Cold Chain Equipment Manager (CCEM) Pakistan

COLD CHAIN INVENTORY SYSTEM IN SELECTED DISTRICTS OF PAKISTAN

Vaccine Management Team – Polio UNICEF Pakistan

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COLD CHAIN INVENTORY SYSTEM IN SELECTED DISTRICTS OF PAKISTAN

(Preliminary Analysis Report)

UNICEF, PAKISTAN

In collaboration with

GOVERNMENT OF PAKISTAN

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Submitted by:

Vaccine Management Team – UNICEF Polio, Pakistan

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Dr. Jose Rolando Figueroa,
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Foreword

Following paragraphs are taken from CCEM website[1] for acknowledging the contribution of PATH team in providing robust software for cold chain solution to countries' EPI departments.

"Vaccine supply and delivery systems in developing countries are increasingly tested as new vaccines become available. Expanded Programme on Immunization (EPI) teams in many low- and middle-income countries are challenged by aging cold chain equipment that is not systematically monitored, replaced, or managed. Furthermore, many countries operate health facilities without access to electricity to deliver essential health services, including immunization. It is important that these countries have access to data on available electricity and new equipment options that offer economic and safe alternatives to kerosene and gas refrigerators, especially as the countries advance plans to both overhaul and expand their existing vaccine cold chains.

The Cold Chain Equipment Inventories project supports the use of equipment inventories to better manage immunization systems. Our initial cold chain equipment inventory tool, the Cold Chain Equipment Manager (CCEM), was designed as a standalone application running on Microsoft Access to help countries forecast cold chain equipment requirements down to the facility level. Since then, we have repurposed the tool as a web-based system, better enabling inventories to be kept up to date and allowing for a greater range of information reporting. We are also working to make the core CCEM database available as a spreadsheet tool, helping users to more seamlessly navigate between Excel and the web-based CCEM. Overall, with more versatile equipment management and planning tools, EPI teams can generate procurement lists and budgets, analyze the cost and logistical implications of potential planning decisions, and benefit from access to accurate equipment inventory data to more effectively oversee and manage a country's immunization cold chain.

To date, Benin, Kenya, Malawi, Nicaragua, Pakistan[2], South Sudan, Uganda, Zimbabwe, and two states in India have successfully implemented cold chain inventories that use the CCEM software technology. CCEM has been recognized by stakeholders as a useful resource for collecting and storing cold chain inventory data, helping them to build an evidence-based investment case for future equipment purchases and upgrades. Alongside these efforts, PATH is working with EPI teams in Kenya and Nigeria to identify additional mechanisms for routinely updating inventory data and supporting inventory-related decision-making at all levels of the vaccine supply chain."

[1] http://www.path.org/publications/files/TS_update_ccem

[2] 56 selected COMNet district/town/agencies/FRs

List of abbreviations & acronyms

ASV	Assistant Superintendent Vaccination
BCG	Bacillus Calmette-Guerin (vaccine for tuberculosis)
BHU	Basic Health Unit
CCEM	Cold chain equipment Manager
CFC	Chlorofluorocarbon
COMNet	Communication Network
CTC	Chip Training & Consulting
D/AHCSO	District/Agency Health Communication Support Officer
DHQ	District Head Quarter
DSV	District Superintendent Vaccination
EPI	Expanded Program for Immunization
FATA	Federally Administered Tribal Area
FO	Field Office
FR	Frontier Region
ILR	Ice Lined Refrigerator
IPV	Injectable Polio Vaccine
KP	Khyber Pakhtunkhwa
LHS	Lady Health Supervisor
LHW	Lady Health Worker
PATH	Program for Appropriate Technology in Health
PCO	Pakistan Country Office
RHC	Rural Health Center
RI	Routine Immunization
SIAs	Supplemental Immunization Activities
SM	Social Mobilizer
THQ	Tehsil/Taluka Head Quarter
UC	Union Council
UCO	Union Council Communication Officer
UNICEF	United Nations Children's Fund[3]
USAID	United States Agency for International Development
VM & CCL	Vaccine Management & Cold Chain Logistics
WHO	World Health Organization
MR	Measles Rubella
PQS	Performance Quality Safety

[3] UNICEF was established on 11 December 1946 by the United Nations to meet the emergency needs of children in post-war Europe and China. Its full name was the United Nations International Children's Emergency Fund. In 1950, its mandate was broadened to address the long-term needs of children and women in developing countries everywhere. UNICEF became a permanent part of the United Nations system in 1953, when its name was shortened to the United Nations Children's Fund. However, UNICEF retained its original acronym.

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Overall supervision of activities

- Mr. Per Engebak, Team Lead UNICEF Polio Pakistan
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Overall support

- Dr. Rana Mohammad Safdar, National EPI Coordinator, Islamabad
- Dr. Altaf Bosan, National Coordinator PM's Polio Control Cell, Islamabad
- Provincial EPI Managers and all the 56 District Health Officers, Islamabad, Sindh, Punjab, KP, FATA & Baluchistan

Training & monitoring team

- Dr. Shahab Saqib Hashim, Health Officer UNICEF Polio Pakistan
- Dr. Saadia F. Younus, Vaccine Management Officer UNICEF Polio Pakistan
- Provincial Health Officers; Dr. Naeem Ullah Khan, Dr. Shoukat Ali, Dr. Abdul Aziz, Dr. M. Jaohar Khan and Dr. Abdul Qayum
- Mr. Ghulam Taqi Bosan, Vaccine Management and Cold chain logistics officer
- Mr. Sunil Raja and Mr. Khalid Javed, COMNet Coordinator Sindh & Punjab
- Mr. Fahad Fehmi & Mr. Akhtar Ali Khosa, Sindh and Balochistan VM&CCL Officer respectively.

Data collection team

UNICEF Polio Communication Network (COMNet) staff of 56 districts where assessment was done:

- Forty four District/Agency Health Communication Support Officers (D/AHCSOs)
- Two hundred seventy seven Union Council Communication Officers (UCOs)
- Four hundred ten Social Mobilizers (SMs)

Data cleaning, entry & management

- Ms. Isma Siddique, Independent consultant
- Vaccine Management & Cold chain logistics (VM&CCL) officers: Mr. Ghulam Taqi (National), Mr. Fahad Fehmi (Sindh), Mr. Asif Nawaz (Punjab), Mr. Khalid Saifullah (KP), Mr. Behramand (FATA) and Mr. Akhtar Ali Khoso (Balochistan)
- Dr. Saadia F. Younus, Vaccine Management Officer UNICEF Polio Pakistan
- Dr. Shahab Saqib Hashim, Health Officer UNICEF Polio Pakistan

Project title:

Cold chain inventory in selected districts of Pakistan.

Specific objective:

To prepare a cold chain inventory data base system and analyze the status of cold chain in 56 selected districts/agencies/towns of Pakistan.

Target areas:

- ICT (2): Islamabad & CDA
- Balochistan Province (5): Quetta, Killa Abdullah, Pishin, Jaffarabad & Nasirabad Districts
- Federally Administered Areas (FATA: 7+6): FR Peshawar, FR Kohat, FR Lakki, FR Bannu, FR DI Khan, FR Tank, Bajaur, Orakzai, Kurram, South Waziristan, North Waziristan, Khyber & Mohmand Agencies
- KP Province (5): Peshawar, Nowshera, Charsadda, Lakki Marwat & Mardan Districts
- Sindh Province (9+14): Karachi, Hyderabad, Kambar, Larkana, Jacobabad, Kashmore, Sukkur, Khairpur, Ghotki & Shikarpur Districts
- Punjab Province (7): Lahore, Multan, Muzzaffargarh, DG Khan, Rajanpur, Rahim Yar Khan, Rawalpindi & Faisalabad[4] Districts

[4] Data from Faisalabad district is not included in the current report and analysis; however it will be included in the future.

Executive summary

The following report on cold chain inventory system is developed by utilizing Cold Chain Equipment Manager (CCEM). Current document aims to present the cold chain assessment report on 55 districts for further use in planning and forecasting of cold chain equipment. A total of 2,083 EPI centres and stores were assessed in 55 districts/ towns/agencies/Frontier Regions (FRs). The data was collected by communication network staff deployed by UNICEF in high risk polio districts for communication and social mobilization.

The results from data collected shows that there exists a discrepancy in population figures used for EPI planning at national and provincial levels; population figures used at national level are less than provincial level. All provincial store figures, except Punjab, exceed 2013 provincial population figures provided by the Federal EPI M&E and used for vaccine/cold chain forecasting and planning for the entire country.

Results show that 90% (n= 1,883) of EPI centers collect their vaccines from stores. Out of all EPI centers that collect vaccines, nearly 61% (n=1148) have some kind of working transport. On an average most of the EPI facilities and stores, from EPI stores to private EPI facilities get their vaccine re-supply every four weeks, which is in accordance with the national policy.

In CCEM, vaccine storage capacity is calculated on the basis of population served by the facility, current EPI schedule, including SIAs, and vaccine resupply interval as per policy. For EPI stores, it was noted that National vaccine store, three provincial vaccine stores, 18 district/agency vaccine stores and 25 tehsil/town/taluka stores have >30% shortage of vaccine storage capacity +2 to +8 ^{o}C. The remaining one provincial store has 10-30% shortage of storage capacity for the same temperature. Concluding that, neither national nor provincial stores have storage capacity that is sufficient to meet storage requirement as per current EPI schedule. However, for freezers capacity (-20°C) at vaccine stores, it was noted that all stores, except Sindh provincial store, have enough capacity.

More than one third of EPI centres (37%, n=741) out of total assessed (N=1994) have >30% shortage of vaccine storage capacity to meet current EPI schedule requirement and in terms of number of facilities this shortage is mostly in BHUs (n=326). Some level of shortage is present in all other types of EPI centres.

Altogether 70 cold rooms were found in 55 assessed districts. Five cold rooms are not working and eight though working but need service. There are 8 locally made cold rooms which are present in National & Punjab EPI stores.

This database setup has a list of all PQS qualified cold chain equipment along with their PQS numbers. Presence of non PQS qualified equipment shows that for procurement of cold chain equipment, Cold Chain Standards are not followed in the country. Developing cold chain standards for the country is one of the recommendations by the Vaccine Management Mission in September 2012.

Cold boxes are needed for transportation of vaccines from main vaccine stores to tehsil/taluka stores and then onwards to EPI centres. Depending on vaccine quantity & resupply interval where quantity is not much most of the EPI centres collect it in standard vaccine carrier. According to data collected 92% EPI centres (n=1,832) collect their vaccines from stores and 83% of those who collect vaccines do not have enough cold boxes for vaccine transport. Cold box shortage is greatest in Punjab (95% of EPI centres) followed by Islamabad (85% of EPI centres), Sindh (81% of EPI centres), Baluchistan & KP (76% and 79% of EPI centres respectively) and is least in FATA (seen in 57% of the facilities assessed).

National EPI policy should elucidate more on strengthening of cold chain system or there should be a separate vaccine and cold chain system logistics and maintenance policy to cover minimum cold chain system standards, periodic maintenance cycle, repair, replenishment, SOPs, HR/capacity building and procedures/protocols regarding cold chain maintenance and equipment maintenance to be followed at every level.

Estimates of existing vaccine storage capacity to cater for current EPI schedule and for revised EPI schedule for five different scenarios is calculated and presented in this report. It is observed that to meet requirements of current EPI schedule with cold chain equipment currently available 39% (n=805) EPI facilities have >30% shortage of vaccine storage space (+2 - +8°C) while 44% (n=911) have surplus (≥10%) vaccine storage capacity. However, with the addition of one dose of IPV in the current EPI schedule, the situation is similar to first scenario.

When Rota is also added in routine EPI schedule along with IPV, it is observed that with the currently available cold chain equipment 46% (N=955) EPI facilities will have >30% shortage of vaccine storage space (+2 - +8°C) while 37% (N=777) will have surplus (>30%) vaccine storage capacity to meet storage requirements of revised EPI schedule (addition of IPV and Rota). As Rota vaccines packed vaccine volume is largest as compared to other vaccines in revised EPI schedule, therefore it occupies a lot of storage space.

In fourth scenario (adding IPV, Rota and MR to current EPI Schedule), it is observed that with the currently available cold chain equipment 45% (N=935) EPI facilities will have >30% shortage of vaccine storage space (+2 to +8°C) while 38% (N=787) will have surplus (>30%) vaccine storage capacity to meet storage requirements of revised EPI schedule.

In fifth scenario (addition of IPV, Rota, MR and Hep B), it is observed that with the currently available cold chain equipment 47% (N=988) EPI facilities will have >30% shortage of vaccine storage space (+2 - +8°C) while proportion of EPI centers with surplus (>30%) vaccine storage capacity reduces to 36% (N=751) when Hep B is also added to revised EPI schedule. After removal of non-standardized, non-environmentally friendly and outdated equipment, it is seen that 89% EPI centers (n=1851) will face>30% shortage of vaccine storing capacity, while only 9% (190) facilities will have a >30% surplus storage space. Additionally, detailed list for distribution of new equipment (in Excel) till EPI facility level can also be generated.

This assessment has enabled EPI managers, partners, Health facility in-charges and other stakeholders to see status of cold chain equipment and other accessories (voltage stabilizers, generators etc.). It is recommended to expand it to remaining districts as well, so that the status of cold chain system of all districts is clear for the future planning and decision making regarding upgrading or maintenance of cold chain system

The experience of this assessment clearly points towards a need of either expanding National EPI policy further on vaccine cold chain system standards and protocols or developing a comprehensive vaccine cold chain system policy that covers minimum cold chain system standards at various levels of EPI centers, cold chain equipment selection (PQS), periodic maintenance cycle, cold chain system HR, capacity building and training of HR, protocols and procedures to be adopted and to be strictly adhered to for ensuring an effective cold chain system at every EPI center/store

This assessment has revealed poor temperature monitoring of cold chain equipment and vaccines. If possible and feasible for Pakistan, procurement and installation of a temperature alarm system is highly recommended for improving EPI/cold chain system standards in Pakistan.

Report shows clear gap in vaccine storage capacity; it is recommended to address the vaccine shortage capacity, especially if EPI authorities plan to add new vaccines in routine EPI schedule. This may be coupled with replenishment of equipment which is outdated, not meeting PQS standards and not CFC free. Any further procurements or donations should meet the cold chain standards and distribution of equipment must be based on actual requirements for vaccine storage for different EPI centers with the help of CCEM.

It is also recommended that cold chain inventory for the rest of country should be completed and vLMIS platform to be used for updating the cold chain inventory after integration of CCEM with vLMIS.

There is a need to have one sustainable system for providing EPI logistical and warehousing needs of the country. vLMIS may be the solution to cater such needs. Currently, vLMIS is in the process of launch and initial training. Phase 1.0 has already been launched and is available online for data entry. Future phases will be introduced as improvements are made in this system in accordance with the needs and demands of health managers/planners. CCEM has many built in and customized reports. It is important that EPI managers decide which reports are most relevant to EPI Pakistan needs for future decision making and planning. These reports can be replicated from CCEM into vLMIS. Cold chain equipment portion of Phase 1.0 of vLMIS has very few variables. It collects information only on type, age, manufacture and model of refrigerators/freezer/ILR. UNICEF Polio team has already communicated vLMIS team to explore further on how strengths of CCEM can be included in vLMIS to make it more useful for managers

Training of EPI managers at provincial and district level to be conducted on CCEM database analysis to enable them to use this system and make evidence based decisions.

1 Introduction

1.1 EPI in Pakistan

As one of the signatories of achieving Millennium Development Goals by 2015, Pakistan is committed to reduce child mortality rate by two thirds from 1990 to 2015, but overall trend shows that it is off track in reaching this goal[5]. However, some progress is definitely made in few indicators of this goal, but it will be difficult to reach the target by 2015. Protection against common vaccine preventable diseases, provision of hygiene and sanitation services, administration of oral rehydration therapy during a diarrheal episode and raising awareness on health related matters are a few key steps taken by the government counterparts and development partners to bring down the child mortality and morbidity rates.

Expanded Program on Immunization (EPI) is country's national level program which, since its launch in 1978, is providing immunization services against common childhood illnesses to curtail the burden of morbidity and mortality among children and women. With the help of development partners the programme has been providing services through first level care facilities as outreach and static service delivery outlets to immunize target age children & women on nine different antigens. Though EPI program made some progress during the initial years, but during the last seven years, as reflected in WHO and UNICEF coverage estimates, routine immunization (RI) coverage has been stagnant in Pakistan. According to Pakistan Social and Living Standards Measurement Survey 2011-12, only 57% children were immunized against measles[6] while the target is 90%. Moreover, one fifth of children of Balochistan have not received any vaccination at all, and significant inequities exist due to numerous geographic, socio-economic and gender issues.[7] With the recent outbreaks of measles that affected more than 30,000 children claiming the lives of more than 300 children[8] and increasing number of polio cases in the country there cannot be a more urgent time for strengthening country's immunization program to be able to deliver safe and effective vaccines at the right time in right quantity to the right communities.

Vaccines for being biological substances need to be transported, stored and used at recommended temperatures, otherwise they lose potency. A well-functioning cold chain system is considered to be the backbone of an effective and efficient immunization program. It is the vital solution for potent vaccines and need to be considered as an integral part of any immunization system. To be able to properly utilize and make a cold chain system functioning in the most efficient manner, it is of utmost importance to have a clear cut information on the quantity, type, capacity and location of each and every equipment included in the system. In addition to that it is compulsory to have the information on working status, proper utilization and quality of the equipment present with information on status of availability of uninterrupted energy for cooling. To furnish such information, an effort was made by UNICEF in 2000 in collaboration with Government of Pakistan, Department of Health

[5] Info-graphics on Pakistan's MDGs status for 2012 available at: http://www.pk.undp.org/content/dam/pakistan/docs/MDGs/COVER-PAGES/MDG%20infographic-November13.pdf

[6] Pakistan Social and Living standards Measurement survey 2011-12, Government of Pakistan, Statistics Division, Pakistan Bureau of Statistics Islamabad, May 2013

[7] Draft report of Pakistan Demographic Health Survey 2012-13

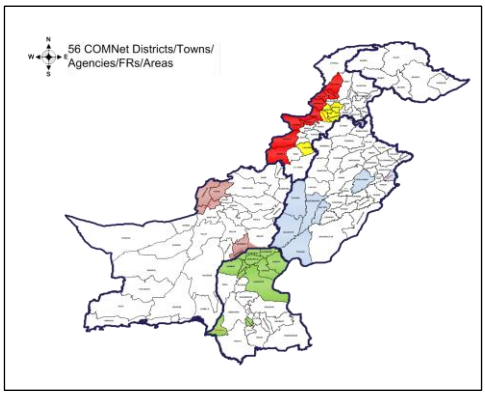
[8] Administrative data

Punjab[9]. Since the information gathered at that time was limited to Punjab province only; data gathered and presented was only on a few indicators and a significant number of years have passed now to consider that information useful for current planning and forecasting, therefore there was a need to develop an updated national computer based cold chain inventory data base system that could serve the planning and forecasting of cold chain for the entire country. This need was also highlighted by an international mission comprising of national and international experts on Vaccine Management arranged by UNICEF in September 2012. Their recommendation for having a national cold chain inventory data base system was later on endorsed by National Steering Committee (NSC) and National Vaccine Management Committee (NVMC). Therefore, upon request of government of Pakistan and in response to this recommendation the PCO UNICEF, Vaccine Management team, under the overall guidance of Polio Team Lead, took initiative to develop a computer based cold chain inventory system for the country.

Cold chain inventory system is developed by utilizing Cold Chain Equipment Manager (CCEM). This exercise for using CCEM will meet the long awaited requirement of having this information on the desktops of health managers at all levels as well as with development partners for planning and decision making purposes. Furthermore, incorporation of CCEM Pakistan data in vLMIS will make the information easily accessible online and updated regularly for: evidenced based planning, monitoring and reporting; which will help strengthening the EPI program to provide quality immunization services to the women & children of our nation, which they certainly deserve.

Box: 1

Communication Network is a network of communication staff deployed in those districts which have been selected by the communication experts of government of Pakistan with the help of UNICEF for communication and social mobilization interventions. The setup has tiers of staff deployed at district (DHCSO: District Health Communication Officer), union council (UCCO: Union Council Communication Officer) and community (SM: Social Mobilizer) levels. The staff has presence currently in high risk UCs of 56 selected districts / towns / agencies / FRs / areas throughout the country.



It was planned that data collection from 38 polio high risk districts will be completed in 2013 and activity will be rolled out nationwide next year to the remaining districts. However, considering the current deployment of Communication Network (COMNet: see Box 1) Staff, UNICEF team was able to finalize the modality for data collection from 56 COMNet polio districts (Table 1). Current document aims to present the cold chain assessment report on 55 districts for further use in planning and forecasting of cold chain equipment. This dataset will be merged with vLMIS which will be available online to make regular updating possible and to be able to use this data meaningfully. Altogether 2083 functional EPI Centers and Stores were visited in these 55 districts for data collection.

9 Provincial EPI Directorate, Department of Health Punjab. EPI Logistics Inventory 2000. Available at: http://www.unicef.org/evaldatabase/files/PAK_01-003.pdf

Table: 1. Name of districts and number of EPI centres assessed[10], 2013

District	No. of EPI centers*	District	No. of EPI centers*	District	No. of EPI centers*
ISB CAPITAL TERITROY		**KHYBER PAKHTUNKHWA**		**SINDH**	
CDA	26	CHARSADA	52	GHOTKI	47
ICT	15	LAKKIMRWT	35	HYDERABAD	69
ICT TOTAL	***41***	MARDAN	68	JACOBABAD	40
PUNJAB		NOWSHERA	65	KAMBAR	34
DGKHAN	60	PESHAWAR	88	KASHMORE	32
LAHORE	177	***KP TOTAL***	***308***	KHAIRPUR	32
MULTAN	113	**FATA**		KHIBALDIA	8
MUZFARGARH	93	BAJOUR	35	KHIBINQASIM	17
RAJAN PUR	41	FR BANNU	13	KHIGADAP	18
RAWALPINDI	109	FR DIKHAN	6	KHIGIQBAL	24
RYKHAN	137	FR KOHAT	11	KHIGULBERG	11
PB TOTAL	***730***	FR LAKKI	2	KHIKAMARI	19
BALOCHISTAN		FR PESHAWAR	7	KHIKORANGI	19
JAFARABAD	42	FR TANK	3	KHILANDHI	14
KABDULAH	14	KHYBER	15	KHILIAQAT	11
NSIRABAD	23	KURRAM	44	KHINNAZIM	7
PISHIN	24	MOHMAND	26	KHINORTH	11
QUETTA	58	ORAKZI	33	KHIORANGI	16
BCHTN TOTAL	***161***	WAZIR-N	8	KHISADDAR	23
* Inclduing EPI Stores		WAZIR-S	9	KHISITE	15
		FATA TOTAL	***212***	LARKANA	50
				SHIKARPUR	53
				SUKKUR	61
				SINDH TOTAL	***631***
GRAND TOTAL					***2083***

1.2 Cold chain equipment manager (CCEM)

The Cold Chain Equipment Manager (CCEM Version 2.1) is an interactive cold chain equipment database management system for immunization program managers and public health officers. The CCEM Tool was designed and developed as a planning tool to facilitate the strategic management of a national cold chain equipment inventory and to ensure the availability of sufficient cold chain equipment for safe vaccine storage and transport, when and where it is needed. The tool is in the public domain and freely available for use, copying, translation and distribution. It was originally

[10] Data from Faisalabad district is not included in the current analysis, however it will be included in the future

developed by a joint effort of PATH/USAID, UNICEF (The American and Caribbean Regional office - TACRO) and WHO (The Western Pacific Regional Office)[11].

CCEM version 2.1 is available to manage and analyze datasets on health facilities and equipment inventories, giving users the ability to model the impact of vaccine introduction, equipment selection, and changes in supply intervals on multiyear equipment costs. Modeling different decisions about when to remove equipment, which equipment to purchase when health facilities have storage capacity shortages, establishing policies around solar equipment, and phasing out of CFC-containing equipment are quick to implement in CCEM 2.1. Capital as well as operational costs can be easily compared between different planning scenarios. Analysis of an up-to-date national inventory of cold chain equipment with the CCEM Tool provides managers with an easy to build ability for an informed multiyear equipment plan from an informed data baseline.

It is a Microsoft (MS)-Access based application and provides users with three primary functional components:

i. A geographic database of health facilities;
ii. A data entry system targeting low-resource environments;
iii. A modeling engine for generating cold chain equipment forecasts.

With CCEM, cold chain managers can automatically analyze and assess the performance of the existing national cold chain and introduce interventions that will optimize the management of cold chain equipment.

To achieve strategic cold chain equipment planning, the tool is designed to meet following objectives:

- Establishing an accurate baseline inventory of existing equipment;
- Analyzing inventory data and furnishing list of equipment requirements;
- Multiyear forecasting of equipment needs to meet future requirements;
- Generating an equipment procurement list and budget;
- Routine updating of equipment inventory details to maintain database accuracy

Before using the CCEM Tool, a well-planned data collection effort is needed in order to collect cold chain essential data from all health facilities that store vaccines or deliver immunizations.

The following data collection tools (Annexure A – Set of CCEM Questionnaire) which have been provided with the CCEM, were modified and adapted as per need of the country, field-tested, and were used for data collection.

1. Health Facility Questionnaire
2. Refrigerator/Freezer/ILR Questionnaire
3. Vaccine Cold Boxes, Carriers, and Ice Packs Questionnaire
4. Cold Room Questionnaire
5. Generator Questionnaire
6. Voltage Regulator Questionnaire
7. Transport Questionnaire

[11] Available on the Internet at http://www.path.org/publications/details.php?i=1569. Email CCEMinfo@path.org.

Additionally, CCEM package contains the following:

- CCEM User Manual
- CCEM Questionnaire Guide
- CCEM Equipment Identification Guide

A "Calculation Sheet" was added to the above set by UNICEF VM Team to make the calculations, involved during data collection, easier. Moreover, CCEM Questionnaire guide and Equipment Identification Guide were revised in accordance to the changes made in questionnaires in order to make them more user friendly for data collectors

Modifications in database:

After piloting of CCEM original questionnaires during May 2013, it was realized that slight modifications will be required in order to make these tools more appropriate and in accordance with the administrative structure of health system in Pakistan and National EPI program's operations in the country. The modifications required were duly communicated to PATH team which agreed to make these changes in the software accordingly. These modifications included:

- A question on number of available skilled human resource related to EPI & cold chain, including vaccinators, store keepers, District & Assistant Superintendent Vaccination (DSV & ASV), cold chain technicians, Lady Health Supervisors (LHSs), Lady Health Workers (LHWs) and other staff capable of doing vaccination and/or related tasks to vaccine management.
- A question on the number of cold chain/vaccine management trainings conducted during the last one year
- Addition of various sizes of ice packs
- Addition of reports pertaining to human resource and training questions.

Furthermore, it is important to mention that some setting up of software in CCEM Setup was required before it could be used in Pakistan. Therefore, the following adjustments were done to make it completely adapted for Pakistan's needs:

- Entering country's current EPI schedule (nine antigens);
- Entering country's current vaccine resupply interval at various administrative levels as per National Health policy;
- Uploading country's entire administrative structure with names of UCs, Tehsils, Districts and Provinces to facilitate data entry process;
- Addition of the cold chain equipment (along with its specifications) which is more likely to be found in Pakistan's EPI centers during data collection, e.g. Rotary vaccine carriers, Vestfrost ILR (MKF 704) etc.;
- Addition of some domestic refrigerators (e.g. Pel & Dawlance) that are available in Pakistani market and are used in EPI centers;
- Entering country's electricity rates (Kwhrs) and demographic rates (birth rate, percentage of pregnant females and child bearing age women).

CCEM original version allows for only single data entry point. PATH team was requested to enable it for multi-center data entry in order to expedite the process.

2 Data collection methodology

As per data collection protocols advised for CCEM, a cross-sectional survey was planned for National and Provincial EPI Stores and all currently functioning EPI centres in 56 target districts of the country.

Meetings were conducted with the National EPI Programme Manager and Prime Minister's Polio Control Cell Coordinator to discuss the details of survey. Provincial EPI managers and Health Officials were met to discuss the required support from EDOs, DHOs and district EPI staff; and to get permission for data collection from EPI centres & accessing necessary information from them. Letters were issued from Provincial EPI Managers & circulated to all the concerned District EPI Departments beforehand, to ensure the availability of vaccinators/store in-charges at EPI centres during data collection dates and to maximize facilitation by EPI staff for data collection process.

2.1 Piloting

In May 2013, vaccine management team piloted data collection questionnaires in Islamabad, Lahore, Peshawar and Quetta. Observations were discussed in detail among the team and data collection tools were modified accordingly. Based on field recommendation some contents were added before printing of material in bulk.

2.2 Data collection teams

COMNet staff previously deployed in the high risk polio districts has three tiers of hierarchy including: District Health Communication Officers (DHCSOs), Union Councils Communication Officers (UCCOs) and Social Mobilizers (SMs). This staff belongs to local communities; is well acquainted with current EPI structure and closely works with them for polio eradication activities. Number of data collectors from COMNet staff trained was around 700 (Table 2).

Table: 2. Province wise number of staff trained on data collection[12]

S No.	Province	Staff trained for CCEM Data Collection			
		DHCSO	UCCSO	SM	Total
1	SINDH	13	83	193	289
2	BALOCHISTAN	6	29	22	57
3	PUNJAB	10	68	192	270
4	KPK	8	73	0	81
5	FATA-FR	7	24	3	34
Total		**44**	**277**	**410**	**731**

DHCSO: District Health Communication Officer
UCCO: Union Council Communication Officer
SM: Social Mobilizer

[12] Chip Training & Consulting (CTC) COMNet Staff Weekly & Training Report-07 January, 2014

Box: 2

Work started with Lahore district during the holy month of Ramadan. Field work during summer season with intense heat, humidity, very limited electricity and no food or drink in entire day was not easy. However, all these difficulties couldn't falter the motivation and willingness of data collectors to complete the task.

2.3 Data collection plan

DHCSOs, in collaboration with District EPI officials, prepared a list of EPI centres in their respective districts one week prior to training of data collectors. Tentative plan for training and data collection was made by District COMNet staff and UNICEF Vaccine Management Team. All the logistical and administrative support including provision of data collection material, stationary, and arrangement for travel plus boarding/ lodging for data collectors and trainers was provided by Chip Training & Consulting (CTC)[13] Regional Officers. EPI material including EPI registers (stock register, daily EPI register and permanent register), cold boxes, thermometers, vaccine carriers and ice packs for practice exercises was arranged by DHCSOs in collaboration with District EPI program.

2.4 Training & selection of interviewers

One day extensive training of data collectors was conducted in the field; training sessions were arranged for 20 – 25 participants. During this daylong training all seven data collection tools were discussed in detail and hands on practical exercises were conducted. Participants were asked to practice filling questionnaires, taking measurements of cold boxes and vaccine carriers, calculating vaccine resupply intervals, reserve vaccine stock from stock registers and ice pack sizes.

Training material distributed among participants included complete sets of data collection tools (7 questionnaires, field guide and equipment identification booklet) measuring tape and stationary material required for data collection.

A preformed "Calculation Sheet" also accompanied the above mentioned set to do the following calculations:

1. Calculation of population served by the EPI centre/ Vaccine Store in case this information was not available at the EPI centre/vaccinator. For most of the big hospitals where it was difficult to estimate the actual population served by the facility or in case of Union Councils where there are more than one EPI facilities, total population (served by the facility or in the catchment area of facility) was calculated based on the number of BCG administered during the last one year as recorded in the EPI registers;
2. Calculation of resupply interval for each EPI Center / Store by recording actual number of "Receipts" of BCG stock as recorded in the stock register during previous one year;
3. Calculation of six month average reserves stock by recording actual balance of BCG stock remaining or available and as recorded on stock register immediately before next vaccine supply;

[13] Chip Training & Consulting is hired by UNICEF for administrative control of COMNet staff.

4. Calculation of ice pack size in litres. Data collectors were trained on taking measurements of ice packs and calculating their sizes in litres.

Filled Calculation Sheets were also attached with the questionnaires, so that they can be rechecked by supervisors during evening meetings.

At the end of training only selected participants were asked to prepare data collection plan. Participants were selected on the basis of their active involvement during the training and their capacity to do various calculations during practical sessions. Although most of the COMNet staff was selected, however there were some exceptions. In Punjab and Sindh all levels of COMNet staff (DHCSOs, UCCOs and SMs) were involved in data collection, however in Baluchistan, KP and FATA only DHCSO/AHCSOs and UCCOs did data collection. This selective involvement of COMNet staff for data collection was done to ensure quality of data collected.

All training sessions were conducted by UNICEF VM Team comprising of: Vaccine Management Officer, Health Officers from PCO & UNICEF FOs and VM & CCL Coordinator.

Box: 3

Record keeping at some centers was impressive, but at others it was difficult to even retrieve six months or three months old record. In some centers staff informed that printed EPI registers are not supplied to them for the last many months. Supportive supervision, monitoring supplemented by effective training may solve this issue. Additionally, special focus is required for centers in Baluchistan and FATA.

2.5 Identification codes for data collection & entry

For identification and tracking purposes each data collector was assigned a unique code and was guided to mark each piece of cold chain equipment s/he finds in the field with this code. Although these numbers are not captured in the database, but they are marked both on the data collection forms and on every equipment: Refrigerators, ILRs, Cold Boxes, all standard vaccine carriers, Cold Rooms, Stabilizers and Generators

The format for equipment code is:

Code for Province	-	Code for data collector			-	Identification number of the equipment		
#	-	#	#	#	-	#	#	#

Set of forms for each EPI Center / EPI Store assessed consisted of Form-1 and Form-2 and may be the other forms depending on the type and number of equipment present at each EPI facility. Each set of forms was punched with a unique number for data entry and these sets are filed in box folders in a chronological order for data entry and for later use for checking during data cleaning.

2.6 Quality control

In order to ensure the quality of data collected, four quality checks were used:

a) Field monitoring of data collection: Data collectors were visited in the field by DHCSOs and by VM team from UNICEF during data collection days, wherever possible. Due to security reasons it was not possible to visit them in FATA, some districts of Baluchistan and Khairpur

district of Sindh. However, DHCSOs and provincial COMNet Coordinators monitored data collection in their respective districts. During monitoring visits data collectors' technique for collecting data was observed and any discrepancy found was rectified on the spot. Filled forms were duly signed by the interviewee (vaccinators in most cases) to ensure the correctness of data and was countersigned by the Health Facility / Store In-charge.

b) Evening meetings with all data collectors were conducted each day at the end of data collection and all forms were checked by the VM team for completeness and quality. Any shortfalls were corrected and if required, data collectors were asked to revisit the center to make necessary corrections.

c) All forms collected were rechecked by respective DHCSOs, signed and arranged in proper order, checked and tallied with original data collection plan to make sure that no facility/EPI center/Store is left out. Forms were then sent to UNICEF Office for punching and data entry.

d) Contact details of cold chain equipment in-charges (vaccinators in most cases) and team leaders (Medical officers or EPI Technicians in most cases) were also gathered and recorded on forms. In case of any confusion at the time of data entry the relevant person (Health facility in-charge or vaccinator) was contacted.

The number of EPI centers assigned to each data collector ranged from 2-6. However, exceptions were there, e.g. in case of Rawalpindi district due to lesser number of trained data collectors as compared to number of EPI centers, some data collectors visited as many as 10 or 12 EPI centers. For each district it took 5-6 days on an average to complete cold chain inventory.

Software (CCEM Pakistan Release 2.0) was first checked/ tested by UNICEF VM team for data entry. After detailed discussions with PATH regarding modifications, the modified version made for Pakistan use was named as "CCEM Pakistan version 2 RI 2.1". Detailed data entry notes were prepared for data entry personnel. Five day training / supervised data entry was arranged at Federal EPI Office Islamabad. Data entry was done by a consultant (especially hired for the purpose), five VM&CCL Officers and VM Officer.

Box: 4

Experience of visiting some stores/centers has revealed that a serious initiative for taking account of useless/dumped old equipment is required. Decision needs to be taken on ways/protocol for identifying and designating useless material and getting rid of it.

2.7 Reward for data collectors

Data collectors were paid Rs. 500/day for the number of days they collected data. In addition, certificate of appreciation will also be distributed to them.

2.8 Data management & cleaning

Before data entry, forms were punched with unique identification numbers; were arranged in separate folders for each district; and were checked thoroughly for data quality, completeness and were tallied with the original plan to confirm the number of EPI centers covered in each district.

As mentioned above, data entry was done at seven entry points and all files were merged into one database by Health Officer, UNICEF at Islamabad office. Each data entry person (at provincial level)

forwarded data entered by him/her to Islamabad office on weekly basis, and preliminary reports were generated on the available dataset to curtail the data cleaning time and, wherever needed, to guide data entry persons on mistakes made by them during data entry. CCEM has built in option to check vital data missing and updating it. Extensive data cleaning was done and dataset was tallied with the original hard copies. If more than 5% errors were found in any set, data entry person was asked to re-enter whole subset of forms.

Box: 5

Entire process of training, making data collection plans and distribution of facilities was highly interactive. Data collectors enjoyed learning new things and applying them in the field.

2.9 Reports available in CCEM Pakistan

There are two types of reports in CCEM: one is in-built reports that are already fed into CCEM and second is customized reports. There are more than 100 in-built reports and needless to say, the number of customized reports depends on the user's requirement and analyses type.

Examples of some reports that can be generated (national as well as geographical e.g. federal, provincial & district) are as follows:

- Number and proportion of EPI centres (by type) with excess or shortage of vaccine storage capacity (+2 - +8°C) to meet routine EPI schedule and also for SIAs
- Number and proportion of EPI centres (by type) with excess or shortage of ice pack freezing capacity to meet routine EPI schedule and also for SIAs
- Types of refrigerators, freezers and ice lined refrigerators
- Proportion of refrigerators/freezers working, not working and more than ten years old
- Proportion of health facilities/EPI centres providing static, outreach or both services
- Proportion of EPI centres (by type) with electricity availability in terms of number of hours/24hours
- Proportion of EPI centres (by type) with less electricity that are suitable for installation of solar equipment
- Proportion of EPI centres (by type) with different modes of vaccine supply (delivered or collected)
- Vaccine resupply intervals for each type of EPI centre or stores (BHU, dispensaries, RHC etc.)
- Current status of vaccine reserve stock (in weeks) for each type of EPI centre
- Proportion of EPI centres (by type) with/ without vaccinator
- Average population per vaccinator for each type of EPI centre
- Number of available EPI staff by EPI facility type and number trained on cold chain/vaccine management during the last one year
- Planning & Forecasting: e.g. If IPV is introduced in 2014 at all centres, which centres will be facing shortage of vaccine storage capacity; if refrigerators/ILRs more than ten years old are removed from all centres, which centres will be facing critical shortages of vaccine storage capacity;

- Budgeting: E.g. In case of removal of old refrigerators/ILRs and introduction of new, what will be the total cost for replenishment; Average cost of electricity/facility and total annual electricity cost to run all centres.

3 Results & discussion

NOTE: While interpreting the results it is important to bear in mind that findings presented here pertain to data from 55 selected COMNet districts/towns/agencies/FRs of the country. However, national and provincial EPI stores from four provinces (Punjab, KP, Sindh and Baluchistan) are also included.

3.1 Health facilities/EPI centres

i. Type of health facilities providing EPI services:

As mentioned above a total of 2,083 EPI centres and EPI stores were assessed in 55 districts/ towns/agencies/Frontier Regions (FRs). Nearly half (48.3% n= 963 out of total 1,994 EPI Centres assessed) are established in Basic health Units, followed by Civil Dispensaries (CD: 16.3% n=325). This means that these two types of health facilities are bearing nearly 65% (n=1,288) of EPI service delivery burden for routine immunization. If cold chain system needs to be strengthened special emphasis should be placed on the infrastructure/services of BHUs and CDs.

Table: 3. Type of health facilities/EPI centres assessed by Province, 2013

Type of facility (EPI Centers n=1994)/(Store n=89)	Province						
	ISB	PUNJAB	SINDH	B. TAN	KP	FATA	TOTAL
National Vaccine Store	1						1
Provincial Vaccine Store		1	1	1	1		4
District/ Agency Vaccine Store	2	7	9	5	5	7	35
Tehsil/Taluka/Town Vaccine Store		13	27		3	6	49
Teaching Hospital	1	14	12	2	2		31
Civil Hospital CH		1	4	1	24	15	45
DHQ/AHQ Hospital		10	5	5	5	5	30
Rural Health Centre RHC	3	69	41	15	25	8	161
Tehsil/Taluka HQ Hospital		4	2				6
Basic Health Unit BHU	11	412	214	81	185	60	963
Dispensary CD	12	69	147	21	30	46	325
MCH Center	1	4	15	4	8		32
Community Health Center CHC						63	63
Urban Health Center UHC			6				6
Hospital – Private	4	22	79	13	4		122
Clinic Private			8		4		12
Others	6	104	61	13	12	2	198
Total	41	730	631	161	308	212	2083

ii. Average population served per facility

Information on catchment area population of each EPI center was collected during the interview. In most cases, this information was available either with vaccinators or with the health facility in-charge. CCEM calculates the requirement of vaccine storage space by taking into account population served by health facility, current EPI vaccine schedule and vaccine resupply interval as stated in the National EPI Policy for each particular type of facility. This information was gathered during

interviews for all EPI centers supplemented by information in EPI records/registers wherever they were available and kept updated. However, in case of some EPI centers established in: private hospitals, private clinics and hospitals run by public sector, the population was calculated as proxy by getting total live births (as total BCG injections administered and recorded in Daily EPI registers for both static & outreach services during the previous 12 months). Based on total live births/year, population served by the hospital/clinic was calculated (live births = 3.53% of total population). Table 4 below, gives a snapshot of average population served by facility type.

Table: 4. Average population served by type of health facility, 2013

I. Vaccine Stores			
Sr. No	**Type of Vaccine Store (N=89)**	**Number**	**Average Population Served**
1	National Vaccine Store	**1**	**175,901,874**
2	Provincial Vaccine Store	**4**	**46,604,387**
3	District/ Agnecy Vaccine Store	**35**	**1,613,385**
4	Tehsil/Taluka/Town Vaccine Store	**49**	**350,735**
II. EPI Centers			
Sr. No	**Facility Type (N=1,994)**	**Number**	**Average Population Served**
5	Teaching Hospital	**31**	**47,146**
6	Civil Hospital CH	**45**	**33,503**
7	DHQ/AHQ Hospital	**30**	**101,170**
8	Rural Health Centre RHC	**161**	**37,067**
9	Tehsil/Taluka HQ Hospital	**6**	**108,644**
10	Basic Health Unit BHU	**963**	**26,587**
11	Dispensary CD	**325**	**31,509**
12	MCH Center	**32**	**23,975**
13	Community Health Center CHC	**63**	**15,938**
14	Urban Health Center UHC	**6**	**55,501**
15	Hospital – Private	**122**	**35,488**
16	Clinic Private	**12**	**57,639**
17	Others	**198**	**38,858**

iii. Target population

It can be noted from Table 5 below, that National vaccine store population figure is less than the combined population of all four provincial vaccine stores (186,417,548). It is important to keep in mind that this figure does not yet include Azad Jammu & Kashmir (AJK) and Gilgit Baltistan (GB) population because these two regions were not part of current assessment. All provincial store figures, except Punjab, exceed 2013 provincial population figures provided by the Federal EPI M&E and used for vaccine/cold chain forecasting and planning for the entire country. This discrepancy is largest (26%) in case of Sindh.

Table: 5. Target population (National & Provincial), 2013

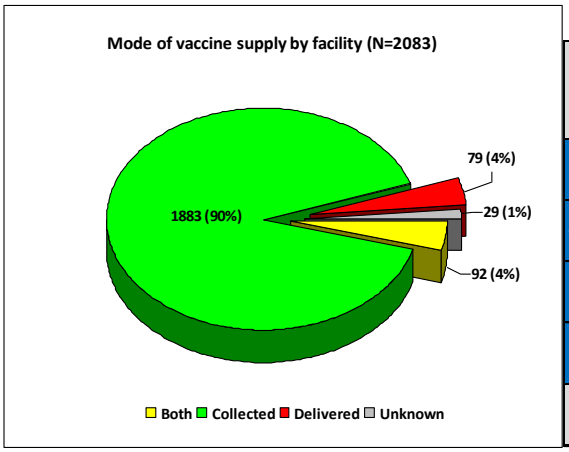
Vaccine Stores (N=5)	Population 2013*	Population 2013^	Est. Population 2014^
National Vaccine Store (n=1)			
Islamabad	**175,901,874**	175,901,874	179,032,924
Provincial Vaccine Stores (n=4)			
Balochistan at Quetta	**8,645,974**	8,443,290	8,593,580
KP & FATA Pistakhara Store at Peshawar	**30,132,891**	27,264,790	27,750,103
Punjab at Lahore	**93,496,970**	93,579,797	95,245,517
Sindh at Karachi	**54,141,713**	39,929,725	40,640,474
Total Provincial Stores	**186,417,548**	**169,217,602**	**172,229,674**

Source: * Population 2013: from EPI Store Record
^ Population 2013 & 2014: from Federal EPI M&E

iv. Mode of vaccine supply

Results show that 90% (n= 1,883) of EPI centers collect their vaccines from stores (Figure 1 Pie chart). Out of all EPI centers that collect vaccines, nearly 61% (n=1148) have some kind of working transport (Figure 1 Table). It was observed during data collection that many centers, where there is no EPI transport, rely on private mode of transport (rickshaw, chingchi, bus etc.) for vaccine collection.

Figure 1. Mode of vaccine supply & transport availability, 2013



Mode of Vaccine Supply		Transport in Working Condition		Total
		No	Yes	
Delivered	Number	31	48	79
	% Transport Working	4%	4%	4%
Collected	Number	735	1148	1883
	% Transport Working	92%	91%	91%
Both	Number	28	64	92
	% Transport Working	3%	5%	4%
Unknown	Number	7	5	12
	% Transport Working	1%	0%	1%
Total	**Number**	**801**	**1265**	**2066**
	% Transport Working	**100%**	**100%**	**100%**

v. Vaccine re-supply interval and reserve stock

On an average most of the EPI facilities and stores, from Divisional EPI stores to private EPI facilities get their vaccine re-supply every four weeks, which is in accordance with the national policy. Only national and provincial vaccine stores get vaccine supply more frequently than what is stated in the policy i.e. their re-supply interval is shorter.

Vaccine reserve stock for all vaccines is calculated as proxy by recording average of six months BCG stock balance (stock remaining or available) immediately before the next vaccine supply. This

average balance stock is then translated into number of weeks stock can last by dividing it with weekly BCG target. BCG stock is thought to be limited at EPI facilities therefore data on this antigen was recorded assuming that reserve stock of other antigens will be anyway greater than BCG.

Report shows that roughly all facilities' reserve stock is less than recommended which needs to be addressed.

Table: 6. Vaccine re-supply interval & reserve stock by type of health facility, 2013

Facility Type	Total Facilities	Resupply Interval in Weeks				Reserve Stock in Weeks			
		Minimum	Maximum	Mean	National	Minimum	Maximum	Mean	National
National Vaccine Store	1	7	7	**7.0**	**16**	11	11	**11.0**	**24**
Provincial Vaccine Store	4	4	12	**6.5**	**12**	0	12	**7.8**	**12**
District/ Agency Vaccine Store	35	0	6	**3.9**	**4**	0	8	**1.4**	**4**
Tehsil/Taluka/Town Vaccine Store	49	0	12	**4.4**	**4**	0	6	**0.8**	**2**
Teaching Hospital	31	2	5	**4.0**	**4**	0	4	**0.5**	**2**
Civil Hospital CH	45	0	12	**3.7**	**4**	0	6	**1.3**	**2**
DHQ/AHQ Hospital	30	0	5	**3.1**	**4**	0	4	**1.2**	**2**
Rural Health Centre RHC	161	0	6	**3.6**	**4**	0	6	**0.6**	**2**
Tehsil/Taluka HQ Hospital	6	1	6	**3.8**	**4**	0	2	**0.5**	**2**
Basic Health Unit BHU	963	0	12	**3.6**	**4**	0	6	**0.6**	**2**
Dispensary CD	325	0	12	**3.6**	**4**	0	6	**0.7**	**2**
MCH Center	32	0	6	**3.1**	**4**	0	4	**0.5**	**2**
Community Health Center CHC	63	0	4	**3.2**	**4**	0	4	**0.3**	**2**
Urban Health Center UHC	6	4	6	**4.3**	**4**	0	4	**0.8**	**2**
Hospital – Private	122	0	12	**4.1**	**4**	0	4	**0.5**	**2**
Clinic Private	12	0	4	**3.3**	**4**	0	3	**0.7**	**2**
Others	198	0	12	**3.7**	**4**	0	6	**0.5**	**2**
NOTE: 0 is Less than a week. National is according to National Health Policy									

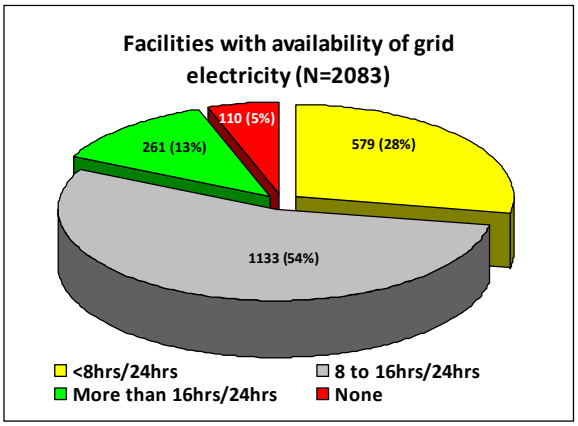
vi. Availability of grid electricity

Report on availability of grid electricity shows that only 13% (n=261) of EPI centers assessed have electricity available for more than sixteen hours in one day (Figure 2 pie chart). Most of these EPI centers are located in Teaching Hospitals (Table 7).

Roughly one third of EPI centers (n=689) have electricity available for less than eight hours (Table 8) and majority of these facilities (nearly 71% n=481) are either Basic Health Units (BHUs) or Civil Dispensaries (CD). Moreover, out of all centers where either there is no electricity or it is available for less than eight hours only 13% (n=92) have back-up generator. This finding points towards lack of distribution of equipment on the basis of actual requirement or ground situation.

In order to minimize the chances of compromised cold chain of precious vaccines at these centers any future intervention regarding back up electricity or some alternative power source should be focused on EPI centers where there is shortage of electricity and which are carrying the largest burden of EPI service delivery.

Figure 2. Availability of grid electricity vs standby generators, 2013



Availability of grid electricity		Generator available		Total
		No	Yes	
None	Number	92	18	110
	% with Generator	83.64	16.36	100
<8 hrs.	Number	505	74	579
	% with Generator	87.22	12.78	100
8-16 hrs.	Number	939	194	1133
	% with Generator	82.88	17.12	100
>16 hrs.	Number	200	61	261
	% with Generator	76.63	23.37	100
Total	Number	1736	347	2083
	% with Generator	83.34	16.66	100

Furthermore, only 9% (n=3) of DHQ Hospitals, 8% (n=14) of RHCs and 6% (n=53) of BHUs have electricity available for more than sixteen hours/24 hours. Information on number of hours grid electricity is available can help in informed decision making related to selection of the type of cold chain equipment (e.g. solar) for future.

Table: 7. Availability of grid electricity by facility type, 2013

Facility Type	Total Facilities	Availability of Electricity							
		None	%	< 8 hours	%	8 to 16 hours	%	> 16 hours	%
National Vaccine Store	1	-	-	-	-	1	100	-	-
Provincial Vaccine Store	4	-	-	1	25	-	-	3	75
District/ Agency Vaccine Store	35	1	3	4	11	21	60	9	26
Tehsil/Taluka/Town Vaccine Store	49	1	2	5	10	33	67	10	20
Teaching Hospital	31	-	-	2	6	9	29	20	65
Civil Hospital CH	45	3	7	13	29	20	44	9	20
DHQ/AHQ Hospital	30	1	3	4	13	22	73	3	10
Tehsil/Taluka HQ Hospital	6	-	-	1	17	3	50	2	33
Rural Health Centre RHC	161	3	2	55	34	89	55	14	9
Basic Health Unit BHU	963	44	5	339	35	527	55	53	6
Dispensary CD	325	20	6	78	24	181	56	46	14
MCH Center	32	1	3	4	13	25	78	2	6
Community Health Center CHC	63	20	32	38	60	5	8	-	-
Urban Health Center UHC	6	-	-	-	-	6	100	-	-
Hospital – Private	122	8	7	6	5	63	52	45	37
Clinic Private	12	1	8	-	-	7	58	4	33
Others	198	7	4	29	15	121	61	41	21
Total	2,083	110	5	579	28	1,133	54	261	13

Majority of EPI centers (99.7% of the 2,083 assessed) where grid electricity is available for less than eight hours have plenty of sunlight during daytime and are suitable for installation of solar equipment (Table 8). However, other factors like availability of trained cold chain maintenance staff

for periodic maintenance of solar equipment should also be considered at the time of assessing EPI centers for possible installation of such equipment.

Table: 8. Suitability for solar equipment by type of health facilities, 2013

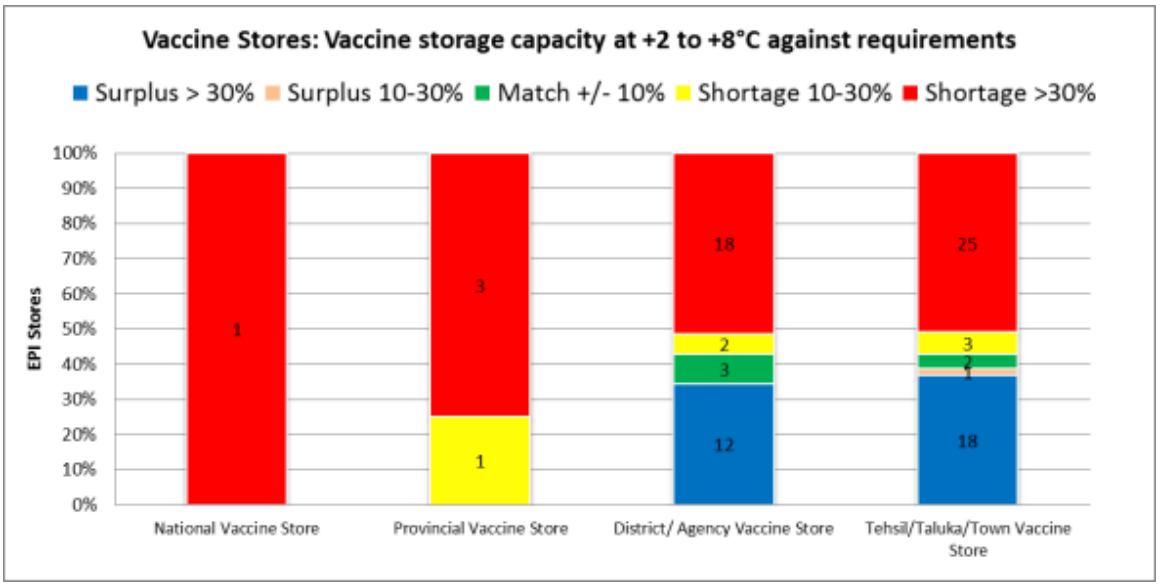
Facility Type	Total # of Facilities	# Facilities with 0-8/24 hrs electricity	Facilities suitable for solar equipment	
			#	%
National Vaccine Store	1	0	0	...
Provincial Vaccine Store	4	1	1	100
District/ Agency Vaccine Store	35	5	5	100
Tehsil/Taluka/Town Vaccine Store	49	6	5	83
Teaching Hospital	31	2	2	100
Civil Hospital CH	45	16	16	100
DHQ/AHQ Hospital	30	5	5	100
Tehsil/Taluka HQ Hospital	6	1	1	100
Rural Health Centre RHC	161	58	58	100
Basic Health Unit BHU	963	383	382	100
Dispensary CD	325	98	98	100
MCH Center	32	5	5	100
Community Health Center CHC	63	58	58	100
Urban Health Center UHC	6	0	0	...
Hospital – Private	122	14	14	100
Clinic Private	12	1	1	100
Others	198	36	36	100
Total	**2,083**	**689**	**687**	**99.7**

3.2 Vaccine storage capacity & freezer capacity

i. EPI stores

In CCEM, vaccine storage capacity is calculated on the basis of population served by the facility, current EPI schedule, including SIAs, and vaccine resupply interval as per policy. For EPI stores, it was noted that National vaccine store, three provincial vaccine stores, 18 district/agency vaccine stores and 25 tehsil/town/taluka stores have >30% shortage of vaccine storage capacity +2 to +8 ^{o}C (Figure 3). The remaining one provincial store has 10-30% shortage of storage capacity for the same temperature.

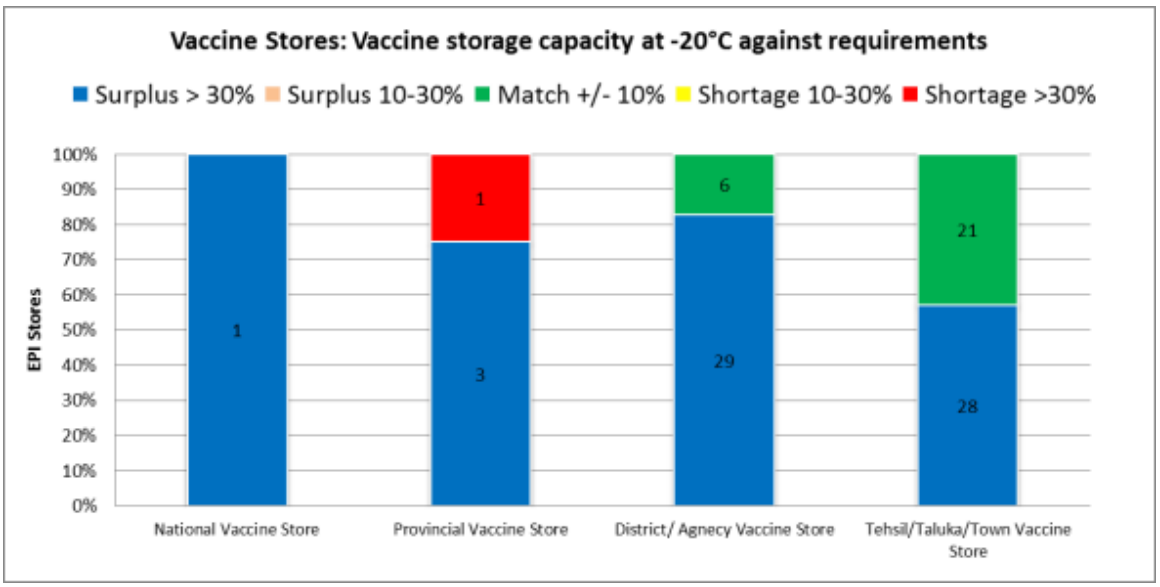
Figure 3. Vaccine storage capacity (+2-+8 °C) by type of EPI stores, 2013



Neither national nor provincial stores have storage capacity that is sufficient to meet storage requirement as per current EPI schedule. However, the situation for district/agency and tehsils/ taluka/town vaccine stores differs, where 34% (n=12) stores at district level and 37% (n=18) stores at tehsil/taluka/town level have surplus storage space. This finding again shows a strong need for the distribution of cold chain equipment on the basis of centers' requirements and actual situation so that already meager available resources can be used in an efficient manner.

For freezers capacity (-20°C) at vaccine stores, it was noted that all stores, except Sindh provincial store, have enough capacity (Figure 4).

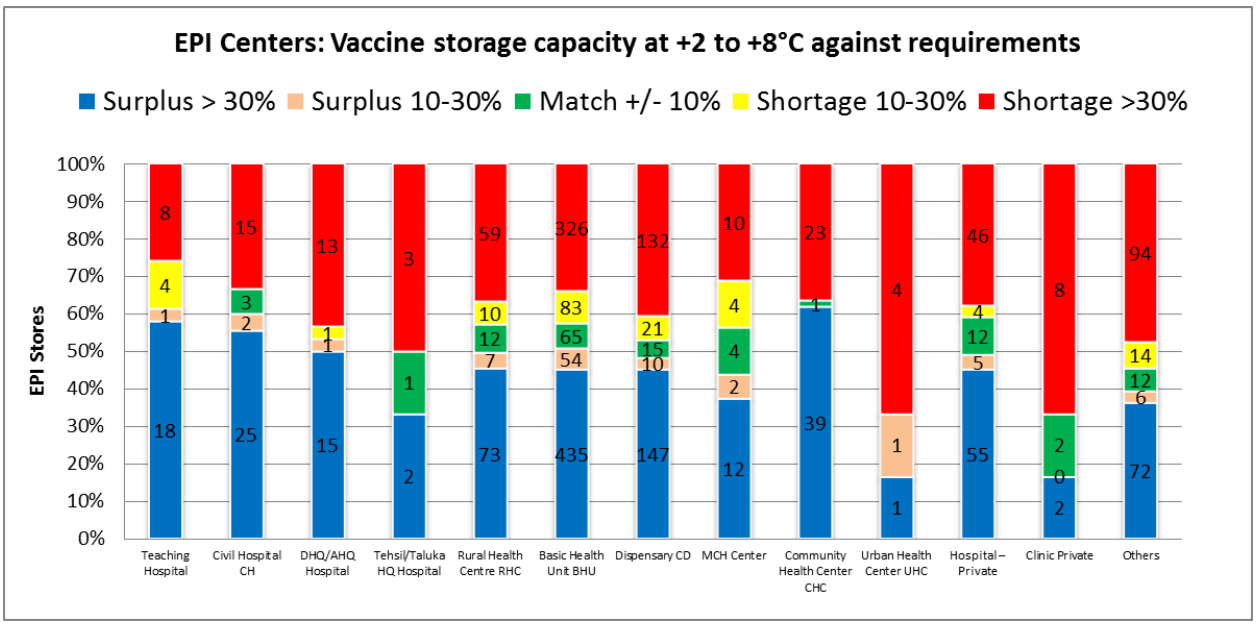
Figure 4. Freezer capacity (-20°C) by type of EPI stores, 2013



ii. EPI centres

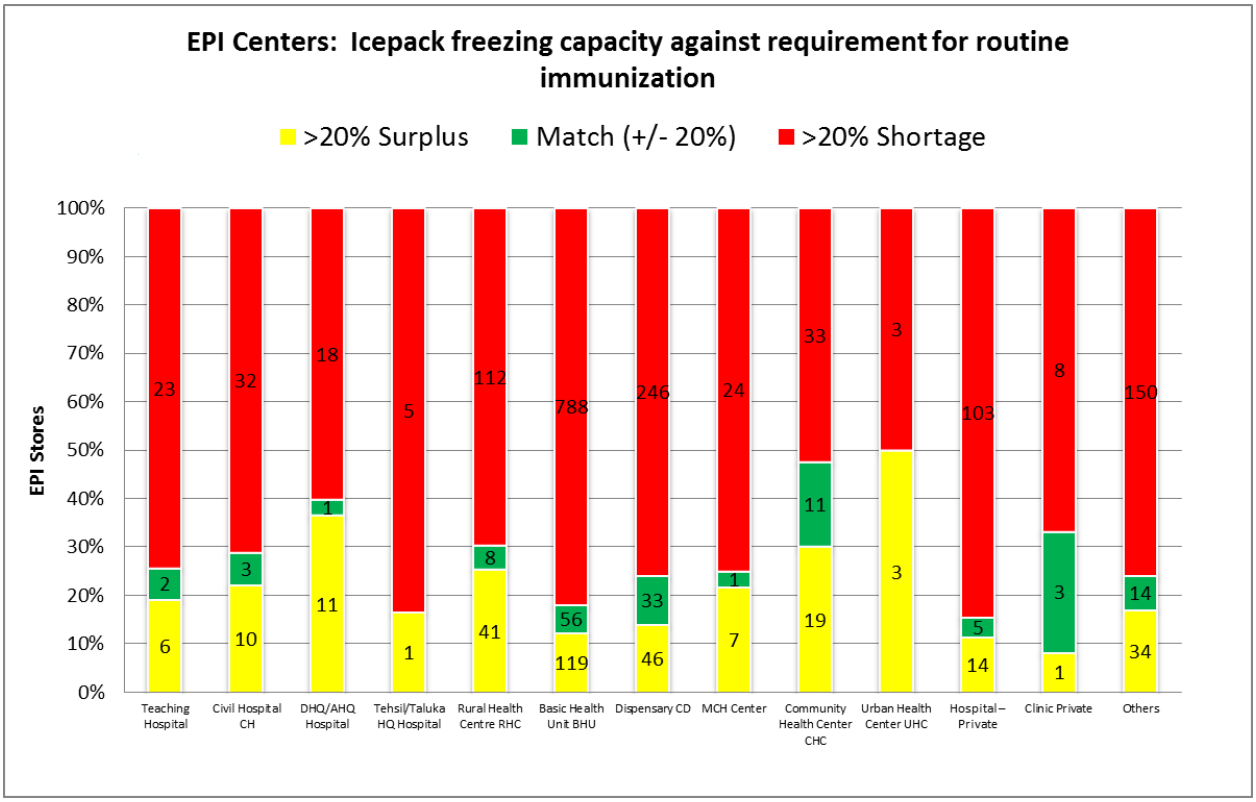
More than one third of EPI centres (37%, n=741) out of total assessed (N=1994) have >30% shortage of vaccine storage capacity to meet current EPI schedule requirement (Figure 5) and in terms of number of facilities this shortage is largest in BHUs (n=326). Some level of shortage is present in all other types of EPI centres. It is important to bear in mind that this report on vaccine storage capacity is for the current EPI schedule. In future, if new vaccines are included (e.g. IPV or Rota) in the schedule, it is possible that this shortage becomes even greater. Therefore, it is recommended to strengthen country's cold chain system before any new vaccine is added into routine EPI schedule.

Figure 5. Vaccine storage capacity (+2-+8 °C) by type of EPI Centres, 2013



Report on ice pack freezing capacity at EPI centres (for routine EPI) showed that though shortage is seen in all types of EPI centres (Figure 6), but is more pronounced at private hospitals (85% of private hospitals, n=103) followed by BHUs (83%) and CD (77%). As mentioned above, both BHUs and CDs are sharing a large burden of EPI service delivery, therefore play a very important role in improving population's immunization status.

Figure 6. Icepacks freezing capacity for routine immunization requirements by type of EPI centres, 2013



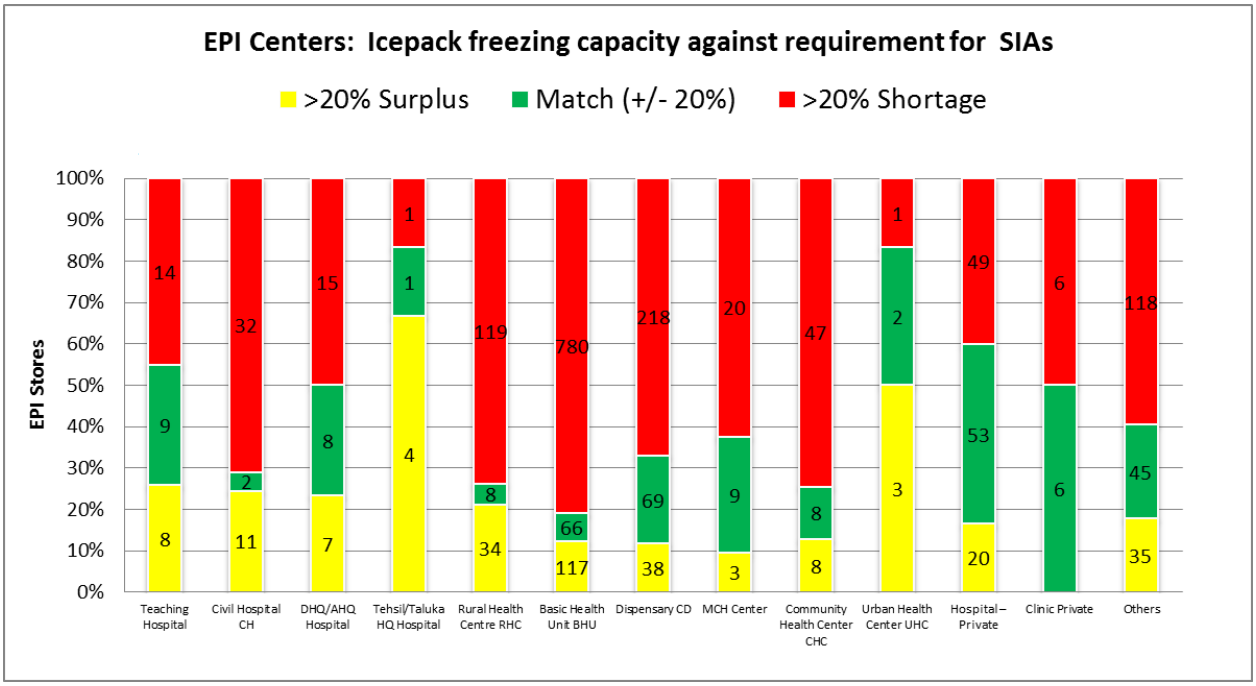
To meet SIA requirement of ice pack freezing capacity (Figure 7), again largest proportion of BHUs (82%) followed by CD (67%) have shortage of more >20% as compared to requirement.

During interviews it was informed that most of the ice requirements for polio campaigns are met through purchase of bulk ice from local market. Reasons for this ad-hoc arrangement could include lack of regular supply of electricity to freeze ice packs, lack of freezers' capacity to meet ice requirements of all vaccination teams and availability of ice packs. Furthermore, polio vaccination teams carry ice in plastic bags. These bags are either kept in small Rotary vaccine carriers or sometimes in other types of carriers including small coolers. Carrying ice with vaccine vials can definitely compromise the cold chain of vaccines or may result in wetting of VVM, especially during the campaigns conducted in summer season. Reason for doing this at many centres was not cited as lack of enough number of vaccine carriers or ice packs, rather it was informed that carrying a polio vaccine carrier may make a vaccination team a direct target for possible attack, therefore vaccination teams carry OPV vials in the field along with small ice in a small hidden plastic bag. As far as maintaining proper standards of vaccine handling and cold chain are concerned, this practice certainly can raise a lot of concerns. Keeping in view the prevailing security situation the local solutions as advised by the law enforcement authority has the prime importance unless it doesn't compromise the cold chain.

Box: 6

Though initially it was planned to add the tier of Divisional store in administrative levels of CCEM, but it was found that only Hyderabad divisional store is functioning truly as a divisional vaccine store i.e. vaccines for all districts that come under this division are supplied to it and then issued from there to district vaccine stores. Rests of the stores at division level are not functioning as divisional stores.

Figure 7. Icepacks freezing capacity for polio SIAs requirements by type of EPI centers, 2013



3.3 Cold chain equipment

iii. Cold rooms

As mentioned above only COMNet high risk areas were assessed in this exercise; however cold chain equipment data for national and all four provincial stores (FATA doesn't have one) was collected. CCEM has now a complete cold chain inventory for these districts. Altogether 71 cold rooms were found in 55 assessed districts. Out of these, a total of 55 are installed (27 at national, 9 at Punjab, 5 at Sindh, 12 at KP and 2 in Baluchistan provincial stores). The details of net storage capacity against requirement are shown in Table 9 with actual shortage in litres. Based on availability of funds, this shortage needs to be replenished on urgent basis as vaccine on arrival needs to be placed at national level in most of the cases; however the storage space for OPV (which is stored at -20°C at national & provincial levels) is found to be more than required.

Table: 9. Cold rooms storage capacity at national & provincial stores, 2013

Province	Name	Cold Rooms	+2 to +8°C Net Storage (Litres)			-20°C Net Storage (Litres)		
			Actual	Required	Difference	Actual	Required	Difference
ISLAMABAD								
ISLAMABAD	National EPI Store Islamabad	27	264,356	706,052	-441,696	44,024	21,512	22,512
PUNJAB								
PUNJAB	Provincial Epi Store Punjab	9	117,982	225,172	-107,190	60,346	6,861	53,485
SINDH								
SINDH	Provincial EPI office Vaccine Store Sindh	5	40,046	130,391	-90,345	0	3,973	-3,973
KP								
KP	Provincial Vaccine Store KP FATA Peshawar	12	55,120	72,570	-17,451	20,784	2,211	18,573
BALOCHISTAN								
BALOCHISTAN	Provincial EPI Store Balochistan Quetta	2	3,227	20,822	-17,596	4,407	634	3,773
	Total	55	480,731	1,155,007	-674,278	129,561	35,191	94,370

Figure 8 below shows the working status of all cold rooms found in the field; 81% (n=57) are found working, 11% (n=8) are working but need maintenance and 7% (n=5) are not working at all. There are 8 locally made cold rooms in National & Punjab EPI store. Those found in Punjab are very old and need to be replaced.

Figure 8. Working status of cold rooms, 2013

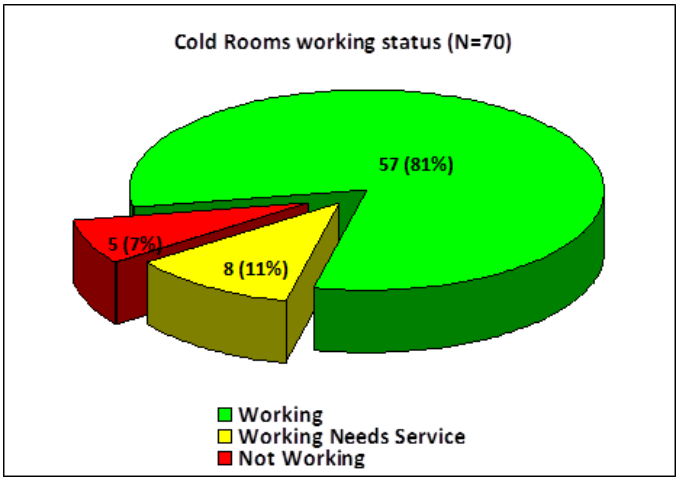


Table 10 gives further detail on number of cold rooms available from national to district levels in all high risk districts.

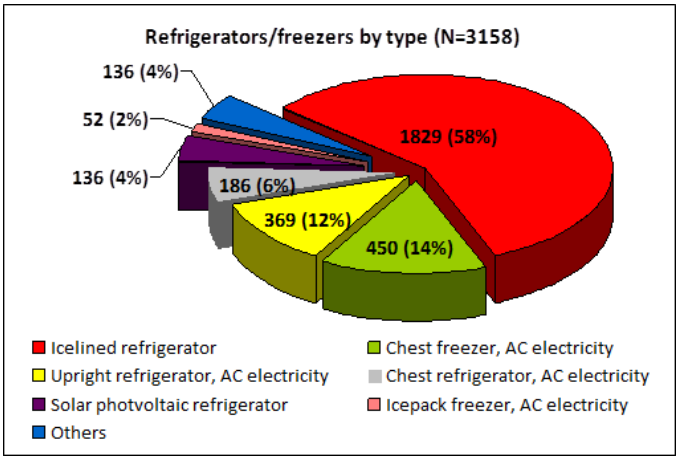
Table: 10. District wise working status of cold rooms, 2013

Type of Vaccine Store	Province / District	# of Cold Rooms	Working well	Working but needs maintenance	Not working
National Vaccine Store	NATIONAL	27	27		
Punjab		**16**	**10**	**3**	**3**
Provincial Vaccine Store	PROVINCIAL	9	6	2	1
District/Agency Vaccine Store	LAHORE	2	1		1
District/Agency Vaccine Store	MULTAN	2	1		1
District/Agency Vaccine Store	MUZFARGARH	1	1		
District/Agency Vaccine Store	DGKHAN	1		1	
District/Agency Vaccine Store	RYKHAN	1	1		
Sindh		**12**	**6**	**4**	**2**
Provincial Vaccine Store	PROVINCIAL	5		4	1
District/Agency Vaccine Store	HYDERABAD	2	1		1
District/Agency Vaccine Store	SUKKUR	2	2		
District/Agency Vaccine Store	SHIKARPUR	1	1		
District/Agency Vaccine Store	KASHMORE	1	1		
District/Agency Vaccine Store	KHAIRPUR	1	1		
Balochistan		**3**	**2**	**1**	**0**
Provincial Vaccine Store	PROVINCIAL	2	1	1	
District/Agency Vaccine Store	NSIRABAD	1	1		
Khyber Pakhtunkhwa (KP/FATA)		**12**	**12**	**0**	**0**
Provincial Vaccine Store	PROVINCIAL	12	12		
District Vaccine Store	MARDAN		1* (Not installed)		
Total		**70**	**57**	**8**	**5**

iv. Refrigerators/ILRs

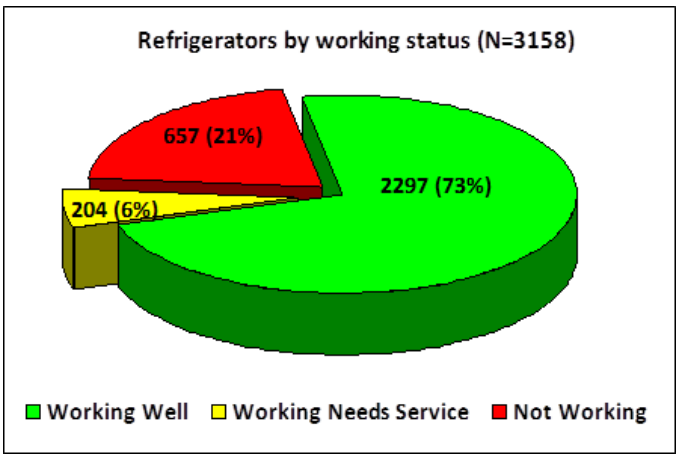
A total of 3,158 refrigerators/ILRs were found in all 2,074 EPI centres/stores present in 55 assessed districts/towns/agencies/FRs. Information on the refrigerators used other than EPI (storing medicines or for purpose other than immunization) was not gathered. Most common type found in EPI use is Ice Lined Refrigerator (ILRs) 58% (n=1,829), followed by Chest Freezer (14% n=450) and Upright Refrigerators (12% n=369). As evident from Figure 9 there are only 4% (n=136) solar ILRs in the assessed health facilities. Keeping in mind the electricity crisis faced by the country with long load shedding, EPI programme is already planning for alternate energy source equipment and photovoltaic solar ILRs seem to be the best option.

Figure 9. Refrigerators/Freezer types, 2013



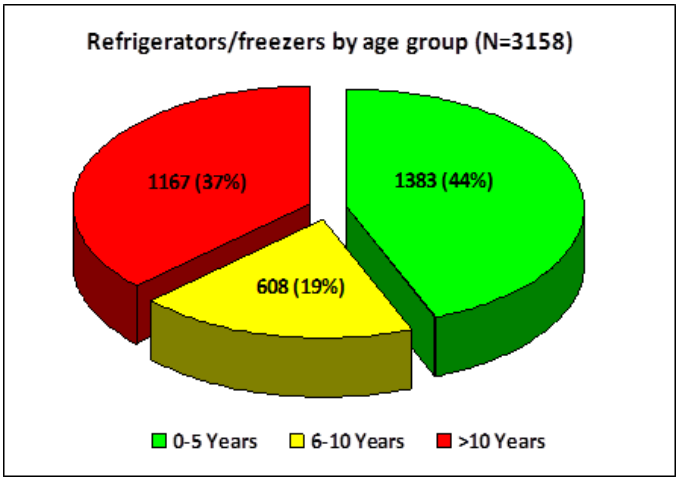
As evident from Figure 10, 21% (n=657) of all refrigerators are not in working condition and six per-cent (n=204) are working but needs service, therefore require attention by the cold chain team leader at EPI centre. On the whole it was found in the field that repair and maintenance of CCE is the weakest area of EPI department and needs to strengthen, especially in terms of number of technical human resource available for repair and periodic maintenance of equipment.

Figure 10. Working status of refrigerators/ILRs, 2013



Report on the age of refrigerator/freezer (Figure 11) shows that 37% (n=1,167) are more than ten years old. Exact locations of old or not working equipment (name of health facility, Union Council and District) can be found by generating a line list from CCEM database.

Figure 11. Refrigerators/freezers by age group, 2013

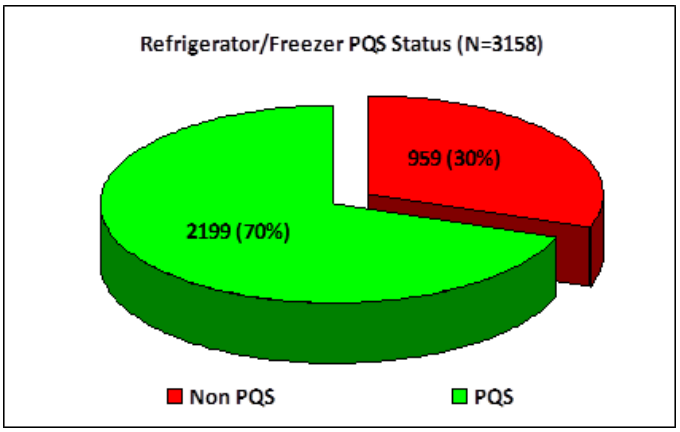


CCEM also gives a report on Performance, Quality and Safety (PQS) [14] status of refrigerator/freezer/ILRs. This database has list of all PQS qualified cold chain equipment along with their PQS numbers. PQS report of all the refrigerators/ILRs found at the facilities assessed show that 30% (n=959) of this equipment is not PQS prequalified and according to WHO standards this needs to be replaced with prequalified equipment (Figure 12). Presence of non PQS qualified equipment shows that for procurement of cold chain equipment, Cold Chain Standards are not followed in the country. Developing cold chain standards for the country is one of the recommendations in the Vaccine Management September 2012 Report.

The Exact location of non-PQS equipment can be found by generating the line list from CCEM database so that further actions regarding replacement of this equipment can be taken as and when required.

[14] Performance, Quality and Safety (PQS) prequalified devices and equipment The WHO Department of Immunization, Vaccines and Biologicals (IVB), Quality, Safety and Standards (QSS) Team prequalifies a comprehensive range of cold chain equipment, injection devices and other products needed for safe and effective immunization delivery.

Figure 12. PQS status of refrigerators/ILRs



v.Cold boxes

Cold boxes are needed for transportation of vaccines from main vaccine stores to tehsil/taluka stores and then onwards to EPI centres. They can also be used in situations when ILR/refrigerator stops working and is required to be replaced by new equipment. During this interim period, vaccines can be stored in a cold box well prepared for storing vaccine. Standard vaccine carriers are used for conducting static and outreach sessions of routine immunization.

Depending on quantity of vaccine & resupply interval where quantity is not very long most of the EPI centres collect it in standard vaccine carrier. Availability of cold boxes and vaccine carriers is presented below in Table 11.

Table: 11. Available cold boxes & vaccine carriers, 2013

Cold Box/Vaccine Carrier Type	Number
Cold box long range	509
Cold box short range	47
Vaccine carrier	2,112
Day carrier (Rotary International)	1,522
Unknown	10
Total	**4,200**

Table 12 shows that 92% EPI centres (n=1,832) collect their vaccines from stores and 83% of those who collect vaccines do not have enough cold boxes.

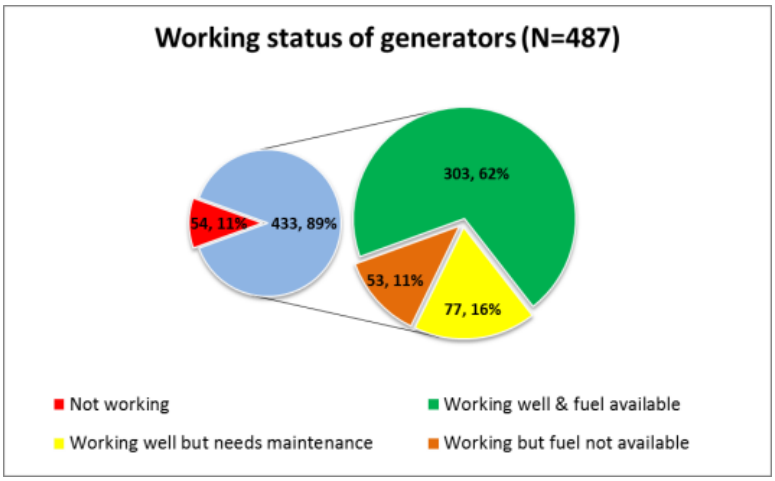
Table: 12. Facilities with insufficient cold box capacity for vaccine resupply, 2013

Facility Type	Total Facilities	Mode of Vaccine Supply				Facilities with >10% Shortage	
		Delivered	Collected	Collected/ Delivered	Unknown	#	%
Tehsil/Taluka HQ Hospital	6	2	4	0	0	6	100
Teaching Hospital	31	0	30	1	0	29	93.6
Civil Hospital CH	45	0	43	2	0	33	73.3
DHQ/AHQ Hospital	30	2	27	1	0	27	90.0
Rural Health Centre RHC	161	8	138	14	1	128	79.5
Basic Health Unit BHU	963	20	889	42	12	804	83.5
Dispensary CD	325	7	302	6	10	268	82.5
MCH Center	32	1	30	0	1	27	84.4
Community Health Center CHC	63	1	58	1	3	30	47.6
Urban Health Center UHC	6	0	6	0	0	6	100
Hospital – Private	122	0	117	5	0	118	96.7
Clinic Private	12	0	12	0	0	12	100
Others	198	11	176	10	1	178	89.9
Total	1,994	52	1,832	82	28	1,666	83.6

vi. Standby generators

A total of 487 generators were found, out of these 11% (n=54) are out of order (Figure 13). Out of 433 found in good condition, 70% (n=303) are working well and reportedly fuel is available; for 11% (n=53) fuel is not available while 16% (n=77) needs some kind of maintenance work

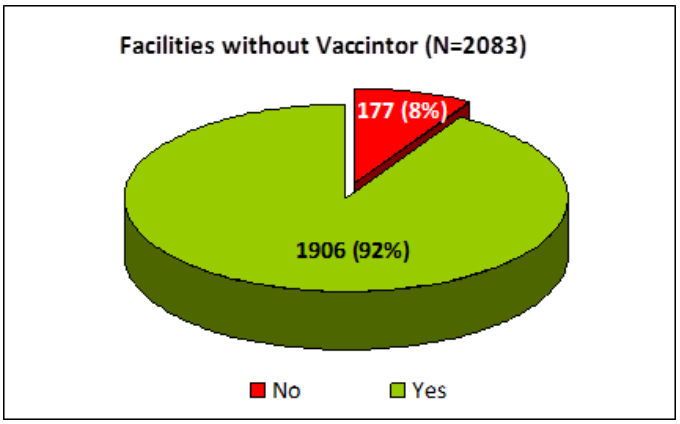
Figure 13. Working status of generators, 2013



3.4 Human resource

Only eight percent of EPI centers (n=177) are without vaccinators; a designated vaccinator is present in most of the functional EPI center, which is very encouraging (Figure 14). However, the situation was inconsistent amongst different provinces and in districts within the province assessed.

Figure 14. Availability of vaccinators at EPI centres assessed, 2013



The average population per vaccinator by facility type is presented below in Table 13.

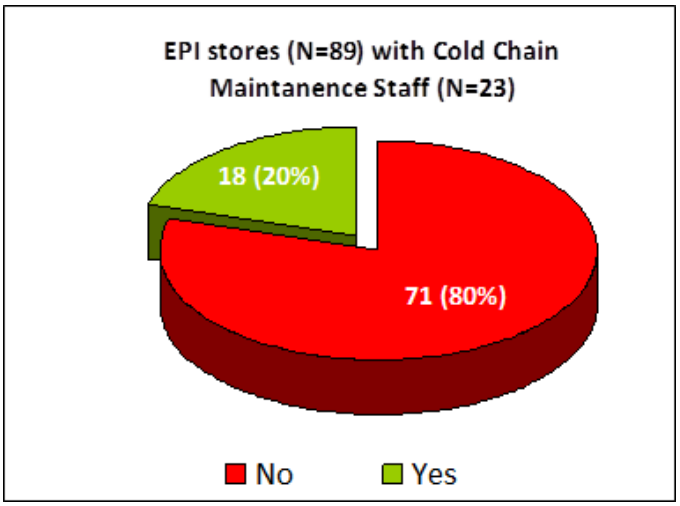
Table: 13. Population/vaccinator by type of health facility, 2013

Facility Type	Total # of Facilities	Average Population per Vaccinator
Teaching Hospital	24	30,805
Civil Hospital CH	45	19,404
DHQ/AHQ Hospital	28	30,717
Tehsil/Taluka HQ Hospital	5	51,931
Rural Health Centre RHC	156	26,091
Basic Health Unit BHU	892	21,946
Dispensary CD	301	21,977
MCH Center	32	19,352
Community Health Center CHC	59	11,964
Urban Health Center UHC	6	31,077
Hospital – Private	116	23,532
Clinic Private	11	50,585
Others	186	23,595
Total	**1,861**	**32,511**

3.5 Cold chain repair & maintenance

From the perspective of strengthening cold chain system in the country it is important to note that out of all the stores assessed (N=89), only 20% (n=18) have designated cold chain maintenance staff (Figure 15)

Figure 15. Cold chain maintenance staff at EPI stores, 2013



In case of EPI centers located in BHUs, civil dispensaries or RHCs vaccinators are responsible for regular cleaning or maintenance of refrigerator/freezer. National EPI policy should elucidate more on strengthening of cold chain system or there should be a separate vaccine and cold chain system logistics and maintenance policy to cover minimum cold chain system standards, periodic maintenance cycle, repair, replenishment, SOPs, HR/capacity building and procedures/protocols regarding cold chain maintenance and equipment maintenance to be followed at every level.

3.6 Cold box capacity for vaccine supply

Table 14 gives province wise details on percentage (and number) of facilities that have >10% shortage of cold box capacity against requirement. It is important to keep in mind that cold boxes are required for vaccine supply and majority of EPI centres in Pakistan collect their vaccines from respective vaccine stores. Therefore, they either rely on standard vaccine carrier or a cold box for vaccine collection. Cold box shortage is greatest in Punjab (95% of EPI centres) followed by Islamabad (85% of EPI centres), Sindh (81% of EPI centres), Balochistan & KP (76% and 79% of EPI centres respectively) and is least in FATA (seen in 57% of the facilities assessed). However, it is important to note that some level of cold box shortage capacity is present in all provinces.

Table: 14. Shortages of cold box capacity for vaccine resupply, 2013

Area	Total Facilities	Mode of Vaccine Supply				Facilities with >10% Shortage	
		Delivered	Collected	Collected/ Delivered	Unknown	#	%
ISLAMABAD	41	6	28	5	2	35	85.37
PUNJAB	730	31	646	48	5	697	95.48
SINDH	631	24	585	16	6	516	81.77
BALOCHISTAN	161	9	136	10	6	123	76.4
KP	308	6	298	2	2	243	78.9
FATA	212	3	190	11	8	122	57.55
Total	2,083	79	1,883	92	29	1,736	83.34

3.7 Multiyear forecast plans for cold chain equipment

Multiyear forecast plans generated by CCEM can evaluate the impact of population increase based on annual growth rates; supplementary immunization activities; introduction of new vaccines into EPI schedule; replenishment of non PQS or outdated equipment with new PQS equipment or replacement/replenishment of equipment utilizing electricity with solar equipment in areas where there is lack or shortage of grid electricity. It also calculates capital and recurrent cost involved in operating cold chain equipment and capital cost involved in replenishment/replacement. The forecast reports could be based on number of parameters, including:

- National EPI policy for replacing outdated equipment;
- Adherence to cold chain standards i.e. standardized (PQS) equipment; availability of effective temperature monitoring system;
- Introduction of alternate energy source equipment needed for cold chain maintenance due to non-availability of uninterrupted grid electricity;
- Change in EPI Policy regarding reserve stock and supply intervals at EPI store and centers located at various levels and vaccine wastage rates;
- Revising immunization schedule e.g. introduction of new vaccines and changes in schedule for supplementary immunization activities.

Reports based on various possible scenarios are presented in the following section which can help in evaluating alternate options and making decisions accordingly. This will certainly be helpful in deciding for the most appropriate time for introduction of new vaccines or taking appropriate steps in advance to make the cold chain system ready for introduction of new vaccines. CCEM budgeting for multiyear plans will help in selecting the most appropriate new equipment in terms of cost implications and also gives the option of reallocation of equipment to different health facilities. CCEM can generate the detailed distribution list as well.

Box: 7

Scenario 1: National current EPI schedule including 9 antigens (one dose of BCG, four doses of OPV, three doses of Penta, three doses of PCV, two doses of Measles and five doses of tetanus toxoid). It also includes doses required for polio campaign as per current year schedule for campaigns. Cold chain system is as is currently available at centers and stores.

Scenario 2: National current EPI schedule including 9 antigens (one dose of BCG, four doses of OPV, three doses of Penta, three doses of PCV, two doses of Measles and five doses of tetanus toxoid) with one dose of IPV added in the schedule. It also includes doses required for polio campaign as per current year schedule for campaigns. Cold chain system is as is currently available at centers and stores.

Scenario 3: National current EPI schedule including 9 antigens (one dose of BCG, four doses of OPV, three doses of Penta, three doses of PCV, two doses of Measles and five doses of tetanus toxoid) with one dose of IPV and 3 doses of Rota added in the schedule. It also includes doses required for polio campaign as per current year schedule for campaigns. Cold chain system is as is currently available at centers and stores.

Scenario 4: National current EPI schedule including 9 antigens (one dose of BCG, four doses of OPV, three doses of Penta, three doses of PCV, two doses of Measles and five doses of tetanus toxoid) with one dose of IPV, 3 doses of Rota and 2 doses of MR added in the schedule. It also includes doses required for polio campaign as per current year schedule for campaigns. Cold chain system is as is currently available at centers and stores.

Scenario 5: National current EPI schedule including 9 antigens (one dose of BCG, four doses of OPV, three doses of Penta, three doses of PCV, two doses of Measles and five doses of tetanus toxoid) with one dose of IPV, 3 doses of Rota, 2 doses of MR and one birth dose of Hep B added in the schedule. It also includes doses required for polio campaign as per current year schedule for campaigns. Cold chain system is as is currently available at centers and stores.

As a part of multiyear planning (MYP) for immunization the following section presents reports which have:

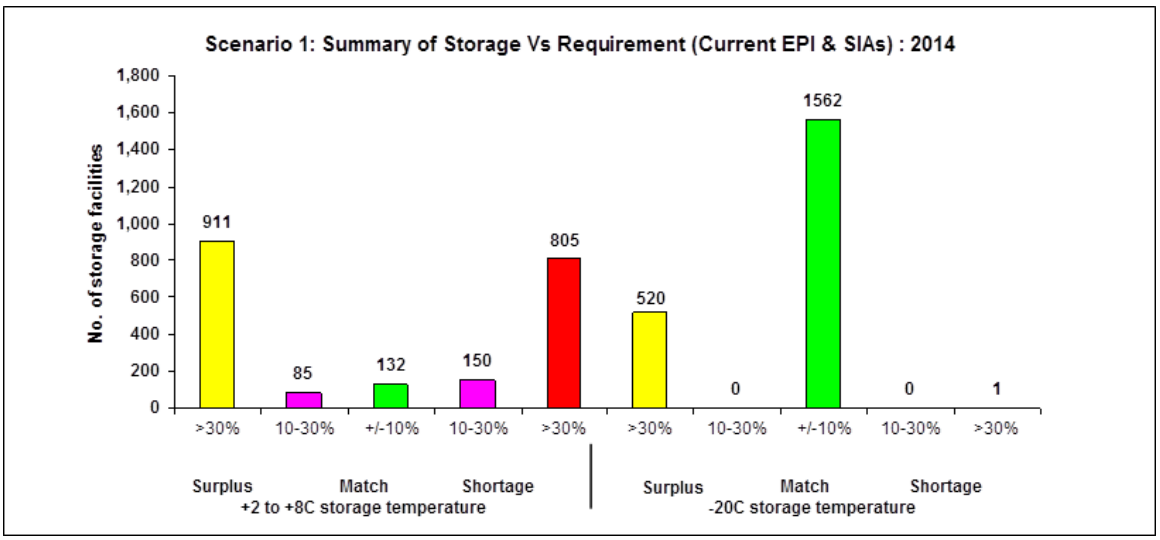
i. Estimates of existing vaccine storage capacity to cater for current EPI schedule and for revised EPI schedule for different scenarios;
ii. Analysis as regards to see the impact on storage capacities at various levels with the systematic removal of outdated and unreliable cold chain equipment;
iii. Analysis as regards to impact of changing resupply intervals on storage capacities;
iv. Equipment procurement lists and estimated capital and operational cost;

i. Estimates of existing vaccine storage capacity compared against current and future requirements

Figures 16 to 20 show forecasting for five different scenarios (see Box 6 for details on scenarios).

In first scenario, it is observed that with current available cold chain equipment 39% (n=805) EPI facilities have >30% shortage of vaccine storage space (+2 - +8°C) while 44% (n=911) have surplus (≥10%) vaccine storage capacity to meet the storage requirements of current EPI schedule (Figure 16).

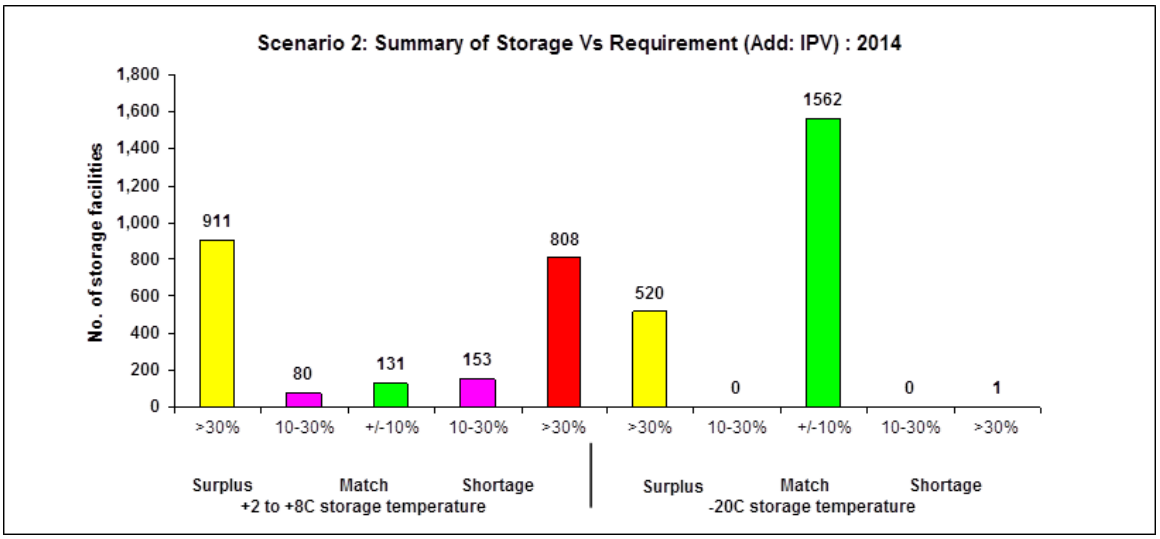
Figure 16. Summary of Storage vs Requirement (Current EPI), 2014



This clearly points towards the fact that due to lack of readily available accurate information on type, number, working status and size of cold chain equipment, evidence based or need based decision on distribution of equipment was not possible in the past resulting in uneven distribution resulting in wastage of already scarce resources. For -20°C storage space all except one EPI facilities have enough capacity (see Figure 12 for more details).

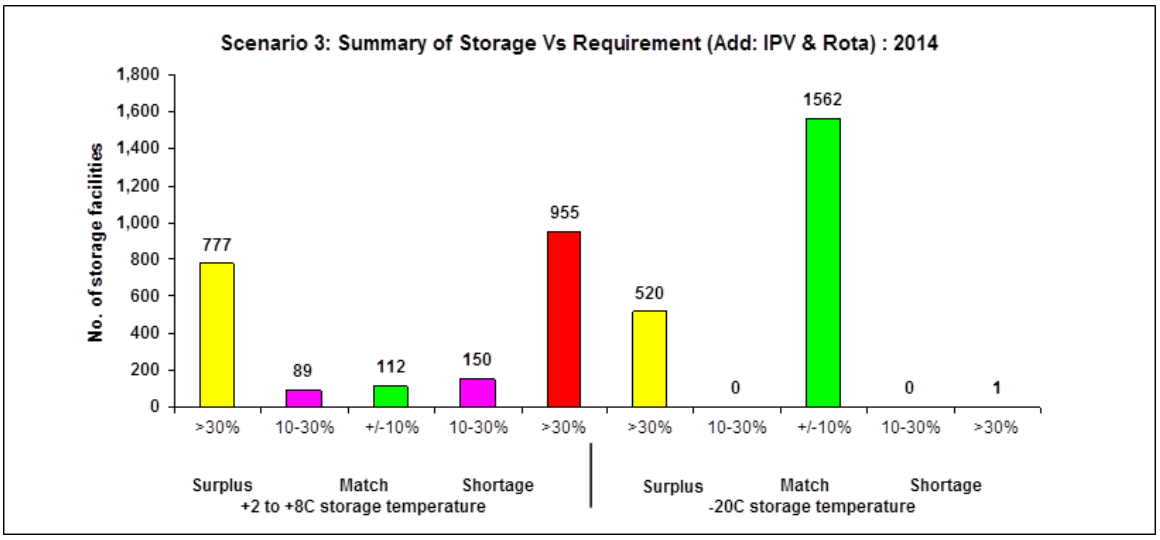
In second scenario, the situation is similar to the above scenario i.e. with the currently available cold chain equipment 39% (N=808) EPI facilities will have >30% shortage of vaccine storage space (+2 - +8°C) while 42% (N=911) will have surplus (>30%) vaccine storage capacity to meet the storage requirements of revised EPI schedule (addition of IPV). For -20°C storage space all but one EPI facilities have enough capacity (Figure 17).

Figure 17. Summary of Storage vs Requirement (Adding IPV), 2014



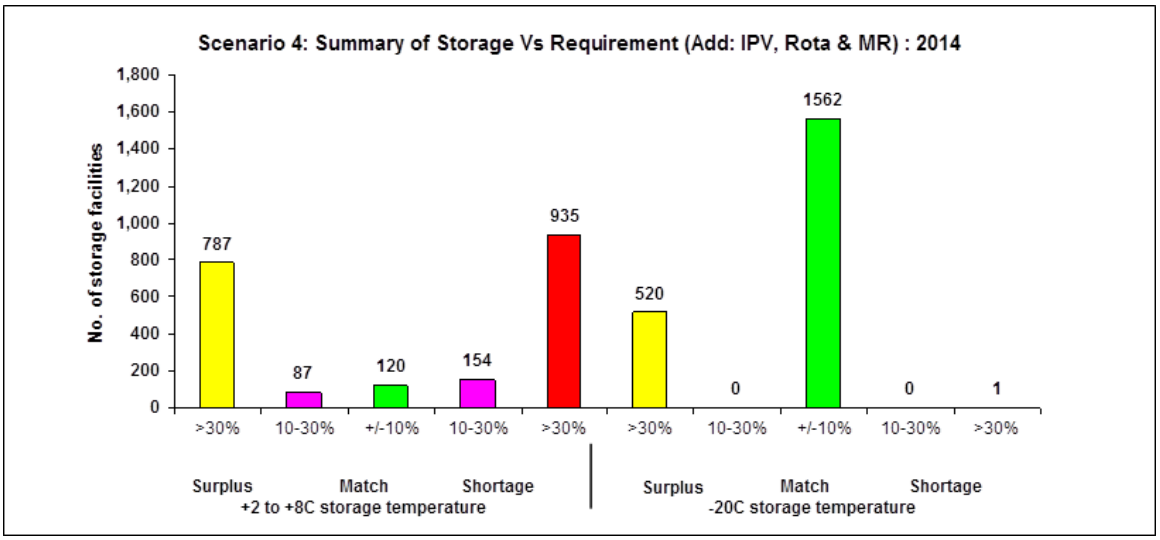
In third scenario, it is observed that with the currently available cold chain equipment 46% (N=955) EPI facilities will have >30% shortage of vaccine storage space (+2 - +8°C) while 37% (N=777) will have surplus (>30%) vaccine storage capacity to meet storage requirements of revised EPI schedule (addition of IPV and Rota) (Figure 18). As Rota vaccines packed vaccine volume is largest as compared to other vaccines in revised EPI schedule, therefore it occupies a lot of storage space. Hence, addition of Rota suddenly brings an 18% increase in the proportion of facilities that were previously short of vaccine storage space. For -20°C the situation of storage space is similar as in above two scenarios i.e. all but one EPI facilities have enough capacity.

Figure 18. Summary of Storage vs Requirement (Adding IPV+Rota), 2014



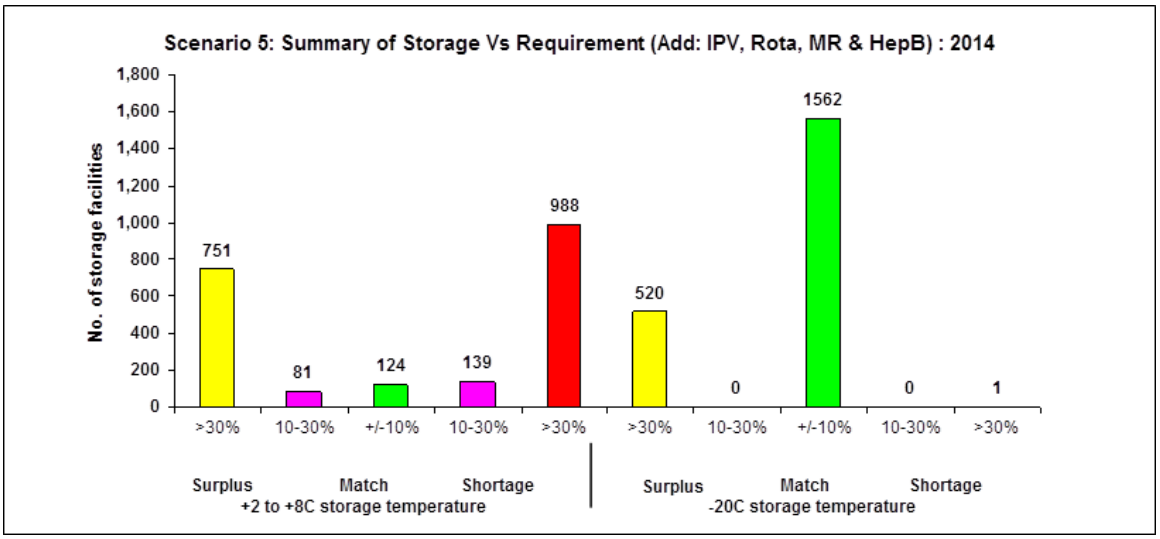
In fourth scenario, it is observed that with the currently available cold chain equipment 45% (N=935) EPI facilities will have >30% shortage of vaccine storage space (+2 - +8°C) while 38% (N=787) will have surplus (>30%) vaccine storage capacity to meet storage requirements of revised EPI schedule (addition of IPV, Rota and MR) (Figure 19). There is no significant change in storage space shortage or surplus in this scenario when compared to third scenario. Reason is because while adding two doses of MR in the EPI schedule two doses of measles were taken out and packed volume of both vaccines is similar, therefore this revision in schedule didn't have much effect on vaccine storage space. For -20°C the situation of storage space is similar as in above scenarios i.e. all but one EPI facilities have enough capacity.

Figure 19. Summary of Storage vs Requirement (Adding IPV+Rota+MR), 2014



In fifth scenario, it is observed that with the currently available cold chain equipment 47% (N=988) EPI facilities will have >30% shortage of vaccine storage space (+2 - +8°C) while proportion of EPI centers with surplus (>30%) vaccine storage capacity reduces to 36% (N=751) when Hep B is also added to revised EPI schedule (i.e. addition of IPV, Rota, MR and Hep B) (Figure 20). For -20°C the situation of storage space is similar as in above scenarios i.e. all but one EPI facilities have enough capacity.

Figure 20. Summary of Storage vs Requirement (Adding IPV+Rota+MR+HepB), 2014



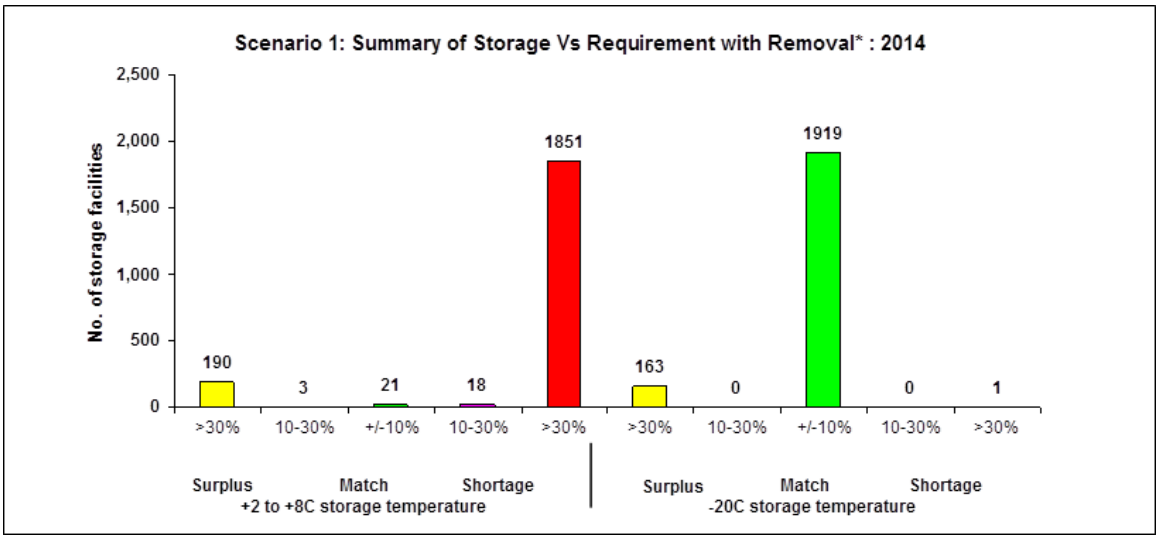
As evident from the figures above, every addition of vaccine in EPI schedule brings a progressive increase in shortage of storage space except in case of MR. This means EPI authorities should first expand storage capacity when there is any plan of adding new vaccines into schedule. Cost involved in this expansion is presented in preceding section of the report, however if proper evidence based plans are prepared and implemented accordingly, country can utilize its scarce resources more efficiently by delivering right goods in right quantity at right place through an effective logistical supply chain.

For -20 ^{O}C, which in case of service delivery level (EPI centers), is mainly utilized for freezing ice packs to meet routine and supplementary immunization activities requirements, is found matching (with 10% +/- range) in majority of cases. Hence it can be concluded that there is sufficient freezers' capacity for current EPI schedule and this space will also suffice the requirements in case new vaccine are introduced in the future.

ii. Impact analysis on the systematic removal of outdated and unreliable cold chain equipment

The report presented below in Figure 21 is based on the scenario 1 (see Box 6 above) for vaccination schedule 2014 along with the condition of removal of all Non PQS, non CFC free and outdated equipment present in the EPI centers/stores of 55 districts assessed.

Figure 21. Storage space with removal of Non CFC free & outdated equipment, 2014

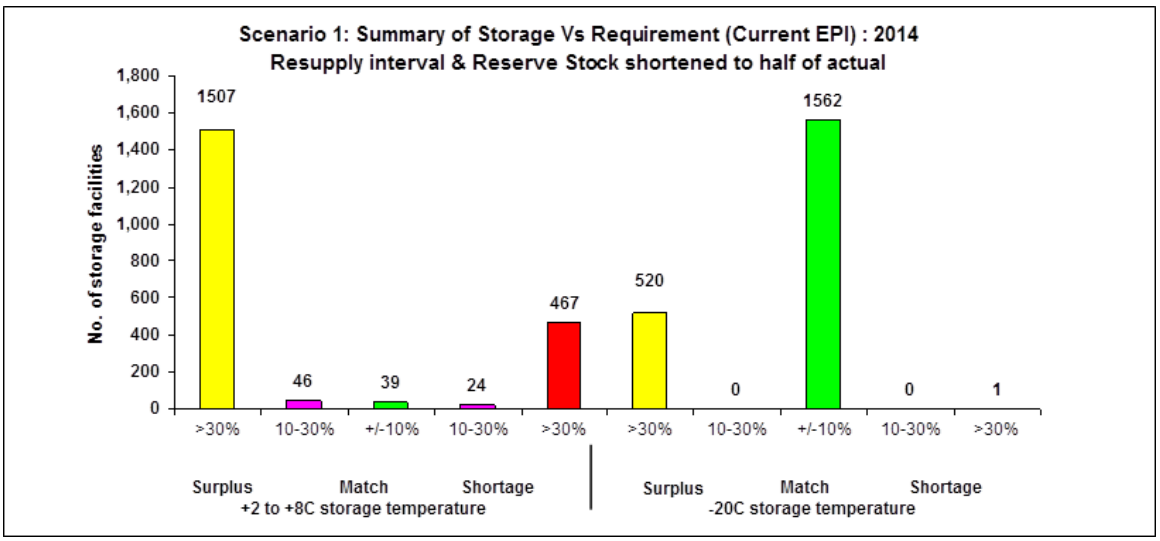


After removal of above mentioned equipment it can be seen from above figure that 89% EPI centers (n=1851) will face >30% shortage of vaccine storing capacity, while only 9% (190) facilities will have a >30% surplus storage space. For -20°C space there will be no shortage.

iii. Evaluation of changing resupply intervals to balancing storage needs against transport cost and availability

As mentioned above, analysis of data collected shows that among various types of EPI centers there is a wide variation in length of vaccine resupply intervals. Also, vaccine resupply interval being experienced at the EPI center level is different from the one recommended in the policy (please see Table 6 above). As evident from Figure 22, even if recommended resupply interval and reserve stock is halved, 22% (n=467) facilities will still be facing >30% shortage against requirement and 25% (n=520) will have surplus space. Obviously if the EPI department needs to manage this, the resupply interval for different facilities needs to be tailored such that there is neither shortage of vaccine storage capacity nor shortage of vaccines. But this could only be a local arrangement by the health authorities.

Figure 22. Effect of shortened resupply interval & reserved stock on storage capacity



BOX: 7

As per Pakistan National EPI policy National, Provincial and District/Agency vaccine stores get vaccine resupply after every four, three and one month respectively while all EPI centers get resupply once a month. For reserve stock, policy says that National, Provincial and District/Agency vaccine stores should have vaccine reserve stock of six, three and one month respectively while for all EPI centers reserve stock should be for two weeks.

iv. Budget for replenishment of outdated & non PQS equipment

Table 15 displays cost for replacement of equipment older than 10 years, non-PQS and non CFC free with new PQS qualified and CFC free solar equipment while keeping current EPI schedule as routine schedule. In addition to that, it will also meet the existing shortages of vaccine storage. Standard cost of the equipment to be procured is already present in the CCEM setup files so that cost incurred can be calculated. This also includes freight and insurance cost up to the port of entry.

CCEM can produce these summary reports for different scenarios developed by the health authorities to check various options depending on the availability of funds. In the end it displays situation of vaccine storage space at facility level once removal criteria is in place. Additionally, it gives detailed list of distribution of new equipment (in Excel) till EPI facility level.

Table: 15. Number of required cold chain equipment along with cost estimation, 2014

Area		ILRs	Cold Rooms	Total
ISLAMABAD	Quantity	47	1	48
	Cost USD	$ 79,005	$ 29,252	$ 108,257
PUNJAB	Quantity	974	13	987
	Cost USD	$1,650,362	$ 780,404	$2,430,766
SINDH	Quantity	915	13	928
	Cost USD	$1,534,275	$ 705,106	$2,239,381
BALOCHISTAN	Quantity	192	3	195
	Cost USD	$ 305,884	$ 166,498	$ 472,382
KP	Quantity	362	2	364
	Cost USD	$ 586,925	$ 58,504	$ 645,429
FATA	Quantity	234	1	235
	Cost USD	$ 368,578	$ 29,252	$ 397,830
TOTAL	Quantity	2724	33	2757
	Cost USD	$4,525,029	$1,769,016	$6,294,045

4 Recommendations

After assessment of EPI centers/stores in 55 high risk polio districts, following is the set of recommendations:

1. The discrepancy of target estimation should be resolved. At least it should be consistent at national and provincial levels. It is recommended that the concerned authorities like Bureau of Statistics may be consulted. Currently there are modern statistical methods for estimation of target population.
2. This assessment has enabled EPI managers, partners, Health facility in-charges and other stakeholders to see status of cold chain equipment and other accessories (voltage stabilizers, generators etc.). It is recommended to expand it to remaining districts as well, so that the status of cold chain system of all districts is clear for the future planning and decision making regarding upgrading or maintenance of cold chain system.
3. The experience of this assessment clearly points towards a need of either expanding National EPI policy further on vaccine cold chain system standards and protocols or developing a comprehensive vaccine cold chain system policy that covers minimum cold chain system standards at various levels of EPI centers, cold chain equipment selection (PQS), periodic maintenance cycle, cold chain system HR, capacity building and training of HR, protocols and procedures to be adopted and to be strictly adhered to for ensuring an effective cold chain system at every EPI center/store.
4. This assessment has revealed the need for effective monitoring of EPI centers to ensure adherence to temperature monitoring of every refrigerator/ILR. Field experience shows that not every refrigerator/ILR has updated temperature monitoring charts, especially in Baluchistan and Sindh. Even if the charts are available and filled manually; they are fake and don't display the actual temperature of equipment. This may lead to loss of vaccine potency and can result in loss of resources/efforts involved in vaccinating thousands of children. There are computerized temperature monitors/loggers available nowadays. If possible and feasible for Pakistan field, procurement and installation of such systems can be done. With the use of automated temperature loggers, there will be no need to manually record temperature and will also reduce the chances of fake temperature recording. Resource mobilization can be done at country level through various donors/funds interested in improving EPI/cold chain system standards in countries like Pakistan.
5. Report on vaccine storage capacity at National and Provincial level (cold rooms) has revealed that there is shortage of capacity. It is recommended to address the vaccine shortage capacity, especially if EPI authorities plan to add new vaccines in routine EPI schedule.
6. CCEM analysis as well as field visits have revealed that some of the cold chain equipment being used at EPI centers are not PQS qualified. It is recommended to replace non PQS qualified equipment with PQS qualified.
7. It is recommended that Health Departments and EPI officials start the process of making inventory of very old & useless cold chain equipment; devise a strategy of categorizing such equipment as useless and develop ways on how to get rid of such equipment as it is acquiring a huge space of stores and warehouses.
8. As divisional store is one of the administrative levels of Pakistan EPI program, therefore it was included initially in CCEM. However, field experience has shown that only Hyderabad divisional store is properly functioning as divisional store i.e. vaccines supply of all districts come first to the divisional store and is further issued to district vaccine stores. Rests are not

functioning as divisional stores in true spirit. It is recommended that EPI officials clarify on the roles and functions of each store and sub-store at various level. This will smooth the process.

9. During data collection at Faisalabad it was noted that ILRs currently being used in some EPI centers have self-regulating thermostat system instead of a manual type, but the inside temperature of ILR goes below 0°C during winter season. At some centers temperature as low as -2°C temperature was noticed during visits to Faisalabad EPI centers. This temperature range definitely poses a risk to Penta & TT vaccine. There is a need that EPI program officials take strict measures for the implementation of steps to be taken by vaccinators/cold chain maintenance staff in situations when temperature goes out of safe range (+2 - +8°C). Surprisingly, all temperature readings recorded on temperature monitoring charts were within range. Again this situation calls for the recommendation mentioned above i.e. installation of computerized temperature monitoring system & effective monitoring in the field.
10. There is a need to have one sustainable system for providing EPI logistical and warehousing needs of the country. vLMIS may be the solution to cater such needs. Currently, vLMIS is in the process of launch and initial training. Phase 1.0 has already been launched and is available online for data entry. Future phases will be introduced as improvements are made in this system in accordance with the needs and demands of health managers/planners. CCEM has many built in and customized reports. It is important that EPI managers decide which reports are most relevant to EPI Pakistan needs for future decision making and planning. These reports can be replicated from CCEM into vLMIS. Cold chain equipment portion of Phase 1.0 of vLMIS has very few variables. It collects information only on type, age, manufacture and model of refrigerators/freezer/ILR. UNICEF Polio team has already communicated vLMIS team to explore further on how strengths of CCEM can be included in vLMIS to make it more useful for managers.
11. Training of EPI managers at provincial and district level to be conducted on CCEM database analysis to enable them to use this system and make evidence based decisions.