

OPTIMIZE

PHASE I SUMMARY REPORT

Evaluating the vaccine supply chain in preparation for demonstrating future options in Vietnam

March 2010



OPTIMIZE

Immunization systems and technologies for tomorrow



NATIONAL INSTITUTE OF
HYGIENE AND EPIDEMIOLOGY



World Health
Organization

Contact information:

PATH
Optimize project
Unit 01-02, Floor 2nd, Hanoi Towers
49 Hai Ba Trung, Hoan Kiem District
Hanoi
Vietnam
Phone: 84.4.936.2215 | Fax: 84.4.936.2216
Email: vietnam@path.org | Website: www.path.org

PATH is an international nonprofit organization that creates sustainable, culturally relevant solutions, enabling communities worldwide to break longstanding cycles of poor health. By collaborating with diverse public- and private-sector partners, we help provide appropriate health technologies and vital strategies that change the way people think and act. Our work improves global health and well-being.

Headquartered in Seattle, Washington, PATH works in more than 70 countries.

The Optimize project is being implemented by PATH and the World Health Organization with the financial support of the Bill & Melinda Gates Foundation. The views in this report do not necessarily reflect the views of the Bill & Melinda Gates Foundation.

Copyright © 2010, Program for Appropriate Technology in Health (PATH). All rights reserved. The material in this document may be freely used for educational or noncommercial purposes, provided that the material is accompanied by an acknowledgement line.

Cover photos (from top): Philippe Blanc, Vu Minh Huong, Katrina Peach, Amynah Janmohamed

Acknowledgements

PATH and Vietnam's National Institute of Hygiene and Epidemiology—National Expanded Programme on Immunization would like to acknowledge the assistance and collaboration from:

- The World Health Organization (WHO) Representative Office in Vietnam
- UNICEF Representative Office in Vietnam
- Regional EPIs including Northern EPI, Central EPI, Central Highland EPI, and Southern EPI

In particular, PATH and National Institute of Hygiene and Epidemiology—National Expanded Programme on Immunization thanks the managers and workers at Preventive Medicine Centers and selected District and Commune health centers in Phu Tho, Yen Bai, Hai Phong, Nam Dinh, Ninh Binh, Quang Tri, Da Nang, Daklak, Can Tho, Ben Tre, and Tay Ninh Provinces for their participation and cooperation with the study.

PATH and National Institute of Hygiene and Epidemiology—National Expanded Programme on Immunization also acknowledge the Collaborative Requirements Development Methodology project funded by the Rockefeller Foundation. We also acknowledge with appreciation the cooperation and collaboration of Luxembourg Development's Vietnam office and technical support consultants from abroad and Vietnam.

Table of contents

| | |
|---|-----|
| Acknowledgements | iii |
| Abbreviations/acronyms | v |
| Introduction | 1 |
| Results..... | 2 |
| Activity 1: Effective Vaccine Management assessment | 2 |
| 1.1. Study sites and methods | 2 |
| 1.2. Nine criteria | 3 |
| 1.3. Key findings | 3 |
| Activity 2: Commune cooling assessment | 5 |
| 2.1. Study sites and methods | 5 |
| 2.2. Findings | 6 |
| Activity 3: Information system assessment..... | 10 |
| 3.1. Study sites and design..... | 10 |
| 3.2. Findings | 10 |
| Activity 4: Fee-based immunization service assessment | 13 |
| Activity 5: Model an optimal public sector supply chain | 14 |
| Annex 1: EVM sites | 16 |
| References..... | 17 |

Abbreviations/acronyms

| | |
|--------|--|
| BCG | Bacillus Calmette-Guérin vaccine |
| CHC | Commune Health Center |
| EPI | Expanded Programme on Immunization |
| EVM | Effective Vaccine Management |
| EVSM | Effective Vaccine Store Management |
| Hep B | Hepatitis B |
| NEPI | National Expanded Programme on Immunization |
| NIHE | National Institute of Hygiene and Epidemiology |
| UNICEF | United Nations Children’s Fund |
| VVM | Vaccine vial monitor |
| WHO | World Health Organization |

Introduction

Optimize is a collaboration between the World Health Organization (WHO) and PATH to help identify innovative approaches to creating a vaccine supply chain that is flexible and robust enough to handle increasing volumes of more costly new vaccines. Optimize is collaborating with the Vietnamese National Institute of Hygiene and Epidemiology (NIHE) on a series of activities designed to assess the opportunities and needs for strengthening the immunization system in Vietnam.

A number of assessments were conducted as part of Phase I of the Optimize project in Vietnam. **This document reports the results of assessments of the vaccine supply chain in Vietnam, completed in March 2010.**

The primary objective of the Optimize project in Vietnam during Phase I was to research the current status of the immunization system and supply chain in order to identify areas of focus and specific interventions for demonstration in Phase II.

The following five proposed activities support achievement of Objective 1: To evaluate opportunities for supply chain system improvement and identify cold chain technology requirements to design optimal supply systems.

Activity 1: Conduct an *Effective Vaccine Management* (EVM) assessment.

Activity 2: Assess challenges and opportunities for *commune-level cooling* and storage of vaccines.

Activity 3: Assess immunization *information system* challenges and opportunities at all levels to improve accuracy and efficiency of supply chain and child tracking.

Activity 4: Assess *fee-based immunization* practices, supply chains, and structures.

Activity 5: Begin work to model an *optimal public-sector supply chain* that will allow comparison to the existing supply chain to see the effect of different interventions.

Results

Activity 1: Effective Vaccine Management assessment

1.1. Study sites and methods

The EVM assessment was conducted from September to October 2009. EVM is a new tool for assessing the quality of a country's vaccine supply chain. It replaces the earlier Effective Vaccine Store Management (EVSM) and Vaccine Management Assessment (VMA) tools, but is organized in a similar way. The EVM assessment in Vietnam was the first large-scale use of the new tool.



The EVM was conducted in national, four regional, and eleven provincial stores. Two districts were selected for each province (one rural, one urban) and two communes for each district (with/without refrigerator, outreach/fixed site). The total numbers of assessment sites were 22 district and 44 commune sites.

The detailed site selection process considered a combination of the following factors: geography

(mountainous areas versus low-lying or coastal); Expanded Programme on Immunization (EPI) system structure (4 regions with 63 provinces: 28 in the north, 20 in the south, 11 in the central, and 4 in the central highland); rural versus urban; outreach versus fixed sites; and the feasibility of carrying out the survey.

Step 1: Eleven provinces were selected from the four regions, with the following distribution and selection of provinces in each region:

- Five provinces in the Northern Region (randomly selected after grouping provinces into urban, mountainous, and flat/coastal) groups: one city (usually with fixed site), two mountainous/rural province (usually with outreach), and two low-lying/coastal/rural provinces (usually with fixed site).
- Three provinces in the Southern Region (randomly selected after grouping provinces into urban, low-lying/coastal/rural): one city/urban province (usually with fixed site), two low-lying/coastal/rural provinces (usually with fixed site and outreach).
- Two provinces in the Central Region (randomly selected after grouping provinces into city and rural groups): one city/urban province (usually with fixed site), and one rural province (could be either fixed site or outreach).
- One province in the Central Highland (randomly selected from four mountainous provinces, usually with both fixed site and outreach).

Step 2: Randomly select one rural and one urban district from each selected city/province (normally each province has some urban districts and some rural districts).

Step 3: Randomly select two communes in each of the selected districts: either one with refrigerator and one without, or one with fixed site and one using outreach.

Please refer to the Annex 1 for more information on EVM sites.

1.2. Nine criteria

The EVM assessment tool is based on quality management principles and is structured around nine overall *criteria* that the supply chain must comply with. These require that:

1. Preshipment and arrival procedures ensure that every shipment from the vaccine manufacturer reaches the receiving store in satisfactory condition and with correct paperwork.
2. All vaccines and diluents are stored within WHO-recommended temperature ranges.
3. Cold storage, dry storage, and transport capacity is sufficient to accommodate all vaccines and supplies needed for the program.
4. Buildings, cold chain equipment, and transport systems enable the vaccine and consumables supply chain to function well.
5. Maintenance of buildings, cold chain equipment, and vehicles is satisfactory.
6. Stock management systems and procedures are effective.
7. Distribution between each level in the supply chain is effective.
8. Appropriate vaccine management policies are adopted and implemented.
9. Information systems and supportive management functions are satisfactory.

All of these nine criteria apply at the *primary* level. At *intermediate* levels, criterion 1 does not apply because vaccine is not received directly from the manufacturer at these levels. In addition, at the *health facility* level, criterion 9 does not apply because information systems and support is largely the responsibility of central immunization program management and management staff in the higher level stores.

The new WHO tools and questionnaires were revised and adapted to suit with current immunization system in Vietnam.

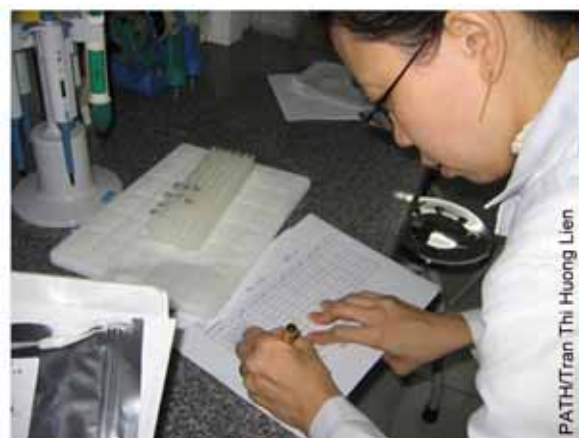
1.3. Key findings

The analysis indicates that the vaccine supply chain in Vietnam has a number of strengths:

- *Generally:* There are examples of excellent practice at all levels in the supply chain and against most major EVM indicators. These strengths can be built upon.
- *Temperature monitoring:* With relatively minor exceptions, temperature monitoring practices appear to be good throughout the supply chain.
- *Cold chain capacity:* With minor exceptions, cold chain capacity appears to be adequate at all levels.
- *Buildings, equipment, and transport:* Generally, the building infrastructure is good. Cold chain equipment is also mostly good at all levels, with the exception of those facilities that still use domestic refrigerators. Transport appears to be adequate, although there are a number of provincial and district stores that have no access to government-supplied vehicles.

There are also a number of areas that need to be improved, of which the most significant are the following:

- *Vaccine arrival procedures:* This is a critical step in the due diligence process. The checking and handover procedure for domestic vaccines needs to be standardized, the Vaccine Arrive Reports (VARs) should be revised based on the receiving procedure for UNICEF-supply vaccines.
- *Buildings, equipment and transport:* Consideration needs to be given to improving and reconstructing several facilities. A plan also needs to be developed to replace the domestic refrigerators used in some district and commune health centers (CHCs) by WHO-prequalified equipment.
- *Stock management:* A policy should be developed to set maximum stock levels, safety stock levels, and reorder levels in individual stores. Directly related to the issue of stock management, there is a need for improved planning at the national level in order to ensure that the correct quantities of vaccine are received from vaccine suppliers at delivery intervals designed to prevent the occurrence of either stockouts or overstock conditions.
- *Distribution management:* Widely varying distribution management standards exist at all levels, although there are examples of good practice throughout the supply chain. The existing best practice in distribution planning and monitoring—the use of freeze indicators and the systematic use of standardized vaccine issue and arrival vouchers needs to be rolled out to all stores.
- *Vaccine management:* There is a need for vaccine management training and re-training for health workers, including knowledge of the shake test and vaccine vial monitors (VVMs). There are also great variations in the practice of safe disposal of syringes and used vials. There is a need for additional national policy and guidance on this important subject.



Activity 2: Commune cooling assessment

2.1. Study sites and methods

The Commune Cooling Assessment—an assessment of current vaccine storage and handling practice at the commune level was conducted in 12 communes in the 3 project provinces Phu Tho (north), Quang Tri (central) and Ben Tre (south). Within each of these provinces, 2 districts were chosen, and within each of the 6 districts, 2 communes were chosen. The communes were chosen with the criteria to provide a variation among the twelve with regard to population size, proximity to the district health center, presence or absence of a refrigerator, and model of immunization (outreach versus fixed model). Table 1 shows the study sites with the attributes of each commune.

Table 1. Study sites

| Province | District | Commune | Commune attributes | | | |
|-----------|--------------|-------------|--------------------|----------------|------------------|-----------|
| | | | Population served | Km to district | Refrigerator? | Outreach? |
| Phu Tho | Thanh Son | Vo Mieu | 11,835 | 17 | yes | no |
| | | Tan Minh | 3,758 | 35 | no ^B | yes |
| | Lam Thao | Hung Son | 9,402 | 6 | no | no |
| | | Xuan Huy | 4,367 | 10 | yes | no |
| Quang Tri | Vinh Linh | Vinh Thuy | 6,547 | 15 | no | no |
| | | Ho Xa | 12,494 | 2.5 | no | no |
| | Huong Hoa | Huong Phung | 12,479 | 60 | yes | yes |
| | | Huc | 3,268 | 14 | yes | yes |
| Ben Tre | Ben Tre City | Ward 6 | 6,785 | 5 | no | no |
| | | Phu Hung | 11,452 | 7 | yes ^D | no |
| | Mo Cay Nam | Minh Duc | 10,528 | 16 | no | no |
| | | Dinh Thuy | 11,584 | 4 | yes ^D | no |

^B Indicates the refrigerator is present but broken and not in use.

^D Indicates the present refrigerator is a domestic model.

The commune cooling assessment consisted of four different elements, listed and described briefly below:

1) **Key informant interviews at national and regional levels**

At NEPI's national center and each of the three regional centers, four individuals were targeted for interviews: Director, Deputy Director, Manager of Information Systems, and Manager of Cold Chain. The questions related to commune cooling assessment focused on priorities and decision-making processes related to cold chain equipment. The goal was to understand what regional and national level leaders think about the Optimize project for commune-level vaccine storage, and how we should work with other active donor projects.

2) **Key informant interviews at vaccine manufacturers**

We met with leadership officials within two vaccine manufacturers: Vabiotech and

Polyvac, with a goal to understand their current level of information, interest, and intentions related to adoption of VVMs.

3) **Assessment at commune health center**

The assessment sought to gather information about the population and geographic characteristics of the commune, the equipment available at the CHC and the current system for managing vaccine.

4) **Commune health center monitoring**

The final part of the assessment at the CHCs consisted of monitoring information about activities during a short period of time (8–10 weeks) starting with the assessment visit. Information monitored included:

1. Refrigerator temperature (if one exists).
2. Ambient temperature inside and outside the health center.
3. Vaccine arrival quantity and frequency.
4. Vaccine wastage quantity and reasons.
5. Energy usage.

For the temperature monitoring, the temperature loggers used were model Trix-8 from LogTag Temperature Recorders based in Auckland, New Zealand. Recording accuracy is $\pm 0.5^{\circ}\text{C}$, and they were programmed to automatically record temperature readings every fifteen minutes during the study. Data was downloaded through use of LogTag software and a LogTag interface cradle. This data was exported into Microsoft Excel for analysis.



The information from the commune cooling assessment will provide context in which to design the demonstration phase of the project, and the data will also form the baseline upon which to measure impacts of the chosen interventions.

2.2. Findings

2.2.1. Achievements

The current immunization system very well manages the distribution and use of vaccine supplies throughout an impressively broad network of commune health centers for monthly immunization sessions. The resulting nationwide coverage of 93.9% children under 1 year fully immunized (according to the National EPI Report 2008) shows that this system is highly effective. As new, more expensive vaccines approach the horizon for Vietnam's immunization system, the engagement and commitment of stakeholders at all levels of the system to maintain this effectiveness and even to improve efficiency is admirable.

2.2.2. Challenges

Finding the right solution (or solutions) for vaccine storage at the commune level is a difficult challenge. Investment in active refrigerators for all CHCs would require a great deal of resources, and the costs of maintaining these devices would be similarly large. Furthermore, most currently available vaccine refrigerators are not well suited for the small volume needs and the intermittent power conditions at many communes. To solve this challenge, NEPI and Optimize should look at innovative technologies that meet the conditions of the CHCs; consider the investment not only against the situation today, but keeping in mind new vaccines that will enter the program in coming years; and continue to grapple with

community and societal issues such as current attitudes toward hepatitis B (Hep B) birth dose. The following paragraphs discuss the results of this assessment in light of these issues.

2.2.3. Hep B vaccine birth dose

The issue of Hep B vaccine birth dose is not straightforward in Vietnamese CHCs. There are several issues. First of all, not all communes provide birth attendants at the CHC or in the community, so not all commune health workers have access to newborn babies. Secondly, there is a cultural/societal issue related to Hep B vaccine birth dose. This stems from a cluster of adverse events following immunization after Hep B vaccination that resulted in deaths several years ago in Vietnam.

Although the resulting investigation did not find the vaccine at fault, the sense has remained with some health workers and members of the general public that Hep B vaccine may be unsafe to administer, especially to newborns. This attitude can result in hesitance of the health care workers to comply with birth dose recommendations, or in some cases, there may be official or unofficial policy in some districts that is incongruous with national policy.

At the same time, it is noted that improving the performance of on-time delivery of Hep B vaccine birth dose should be the highest priority for work on the commune vaccine storage system, according to many of the national and regional stakeholders interviewed in this assessment. If this is to be one of the goals of the next phase of Optimize work, it will be important to identify the conditions under which this can happen, as it appears that simple provision of vaccine storage may not be sufficient to make a difference in some locations.

2.2.4. Refrigerator performance

The results from the temperature monitoring of refrigerators during this study highlight the need to ensure that any technical solution evaluated during Phase II be capable of sufficient temperature control to maintain vaccine storage between 2°C and 8°C at all times.



RCW 50EG refrigerator equipped by Lux-Development project.

2.2.5. Closed vial wastage

Closed vial wastage is an indicator that could be improved through a better solution for vaccine storage at commune level. We have collected information from interviews at upper levels, as well as the commune level, that unopened vaccine vials may be discarded at the end of an immunization session rather than returned to the district. This makes sense given that CHCs are often significant distance from the district, and that health workers must bear the cost of transportation to and from the district. However, the tracking data does not show closed vial wastage. Discussion with health care workers in demonstration CHCs will be necessary to derive an appropriate baseline value for closed vial wastage prior to Phase II activities, and a different method of tracking closed vial wastage other than self-reporting will be required.

2.2.6. VVMs for vaccine manufactured in Vietnam

VVMs are a valuable tool for helping ensure safety and effectiveness of vaccine at point of use, and for effectively managing vaccine stocks to minimize wastage. Vaccine manufacturers in Vietnam are aware of VVMs and interested in exploring the steps required for adoption for at least some vaccines. The Optimize project is well-positioned to help the Vietnam government and manufacturers make informed decisions related to the adoption of VVMs.



2.2.7. Specific recommendations

Based on the information gathered in interviews and assessments, there are some clear recommendations for the design of commune-level vaccine storage demonstration projects in Phase II. These are listed below.

- 1) It would be interesting to explore the impact of innovative vaccine storage technology at the commune level on a few indicators such as on-time delivery of Hep B vaccine birth dose, closed-vial vaccine wastage, and system costs.
- 2) The ideal technology for vaccine storage at the commune level would be relatively small volume, require low- or no-energy consumption, would not rely on constant grid electricity, would be low cost to purchase and to maintain, and would be simple to use.
- 3) Solar energy is possibly a good fit in a majority of the communes assessed, but it is important to add an analysis of solar radiation received at the sites from the perspective of weather patterns and typical cloud cover before proceeding with a solar power option at any individual health center.
- 4) Communes in Vietnam are not all the same, and different impacts would be expected in different communes depending on a number of factors including: distance from District center, availability of electricity, local attitudes toward Hep B vaccine birth dose, and number of births attended at the CHC. Care should be used when selecting project sites, and variation in these conditions should be mapped to the demonstration results.



Solar power installation.

- 5) Out-of-cold-chain storage of Hep B vaccine for birth dose is an interesting alternative to new cooling technology, though it is recognized that there may be policy, regulatory, and/or community barriers to this approach. In collaboration with NEPI, Optimize should compare this alternative to the demonstration technology in terms of cost, feasibility, and acceptability. In addition, WHO will provide support in term of recommendations and guidelines.
- 6) Optimize should proceed to work with NIHE and vaccine manufacturers to explore the adoption of VVMs for some vaccines.

Activity 3: Information system assessment

3.1. Study sites and design

An information system assessment was conducted in November, 2009, integrated with Commune Cooling Assessment. The commune study sites were the same as Commune Cooling Assessment sites in Quang Tri, Ben Tre and Phu Tho. However, this assessment also included participants from the national, regional, provincial, and district level.

The information system assessment consisted of five different elements, listed and described briefly below.

1) **Key informant interviews at national and regional levels**

In each center, four individuals were targeted for interviews: director, deputy director, manager of information systems, and manager of cold chain. The questions for information systems related to description and status of NEPI reporting systems, status of current electronic database and/or reporting systems and other software projects, political drivers and financial priority of information systems within NEPI and NIHE, and information about the administrative burden of reporting and completeness/timeliness of reporting from the lower levels.

2) **Assessment at province and district levels**

The interview targeted the EPI manager, EPI officer, store keeper, and information system manager. Topics included coverage monitoring, stock management, cold chain equipment management, information technology infrastructure, and reporting systems.

3) **Assessment at commune health center**

The assessment sought to gather information about the processes used for collecting and reporting information in the commune-level health centers, some information about the availability of certain technologies, such as computers and mobile phones, and baseline data for vaccine wastage and administrative burden of reporting.

4) **Analysis of reports and ledgers**

During the assessment, copies of reports and ledgers were taken from health centers at different levels. Analyses were conducted at PATH to evaluate the accuracy of the reporting systems, and to assess the effectiveness of the vaccine stock management system.

5) **Requirements development process**

In collaboration with another PATH project funded by Rockefeller Foundation, NEPI staff participated in a process to define the critical business processes used in managing, distributing and using vaccine stock throughout the country-wide immunization system. The result of this work will be a list of system requirements from which critical requirements can be selected for the design of an information management system.

3.2. Findings

3.2.1. Achievements

The current immunization system achieves quasi-perfect coverage with a monthly session-based system. Its effectiveness in Vietnam can therefore not be doubted. Furthermore, it does

this without investing in cold chain capacity at the lowest level and with extremely low average stock levels, making it very efficient from that point of view.

3.2.2. Challenges

The system is very information- and labor-intensive, and relies on a communal political structure that is not unique to Vietnam, but not found in all countries. It relies on dedication of staff to do it well. Errors are easy to introduce in the paper-based system where the same information is spread across several ledgers and reports. Furthermore, there is considerable confusion about the calculation of the immunization coverage target number.

There is a high level of turnover in human resources within the NEPI system, and leaders at Regional and National level recognize that increased training and supervision for healthcare workers should be a high priority.

3.2.3. Current Information System

- **The monthly reporting system** consists of two distinct reports that contain information on coverage and vaccines respectively.
 - The coverage report originates from the immunization register and is aggregated at all levels, but maintaining details about the next lower level (at national level, information is available by province).
 - The vaccine report contains information about vaccine stocks and utilization as well as the orders for the next period. (It is therefore both part of the reporting system and the vaccine management system.) Orders are based on scheduled immunizations up to province level.
 - Part of this reporting system is currently being computerized, down to the province level, with a Microsoft Access-based tool. Some provinces may use Microsoft Excel- or Word-based tools for reporting subprovince level.
- **The stock management system** consists of vaccine ledgers at all levels where stock is kept, as well as dispatch notes, vaccine arrival reports, packing slips and bin cards. Only at the national level is this system is computerized.

Monthly EPI report from commune to district level.

3.2.4. Opportunities

The staff in district-level and higher-level centers already have some exposure to computer systems, and software programs have been introduced at least to province level in the past. There is a high level of interest by leaders at the regional and national level in exploring new information systems for managing the processes, supplies, and equipment used in the immunization program. The country is well-served by mobile phone networks, and staff are familiar with and use their own cell phones regularly.

3.2.5. Specific Recommendations

Based on the information gathered in interviews and assessments, there are some clear recommendations for the selection of information system demonstration projects in Phase II. These are listed below:

- 1) The intervention should reduce the burden of reporting on health care workers.
- 2) The intervention should improve training and support for health care workers.
- 3) The intervention should improve the completeness and timeliness of information available at all levels.
- 4) The intervention should improve the quality and accuracy of information available at all levels, and seek to solve the problem of determining the correct number for the immunization target.
- 5) The intervention should increase the level of information about vaccines in stock at all levels.

Activity 4: Fee-based immunization service assessment

An assessment of fee-based immunization services was conducted from December 2009 to January 2010 in Quang Tri, Phu Tho and Ho Chi Minh city. Thirty-two among 80 facilities were randomly selected in Ho Chi Minh city including provincial/district PMCs, the Pasteur Institute, private/public hospitals, private/public clinics. Seven and five public facilities which provide fee-based immunization services were selected in Phu Tho and Quang Tri, respectively. Facility managers, procurement officers, store keepers, vaccinators and clients were interviewed in each selected facility. Immunization practice and facility checklists were also evaluated in each selected facility.

The detail results will be reported in another document.



Vaccine storage at a fee-based facility.

Activity 5: Model an optimal public sector supply chain

In order to model Vietnam's vaccine supply chain logistic model, we developed two computer-based models to capture the structure, resource use, and costs. The two models are briefly described below:

- 1) A supply chain model has been developed in Arena, a logistic simulation software, designed to provide a visual model of the transport, cold chain, storage, and vaccine modules of the national supply chain and provide a platform for simulating changes to the existing vaccine supply chain logistic system and evaluating the associated costs.
- 2) An Excel-based costing tool consisting of a series of modules, informed by the structure of the Arena model. Each module is designed so that: (a) baseline and scenario information can be entered; (b) each component of the logistics system is included, such as transportation and cold storage; and (c) each level of the supply chain is included within each component.

Cost data were collected at national, regional, and 5 provinces, 10 districts, and 20 communes from November 2009 to January 2010. The provinces included were Ninh Binh, Phu Tho, Quang Tri, Ben Tre, and Dak Lak. All cost data associated with cold chain storage, maintenance of equipment, transportation, facilities, staff salary, vaccine and immunization supply were included.

Table 2. Locations of data collection for the vaccine supply chain logistic model

| Provinces | Ninh Binh | Phu Tho | Quang Tri | Ben Tre | Dak Lak |
|---------------------------|---|---|--|---|--|
| Districts | Tam Diep Kim Son | Thanh Son Lam Thao | Vinh Linh Huong Hoa | Mo Cay Nam Ben Tre City | Krong Nang Buon Ma Thuot |
| Commune Health centers | Kim My Quang Thien Yen Son Bac Son | Vo Mien Tan Minh Xuan Huy Hung Son | Ho Xa Vinh Thuy Huong Phung Huc | Dinh Thuy Minh Duc Phu Hung Ward 6 | Phu loc Eapuk Eakao Tan Thanh |

The model is currently being designed for the EPI vaccines in the routine system, including BCG, diphtheria-tetanus-pertussis, Hep B, oral polio, Measles, and tetanus toxoid, but can be expanded to include additional routine vaccines. We are assuming that a fully immunized child receives 12 doses, and pregnant women receive 2 doses of tetanus toxoid.

Table 3: Average supply chain logistic cost per dose for national and regional levels

| Level | Average supply chain logistic cost per dose | Cost drivers |
|------------------------|---|---|
| National vaccine store | \$0.005 | <ul style="list-style-type: none"> Infrastructure. Cold chain equipment depreciation, electricity, and maintenance. |
| Regional store | \$0.011 | <ul style="list-style-type: none"> Vehicle depreciation and fuel. Cold chain equipment and electricity. |

Table 4: Average supply chain logistic cost per dose for province, district and commune health centre for Ninh Binh and Phu Tho provinces

| Average supply chain logistic cost per dose | Ninh Binh province | Phu Tho province |
|---|--------------------|------------------|
| Province | \$0.03 | \$0.01 |
| District | \$0.05 | \$0.04 |
| CHCs | \$0.10 | \$0.15 |

As the demonstration project moves forward, the data collection and calculation will be continuing to identify the current supply chain logistic cost at each level and see how these indicators change with changes to the vaccine supply logistic system based on the proposed interventions planned for Phase 2 and for possible scenarios aimed at optimizing the vaccine supply chain logistic system.

Possible scenarios to consider include:

- 1) What is the optimal *frequency of distribution* of vaccines down the chain given the storage capacity and relatively good electrical power in the country? The idea is to explore how savings can be made on transportation costs.
- 2) What is the impact of *eliminating one or two intermediate levels of storage* from the distribution channel for the supply chain?
- 3) What is the cost and benefit of different options for *increasing coverage of the Hep B birth dose*? Options could include relevant solution for cooling at the commune level, or allowing Hep B vaccine to be kept at temperatures higher than 2° to 8°C in a controlled temperature chain. The idea is to explore whether or not it makes economic sense to have cold chain in some CHCs, and what factors favor which storage technologies.
- 4) What is the cost and impact of an integrated storage and distribution of EPI and non-EPI vaccines system at provincial level and below?

The model could become a useful tool to NEPI and NIHE to evaluate the cost of different proposed interventions. To identify the future scenarios with Vietnam it will be essential to engage with NIHE and other stakeholders at multiple EPI levels.

Annex 1: EVM sites

| Regional | Province/City | District | Commune |
|----------|---------------|--------------------|----------------|
| North | Phu Tho | Viet Tri City | Chu Hoa |
| | | | Gia Cam |
| | | Phù Ninh | Tien phu |
| | | | Gia Thanh |
| | Hai Phong | Tien Lang | Tien Minh |
| | | | Tien Lang town |
| | | Ngo Quyen | May Chai |
| | | | Đông Khe |
| | Yen Bai | Yen Bai City | Yen Ninh |
| | | | Minh Bao |
| | | Luc Yen | Phuc Loi |
| | | | Mai Son |
| | Nam Định | Nam Định City | Loc Ha |
| | | | My Xa |
| | | Vu Ban | Đai An |
| | | | Kim Thái |
| | Ninh Binh | Ninh Binh City | Van Giang |
| | | | Bich Dao |
| | | Kim Son | Luu Phuong |
| | | | Quang Thien |
| Central | Quang Tri | Đông Ha City | Ward 4 |
| | | | Ward 5 |
| | Đà Nang | Huong Hoa | Thuan |
| | | | Lao Bao |
| | | Hoa Vang | Hoa Phuoc |
| | | | Hoa Chau |
| | | Thanh Khe | Chinh Gian |
| | | | Hoa Khe |
| Highland | Đăclăk | Buon Ma Thuot City | Eakao |
| | | | Tan Thanh |
| | | Krong Nang | Phu Loc |
| | | | Eapuk |
| South | Ben Tre | Ben Tre City | My Thanh An |
| | | | Ward 8 |
| | | Ba Tri | An Binh Tay |
| | | | Vinh An |
| | Can Tho | Ô Mon | Thoi Long |
| | | | Long Hung |
| | | Thoi Lai | Thoi Thanh |
| | | | Đinh Mon |
| | Tay Ninh | Tay Ninh Town | Ward 4 |
| | | | Ward 2 |
| | | Chau Thanh | Thanh Dien |
| | | | Thai Binh |

References

1. World Health Organization (WHO)-UNICEF *Joint Reporting Form on Immunization for the Period January–December, 2008: Vietnam*. Geneva: WHO; 2008.
2. WHO. *National EPI Review—Vietnam*. Geneva: WHO; 2009. Available at: http://www.un.org.vn/index.php?option=com_docman&task=cat_view&gid=130&Itemid=266&lang=en.
3. WHO. *PQS Performance Specification: Refrigerator or Combined Refrigerator-Icepack Freezer: Absorption Cycle*. Geneva: WHO; 2007.
4. WHO. *PQS Independent type-testing protocol: Refrigerator or combined refrigerator-icepack freezer: absorption cycle*. Geneva: WHO; 2007.
5. WHO. *Vaccine Volume Calculator Tool*. Geneva: WHO; 2006. Available at: http://www.who.int/entity/immunization_delivery/Vaccine_Volume_Calculator_2008.xls
6. WHO. *Quality of the Cold Chain: WHO-UNICEF Policy Statement on the Use of Vaccine Vial Monitors in Immunization Services*. Geneva: WHO; 1999.
7. WHO. *Guidelines on the International Packaging and Shipping of Vaccines*. WHO/V&B/01.05. Geneva: WHO; 2002. Available at: <http://www.who.int/vaccines-documents/DocsPDF99/www9942.pdf>
8. WHO. *WHO Vaccine-Preventable Diseases Monitoring System, 2006 Global Summary*. WHO/IVB/2006. Geneva: WHO; 2006. Available at: <http://www.who.int/vaccines-documents/GlobalSummary/GlobalSummary.pdf>.
9. PATH, Public Health Informatics Institute. *Development of User Requirements for Logistics Management Information Systems*. Seattle: PATH; 2009. Available by request.