed to vaccine preventable diseases which accounts 29% of world-wide. Vaccinations to protect against vaccine preventable diseases require a greater maintain cold chain capacity [4].

However, as WHO (2006) indicated that the cold chain remains a highly vulnerable point for maintaining its status [5]. In the last

decade, most countries in the world achieved immunization coverage were high and African Region showed progress [6]. Due to cold chain failure 2.8 million vaccine doses lost in five countries [7]. In addition, assessment carried out in more than 70 countries between 2010 and 2012 found that only 29% of countries met its minimum recommended standards for temperature control and merely less than 10% of countries met out of 24 countries in 2013 [8]. Also cold chain monitoring is still a major challenge in developing countries that only about 56% of health facilities fill their temperature charts systematically twice a day as recommended [9]. Vaccine potency was highly sensitive to the cold chain status [10]. So that vaccine lost its potency when exposed to excessive heat, cold, or light and once it loses its potency cannot be restored and people who receive the vaccine with reduced potency may not be fully protected against vaccine-preventable diseases [11]. The consequence of this failure caused extra doses for patients, increased costs for providers and damage to public confidence in vaccines.

The inventory data analysis identifying the gaps in knowledge and practice in vaccine management of health staff at all levels, such as did not comply with the WHO/UNICEF standards [7]. The study done in Central Ethiopia suggests that an urgent need to improve knowledge on cold chain management of vaccine. The study done in Lagos,

Nigeria indicated that 95% of health workers interviewed had little or no knowledge about vaccine vial monitor [12]. Study done in Cambodia indicated a lack of knowledge on how long a multi-dose vial could remain open was commonly reported [13].

More than three decades since Ethiopian was launched in 1980 EPI to address vaccine preventable diseases and vaccine coverage in Ethiopia is 83% in 2014 [10,14]. However, Ethiopia is one of the countries that safer from vaccine preventable diseases. One out of five children is still unprotected against vaccine preventable illness [15]. With this situation, the cold chain status of vaccines was seen as one of the major issues of the EPI. In the past decade, all efforts had been focused towards the increment of vaccine coverage, but adequate attention was not given to address the issue of quality of vaccination that greatly depended on cold chain management, that plays a great role for vaccine potency [16]. One key factor in the battle against vaccine preventable diseases for the achievement of child survival and other child development goals was maintaining vaccine potency at all levels of storage and administration throughout the country [17-19].

The National Cold Chain Equipment inventory was carried out in 2002 indicated inadequate and aging cold chain equipment, lack of maintenance system at all levels, lack of spare parts and the use of several makes of refrigerators and freezers. In addition, the analysis showed that 35% of equipment was not functional [20]. The data on management of cold chain status and knowledge of vaccine providers were limited. So this study aimed to assess status cold chain and knowledge of vaccine providers of primary health care units in Bale Zone Southeast Ethiopia.

Methods

Study setting and participation

An institutional based cross-sectional study was conducted in November 2015, at Primary health care units in nine sampled districts of Bale zone Southeast Ethiopia. Bale Zone is one of the Zones in Oromiya Regional State, with an area of 62555 km². The robe is a zonal administrative town which is located at 430 km from Addis Ababa. The total population of Bale zone is about 1.7 million, among this 837,366 (49%) are male and 871544 (51%) are female. The zone is composed of 14.92% highland, 21.53% mid-land, and 63.55% lowland with an altitude of 300–4,377 km and annual rainfall of 900–1,400 mm. Bale zone had four governmental hospitals, 81 health centrals and 356 health posts [21]. From the total eight districts of Bale Zone, nine of them were selected by simple random sampling. All Primary health care units of selected districts which taking part in the vaccine providing were the study subject. All refrigerates exist in health facilities that used for immunization program were observed. Vaccine providers present at the time of data collection were interviewed and if more than one lottery method was used to select one to be interviewed the knowledge part of the questionnaire.

Data processing and management

Observational checklist and interview questionnaire which were developed after meticulous literature review were used to observe

vaccine handling of health facilities and to assess knowledge of vaccinations respectively. Pre-test was done in health facilities found in districts not included in the actual study. The data were checked for completeness and consistencies; then cleaned, entered and coded into the Epi-data version 3.1. Then data were exported to statistical package for social sciences (SPSS) for windows version 21 for analysis. Descriptive analysis computed to determine frequency of the variables.

Results

General characteristics of respondents

Among 189 health facilities selected for the study, 183 (96.83%) health facilities were visited during the period of data collection of which majority 146 (79.8%) were health posts and followed by health centrals 35 (19.1%). Only 56 (30.6%) of health facilities had refrigerator out of which only 15 (40.5%) were got supportive supervisions from District Health Office in the month prior to data collection. In 21 (37.5%) health facilities refrigerators were not functional at time of data collection. Eight refrigerators (14.28%) of the health facilities stopped working in the last six months and of these only 5 (62.5%) of them maintained in one week duration. The major source of power for refrigerator was electricity 33 (58.9%). In case of their refrigerator is out of function 16 (72.72%) and 5 (27.28%) health facilities were store vaccine in nearby health central and district health office respectively. Majority of vaccine providers 162 (88.5%) were female, 146 (79.8%) of them were Health Extension Workers in profession. One hundred thirty two (72.1%) of vaccine providers had served in expand program of immunization for more than >2 years. From all vaccine providers; only 40 (21.9%) of them received training on cold chain management; while 21 (53.8%) of them received training on duty. From 56 health facilities which had refrigerators about 21 (37.5%) of their refrigerator were not functional at time of data collection (Table 1).

Status of cold chain

Out of the total 35 functional refrigerators, 20 (57.1%) have national cold chain monitoring guideline and 9 (53.84%) placed vaccine stock record complete/updated. Health facility which had refrigerator only 5 (14.3%) posted 'do's and don'ts' sticker on the refrigerators door, 13 (37.14%) placed vaccine stock record including diluents, 7 (20.0%) posted daily temperature recording sheets on refrigerators. From those posted sheet only 3 (42.86%) recorded twice daily but all were not complete/updated. There were no posted contingency plans on the fridge in all health facilities. In all functional refrigerators; thermometer/tag card for temperature monitoring placed in the refrigerator; out of these 29 (82.86%) thermometer showed temperature readings within the standard range (2°C-8°C) while the remaining thermometer read temperature out of recommended range at which was >8°C. From those observed refrigerators only 14 (40%) were properly store vaccines. Of which not store vaccine properly 21 (60%) of these vaccine placed in inadequate air circulation, vaccine not placed in the proper compartment and vaccine placed with others biological 17 (48.6 %), 15 (42.9%) and 16 (45.7%) respectively (Table 2).

Variable		Frequency	Percent
Types of health facilities	Hospital	2	1.1

	Health Central	35	19.1
	Health Post	146	79.8
Age of respondents	18-22	33	18
	23-27	113	61.7
	>=28	37	20.2
Sex	Male	21	11.5
	Female	162	88.5
Profession of respondents	Health Extension worker	146	79.8
	Nurse	26	14.2
	Midwifery	11	6
Service year of respondents	<1 year	21	11.5
	1-2 years	48	26.2
	>2 years	114	62.3
Training	Yes	51	27.9
	No	132	72.1
Type of training	In service	26	51
	Out of service	25	49
Duration of training	<1 year	17	33.3
	1-2 years	10	19.6
	>2 years	24	47.1
Supportive supervision of district health office in one month prior data collection	Yes	15	40.5
	No	22	59.5
Feedback of supportive supervision	Yes	13	7.1
	No	2	1.1
Were vaccines were stored in case their refrigerator out of function	District health office	5	27.28
	Near health Central	16	72.72
Broken refrigerator in the last six months	Yes	8	21.6
	No	29	78.4
Time required for fixing the broken refrigerator	one week	5	62.5
	one month	1	12.5
	>one month	2	25
Available person responsible for refrigerator minor maintenance	Yes	19	51.4
	No	18	48.6
Personnel assigned during holidays/weekend for refrigerator follow up	Yes	30	81.1
	No	7	18.9
Main source of power for refrigerator(s)	Electricity	33	58.9

	Kerosene	20	35.7
	Solar	3	5.4

Table 1: Infrastructure and Cold Chain Equipment/Resource Availability in the Study Facilities Bale Zone, Southeast Ethiopia November 2015.

Items	Proper storage	
	Yes (%)	No (%)
Vaccine placed in inadequate air circulation	18 (51.4 %)	17 (48.6%)
Vaccine placed in fridge where bottled water kept in the lower compartment of the fridge.	7 (20%)	28 (80%)
Vaccine placed with food and drink in fridge	1 (2.9%)	34 (97.1%)
Vaccine not placed in the proper compartment	20 (57.1%)	15 (42.9%)
Vaccine placed with others biological	19 (54.3%)	16 (45.7)

Table 2: Vaccine storage condition in the health facilities Bale Zone, Southeast Ethiopia November 2015.

Vaccine providers' knowledge on cold chain management in the study facilities

Out of 183 vaccine providers questioned about the recommended range of temperature for vaccine storage 124 (67.8%) were responded correctly and 106 (57.9%) respondents were correctly described the recommended frequency of temperature recording per day. Majority of the respondents (89.1%) did not know the extent to which refrigerator compartment is fill vaccine in. Proper compartment for placement of oral polio vaccine (OPV), BCG and measles in front open refrigerator was correctly described by 123 (67.2%) respondents. Out of 183 respondents 27 (12%) and 73 (39.9%) correctly described placement of OPV, BCG, and measles; and DPT and TT in ice lined fridge (Figure 1).

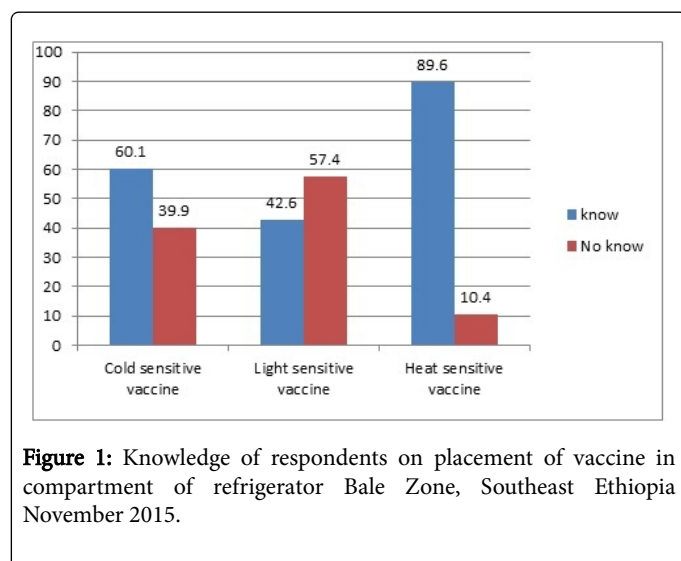


Figure 1: Knowledge of respondents on placement of vaccine in compartment of refrigerator Bale Zone, Southeast Ethiopia November 2015.

The purpose for application of the shake test vaccine vial was correctly mentioned by 42 (36.2%) health workers. Types of vaccines that were most sensitive to heat, extreme cold and light were correctly

identified by 164 (89.6%), 73 (60.1%) and 110 (42.6%) respondents respectively (Figure 2).

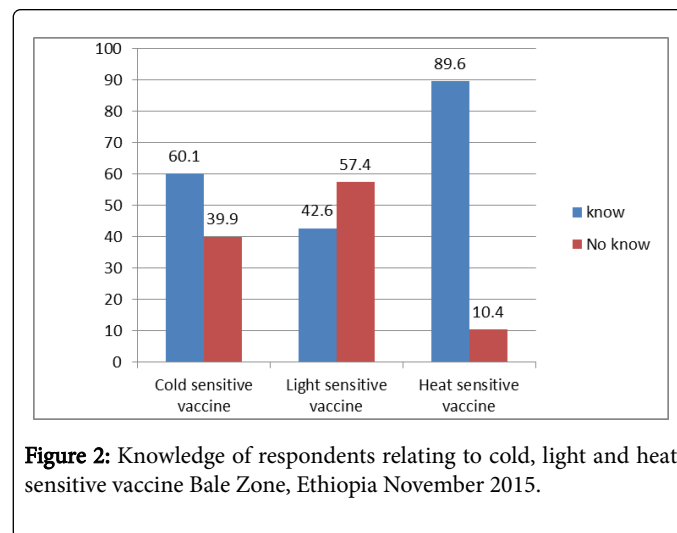


Figure 2: Knowledge of respondents relating to cold, light and heat sensitive vaccine Bale Zone, Ethiopia November 2015.

Variables	Know (%)	Not know (%)
Duration of vaccine in the vaccine carrier	141 (77%)	43 (33%)
Duration of vaccine in the cold box	98 (53.6%)	85 (46.4%)
Importance of Vaccine Vial Monitor	104 (56.8%)	79 (43.2%)
Vaccines to be discarded in six hours	68 (37.2%)	115 (62.8%)
Preconditions of Multi Dose Vail Program	38 (20.8%)	145 (79.2%)
Cold chain monitoring tool	45 (24.6%)	138 (75.4%)
Vaccine management in case refrigerator out of function	81 (44.3%)	102 (55.7%)
Time of shift vaccine when refrigerator power failure	5 (2.7%)	178 (97.3%)
Safer method of vaccine handling	128 (69.9%)	55 (30.1%)

Table 3: Knowledge of the vaccine provider on the vaccine handling in Bale Zone, Southeast Ethiopia November 2015.

Out of all respondents questioned on appropriate duration of vaccine storage in the vaccine carrier and in the cold box responded correctly were 141 (77%) and 98 (53.6%) respectively (Table 3). Hundred (54.6%) respondents were rated as having satisfactory knowledge while 83 (45.4%) had unsatisfactory on cold chain management.

Discussion

Immunization is the most precious gift that a health care worker can give to a woman and child in order to address vaccine preventable disease. This gift is the real gift only when keeps vaccine potent through maintaining cold chain status as WHO recommended. The aim of this study was to assess the cold chain status and knowledge of care providers at Primary Health Care Units.

In this study only 56 (20.2%) health facilities had refrigerators of which 35 (62.5%) were functional. This is very different from the result of a study done in central Ethiopia, in which only 22 (19%) of the health facilities had a functional vaccine refrigerator [22]. This difference might be due to sample variation. National Cold Chain Equipment inventory analysis also showed 35% of equipment was not functional [19]. During this study, trained personnel for minor maintenance of refrigerator were available in 19 (51.4%) health facilities. The study conduct in Central Ethiopia shows facilities had of technicians for refrigerator maintenance (38.8%) [17].

One encouraging finding of this study was that all functional refrigerators had temperature reading thermometers placed in. This result was in line with WHO recommendation that all refrigerators have thermometer [23]. Study conducted in Cameroon indicate that thermometer available in refrigerators were 27 (96.4%). During this study vaccines in 6 (17.14%) health facilities were stored in temperature read out of range which was above 8°C. This was not in line with WHO recommendation that vaccine store with temperature 2-8°C. In studies done in Central Ethiopia 13 (59.1%) and 37 (57.8%) of the health facilities thermometer reading was outside the recommended range [17,22]. Therefore, even if the vaccines were potent on arrival at the health institutions, this potency could easily be compromised because of lack of proper monitoring of the cold chain system.

In this study, 15 (42.9%) of primary health care units had no national cold chain monitoring guideline. Study in Cameroon show relatively better than this finding that the national guideline of expand program of immunization was not present in 21 (33.9%) health facilities [24]. This might shows that there was poor distribution of logistics in our case.

In this study, out of health facilities which had functional refrigerators, only 7 (20.0%) had a temperature recording chart posted on refrigerators and among these, 3 (42.9%) had not maintained the twice daily recording practice. Study conducted in Cameroon shows temperature monitoring chart posted on cold chain equipment were 27 (96.4%) and temperature was not systematically recorded on charts twice daily as required on the chart in 11 (40.7%) [5]. This might be explained by lack of motivation, training and supervision of health personnel. In addition study done in shows that, cold chain monitoring is still a major challenge in developing countries that only about 56% of health facilities fill their temperature charts systematically twice a day as recommended [9].

One of the improper practices identified in this study was that the arrangement of vaccines in refrigerators was not correct in 21 (60%) health facilities. The studies conducted in Cameroon and Central Ethiopia indicate that 22 (78.6%) and 7 (10.9%) facilities had improper vaccine storage respectively [5,17]. This study showed from vaccines with improper storage 20 (57.1%), 19 (54.3%) and 18 (51.4 %) of them were not placed in the proper compartment, sharing space with others biological and vaccine placed in inadequate air circulation infridges

respectively. The findings of study done in Central Ethiopia in 2012 showed that 40.9% vaccine shared space with other biological [22].

Of 183 health workers included in the survey 124 (67.8%) them knew the recommended range of temperature for vaccine storage. Study conducted in Mozambique indicated that the recommended temperature range for vaccine storage was known by 52% of the respondents [25]. The study done in Western India also shows that only 5 (25%) respondents knew the exact temperature range for deep freezer [26]. This might be due to the fact that there were difference in professional qualification and the time of study.

This study identified that importance of shake test is known by 101 (55.2%) of the respondents but in contrary to this Study conducted in Mozambique indicated that the shake test was known by only four respondents [25]. This might be due to the reason that, shake test was well practiced in our case to check vaccine potency after the revised recommended range of temperature for vaccine storage. From those respondents who know about vaccine 164 (89.6%), 73 (60.1%) and 110 (42.6%) of them revealed that most vaccine sensitive for heat, extreme cold or light respectively. WHO indicated that vaccine lost its potency when exposed to excessive heat, cold, or light and once its loss its potency cannot be restored [11].

According to this findings, from 183 interviewed vaccine providers, 100 (54.6%) were rated as having satisfactory knowledge on the cold chain management. One study in Central Ethiopia was in line to this finding which was sixty-five (56%) health workers had satisfactory knowledge on cold chain management [21].

Conclusion

This study indicated that there were under cold chain status maintain practice in primary health care at study area which could compromise the potency of the vaccines and the general quality of the immunization services. Also there are problem on proper storage of vaccine and gaps in knowledge for maintaining recommended cold chain system. Therefore, there is a need to well-designed regular supportive supervision and training that supported with practical demonstrations to monitor the system. Also, possibilities must be explored to assess the level of cold chain monitoring daily immunization sessions and outreach program.

Acknowledgments

We would like to thank Madda Walabu University, for its financial support. Our thanks also extend to Bale zone and districts Health Offices for their support. Finally our appreciation also goes to individuals who work at immunization room for assisted this study.

Funding

This paper has been funded by World Bank because our country which is classified by the World Bank as a low-income.

Availability of Data and Materials

The datasets supporting the conclusions of this article are available upon request from the corresponding author.

Author Contributions

BW, AE&DB conceived and designed the study, performed analysis and interpretation of the data. BW prepared the manuscript. BW & AE critically reviewed the manuscript. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

The ethical approval was obtained from Ethical and review committee of Madda Walabu University. Supportive letter obtained from University was given to Zonal Health Office and then communicated with District Health Offices. Verbal consent was obtained from the participants. Confidentiality and privacy of the respondents were maintained by omitting the name of the respondents during data collection procedure.

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