ORIGINAL ARTICLE

Status of cold chain in routine immunisation centres of the Expanded Programme on Immunisation in Quetta, Pakistan

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Abstract

Objective: To determine the status of cold chain and knowledge and practices of health workers about cold chain maintenance in routine immunisation health centres.

Methods: This cross-sectional study was conducted in Quetta, Pakistan, from May to July 2012, and comprised health facilities in the district. We interviewed the staff responsible for vaccine storage and cold chain maintenance and used a checklist to assess cold chain maintenance of routine expanded programme on immunisation vaccines. SPSS 16 was used for data analysis.

Results: Of the 42 health facilities, staff of 13(30%) wrongly indicated that measles and Bacillus Calmette-Guérin were cold sensitive vaccines. Temperature of the ice-lined refrigerators was not maintained twice daily in 18(43%) centres. There were no voltage stabilisers and standby power generators in 31(74%) and 38(90%) centres, respectively. Vaccine arrangement was found to be inappropriate in ice-lined refrigerators of 38(90%) centres and ice packs were incorrectly used in carriers in 22(52%) centres. Vaccine stock was not charted in 39(93%) centres. Moreover, 4(10%) facilities did not have dedicated expanded programme on immunisation rooms whereas about 5(12%) and 33(79%) had no vaccinator and separate expanded programme on immunisation incharge appointed. Also, 32(76%) centres did not have a female vaccinator appointed.

Conclusion: Although the majority of health staff had adequate knowledge, there were weaknesses in practice of maintaining the cold chain.

Keywords: Immunisation children, Cold chain maintenance, Expanded programme on immunisation. (JPMA 67: 739; 2017)

Introduction

Immunisation is the most cost-effective public health intervention which not only reduces the risk of morbidity and mortality by preventable diseases but also saves the cost of treatment for these diseases. Among the diseases preventable with immunisation, hepatitis B, poliomyelitis and measles are the major causes of deaths and disability among children under five years of age in developing countries.[1] Expanded Programme on Immunisation (EPI) was introduced by the World Health Organisation (WHO) in the 1970s to prevent childhood communicable diseases in developing countries. In Pakistan, it consisted of, initially, vaccines against six childhood diseases including tuberculosis (TB), diphtheria, pertussis (whooping cough)and tetanus (DPT), poliomyelitis and measles and later hepatitis B, haemophilus, influenza and pneumococcal vaccines were included.[2] As a result, the burden of these diseases has declined;[3] however, many countries still have high burden of vaccine preventable diseases.[4] Pakistan invests huge resources in the EPI programme to improve the immunisation coverage of children. Often the government reports show immunisation coverage rates of 80% or over, but there are questions to the validity of these rates; for example, poliomyelitis eradication still remains a challenge, in Pakistan in spite of a high reported coverage.[5] Pakistan also has wide variation of weather conditions and temperature which can affect vaccine supply chain. The burden of other vaccine-preventable diseases is still very high and the progress in this regard has been sluggish. The security conditions of the country, environmental changes, poverty and low literacy are important factors for high burden of vaccine-preventable diseases.[6]

Vaccines are sensitive biological products which may lose potency if exposed to temperatures other than the recommended range.[7] Vaccines are sensitive to heat or cold and may lose potency if they are frozen or exposed to heat or sunlight. Bacillus Calmette-Guérin (BCG) vaccine

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(for TB) and oral polio vaccine (OPV) are highly sensitive to heat, whereas hepatitis B and DPT have sensitivity towards cold. The WHO recommends that at national, regional or district stores, OPV, measles and mumps vaccines be kept between -15°C and -25°C, and hepatitis B, DPT, diphtheria and tetanus toxoids (DT), tetanus and diphtheria (Td), tetanus toxoid (TT) and BCG vaccines between 0°C and 8°C. Moreover, vaccines must be transported to regions in insulated containers between 0°C and 8°C. At the health facility level, vaccines are recommended to be stored for a maximum of 1 month between 0°C and 8°C.[8]

Cold chain maintenance is a continuous and systemic process of preserving vaccines to ensure their availability and potency during vaccine manufacturing, transport, storage and delivery.[9] According to the WHO, cold chain system consists of three elements, namely personnel, equipment and procedures.[8] Recommended criteria for evaluation of cold chain system include items related to vaccine storage (refrigeration condition and maintenance), temperature monitoring and maintenance, vaccine stock (quantity, wastage and reserves) and record keeping and monitoring.[8] However, most importantly, proper functioning of a cold chain system depends on the knowledge and practices of health personnel responsible for maintaining the cold chain.

Vaccines tend to turn inactive mainly because of faulty cold chain maintenance. Studies show that lack of cold chain maintenance is mainly because of scarcity of proper thermometers, thermometer reading to be outside the optimal range, electricity shortage or frequent breakdown and long distances from health centres to the communities.[7] Coverage and potency of vaccines depend on the knowledge and expertise of healthcare staff on cold chain maintenance.[10]

Electronic thermometers guarantee better vaccine cold chain as they provide multiple readings of temperatures.[11] Electronic refrigerator temperature logger is also appropriate and innovative in maintenance of vaccine cold chain during transport between peripheral and rural locations.[12] Vaccine refrigerators which are built for the purpose of storing vaccines and vaccine vial monitors (VVM) are essential elements for maintaining the viability of vaccines; however, the latter can be less dependable in hot weather.[13] Trained staff is also important for maintaining cold chain in the centres.[14] the current study was planned to assess the knowledge and practices of cold chain handlers, status of cold chain maintenance and to identify factors associated with cold chain maintenance of government's EPI centres.

Materials and Methods

This cross-sectional study was conducted in Quetta, the capital of the Pakistani province of Balochistan, from May to July 2012, and comprised the staff responsible for vaccine storage and cold chain maintenance. Quetta is the most populated and developed district of the province, and is among the high-risk districts with respect to vaccine-preventable diseases, mainly poliomyelitis, due to its neighbouring districts including Pishin and Killa Abdullah where poliomyelitis cases are quite commonly notified as the population is highly mobile across the border with Afghanistan. Quetta consists of both urban and rural areas and had an estimated population of 1.5 million in 2012, according to estimates from the district health information system office.

In this study, government EPI centres included the health facilities providing immunisation services under the management of provincial health department. Cold chain meant a supply chain consisting of a regular and consistent storage and distribution activity which maintains a given temperature ranges (vaccines are stored at temperatures between 2°C and 8°C).[15] Knowledge indicated the knowledge of the vaccine handlers regarding the cold chain maintenance protocols recommended by the WHO.

The study sites were selected to include both urban and rural areas. The list of static centres was obtained from office of the District Health Officer. All the public sector functional static immunisation centres in district Quetta equipped with a refrigerator or iced line refrigerators (ILRs) were included. Private and non-functional static immunisation centres were excluded. Health facilities which were part of pretesting of questionnaire and checklist, and with non-functional ILRs were also excluded.

The selected EPI centres included hospitals, rural health centres (RHCs), basic health units (BHUs), civil dispensaries and mother and child health (MCH) centres.

We used structured questionnaire and a checklist to assess the knowledge of the vaccinators about cold chain and to record physical observations at static centres, respectively. Both the questionnaire and checklist were pretested at static centres in district Quetta. The checklist consisted of items related to cold chain maintenance and vaccine monitoring at the static centre level. It included items on vaccination area

specification (separate EPI room, ventilation, seating for mother and child) and arrangement (separate refrigerator for vaccines, proper shelving, ice packs), temperature monitoring equipment (thermometers), availability of staff, electricity and backup support (generator, voltage stabilisers, cold boxes and vaccine carriers), and records (daily and stock registers, temperature monitoring charts, emergency plan) availability and maintenance.[8]

Data was collected from the immunisation centres by interviewing the person in charge of fixed immunisation centres. The data was analysed using SPSS 16. Frequencies and percentages were calculated as appropriate. Written informed consent was obtained from all participants. Approval was also obtained from the ethics review committee of the Health Services Academy, Islamabad.

Results

Of the 69 health facilities in the district, 42(60.87%) were selected. The mean age of the participants was 34±6.9 years. Qualification of the vaccination staff varied as 11(26.19%), 20(47.62%), 7(16.67%) and 4(9.52%) of them had matriculation, intermediate, bachelor's and master's degrees, respectively. The mean duration of participants' service was 11±6 years. The vaccination services were being provided by 36(85.71%) vaccinators, 3(7.14%) lady health visitors (LHVs) and 3(7.14%) dispensers or BCG technicians. All were regular staff of the government of Balochistan and 37(88%) of them had been trained under the provincial EPI programme with a mean of 2±1.5 trainings, but they had not received any formal training on cold chain maintenance.

Table-1: Knowledge and practice about the optimal temperature maintenance for vaccines and ice lined refrigerators (ILR) in the health facilities of Quetta,Balochistan.

		Frequency	Percent
Optimal temperature for vaccines	2°C to 8°C	35	83.3
	I don't know	1	2.4
	Any other	6	14.3
Optimal temperature for vaccines in ILR	2°C to 8°C	35	83.3
	I don't know	3	7.1
	Any other	4	9.5
Temperature Recording	Once a day	1	2.4
	Twice a day	41	97.6
Vaccines arrangement technique	Yes	29	69.0
	No	13	31.0
Top to bottom arrangement	Yes	17	40.5
	No	14	33.3
	Not applicable	10	23.8
Priority for vaccine early expiry	Yes	19	45.2
	No	11	26.2
	Not applicable	10	23.8
Space between boxes	Yes	8	19.0
	No	23	54.8
	Not applicable	10	23.8

ILR: Ice lined refrigerators.

Table-2: Staff and infrastructure at the in the health facilities of Quetta; Baluchistan (n=42).

	Yes n (%)	No n (%)
Separate EPI room	38 (90.4)	4 (9.6)
Seating area for mother and child	41 (97.6)	1 (2.4)
Proper ventilation	20 (47.6)	22 (52.4)
ILR available	38 (90.4)	4 (9.6)
Refrigerator as an ILR	4 (9.6)	38 (90.4)
Distance from wall >10cm	35 (83.3)	7 (16.6)
Voltage stabiliser	11 (26.2)	33 (73.8)
Wire properly inserted in Socket	25 (59.5)	17 (40.5)
Dedicated EPI in-charge	9 (21.4)	33 (78.6)
Any Vaccinator present	37 (88)	5 (12)
Male vaccinator appointed	32 (76.2)	10 (23.8)
Female vaccinator appointed	10 (23.8)	32 (76.2)

EPI: Expanded programme on immunisation
ILR: Ice lined refrigerators.

Moreover, 31(74%) participants knew about shake test (performed to determine whether adsorbed vaccines have been affected by freezing) and 34(81%) vaccinators knew how to perform the test as they demonstrated it correctly. In examining the participants' knowledge about VVM, 41(97.6%) of them had heard about it while 37(88%) used VVM in routine to determine the viability of the vaccines.

Furthermore, 38(91%) and 36(86%) staff members wrongly reported the pentavalent and TT vaccines, respectively, as cold sensitive, whereas 41(97.6%), 29(69%) and 30(71%) reported OPV, BCG and measles vaccines, respectively, as not cold sensitive. In response to the question regarding knowledge about the heat sensitive vaccines, 38(91%), 39(93%), 38(91%), 41(98%) and 42(100%) participants said that BCG, TT, measles, pentavalent and OPV vaccines, respectively, were heat sensitive vaccines. All participants knew that OPV could lose potency on exposure to light. For pentavalent, BCG, TT and measles, 34(81%), 33(79%), 30(71%) and 32(76%)participants, respectively, believed that vaccines were sensitive to light.

The optimal temperature for vaccines and ILR was known to 35(83.3%) participants and all participants said that they recorded the temperature twice daily. All of

Table-3: Characteristics of Ice Lined Refrigerators (ILR) in the health facilities of Quetta; Baluchistan.

	Yes n (%)	No n (%)
ILR/Fridge seal in order	40 (95.2)	2 (4.8)
ILR supported by wooden rack	16 (38)	26 (62)
ILR Adequately Maintained (not cracked)	41 (97.6)	1 (2.4)
Monitoring chart on Wall	32 (76.2)	10 (23.8)
Monitoring chart up to date	15 (35.7)	27 (64.3)
Expiry date mentioned on chart	5 (11.9)	37 (88.1)
Stock of vaccines charted	3 (7.1%)	39 (92.9%)
Temperature maintenance chart available	39 (92.8)	3 (7.2)
Temperature monitoring device placed	40 (95.2)	2 (4.8)
Temperature maintained currently	41 (97.6)	1 (2.4)
Temperature maintained at least twice daily	24 (57.1)	20 (42.9%)
Freeze sensitive vaccines away from compartment lining	38 (90.4)	4 (9.6)
Boxes of vaccines arranged in stacks	4 (9.5)	38 (90.5)
Correct use of Ice packs	20 (47.6)	22 (52.4)
Vaccines placed in basket	40 (95.2)	2 (4.8)
Catchment are charted	13 (31)	29 (69%)
Cases of Target disease charted	30 (71.4)	12 (28.6)

EPI: Expanded programme on immunisation
ILR: Ice lined refrigerators.

them recorded the temperature using the thermometer placed inside the refrigerators. Also, 29(69%) participants had correct knowledge of the arrangement of vaccines in the refrigerators, but only 20(48%) reported that they followed early expiry date. Only 8(19.01%) participants were aware that when vaccines are arranged in the ILR there should be some space between the boxes (Table-1).

All the health facilities included in our research reported to the District Health Officer's office every month. In case of power failure, 29(69%) of the vaccination centres reported that there was no contingency plan in place. Only 3(10%) of the health facilities had standby power generators and staff in 38(90%)centres were in the habit of taking vaccines to homes, nearby EPI centres, EPI cold rooms or stored vaccines in ice containing carriers.

It was observed that 20(48%) facilities were properly ventilated, though most were equipped with ILRs, whereas 4(10%) used commercial refrigerators. Only 11(26%) centres had voltage stabilisers and power supply was properly placed in the socket in 25(60%) health facilities. In addition, 38(91%) facilities had separate rooms for EPI services but 33(79%) had no separate incharge. Vaccinators were available at 37(88%) centres. Male vaccinators were appointed at 32(76%) and females at 10(24%) EPI centres (Table-2).

ILRs were properly maintained in 41(97.6%) centres whereas fridge seal of ILR was properly maintained in 40(95.2%) and vaccine carriers were available at all of the facilities. At 39(93%) centres temperature monitoring charts were displayed outside the refrigerator or on the wall but charts were not up to date in almost all centres. Beside, 24(57.1%) centres maintained temperatures twice daily and stock was charted in 3(7.14%) facilities. In none of the centres the old or new vaccine stock was placed separately in the refrigerator, neither were the vaccines nearing expiry dates placed in the front of the ILRs. Boxes of vaccines were found arranged in stacks in 4(9.5%) facilities and 26(62%) ILRs were not supported by a wooden rack. Besides, 20(47.6%) centres used ice packs correctly. Charts for catchment area were available in 13(31%) and cases for target diseases were displayed in 30(71.4%) centres (Table-3).

Discussion

Our study highlighted that immunisation staff had satisfactory knowledge of cold, heat and light sensitive vaccines, shake test, VVM and temperature maintenance. However, majority of them had poor knowledge about vaccine arrangement in ILRs. Most of the participants were found efficient in maintaining record, temperature charts and monthly reports. Contingency plans for electricity breakdown were deficient in most of the health facilities.

Knowledge of the health workers responsible for maintaining cold chain of vaccines in immunisation centres in developing countries varies significantly, between 18-96%.[16] The results from our study were better in that regard as almost all our participants correctly identified vaccines sensitive to heat. In another research study, the vaccines in charges were well aware that freezing could destroy the vaccines, but they could not identify correctly those vaccines; however, most participants in our study were able to identify them correctly.

The knowledge of the fixed centre staff regarding vaccine potency can be gauged from shake test and VVM. Most participants in our study were well aware of the reason to perform a shake test and majority of them performed the test correctly. Also, majority of our participants were well aware of VVM. Results from a study conducted in India showed that 80% of the healthcare staff performed the shake test and interpreted VVM correctly.[17]

In order to monitor the performance of ILRs, temperature charts have to be regularly maintained.

Although the participants we interviewed recorded the temperature of ILRs every day, the charts were maintained in only 60% of the facilities. Lack of temperature monitoring is a challenge in developing countries; for instance, in India 60% of health workers recorded the temperature twice daily.[17] Vaccine arrangement in ILR is indispensable for the viability and appropriate use; however, only 29 participants knew about arrangement of vaccines.

Vaccine utilisation and coverage rate depends on the client satisfaction with the environment at the facilities which consists mainly of availability of seats for mother and child in the waiting areas, proper ventilation of EPI room and availability of and condition of ILRs in the facility. Fewer than half of the centres had adequate ventilation and majority had ILRs installed in them. A regional study showed that vaccination rooms were well ventilated at 68% of the health facilities.[18] Our results are consistent with other studies; for instance, a study reported that 80% of the centres had ILRs available.[17] We observed that ILRs were placed at >10cm from the wall in 35 of the health facilities; however, very few of health facilities had voltage stabilisers or a power supply properly placed into the socket. A study conducted in India reported that only 20% of the health facilities were found to have ILRs placed >10cm away from the wall.[17]

It is essential to have a separate room for EPI to ensure the quality of services. Most centres in our study had dedicated rooms for EPI services. Refrigerator seal and vaccine carriers were available in most centres and ILRs were not cracked in any of the health facilities. However, most staff did not know how to use them properly. Our results are consistent with studies from other regional countries which showed that the vaccine carriers were present in majority of the health facilities.[19]

Electricity breakdown and load-shedding are frequent and an appalling challenge in Pakistan. Since health facilities have limited resources, it is even a bigger challenge to install an alternative power source. As most facilities did not have contingency plans for electricity breakdown displayed or power generators available, the vaccine potency could be affected during a long power failure. Studies have shown that an alternative power plan lacks in health facilities of developing countries and more innovative alternative sources of electricity have been successful in maintaining the cold chain in developing countries.[20]

A limitation of our study was that we excluded private hospitals and clinics where vaccines were stored in Quetta; therefore, we were not able to evaluate the knowledge of vaccinators and observe the cold chain maintenance process at those facilities.

Conclusion

A majority of the health workers had adequate knowledge of the cold chain but there were weaknesses in practice of maintaining the cold chain at the health facilities. Although the infrastructure and equipment was available, it was not properly maintained and there was absolute lack of management of EPI-related activities, mainly cold chain for vaccines. Regarding infrastructure, the ILRs, EPI-related equipment and buildings required repair and renovation in most health facilities of Quetta. There is also a need for a separate and well-equipped room and dedicated staff, especially females, for EPI activities in these centres. There is an urgent need to conduct trainings, specifically on cold chain for health workers directly involved in managing cold chain and to improve the monitoring and supervision mechanism at district as well as provincial level.

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