



Cold Chain and Logistics Management: An Essential Part of Safe and Effective Vaccination Programs

The topic

Cold chain and logistics refer to the system of people, policies, procedures, vehicles, fuel, equipment, and technologies that work together to make sure that vaccines given to people are safe and effective. Because most vaccines have specific temperature requirements, an effective cold chain and logistics management system prevents both excessive heat and cold from damaging the vaccines from the time of manufacturing until they are used.

Why is this topic important?

An effective logistics system and a well-maintained cold chain are essential for safe and effective immunization service delivery. An improperly functioning cold chain can lead to wasted vaccines, missed opportunities to immunize due to lack of vaccines, and children receiving vaccines that do not protect them as intended or that actually make them sick. Problems with aging or insufficient cold chain equipment, as well as with transport and storage, have become more urgent as new and more expensive vaccines are being introduced (see Snapshots #7 and the box below).

Every immunization program must assess cold chain equipment needs periodically and replace broken equipment not worth repairing. As plans for introducing new vaccines are developed and implemented, additional equipment is needed to handle increased storage requirements. Financing for cold chain and logistics must also be given priority.

Impact of New Vaccines on the Cold Chain

The benefits of immunization have increased with the addition of new vaccines, but so have the costs. A decade ago, the vaccines used in most developing countries cost only about US\$ 1 per child. Today, with the addition of combination vaccines against hepatitis B and Haemophilus influenzae type b (Hib), the vaccines alone cost as much as US\$ 14 per fully immunized child.

A quick comparison of cold chain storage costs and vaccine costs makes it clear why properly functioning cold chain equipment is so important.

- Typically found at the district level, the top-opening Electrolux TCW1152 refrigerator (pictured) has a vaccine storage capacity of **169 liters** and costs about **US\$1,500**, not including transport, insurance, and installation.
- The Electrolux TCW1152 can store approximately 56,000 doses of **DPT vaccine** (which comes in 10-dose vials). The value of this vaccine in a fully-loaded refrigerator is approximately **US\$9,400**, or **6 times** the cost of the refrigerator in which it is stored.
- When filled with the new liquid pentavalent **DPT-HepB+Hib** vaccine (which comes in more bulky one-dose vials), the same Electrolux TCW1152 can hold less vaccine (only about 13,000 doses). But because the vaccine is more expensive than DPT on its own, its value is over **US\$46,000**, or **31 times** the cost of the refrigerator.



The need to protect today's more expensive vaccines is clear. Preventive maintenance, timely repair and replacement of malfunctioning cold chain equipment—cost-saving interventions that protect investments in expensive vaccines—must be a focus of all national immunization programs.

Challenges to maintaining effective cold chain and logistics in developing countries

Insufficient, outdated and broken cold chain equipment (see box below) are often cited as major problems affecting routine immunization efforts during country immunization program reviews and supervisory visits. Additional problems are lack of technically-trained staff and inadequate financing for procuring new equipment and transporting technicians and/or broken equipment.

Outdated equipment is still in use and often needed as back-up due to delays in providing new equipment, insufficient stock capacity (both permanent and temporary, if the equipment is being used for immunization campaigns), or occasional problems with new equipment (e.g. lack of spare parts or appropriate tools).

There is often a lack of field-based procurement and repair plans, which means that cold chain and logistics inventories are not sufficiently linked with new equipment projections. This makes it difficult for countries to prioritize districts and provinces with the greatest need for new equipment.

Cold chain inventories, conducted at least annually, are needed to ensure repairs and replenish equipment. However it is often the case that inventories do not allow for appropriate procurement planning because they fail to provide necessary details, such as:

- The equipment is not working, but is repairable
- The extent of the repair needed (e.g. onsite repair, major overhaul, spare parts)
- The equipment is not working and should be replaced

Relatively recent CFC (Freon)-free requirements have made repair work on cold chain equipment more complicated. Technicians are often insufficiently trained to work on the newest equipment, and/or are not available to ensure proper maintenance and rapid, high-quality repairs.

Technicians need considerable training to be able to correctly use the more expensive tools and instruments for repairing CFC-free equipment. In some cases, it may be cheaper to procure new units than to repair broken units with more complex inner leaks or burned-out compressors.

Finally, few countries clearly define the conditions that merit condemning equipment for scrap or resale, which contributes to the use of outdated equipment.

Environmental factors complicate cold chain and logistics management

Poor or unreliable energy sources, a common problem in developing countries, weaken the effectiveness of equipment and shorten its lifespan. Also, equipment in remote areas is difficult to reach with timely repairs and routine maintenance, which are necessary to avoid more costly repairs or replacement.

Tanzania: A Role Model for Good Cold Chain and Logistics Management

At the central level, the Tanzania Expanded Program on Immunization has a Cold Chain and Logistics section that plays a role in vaccine management and conducts field tests of new equipment and technologies. This section forecasts equipment needs, procures the equipment, and allocates it across the country. It also develops guidelines and standards for cold chain equipment, conducts supportive supervision, repairs defective cold chain equipment and coordinates cold chain trainings for technicians.

At the health facility level, facilities have procured many different kinds of refrigerators. They run on various sources of energy including solar, electricity, LP gas and kerosene. Almost all of the refrigerators are CFC-free and therefore environmentally friendly. For their part, health facilities are required to:

- Provide preventive maintenance on schedule and repair services as needed
- Receive and store supplies, including vaccines and other immunization supplies
- Conduct immunization sessions according to planned schedules
- Conduct mobile and/or outreach services
- Plan, monitor and evaluate the performance of health services provided

The Expanded Program on Immunization emphasizes monitoring vaccine stocks and temperatures at all levels of storage, distribution and administration in order to avoid or reduce wastage. Monitoring tools include vaccine vial monitors and freeze watch indicators. In addition, electronic temperature data loggers have been introduced at the regional level to 1) monitor the transportation of freeze-sensitive vaccines and 2) randomly study the storage temperatures of some refrigerators over a defined period of time.

Supervision (including cold chain and logistics) is done at all levels and on-the-job training is provided to strengthen the skills of health workers. Districts provide cold chain equipment, spare parts and supplies free of charge to users. The districts also supervise the users and assist them to make repairs when necessary. Users are also responsible for performing routine maintenance on their cold chain equipment.

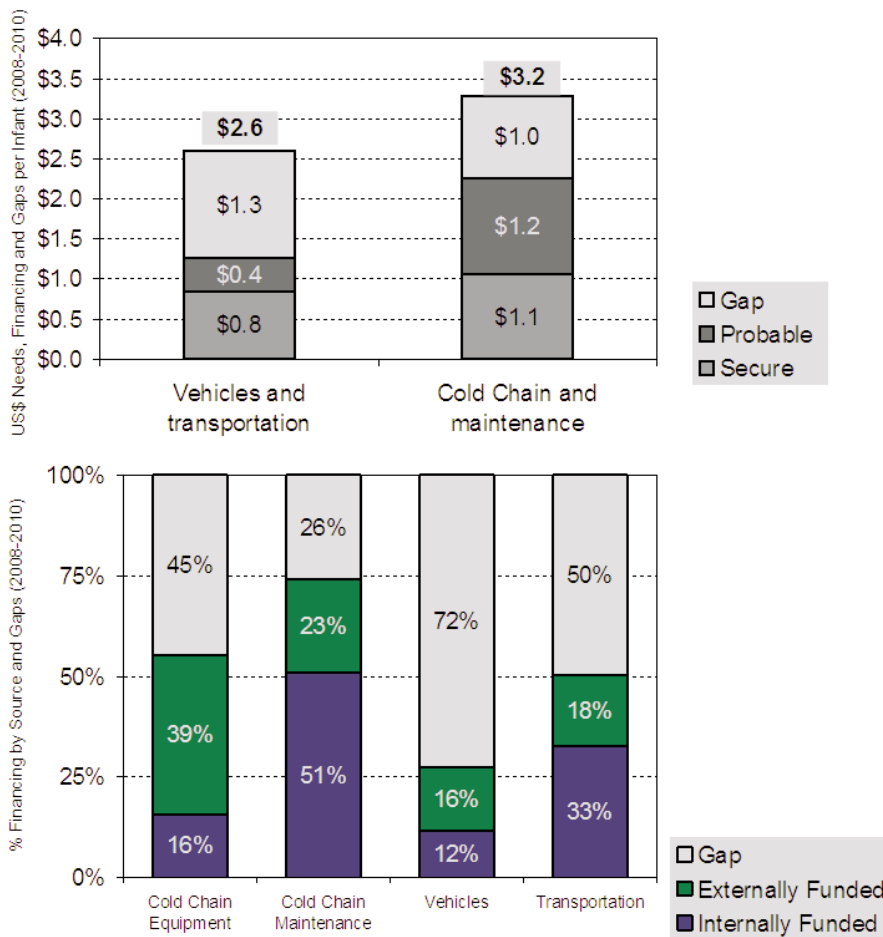
Regional staff have been trained to repair solar and compression refrigerators. And at the central level, there are skilled technicians who visit regions and districts to help repair solar refrigerators and conduct on-the-job training.

Source: K.G. Kagaruki, National Cold Chain & Logistics Officer, Tanzania EPI/MoHSW

Costs of cold chain and logistics management

An analysis of 45 national comprehensive Multi-Year Plans (cMYP), conducted by WHO and presented at the Cold Chain Logistics meeting in Geneva in February 2008, estimated that 40% of non-vaccine needs for 2008-2010 will be for cold chain and maintenance (22%) and vehicles and transport (18%). These cold chain and logistics needs are estimated at \$6 per infant for the three-year period between 2008 and 2010, with additional increases as vaccines against rotavirus and pneumococcal disease are introduced. Currently, funding gaps exist to meet this requirement (see graph), with maintenance primarily internally funded and therefore possibly not considered in donor contributions (see graph).

Cold Chain and Logistics Funding Gaps in 45 Countries, 2008-2010



Source: cMYP data from 45 countries, WHO/Geneva, Global Immunization Meeting, February 2008, presented by Patrick Lydon

The Optimize Project

A new partnership, known as the Optimize Project, was announced in January 2008 between the World Health Organization (WHO) and PATH. Funded by the Bill & Melinda Gates Foundation, the project examines current supply and delivery systems for vaccines and other health products.

The goal is to create a shared vision among national and international stakeholders and to develop a roadmap of immunization-related public health interventions. The work will be conducted in collaboration with ministries of health, regional WHO offices, other non-governmental organizations, and international agencies. The partnership will also evaluate the feasibility of integrating the distribution of vaccines with other health products.

By identifying, adapting and demonstrating the full potential of innovative products and practices, the partnership will develop short-term solutions and a long-term vision for delivering health supplies to people in need. For more information on this project, contact: info@path.org

DR Congo: Challenges to Maintaining the Cold Chain

DR Congo has made impressive improvements to its cold chain and logistics system in the last several years. However, the program only meets about 50% of its needs nationwide. The health system currently does plan and budget for cold chain equipment maintenance, but needs are increasing as new vaccines (e.g. the pentavalent vaccine, which combines DPT, HepB and Hib) are being introduced in one-dose vials instead of DPT (which comes in 10-dose vials). Given that the mid-annual Expanded Program on Immunization review in July 2007 found that only 16%, 21%, and 24% of the planned maintenance budget for cold chain was provided in 2005, 2006, and 2007 respectively, additional resources are needed not only for new equipment but also to maintain existing equipment to transport and store these more expensive vaccines.

Source: Mid-annual EPI review (July 9-14, 2007), Lubumbashi, DRC.

What countries can do to protect their cold chain

1. Develop or update policies for the purchase, repair and replacement of cold chain and transport equipment. Policies and guidelines should:
 - Specify the frequency of conducting cold chain inventories
 - Include equipment specifications, appropriate locations and most reliable energy sources in light of health system needs
 - Describe procedures for using these inventories to track breakdowns and schedule equipment repair and replacement
 - Incorporate “best practices” to achieving rapid, high-quality equipment repairs
 - Specify a timeframe for equipment replacement (i.e., poorly working or nonfunctional equipment that is over ten years old should be replaced)
 - Outline procedures and a reasonable timeframe for the disposal of nonfunctional equipment (i.e., equipment that is condemned for disposal should be collected from the facility and taken to an environmentally acceptable disposal facility or location)
2. Determine the need for new cold chain and transport equipment, spare parts and repair tools and establish a schedule for procuring them.
3. Develop and finance a maintenance organization or unit to ensure that cold chain technicians are available at appropriate levels (e.g. in each district or region, or stationed at the central level and able to travel to regions to repair defective equipment). In planning for this unit, clearly define profiles and competency requirements for cold chain technicians, prepare job descriptions, and estimate costs (e.g., salary, travel and transport for technicians, budgets for spare parts and tool kits).
4. Plan and finance refresher trainings in cold chain repair and maintenance for technicians and logisticians. Determine if additional staff are needed.
5. Build capacity of technicians to manage, monitor, and supervise all aspects of the cold chain and logistics system including routine maintenance and repair; temperature monitoring, correct inventory management (including spare parts and tools), and use of equipment.
6. Ensure that cold chain equipment, maintenance and logistics are a part of new vaccine introduction plans and that program support costs are included in budgets and financed appropriately.



*Cold chain equipment in Nigeria.
Credit: Jenny Sequeira*

What USAID Projects and Missions Can Do

- Collaborate with other donor and technical agencies and ministries of health to advocate and ensure that the Expanded Program on Immunization has sufficient and appropriate equipment and personnel.
- Support the development of policies and procedures that strengthen countries' ability to manage the cold chain (and thus maintain an effective immunization program).
- Provide support for personnel and resources to periodically assess, monitor, repair and replace equipment.

Resources

- Immunization Essentials, chapter 6: http://pdf.usaid.gov/pdf_docs/PNACU960.pdf#page=102
- WHO/AFRO Mid-Level Management Course for EPI Managers, Block III; Logistics: http://www.afro.who.int/ddc/vpd/epi_mang_course/
- TECHNET forum: <http://www.technet21.org>
- Cold Chain Equipment Management Tool: www.path.org/projects/cold-chain-ccem.php

Acknowledgements: *Mogens Munck, John Lloyd, Keerti Kumar, Serge Ganivet, K.G. Kagaruki, Patrick Lydon, Michel Othepa, and the Tanzania and DR Congo EPI offices.*

This publication was made possible through support provided by the Office of Health, Infectious Disease and Nutrition, Bureau for Global Health, U.S. Agency for International Development, under the terms of Award No. GHS-A-00-04-00004-00. The IMMUNIZATIONbasics project is managed by JSI Research & Training Institute, Inc. and includes Abt Associates, Inc., the Academy for Educational Development, and The Manoff Group, Inc. as partners. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Agency for International Development.