Technical Report

Supply Chain Solutions for Achieving Health Goals:

A Landscape Analysis of Public Health Supply Chains to Identify Potential Solutions for Neglected Tropical Disease Supply Chain Constraints

January 2015

JSI
Health Logistics

Support for this work was provided by the Bill & Melinda Gates Foundation

About JSI

John Snow, Inc. (JSI) is a U.S.-based health care consulting firm committed to improving the health of individuals and communities worldwide. Our multidisciplinary staff works in partnership with host-country experts, organizations, and governments to make quality, accessible health care a reality for children, women, and men around the world. JSI's headquarters are in Boston, Massachusetts, with U.S. offices in Arlington, Virginia; Atlanta, Georgia; Burlington, Vermont; Concord, New Hampshire; Denver, Colorado; Providence, Rhode Island; and San Francisco, California. JSI also maintains offices in more than 40 countries throughout the developing world.

Recommended citation

McCord J., Laaff, S., Nersesian, P., & Perry, S. 2014. *Supply Chain Solutions for Achieving Health Goals: A Landscape Analysis of Public Health Supply Chains to Identify Potential Solutions for Neglected Tropical Disease Supply Chain Constraints.* Arlington, VA. Improved Supply Chains for NTD Drugs (SC-NTD)/John Snow, Inc. for Bill & Melinda Gates Foundation.

John Snow, Inc.
1616 Fort Myer Drive, 16th Floor
Arlington, VA 22209 | USA
Tel | +1 703 528 7474
Health Logistics

Table of Contents

Acronyms

AIDS	Acquired immunodeficiency syndrome
AMFm	Affordable Medicines Facility for Malaria
ARV	Antiretroviral drug
BMGF	Bill & Melinda Gates Foundation
CDD	Community drug distributor
CHAI	Clinton Health Access Initiative
CHW	Community health worker
CMS	Central medical store
DEC	Diethylcarbamazine
EPI	Expanded Programme on Immunization
FEFO	First-expire-first-out
FLHW	Front-line health worker
GAVI	Global Alliance for Vaccines and Immunisation
GFATM	Global Fund to Fight AIDS, TB and Malaria
GPRS	General Packet Radio Service
GSK	Glaxo Smith Kline
GSM	Global system for mobile communication
HIV	Human immunodeficiency virus
ICT	Information and communications technology
ITI	International Trachoma Initiative
JSI	John Snow, Inc.
LMIS	Logistics management information system
LMU	Logistics management unit
LF	Lymphatic filariasis
MDA	Mass drug administration
MOH	Ministry of Health
NGO	Nongovernmental organization
NTD	Neglected tropical disease
NTDCP	Neglected Tropical Disease Control Program
NTDD	Neglected tropical disease drug
OJT	On-the-job training
PAHO	Pan American Health Organization
PCT	Preventive chemotherapy
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PPMR	Procurement Planning and Monitoring Report
RMNCH	Reproductive, maternal, neonatal, and child health
SCMS	Supply Chain Management System
SDP	Service delivery point
SMS	Short message service
SOP	Standard operating procedure
STH	Soil-transmitted helminthes
TB	Tuberculosis
TOT	Training-of-trainer
UNCoLSC	UN Commission on Life-Saving Commodities
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

Acknowledgements

The authors of this analysis would like to thank the many thinkers, contributors, and reviewers who helped to shape the document from its inception. They include:

- Staff at the Bill & Melinda Gates Foundation and the NTD Last Mile Technical Advisory Group who helped with initial framing and final reviews
- David O'Brien (John Snow, Inc. (JSI)) who helped outline, draft, and revise content
- Nadia Olson (JSI) and Chris Wright (JSI), who provided in-depth technical reviews
- Leah Hasselback (IntraHealth International), Mike Frost (JSI), Craig Usswald (Deloitte Consulting LLP), Maeve Magner (Independent Consultant), Yasmin Chandani (JSI), Claudia Allers (JSI), Dave Alt (JSI), Greg Roche (JSI), Diane Reynolds (Supply Chain Management System Project), and Alex Mokori (JSI), who participated in interviews regarding their deep and wide-ranging experience in last-mile supply chains.

Executive Summary

In January 2012, the goals of the WHO Roadmap for NTDs, as reflected in the London Declaration 2020 and as pertains to the five core preventive chemotherapy (PCT) mass drug administration (MDA) NTDs, were established as a unified goal of controlling or eliminating at least ten neglected infectious diseases by 2020. Declaration endorsers and NTD implementers—including donors, pharmaceutical manufacturers, and Ministries of Health (MOHs)—committed to exert significant effort to achieve the Declaration's ambitious goals. However, funding and medicine donations comprise only part of the requirements to achieve success. The national-level health systems and the people who run them are responsible for ensuring that donated medicines reach the community to interrupt transmission of the infectious agents.

The objectives of this analysis are to synthesize lessons from programs focused on strengthening public health supply chains in non-NTD programs in developing countries, and identify approaches to supply chain strengthening that could be applied to NTD programs to contribute to achieving the goals of the London Declaration.

Three decades of experience in improving public health supply chains for other disease-specific programs provides a substantial foundation of knowledge about typical barriers to full supply and the best strategies for improving commodity availability. Major supply chain interventions and solutions identified from non-NTD programs include the following, categorized by supply chain functional components:

- Human resources: cascade training of trainers, on-the-job training, pre-service training, incentivization, professionalization, supervision job aids, and feedback mechanisms.
- Information systems and inventory management: paper-based recording and reporting tools, short message service (SMS)-based reporting, web-based logistics management information systems (LMIS), dedicated logistics data collection teams, external technical assistance for data use, and establish logistics management units (LMUs).
- Medical products, technologies, manufacturing, and design: optimize packaging and project design at point-of-manufacture through application of new technologies to support community-level distribution.
- Demand quantification: external technical assistance-led forecasting followed by pipeline monitoring, capacity building, and institutionalization of software tools.
- Procurement and commodity funding: establish global pooled procurement, regional distribution centers for order fulfillment, global stock monitoring, and global pricing mechanisms.
- Storage: build or refurbish warehouses, outsourcing, use of alternatives to central medical stores (CMSs), network optimization, cross docking, international pre-packing, and use of shipping containers as mobile temporary storage units.
- Commodity transport: procure new vehicles, analyze networks, outsource distribution transport, and direct delivery to lower levels of the supply chain.

- Funding for routine operations and system strengthening: supply chain costing, and privatize publicly-managed activities.
- Leadership and governance: institute LMUs, supply chain master plans, and risk management.

The above list is not meant to imply that all the interventions listed are required by or should be adapted for a given NTD control program (NTDCP). Identifying relevant and impactful interventions from this list for the NTD context requires first assessing supply chain strengths and challenges and choosing an overall supply chain strengthening strategy for specific country contexts. MOHs and supporting partners may choose to strengthen public sector capacity, develop public-private partnerships, or develop an external, parallel supply chain to deliver commodities for MDA. Subsequently, a thorough understanding of the drivers of NTD supply chain requirements will inform identification of supply chain interventions. This paper's findings reveal that the following general supply chain strengthening approaches will contribute most significantly to achieving the London Declaration goals. The approaches are grouped by level to emphasize where the decision-making authority resides.

Decision-Making Level	Supply Chain Strengthening Approach
Ministry of Health	• **Emphasize rapid scale-up** of logistics system capacities, considering private as well as public resources, to achieve performance goals • **Mobilize cost-effective and adequate storage, transport, and commodity management capacity** • **Reduce and sustain procurement lead time variation** • **Emphasize expansion of visibility into stock status** • **Increase forecasting accuracy** by using stock information, particularly in-country stock balances • **Strengthen human resource** capacities for managing NTD drugs at the volunteer, intermediate, and central levels
First-Mile	• **Optimize medical products, technologies, manufacturing, and design** to promote product quality and logistics management

These approaches will contribute the most to achieving the London Declaration goals because they recognize the need to harmonize proven public health non-NTD supply chain tactics with the unique attributes of NTD programs. They also represent best practices In light of the London Declaration's goal for control and elimination by 2020. For example, rapid NTDD supply chain scale-up is critical for NTD elimination as compared with standard public health approaches. NTD drug supply chains must achieve a high standard of drug availability to succeed, but need not sustain that success, or even that supply chain, in the long term. Minimizing variation in procurement lead times is important because greater predictability in product supply enables more cost-effective and adequate storage, transport, and commodity management.

Products must be available for distribution at MDAs and in the appropriate quantities. While these considerations are important for any health program, MDAs only occur once or twice a year and involve a large community mobilization effort. Any variation from this schedule risks the failure of interrupting

the biological pathway between parasite and host, thus compromising the MDA's integrity. Ultimately, data visibility is critical, not only during campaigns to allow for adjustments of stock imbalances, but also at a macro level to increase national forecasting accuracy.

This landscape analysis investigates supply chain solutions for achieving public health goals and recognizes that lessons from the non-NTD experience can yield potential solutions to NTD supply chain constraints worldwide.

Introduction

The endorsing signatories of the London Declaration on Neglected Tropical Diseases (NTDs) in January 2012 set clear and ambitious goals to achieve by 2020. Achieving the declaration's goals will require increasing effort and success from the national control programs and significant, sustained commitment of the global NTD community, including donors and pharmaceutical manufacturers. Rapid scale-up of medicine distribution systems to the community level is essential to reach the 2020 control and elimination targets. Sustaining 80 percent treatment coverage across districts, countries, and regions for the next six years will be a challenge for MOHs that have already stretched human and financial resources. Current treatment coverage for lymphatic filariasis (LF) is at 80 percent in Malawi and Sierra Leone, but only at 14.6 percent in Nigeria, and 3.3 percent in Ethiopia (WHO 2012). Low coverage in large complex countries such as these demands focused attention to supply chain scale-up and significant input of resources.

To provide perspective on this challenge, the focused requirement of NTD supply system scale-up should be examined through the lens of three decades of experience in improving public health supply chains for other disease-specific programs. Supply chains in resource-constrained Ministry of Health settings are hard pressed to achieve and sustain the high level of performance that will be required by NTDCPs to reach and sustain the 80 percent coverage target required to achieve elimination. A secondary analysis of 45 sub-Saharan Africa country studies revealed that the average public sector availability of a common set of medicines was only 38.2 percent (Cameron et al 2008).

Moving health commodities effectively and efficiently depends on infrastructure such as functional ports, well-maintained roads, and operational communication systems. In low-resource countries, health systems managers cannot assume that the infrastructure is intact, especially in communities with the highest rates of NTDs. The 2012 World Bank's Logistics Performance Index (which aggregates supply chain input and output indicators on a country-by-country basis) highlights that NTD endemic countries, particularly in sub-Saharan Africa, face the greatest supply chain challenges. Moreover, the regions and districts within countries hardest hit by NTDs are often the least well-served by national infrastructure.

National supply chains for NTD medicines can also be characterized as "neglected" since few countries have received focused, coordinated, and sustained investments to build systems that ensure the NTD medicines are moved from the central level to communities where they are needed for the MDAS.

Tailored supply chain solutions have rarely been systematically designed and implemented to support NTD program objectives. For example, coordinated supply chain business processes that optimize delivery of health products for MDA campaigns are uncommon.

Despite numerous challenges, public health programs in low-resource countries have made significant strides in health outcomes over the past several decades. Many of these programs rely on the availability of essential commodities when and where people obtain services. Through dedicated funding, technical competency, stakeholder commitment and coordination, and the strong efforts of health managers and workers on the ground, global public health supply chain strengthening efforts have:

- Contributed to halving childhood deaths from malaria between 2000 and 2013 (WHO 2013).
- Secured uninterrupted treatment of AIDS for millions of affected people in developing countries (SCMS 2012).
- Supported scale-up of global immunization coverage from 20 percent in 1980 to over 70 percent in 1990 (GAVI 2005).

The objectives of this analysis are to synthesize lessons from programs focused on strengthening public health supply chains in non-NTD programs in developing countries, and identify approaches that could be applied to NTD programs to contribute to achieving the goals of the London Declaration.

Specifically, this analysis seeks to obtain answers to the following questions:

- What are the general challenges faced by various public health supply chains, and how have they been overcome?
- Which challenges faced and overcome in public health supply chains over the past several decades are most analogous to the challenges faced by comparatively new integrated NTD commodity logistics systems today?
- How can lessons learned from public health supply chain management be applied to NTD supply chains in order to support achievement of the London Declaration by 2020?

The aim of this paper is to support discussion and decision-making among supporters of the London Declaration on how they can achieve the declaration's goals by overcoming "last mile" challenges within NTD supply chains and scaling up delivery of NTD medicines within a short time frame.

Structure of the Paper

First, the authors present the methodology used to collect and synthesize the content of this paper, followed by the experiences of non-NTD public health supply chains within a functional framework. Each element of the framework includes commonly referenced challenges and global best practices. Drawing from these experiences, the paper identifies several best practices that could facilitate achievement of the London Declaration for NTDs.

Methodology

This document synthesizes information from a literature review that includes operations research reported in peer-reviewed journals, implementation experience included in partner reports, donor-commissioned reports, and other grey literature, as well as key informant interviews about experiences of health system employees who have operated supply systems and NTD programs for decades.

Literature Review

This paper includes reviews of supply chain experience for the following health programs:

- Family planning, reproductive health, and maternal/neonatal/child health (RMNCH)
- Human immunodeficiency virus and acquired immunodeficiency syndrome (HIV and AIDS) treatment and prevention
- Tuberculosis (TB) control
- Malaria control
- Immunization
- Essential medicines
- Integrated community case management
- Nutrition
- Humanitarian, emergency, and disaster response

A list of initiatives, funders, projects, and implementing partners was compiled and an internet search conducted to identify documentation available online. Global best practices documents and country-specific cross-sectional supply chain assessments were also included.

A limitation of the literature review is that donors' funding priorities influence which supply chain strengthening work is completed and documented. Some donors restrict resources for documentation and as a result, available material may not accurately reflect the breadth of the lessons in supply chain management for health programs.

Key Informant Interviews

Nine interviews were conducted with key informants to validate and complement findings from the literature review. The informants were selected to represent the programs included in the literature review. Interviewees were given a summary of NTD supply chain constraints and a list of challenges and solutions identified through the literature review. They were then asked to share their experience-based perspectives on how NTD supply chains could be strengthened. The key informant interviews provided subjective individual perspectives on non-NTD supply chains that supported the development of general conclusions, specific supply chain solutions, and illustrative quotes, which are highlighted in the paper.

Landscape of Developing Country Public Health Supply Chains

Organizational Outline

Supply Chain Functional Components

- Human resources
- Information systems and inventory management
- Medical products, technologies, manufacturing, and design
- Demand quantification
- Procurement and commodity funding
- Storage
- Commodity transport
- Funding for routine operations and system strengthening
- Leadership and governance

The outline above, used to guide this analysis, includes supply chain-related inputs to health system outcomes. Steele (2013) organizes supply chain activities and support functions according to the World Health Organization's (WHO) Health System Strengthening Building Blocks: service delivery, health workforce, information, medical products and technologies, financing, and leadership/governance. The main logistics and supply chain operational activities—plan, source, make, and deliver—fall within the "medical products and technologies" building block. Other building blocks link system-level components to a supply chain's support of health outcomes. For example, health workforce is important for public health supply chain as well as overall health system performance. This analysis examines challenges and possible solutions within each element in the context of current NTD practices.

Human Resources

In a well-functioning public health supply chain, staff are trained and empowered in all facets of their work. Initial orientations are followed by on-the-job and refresher trainings to update professional skills. Staff are remunerated fairly and on time. There are incentives to optimize performance and generate loyalty. However, in resource-limited settings, a complex set of challenges means that having a cadre of skilled and motivated staff is the exception rather than the rule.

Common challenges among non-NTD program supply chains

Human resource capacity is limited for logistics roles across country health systems for all health programs. This applies to central-level management roles as well as logistics responsibilities of dispensing pharmacists and community health workers (CHWs) at service delivery points (SDPs). Key reasons for this limited capacity include inadequate training and resultant knowledge gaps. Training

inadequacies can result from a lack of funding for facilitation or a lack of time to develop curricular materials. Another identified training challenge is ensuring an appropriate participant list and that participants are attending for the prime purpose of skills development and not for incentives such as per diems.

Competing priorities pose a serious challenge to health workers across the supply chain. Often too few staff are employed so people are required to perform multiple tasks beyond a reasonable scope and sometimes at multiple locations. Further, the design of a supply chain system can place the logistics burden on health personnel and clinical staff and diminishes their ability to perform their actual jobs. As Professor Saracino, former Minister of Health in Côte d'Ivoire, says "When you use a nurse or a physician as a logistician, you lose the nurse or physician and you don't get a good logistician!" (Global Health Supply Chain Summit, 2013).

Leah Hasselback (Project Director, IntraHealth International) thinks outsourcing, though not necessarily to the private sector, can be useful to improve supply chain human resource capacity. By task shifting "instead of relying on everyone who's not trained in logistics work, put a lot of the logistics work in the hands of a few well trained people. This has the overall effect of increasing HR capacity which is probably really appropriate for campaigns." One example she suggests is assigning malaria net distribution staff to NTDs when needed. There is an "advantage to not involving all the staff in the system. The idea is having a small subset of staff to do the work."

Staff retention is a significant challenge to health supply chain workforces worldwide. Even in an environment where training and other resources are adequate, staff turnover undermines the preexisting knowledge base when trained and skilled personnel leave the system or are transferred elsewhere. Workers depart for many reasons and this is frequently linked to disincentivization, as when qualified staff leave public-sector jobs for better remuneration. This pertains to paid employees as well as volunteer health workers who may feel they do not receive adequate compensation or reimbursement for basic costs (Chandani & Noel et al, 2012). Therefore, any job opportunity that is higher-paying or has greater perceived benefits or more prominent status is likely attract trained staff away from their current positions.

Limited supervision at all levels of the supply chain can produce a system where accountability is minimal or absent. Poor performance can emerge when staff realize that they are not being monitored. This can be particularly problematic in terms of cost of supply chain failure and the potential for reversal in progress toward disease elimination. It is equally problematic if excellent performance goes unrecognized because supervision is not conducted all the way down to the service delivery level. Travel to remote service delivery points (SDPs) can be challenging, long, and arduous, and field trip budgets are often insufficient, so supervisors are poorly motivated to visit them. Even when there is sufficient motivation, the inevitable challenges of visiting remote locations may preclude supportive supervisory visits.

Known solutions – Human resources

A variety of techniques are used to build cadres of trained staff. A cascading training-of-trainers (TOT) approach establishes a cohort of facilitators who are responsible for training facility-level staff using standard in-service training formats. Periodic mop-up trainings can meet the training needs of individuals who missed offered courses. Furthermore, trainings require personnel to leave their duty posts, resulting in periodic vacancies. Trainings can also provoke discordance within a workplace because only selected individuals attend.

On-the-job training (OJT) involves coaching staff in their work environment while they engage in their typical daily practices. Taking advantage of appropriate moments for instruction enables real-time mentoring and fosters a closer relationship between the trainer and trainee. Because it occurs within the workplace, it incurs few exceptional costs and these are offset by the long-term benefits to the trainee. However, while OJT is particularly useful for staff who work at fixed sites, short-term NTD workers have scant opportunity for this type of training.

Pre-service training for nurses, pharmacists, and other clinical workers is another approach for instituting general supply chain management capacity. Collaboration with academic institutions and MOHs is essential if supply chain instruction is to be integrated into existing curricula. The benefit of pre-service instruction is that graduates arrive on the job already cognizant of supply chain responsibilities. However, it may be difficult to convince institutions to allocate limited teaching time to health system management skills.

Opportunistic approaches constitute another form of non-traditional training. In a child health program in Ethiopia, managers have included supply chain fundamentals in monthly meetings and salary pick-up interactions. In this way, required interactions are used as teaching/learning opportunities for "ready lessons" on logistics topics and problem-solving strategies (Supply Chains 4 Community Case Management (SC4CCM), 2013).

Task shifting can mitigate challenges in the health workforce. Non-critical tasks are "moved, where appropriate, from highly qualified health workers to health workers with shorter training and fewer qualifications in order to make more efficient use of the available human resources for health" (WHO 2007). Task shifting for supply chain management can involve balancing the workload of logistics activities by designing a system that centralizes logistics tasks with dedicated specialists or automated systems rather than clinical health workers.

In Kenya, the Ministry of Public Health and Sanitation sought to solve the problem of a shortfall in logistics system human resources by arranging for the

Yasmin Chandani (Project Director, JSI) emphasizes a key finding in many countries with volunteer community health workers: if anyone in the system is non-salaried, incentivization is critical. While monetary incentives are not always necessary, it is important to figure out a way to motivate many people at once. Establishing multi-level teams with common goals can be quite powerful. When teams are established and employed effectively, Yasmin has seen significant product availability improvements close to the community level.

employment of contract staff through development partners (Ramana & Chepkoech et al., 2013). Ultimately, this task shifting initiative did not solve the personnel problem because it was difficult to attract personnel to the most needy, distant, and underserved areas. However, it effectively addressed the staffing reality at least for the short-term, and could specifically be a promising solution for NTDs, which are expected to be eliminated within the next several years.

In Mozambique, an effort to shift vaccine logistics tasks to a dedicated district-level cadre known as field coordinators was a cost-effective way to establish a routine logistics system at the lowest level of the country's supply chain (VillageReach, 2012).

Incentivization and motivation of health supply chain staff can diminish high turnover and increase retention, and are especially important for non-salaried volunteers. A variety of workforce retention strategies can be employed in different environments based on factors such as resource availability and preference. The USAID | DELIVER PROJECT's Human Resource Capacity Development Assessment Guide and Tool outlines the following suggested incentivization mechanisms: monetary incentives; public recognition; improved work environments; living condition incentives/perks; and professional development opportunities.

Professionalization aims to alleviate human resources challenges by building up roles within the logistics vocation. Supply chain work has historically not been "considered a professional role requiring specialized training" (USAID | DELIVER PROJECT, Task Order 4, 2013). Professionalization formalizes the function of the logistician, recognizing the critical public health service delivery role of these individuals. The process involves developing job descriptions that include official titles, compulsory background experience and educational requirements, and assigning specific responsibilities to these already qualified professionals. Global organizing bodies such as the Association for Operations Management and Council of Supply Chain Management Professionals have contributed to developing universal guidelines and accreditation processes for the professionalization of supply chain workers.

Supervision tools and user-friendly job aids to support supervision activities should be developed. In an ideal system, "clear, transparent supervision guidelines are operational and administered in coordination with performance management processes; scheduled supportive supervision visits occur regularly. Actions from these visits are followed up on and feedback is documented" (USAID | DELIVER PROJECT, Task Order 4, 2013). While this may not always be the case in practice due to resource constraints, these tools do exist in many settings, and tailoring them is a possibility. Rolling out tools, job aids, and SOPs may be costly initially, but generally require infrequent printing and distribution and can be highly beneficial in the long run.

Feedback is a critical element of effective human resources systems and two-way communication should be evident throughout the supply chain. A lack of information flow—not only of logistics data but also in the context of providing feedback on staff performance—can severely hamper a system and limit accountability.

NTD Perspective – Human resources

In general, challenges listed for non-NTD programs also describe the situation for NTDs. There are too few staff dedicated to logistics functions and these individuals are typically supervised by a small management team at the central level and focal persons who coordinate activities at lower levels. They often lack sufficient support for their logistics responsibilities and have limited capacity in logistics. Because of their limited numbers and multiple roles, NTD managers are over-burdened with planning, coordination, and reporting responsibilities.

Integrated NTD programs are comparatively new and because vertical programs persist, NTD supply chain responsibilities can be fragmented, resulting in duplication of human and financial resources. Community drug distributors (CDDs) responsible for implementing the MDAs often have lower literacy and numeracy skills and are not always compensated. Yet, they are the key community-level actors relied on to record and report quantities distributed and quantities left in balance.

There are multiple potential solutions to these problems, including training in logistics management, which could benefit central-level staff who are responsible for managing NTD procurement and supply chain operations. For those downstream, the development of standard operating procedure (SOPs) or training in supply chain functions for staff responsible for handling the medicines at would be beneficial. Specific solutions that may improve downstream data management or reduce the amount of data that needs to be collected could include performance-based incentives, task shifting, and enhanced logistics system design. For those NTD programs not supported by CMSs and ministry of health (MOH) distribution systems, or are only partially supported by these structures, drug distribution system solutions must be devised.

Information Systems and Inventory Management

Supply chain information systems make data available to decision makers for managing distribution of required commodities. To make operational decisions about quantities of commodities to deliver to which locations, how much to order, and longer-term decisions about supply chain design, staff need access to accurate timely logistics data such as stock on hand and quantities dispensed within specific time frames and to which locations (USAID | DELIVER 2011). This is essential data for supply chains that fill orders based on need. It is also valuable in systems that determine resupply amounts at the central level based on allocation calculations derived from treatment strategies such as in NTDs. When high-quality data is available in an accessible format, stakeholders and supply chain managers can it for operational and strategic decision-making.

Inventory management includes adhering to ordering policies such as how much and when to order and how to issue products in response to order requests. Inventory control systems vary regarding who determines the order quantity. In a pull system, it is the recipient; in a push system, it is the sender.

Campaign-based programs typically use push systems, while routine service delivery programs may use either. Adherence to a well-designed inventory control system is crucial for ensuring that the right quantities of commodities reach SDPs on time.

Well-designed LMISs rely on logistics data as key inputs. The system then supports essential functions such as quantification and distribution planning. These benefits are diminished when the key data inputs are treatment coverage and population estimates. Managers can make well-informed decisions about drug forecasts when stock on hand information is available, but too often such information is not timely, complete, or accurate.

Common challenges among non-NTD program supply chains

Many health program supply chains lack standardization for recording and reporting logistics data, and some programs may not have a system for tracking and reporting commodity inventory levels and consumption. More common are systems that have relevant forms, but their use is not institutionalized at the facility level. In these situations ordering staff use their best estimate to request medicines. Otherwise, they receive whatever the higher level pushes to them. The result is a lack of visibility into demand and current stock status, resulting in some facilities being overstocked while others are stocked out. Lack of visibility also forces forecasts to be based on demographic data instead of logistics data.

Limited information communications technology (ICT) infrastructure, such as an unreliable electricity supply, poor data connections, out-of-date computers, and insufficient computer literacy, adversely affects public health systems at the service delivery-level. Modern commercial operations capture and share logistics data using electronic systems. As customers make purchases, sales and inventory databases are updated electronically without input from sales staff. These operations typically apply complex stock requirement calculations by product. However, at health SDPs in the developing world, lack of infrastructure and computer literacy make this scenario unlikely or impossible. At higher levels, developing country health systems may lack skilled information technology staff capable of setting up and maintaining management information systems.

Limited capacity in time and knowledge to complete forms and reports at the service delivery-level results in low reporting rates and/or poor-quality reports. It is difficult to operate an LMIS that requires staff to quantify amounts dispensed, track inventory, and complete paper reports. Additionally, lack of supervision and quality monitoring puts information systems at risk of missing and poor data.

Supervision also facilitates building staff understanding, skills, and adherence to inventory management best practices such as stock rotation, batch control, stock recall processes, and first-expire-first-out (FEFO) through on-the-job training.

Known solutions – Information systems and inventory management

One approach to standardize record keeping and reporting is to use **paper-based tools** such as logistics records, reports, and job aids. When these tools are accompanied by training and supervision, there is a greater likelihood that service delivery-level staff will capture and report current essential data such as stock on hand, quantity dispensed to patients over the previous period, and quantities of losses and receipts of each commodity included in the system. However, there are several potential barriers to implementation of this approach: it requires significant time to design and roll out to facilities; places significant burden of effort on clinical staff; is vulnerable to staff turnover; requires ongoing management effort to maintain reporting quality; requires additional resources to convert hard-copy data into electronic format; can be difficult to apply to a large number of products; institutes a long 'lead time' for data to become available to decision makers; and can be expensive given the cost of printing and transporting materials to each facility.

Short message service (SMS)-based logistics reporting is a growing mHealth solution. Given expanding global system for mobile (GSM) communication coverage in developing countries, essential logistics data can be transmitted wirelessly through SMS using hardware already available at the service delivery level, resulting in data reaching electronic servers much more quickly than a paper system. This approach requires information system design and implementation, but open-source platforms are increasingly available (e.g., CommTrack). SMS-based reporting requires staff development and the staff will still have to conduct physical counts, keep physical records, and maintain a 'back-up' reporting method in case mobile phones are unavailable. Character-length restrictions make reporting on large numbers of products challenging. Other mobile reporting platforms, such as general packet radio service (GPRS), offer similar benefits with different cost and implementation profiles (i.e., fixed costs are higher but variable costs are lower). Several examples include the ILSGateway for reproductive health commodities in Tanzania; cStock for community health worker commodities in Malawi; and the Early Warning System in Ghana (USAID DELIVER | PROJECT 2011 [mHealth presentation], SC4CCM 2013, and Focus Regions Health Project 2013). Other applications of SMS suggested by interviewees included administration of quick surveys to service providers to capture and validate demand.

Web-based LMISs offer another approach to improved reporting. Extension of computer and internet access to district or SDPs allow electronic record keeping and reporting in a fashion similar to many commercial-sector operations. This real-time access to data requires access to working computers and computer literacy [USAID | DELIVER PROJECT 2011 [last mile doc], USAID | DELIVER PROJECT 2010 [Bangladesh]). Computer-based systems can also automate elements of inventory control by automatically calculating requirements based on reported demand and stock on hand, rather than relying on staff to perform the calculation.

Dedicated logistics data collection teams can also be used in a variety of ways to 'task shift' the responsibilities from health facility staff to teams specifically trained for the job (see general description of task shifting in the Human Resources Section) (Tompsett 2013). The teams count stock, infer consumption, determine order quantities, and create logistics reports. In this approach, trained data

collection teams routinely travel to health facilities to collect logistics data and enter it into a portable computer that can subsequently be used to provide near-real-time data to an electronic database.

Many public programs receive **external technical assistance** for data-driven decision-making in order to develop high-quality distribution plans and central-level forecasting. This approach quickly introduces analytical rigor and best practice methodologies without necessarily instituting public-sector capacity. Secondment of experienced professionals to key public sector roles also serves this purpose.

Establishing and empowering a **logistics management unit** (LMU) or logistics management office (LMO) is an approach that might be appropriate for the management of campaign-based systems. Although their exact responsibilities can vary, LMUs are MOH management structures responsible for dedicated logistics data management, quantification, monitoring and evaluation, supervision, and stakeholder coordination (USAID | DELIVER 2010). This approach builds local capacity and institutionalizes that capacity within an empowered structure in the MOH—giving the unit the ability to act on data, convene stakeholders, and advocate for resources.

NTD Perspective – Information systems and inventory management

NTD systems currently have a low level of logistics information system functionality, made worse by the fast pace of campaign distributions. The fact that quantities are pushed from the central level based on the annual population-data driven quantification process may also serve as a disincentive to active recording and reporting of logistics data. The usage data that is available serves a non-essential role at the central level for determining procurement quantities, whereas stock balances are important for repositioning commodities during MDAs at lower levels. An LMIS that provides rapid visibility is needed to support stock repositioning. Given the lack of communications infrastructure at the lowest levels, mobile information systems may be needed. A task-shifting approach that ties information system requirements to dedicated logistics staff rather than clinical staff may also provide benefits to NTD systems.

Large NTD drug shipments received at the central level are commonly distributed to lower levels as soon as possible to ensure availability of the medicines for MDAs, and also to relieve the burden of keeping large quantities in over-crowded facilities. Due to this rapid distribution practice, stock cards and other reporting mechanisms are not always used to monitor movement of campaign commodities to districts and communities where they will be used within a short time frame. LMISs are typically designed for routine service delivery and therefore health staff at all levels are challenged when faced with adapting their use for periodic MDA drugs. Few resources are expended on NTD LMISs, resulting in lack of standardized procedures and materials.

Medical Products, Technologies, Manufacturing, and Design

While this document focuses on country-level approaches, considerations for packaging and product design by the manufacturer have significant implications at the country level.
Beyond basic protection for commodities in transport and storage, packaging can provide critical information on dosing to providers and patients, encourage rational use, and reduce medicine wastage and generation of health care waste. Needs for a particular commodity may vary by country, depending on factors such as existing policies and regulations, local environmental concerns and laws, and how services are delivered.

Common challenges among non-NTD program supply chains

For any program, **packaging may not support common dosages** or may force service providers to expose commodities to harmful conditions (United Nations Foundation 2013). Bottles of liquid preparations that are too large for daily consumption patterns also increase drug wastage. Packaging and design may also interfere with uptake in specific communities. For example, in some sub-Saharan African communities, the white color of donated long-lasting insecticide treated nets was associated with mourning.

Known solutions – Medical products, technologies, manufacturing, and design

Application of new technologies can increase patient and service provider safety. Prefilled Uniject™ devices offer a method of vaccine administration that ensures effective delivery and greater adherence to injection safety, but that also increases cold chain storage capacity requirements (PATH 2010). New technologies can also improve product quality. For example, vaccine vial monitors provide information to the service delivery provider about the potential quality of the vaccines being delivered (PATH 2010). In Rwanda, switching from use of loose tablets to blister packs for dispersible amoxicillin allowed community health programs to avoid product spoilage at the lowest level of the system, where humidity was causing the tablets to disintegrate. Convening a technically knowledgeable advisory group can help identify solutions to specific product design challenges. For example, the GAVI Alliance established the Vaccine Presentation and Packaging Advisory Group in 2007 to investigate the optimal number of doses per vial for vaccines. This group produced technical inputs for product profiles and recommended adaptations to formulation of one vaccine to change its storage requirements from more than 100 cm^3 per dose to 17 cm^3 per dose (Mansoor et al 2012).

NTD Perspective – Medical products, technologies, manufacturing, and design
NTD program supply chain assessments highlight concerns with packaging size where the smallest size packaging (bottles) contains 500 or 1,000 tablets. Stakeholders have reported that the large number of tablets per bottle increased wastage, decreased hygiene, and discouraged inventory control at the service delivery level. Additionally, non-optimized packaging may lead to increased transport costs and storage requirements.

Demand Quantification, Including Requirements Forecasting and Supply Planning

Quantification, which includes forecasting and supply planning for future commodity requirements, is crucial for ensuring a sufficient but not excessive supply of commodities. Proper execution of the process requires logistics data, or failing that, health service, demographic, or morbidity statistics. Quantification outputs are more accurate when a facilitated workshop is held to draw upon the expertise of system stakeholders on current supply chain realities and anticipated programmatic changes. A facilitated process also results in thorough documentation of forecasting assumptions so that forecasts can be routinely revisited and updated properly. Finally, supply planning, the step of turning forecasted demand into quantities for procurement, uses logistics data (current stock on hand) to help stakeholders identify the proper quantities and timings of shipments as well as potential commodity funding gaps.

Many developing country health systems conduct quantifications on an annual basis, either combining programs into large workshops or by individual programs leading quantifications independently. The activity may take place with or without external technical assistance and typically forecast need to cover time periods of two-to-five years. This process applies to both routine pull systems and campaign-based push systems.

Common challenges among non-NTD program supply chains

A lack of capacity and knowledge for proper application of best practices in forecasting can affect any program, particularly in use of consumption data or logistics data from other system levels (Dickens 2011). Even when logistics, service, and/or demographic and morbidity data are available, some data are always missing and must therefore be imputed based on consumption trends to arrive at a forecasted figure that takes all service sites into consideration. Best practices may be subverted by programmatic goals. When new programs are scaling up, political pressure may lead stakeholders to overestimate the rates of program expansion and coverage, causing overstocks (Institute for Reproductive Health et al., 2012). In the case of campaigns, coverage targets may drive procurement requests over realities of system distribution capacity.

Forecast exercises are often completed on an annual basis without updates or pipeline monitoring during the year. Following annual budgetary cycles, national programs sometimes employ annual forecasts that are used for procurements placed several months into the budgetary year without revision or updates, which limits forecast accuracy (Akhlaghi 2011). In the case of annual campaigns, active pipeline monitoring could help stakeholders understand the accuracy of forecasts in place. When current stock on hand information is not taken into account, supply plans may be inaccurate. Even when current stock on hand data are available, supply planning requires realistic assumptions about procurement lead times and central-level storage capacity, as well as rigorous updating of procurement status.

Known solutions – Demand quantification, including requirements forecasting and supply planning

External technical assistance-led forecasts followed by active pipeline monitoring can build forecasting capacity. Weak or limited host country capacity can be compensated by dedicated, externally funded project staff to ensure that data are properly collected, best practice forecasting methodologies are employed, and that an initial supply plan is developed and updated using pipeline monitoring.

Capacity building of local staff may include targeted support of LMU staff to enable them to coordinate and facilitate forecasting workshops and lead forecasting efforts. Once local capacity is developed, this approach can be phased out.

Institutionalization of supply planning using appropriate tools helps maintain appropriate commodity stock levels. Similarly, dedicated public-sector staff can be identified and trained to manage supply planning and pipeline monitoring stages of quantification. Based on experience in these areas, several software tools have been developed and applied extensively toward developing quantification of health commodities. Quantimed (MSH.org) is a freely-available tool that supports forecast development and documentation, while Pipeline (JSI.com) supports supply plan development and active pipeline monitoring.

NTD Perspective – Demand quantification, including requirements forecasting and supply planning

NTD programs rely first and foremost on target population data, and to a lesser degree treatment protocols, prevalence data, and stock on hand to inform annual quantifications of drug needs. Logistics data from the service delivery level are infrequently available and used at the higher levels to refine and validate the prepared forecasts. Using imprecise population and stock on hand data to inform quantities for procurement can lead to over- or under-supply.

With well-functioning LMISs in place, NTD programs could benefit from forecasting approaches that consistently include logistics data. Determining procurement quantities could be made more accurate by including quantities on hand in the calculation. Resources for supply planning and pipeline monitoring can help avoid some of the negative consequences of lead time fluctuations that force program planners to submit forecasts for the next MDA before the current one is underway, and shipments that are too large for central-level recipients (see NTD challenges with procurement below).

Procurement and Funding for Commodities

Timely execution of procurement in accordance with relevant regulations is challenging and directly influences national availability, price, and quality of health products. Some challenges vary depending on whether the procurement is for goods sourced internationally or locally, but public health supply chains

typically deliver both. The process can involve numerous stakeholders, including health program staff, drug regulatory agencies, funding agencies, procurement agents, and manufacturers (USAID | DELIVER 2011 [handbook]). PATH's procurement process for reproductive health commodities includes three steps with ten elements that can be applied to other publicly-procured health commodities as well (2009):

- **Program planning**: This step includes defining requirements, developing specifications, assessing procurement options and funding, and preparing a procurement requisition. The result is a funded procurement requisition.
- **Procurement process:** This step includes procurement planning, inviting offers, selecting suppliers, and developing contracts. The result is a signed contract and payment guarantee.
- **Contract performance**: This step includes performance management and delivery of goods. The result is delivery and acceptance of high-quality goods.

Availability of funding for commodity purchase directly impacts supply chain performance, as failures to obtain sufficient quantities of essential health products can reverse program success even with a generally effective last mile supply chain in place. Additionally, the funding source can affect last mile supply chain operations due to the influence of funding cycles and reporting requirements. Over the past several years, with the introduction of global and bilateral mechanisms such as the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), the Global Fund to Fight AIDS TB and Malaria (GFATM), the London Declaration, and other initiatives, the general availability of public health commodity funding or donations has increased significantly. While these funding mechanisms have contributed greatly to health program success, gaps and challenges remain.

Common challenges among non-NTD program supply chains

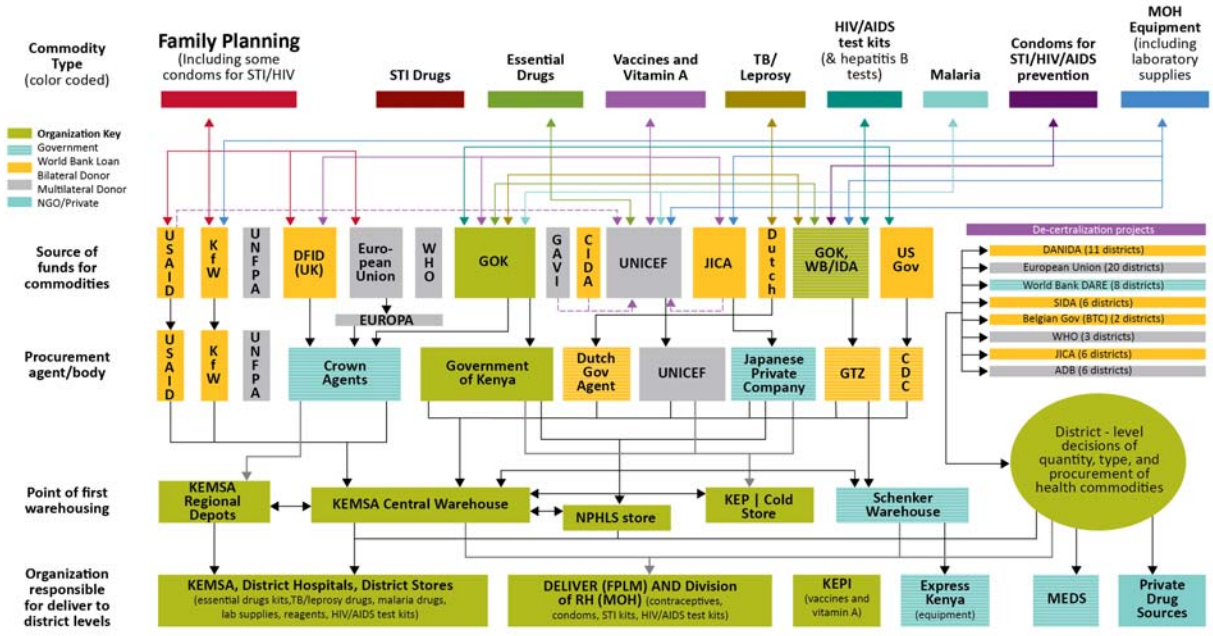
For procurements from global suppliers, **unpredictable and long lead times** cause delays and, when combined with inflexible procurement mechanisms, prevent the desired quantities from arriving at the desired time. Delays come from many sources, including required order approvals, upstream supply issues, and port clearance.

Port and customs clearance can introduce unanticipated delays and demurrage expenses (Durgavich 2009). The number of days required for customs clearance is used by the World Bank and national authorities to measure the overall efficiency of importation infrastructure and policies, and can be high and variable for developing countries. A 2006 analysis conducted by the USAID | DELIVER PROJECT and Tanzania's Medical Stores Department found that the overall importation process from pre-shipment inspection to delivery at the Medical Stores Department "required 10 steps, 15 agencies, and 18 documents and took 67 days" (Durgavich 2009). The large number of steps, agencies, and documents will inevitably result in delays. In this example, actual port clearance required 27 days and required 22 days' worth of demurrage expenses over the five days allowed at no cost by the customs authority.

In numerous locations, the high value of publicly procured health commodities attracts **corruption** (Diack et al. 2010). Corruption undermines the effectiveness of public funds, resulting in an insufficient quantity of available medicines. Furthermore, this stock is often of lower quality or higher cost than would otherwise be achieved for the health system. A lack of transparency or effective oversight compounds this challenge. While this issue is not common to NTD programs, it is not unknown.

Verticalization of funding streams can lead to gaps and overlaps in funding commitments. External funding for commodities is typically dedicated to particular programs, and with the proliferation of global funding streams and NGOs, lack of coordination between health program managers and funding representatives can result in the wrong quantities of commodities arriving in-country. As external funding sources have their own stipulations and requirements, proper management and coordination of funders requires significant capacity within MOHs. A common illustration of this complexity is shown in Figure 1, the Kenya wiring or 'spaghetti' diagram depicting flows of commodity funding and commodity supply chains within a single country's public health context (Aronovich and Kinzett 2001).

Figure 1. Kenya Wiring Diagram of Commodity Funds



Wastage of donated commodities can also occur through poor coordination, inefficient systems, ineffective management, and corruption. In numerous documented instances, original funding commitments do not result in the intended commodity quantities at the service delivery level or even the national level. Poor supply chain performance and lack of accountability lead to problems with forecasting (see above) and poorly executed procurement processes or corruption can lead to higher-than-average commodity unit prices (Management Sciences for Health 2012).

Known solutions – Procurement and funding for commodities

Establishing global and regional pooled procurement mechanisms helps to reduce country-level procurement problems by moving them upstream (Dickens 2011). Given the similarity in national health program commodity requirements across countries and the collectively large quantities of demand represented by these programs, establishing and using mechanisms for pooling requirements offers several valuable supply chain benefits. The mechanisms provide national programs with access to established supplier relationships that adhere to prequalification requirements and provide pooled information and more reliable payment to suppliers. Examples include Supply Chain Management System (SCMS) for HIV and AIDS commodities, and the Pan American Health Organization's (PAHO) regional revolving fund for vaccines and related commodities (PAHO 2011).

Fulfilling and consolidating country orders through regional distribution centers produces similar desired effects. Several international initiatives have developed regional distribution centers to reduce procurement lead times in the face of country-level demand variability and to consolidate international shipments to reduce transport costs. SCMS, for example, has established three centers "to support global pooled procurement and reduce turnaround for antiretroviral drugs (ARVs)," which as independent commercial entities are also able to handle shipments for private-sector clients (SCMS 2012).

Establishing global stock monitoring efforts can improve understanding of country-level demand and supply situations and enable manufacturers to better plan production, lower prices, and improve global availability. These efforts can complement or be included in pooled procurement mechanisms and can also provide rapid response to pending stock shortages within a particular country. One example includes the Procurement Planning and Monitoring Report (PPMR), maintained by the Coordinated Assistance for Reproductive Health Supplies group of the Reproductive Health Supplies Coalition (USAID | DELIVER 2010).

Establishing new pricing mechanisms includes direct negotiation between suppliers and a third party and can reduce prices globally. Examples include the Accelerating Access Initiative for ARVs, the Affordable Medicines Facility for Malaria (AMFm) for artemisinin-combination therapies, and the Clinton Health Access Initiative (CHAI), which has achieved cumulative price reductions of 60 percent for pediatric ARVs (Dickens 2011).

NTD Perspective – Procurement and funding for commodities

NTD program drug procurement is largely driven by donation commitments made by large pharmaceutical corporations that plan and implement global production and distribution based on aggregated country data provided by the WHO or a coordinating program such as the International Trachoma Initiative (ITI) for Zithromax®. In some cases, implementing partners serve as procurers using bilateral funding. Regardless of who is brokering the orders with the pharmaceutical companies, both the manufacturers and the neglected tropical disease control programs (NTDCPs) face challenges with lengthy lead times and the need for adequate notifications. Additionally, the multiplicity of commodity sources can complicate the coordination process for over-burdened in-country staff.

With large commitments from pharmaceutical manufacturers and the intention to eventually scale down the need for NTD drugs for MDA, some country-level procurement challenges do not apply to NTD programs the way they might apply to other health programs with no prospect for near-term elimination. Essential medicines and family planning programs, for example, require longer-term country-level capacity. Long lead times, large shipments, and issues of coordination between country and global-level partners are issues shared between NTD and other disease control programs. Improved forecasting may be the basis for improved global level planning and responsiveness.

Storage

At certain points along the last mile supply chain, health commodities must be physically stored in order to be available for order fulfillment. Proper storage "ensures the physical integrity and safety of products and their packaging … until they are dispensed to clients" and protects commodities from damage, theft, and exposure to harmful temperatures (USAID | DELIVER 2011 [handbook]). For routine systems, the total storage requirement depend on the network structure (the number and location of storage tiers), the inventory control rules for those particular commodities (see section on information systems and inventory management), and special handling requirements such as cold storage. Many medicines in liquid or tablet form require storage at temperatures below 30° or 25°C, which in tropical climates can be difficult to maintain without air conditioning.

Central and intermediate-level warehouses are generally responsible for storage and order fulfillment for a large quantity and wide range of commodities. SDPs store fewer commodities and are usually not responsible for filling orders. Because campaigns are seasonal and have short-term order fulfillment requirements that may skip levels in the storage network, the NTD medicines require adequate and proper storage to protect commodities from damage and theft and to support staging of distribution.

Common challenges among non-NTD program supply chains

For many programs—both campaign and routine resupply—there is an insufficient quantity of **quality storage space**. Products stored in undesirable conditions because of a lack of suitable facilities can be found at all levels of the system. Within the public sector, dedicated medicine warehouses may be too small to hold current volumes of commodities, in a state of general disrepair, or may not be well designed as modern warehouses. Even when CMSs have sufficient capacity, lower levels of the health system may use buildings without power or with leaking roofs because they lack funds for refurbishment. Non-adherence to basic guidelines also affects product quality. Even in instances where infrastructure is sufficient, warehouse staff must adhere to basic storage guidelines. At lower levels of the health system where there may not be dedicated space for commodity storage, staff may not be aware of these standard practices and therefore inadvertently expose products to risky conditions.

This problem can be exacerbated when poor forecasting results in a commodity overstock. During an assessment in Ghana, for example, the central medical store was holding millions of units of a particular contraceptive that was not being requested by regional stores. This forced the CMS to use a semi-exposed shipment staging area to store the contraceptive. Also, at the regional level, inefficient design of several locations led commodities to be stored outside or in small rooms without temperature control (Ghana Warehouse Assessment 2013).

Cold storage capacity can also be problematic. Many vaccines and oxytocin must be kept well below ambient temperature, usually between 2-8°C (UNICEF 2014) in order to maximize their shelf life. As an added complexity to normal storage requirements, cold storage requires dedicated equipment and a constant power source. This requires up-front equipment investments, ongoing maintenance, and coverage of fuelling expenses. Vaccines are facing the challenge of new technologies and increased coverage, which require countries to hold larger volumes of vaccines and provide sufficient cold storage (Dicko 2008).

For all programs, **the public sector supply chain infrastructure may be designed to mirror the health system administration** rather than designed for supply chain performance optimization (desired service levels for minimum costs). A traditional public sector distribution system in developing countries includes a CMS as a central-level storage and distribution organization designed to support national availability of health commodities (Vogel and Stephens 1989; Yadav, Tata, and Babaley 2011). The CMS receives deliveries from national and international suppliers and fills orders for regional (or other sub-national) medical stores. These regional stores in turn provide a similar service to district stores, which in turn fill orders from SDPs (MSH 1997). This kind of approach draws on the predominant political and health system administration structure, and assumes that each level in the health administration has a role in placing orders, receiving and storing commodities, and filling orders to the next level of the system. This may not always be an optimal arrangement for the supply chain, however.

Public ownership and management of storage facilities inhibits efficient accommodation of seasonal fluctuations in commodity volume. If public health supply chain storage capacity is publicly owned, as is often the case, the system cannot accommodate short-term fluctuations in commodity volumes efficiently. A single warehouse may have been built, staffed, and equipped to handle a particular level of commodity throughput, but if throughput suddenly rises above that capacity, the public sector may have difficulty drawing resources to properly handle it. Additionally, when throughput is low, the public sector may not have sufficient flexibility to repurpose unused capacity. This means that sometimes there is empty space and underemployed staff, while at other times—during campaigns, outbreaks, or when shipments are poorly planned—commodities may be stored improperly in unsecure locations.

Inefficient processes for order fulfillment are also a challenge. Many storage locations still employ manual processes for receipt, put-away, and order picking and packing. These approaches increase staffing requirements and order-fulfillment lead time and can lead to mismanagement of inventory within the warehouse. Even if a location has a warehouse management system, it may not be fully implemented or used to their potential. The use of public management and resources for warehousing operations (as in the case of NTD programs' use of CMSs) may contribute to process inefficiency and overall poor performance ("Drug Supply Choices, What Works Best?" 1998).

Proper disposal practices may be absent or not followed. Compounding other storage problems is the frequent lack of processes for collection and disposal of expired or unusable commodities. Because commodity expiry is a visible supply chain failure, warehouse staff in the public sector may prefer to avoid official declaration and disposal of expired goods even if it means dedicating warehouse space to store them.

Known solutions – Storage

Many partners **build or refurbish warehouses** for the host government to operate. This offers a direct mechanism for funders to address fundamental issues such as lack of warehousing capacity or quality. Particularly for ARVs, funders of commodities have been aware of the limitations of in-country storage capacity and have sponsored warehouse construction, refurbishment, and warehouse management capacity building.

Partners have also **outsourced** storage to the private sector. As long as operational funding and contract management capacity are sufficient to maintain a contract and local private sector capacity is available, outsourcing warehousing offers many advantages. Commodity funders can quickly gain access to high-quality storage space under effective management, and can more efficiently handle fluctuations in storage requirements.

Interviewee Craig Usswald (Specialist Leader, Deloitte Consulting LLP) sees containerization as a potential solution for temporary storage for NTD drugs. A lockable shipping container between 20-40 feet would allow a surge in commodities to not disrupt the existing processes. This would be similar to practices in malaria indoor residual spraying. Treatments are seasonal, thus equipment must be mobilized rapidly at a specific time of the year. When the campaign is over, the container can return on the back of a flatbed truck.

Other CMS-alternatives include commodity funders and country governments channeling their commodities through a competing or complementary central store; bypassing the central level entirely by introducing non-public sector CMS management; or privatizing the CMS completely (Watson 2013). Verticalized commodity funding streams and program management sometimes use parallel distribution networks, which allow external funders to have distinct capacity and processes to support their commodities. In Sudan, for example, GFATM commodities have been stored and distributed outside the main public system using a parallel system. These instances may also include distinct data collection and information systems. Several countries have tried product integration, which is a process of merging parallel systems to improve coordination and reduce redundancy.

Maeve Magner (Independent Consultant) advised that given the short-term storage requirements, pharmaceutical organizations or their in-country partners could be asked to provide storage space at no cost. She cites GlaxoSmithKline, Pfizer, and Merck Serono as organizations that currently have facilities in-country or work with regional and local distribution partners that have storage facilities in southern, East, and West Africa.

Network optimization is a quantitative approach to identifying a network structure that achieves desired performance at the lowest cost. While public health supply chain networks traditionally follow administrative structures (see above), network optimization ideally identifies the minimal amount of storage locations and tiers necessary to fulfill demand requirements. Under this approach, stakeholders identify a storage network design that greatly reduces requirements with minimal need for new construction (PATH 2012).

While also a distribution approach, **cross-docking** is a storage method that uses locations to receive shipments of pre-packed orders for lower system levels and makes shipments available to the lower level sites immediately. For example, instead of holding commodities at district storage facilities and filling orders for SDPs, a cross-docking approach would fill the SDP orders at a higher level and deliver them pre-packed to the district. This reduces the need for product storage at the cross-dock level and shifts order fulfillment responsibility to a more centralized level. This has been applied in Zambia and Tanzania and could apply to NTD programs that have predetermined lower level requirements.

Related to cross-docking, **international pre-packing** of district-specific commodity requirements could take advantage of regional order fulfillment in a way that minimizes disruptions to a recipient country's central level. As suggested by interviewees, once the pre-packed orders arrive at the port of entry, they can be briefly staged at a warehouse before being distributed to lower levels of the system. This approach is used for malaria bednet campaigns. This approach would, however, place additional requirements on global partners.

An interviewee also suggested that **shipping containers** could serve as mobile temporary storage units. To minimize storage disruptions at lower levels of the system, shipping containers could be filled and serve as temporary storage units at the central level during a campaign, and be recollected when the

campaign ends. The containers could also include inventory management systems and records that travel along with the commodities.

NTD Perspective – Storage

The current trend in drug supply for NTD programs is toward increasingly large and integrated (single) shipments of NTDs drugs received annually by Ministries of Health. This can lead to a spike in central-level storage requirements, followed by a similar spike in storage capacity requirements at lower levels of the system. Some countries have employed ad-hoc storage solutions to alleviate problems such as overflow at MOH or contracted warehouses. This is an important consideration since central- and district-level storage facilities will have to identify and make adequate storage space available.

Like other health programs in developing countries, a lack of suitable storage space affects NTD programs. However, in the case of NTDs, the seasonality of capacity requirements renders the shortage time-bound. This factor, combined with the fact that NTD volumes should diminish within the relatively near future, implies that building new facilities is not an ideal approach. Contracting space at the central level, along with contracting or construction of temporary storage units at the district level might prove more cost-effective. Alternatively, if a different program has opposing seasonality, that program could share storage space with NTDs. Another possibility would be to secure donated or discounted space from private distributors or drug wholesalers affiliated with the international manufacturers that donate the commodities.

Commodity Transport

Physical movement and delivery is required for commodities to reach SDPs. For most commodities, the initial point of receipt within the public sector is a warehouse rather than an SDP, meaning that the commodities must be packed and physically moved to intermediary storage sites before being transported to their final destination. Transport capacity requirements across country programs vary based on total volume to be distributed, number and dispersion of SDPs, and the challenges of physical terrain including seasonal flooding and poor road quality, especially in remote areas.

Common challenges among non-NTD program supply chains

Inadequate and poor-quality infrastructure (including cold chain) is common to many programs. Many countries in sub-Saharan Africa have limited road infrastructure, making physical movement of goods challenging. Worldwide, an estimated 1 billion people lack access to all-weather roads, meaning that those communities are difficult to reach from commodity resupply points for at least some portion of each year (World Bank 2008). Compounded by the lack of infrastructure, physical distance and terrain challenges can make some facilities inaccessible.

Even when transport assets are available, **poor maintenance practices** and fleet management (including scheduling, routing, and driver management) reduce the delivery capacity at facilities responsible for transport operations. Harsh operating environments necessitate routine maintenance and servicing of vehicles, but capacity and operations funding for this can be lacking within the public health supply chain. The result is that many locations with transport responsibility possess vehicles that are prone to breakdowns and idle for much of a given working month. A related challenge is that when vehicles are publicly owned, local politicians are liable to commandeer these during election cycles or other public functions, preventing them from serving their intended purpose.

Rapid fluctuations in commodity volumes for distribution, as in the case of campaign-based programs, lead to inefficient use of owned assets. In a similar way to storage, the peaks and troughs of point-in-time commodity volumes for distribution are difficult to accommodate with owned vehicle assets that are generally dedicated to a single purpose. A sudden increase in delivery requirements may cause delays, while at other times the vehicles might be under-used.

Many systems require SDP staff, including primary health care clinicians or CHWs, to pick up their commodities from their resupply point. This presents several problems. Clinical staff are not able to provide health services when they are away from the facility; they are not necessarily allocated funding to travel to their resupply point; and small rural clinics do not usually have the ability to service vehicles.

Known solutions – Commodity transport

Health sector funders may **procure and allocate trucks** to support commodity transport for public sector programs. Designing and implementing fleet management systems can also improve use of existing resources. Technical assistance can introduce SOPs, tools, and information systems to help staff meet transport performance goals (Transaid 2008).

Redesigning the storage and distribution network can help achieve maximum performance efficiency through use of network analysis (see above). Network and transport optimization exercises can be used to identify the network structure, resupply point service areas, resupply frequencies, and static routes that deliver the lowest average cost to the system. This can help guide partner investments and network design to make the best overall use of assets and capacity.

Similar to storage outsourcing, transport **contracting** can help the public sector rapidly achieve improved service levels. With availability of public-sector contract management capacity, private sector partners, and secure funding, the public sector can outsource transport entirely or use smaller contracts to supplement capacity shortages or to handle seasonal peaks. In the 1990s, Bangladesh's Directorate General for Family Planning contracted 20 percent of the program's distribution requirements to private providers. By allowing public-sector transport staff to retire without replacement, this gradually increased to 80 percent. Through this approach, the directorate general saw service and efficiency improve and costs decline by 25 percent (USAID | DELIVER 2010). As with outsourcing of storage or any service contract, successful execution of the contract requires ongoing communication and dedicated

oversight by a contract manager. For an outsourced distribution system for vaccines in South Africa, the appointment of a contract manager markedly improved communications between the service provider and health system and allowed for joint forecasting and discussion of operational challenges (PATH and WHO, 2011).

Finally, **direct delivery** to the service delivery-level from a resupply point can help reduce overall transport requirements. In instances where clinical staff pick up their commodities, a more centralized transportation approach could lower total transport costs, introduce better management control, and reduce the logistics burden on clinical staff (USAID | DELIVER 2011).

NTD Perspective – Commodity transport

Similar to storage, the transport requirements of MDAs for NTDs are not year-round. This implies that renting makes more sense than purchasing a new vehicle that would be used for other purposes for long periods of time, placing the integrity of the vehicle at risk. In some countries, however, the capacity of private transport providers may be limited in rural areas. An NGO or external contractor might be able to rapidly scale-up capacity and scale back down or spin off as a private entity once NTD campaigns are no longer occurring.

NTD program distribution transport challenges, like those for storage, are linked to the short, sharp demands of annual MDA campaigns. MOH systems are oriented to routine delivery and are often not flexible enough to accommodate annual campaign commodities. Furthermore, relatively new NTD programs may be lower priority than larger, better established and resourced MOH programs. This leads to ad-hoc solutions that range from specially-funded arrangements with CMSs to identifying and contracting commercial transporters for use of their trucks.

Funding for Routine Operations and System Strengthening

The net sum of the operations involved in procuring, receiving, and distributing health commodities from the central level of the public health system to the SDPs is significant. As a percentage of total value of commodities handled, an average figure for developing countries can be 16 percent, while individual programs and countries can experience much higher average costs for challenging delivery environments or for relatively inexpensive but bulky commodities (Yadav 2011). Successful execution of operations depends on the ability to fund routine direct variable costs such as fuel, asset maintenance, and salaries. Failure to cover these costs can interrupt distribution. Funding for system strengthening serves as an investment to support performance improvement or increase capacity. This can include any number of expenses, such as development and implementation of information systems, warehouses, vehicles, staff training, and computers for management activities (Lalonde and Pohlen 1996).

Common challenges among non-NTD program supply chains

Local partners may have a poor and/or incomplete understanding of supply chain costs, and therefore have a tendency to under-budget. Supply chain operations can often be behind-the-scenes, and generally the funding for operations has not increased in line with commodity funding. This means that many countries are handling greater quantities of commodities with the same annual budgets. Furthermore, last mile supply chain operations may be executed and funded by multiple levels of administration or contained within broader budgets such as health sector staffing, meaning that no single entity has a clear perspective of total supply chain costs. In the case of assets, the lack of accounting for depreciation leads to use of assets long past their economic working life and an inability to directly fund new major purchases. Additionally, some significant costs may occur as out-of-pocket expenses. For example, clinical staff may pay taxis or couriers out of their own pocket or out of general cash funds at the facility to collect commodities from their resupply point.

Public health supply chains generally lack dedicated budgets for operations and have unclear future funding situations (Yadav 2011). Supply chain operations at the lowest levels of the system are often overlooked and rarely have dedicated budget sources. Funding for operations instead comes from broader health sector budgets or drug revolving funds. This produces a risk of funds being diverted—a particular problem during election cycles. Additionally, the lack of dedicated budgets and the bureaucratic timeline for payment processing hinders the public sector's ability to outsource and discourages private partners from bidding on work.

Known solutions – Funding for routine operations and system strengthening

Partners can conduct **supply chain costing** to determine point-in-time total costs, average costs, and cost drivers to support efficiency improvement efforts and advocate for increased operations funding. Using activity-based costing approaches and analysis of current accounts and LMIS data, stakeholders can gain a perspective of total direct and economic costs of their supply chain as well as the relative influences of those costs. With this information, partners can advocate for improved funding or identify ways to improve efficiency (Lalonde and Pohlen 1996).

Alternatively, **privatization** of public operations (Govindaraj and Herbst 2010), or efficiency improvement efforts can help drive costs down. Privatization of public health supply chain institutions such as CMSs can introduce improved revenue streams and improved effectiveness of expenditures. Reduction in last mile supply chain redundancy in the form of parallel operations can reduce total supply chain costs and improve utilization of assets.

NTD Perspective – Funding for routine operations and system strengthening
NTD programs have benefitted from the global NTD community focus on making NTD drugs available to country programs in ever-increasing quantities and efficiencies. However, there has been less attention paid to the challenges and resource requirements for ensuring that the drugs received in-country are distributed efficiently. Once in-country, the NTD drugs are both owned by and are the responsibility of the MOHs, typically with minimal outside support for distribution.

Country distribution requires funding for operations, particularly if private sector partners are to be involved. NTDs could benefit from advocacy efforts among potential funding sources for stable operations budgets or funding streams that sometimes accompany donations of commodities in the form of a handling fee paid to CMSs. Because there are various approaches to determining the basis for and assessing handling fees, relevant partners should be involved in negotiations and decision-making.

Leadership and Governance

Effective supply chain management requires strong leadership to instill trust among partners, establish joint goals to improve alignment, and provide dedicated management and oversight. Public health supply chains are no exception to this, given the multitude of stakeholders responsible for supply chain activities. Given the trends towards integrating vertical health program supply chains and reduction in redundancy, public health systems require supply chain managers who can monitor performance, advocate for resources or policy changes, and support health system strengthening efforts.

Common challenges among non-NTD program supply chains

Lack of trust and coordination among partners for forecasting, purchasing, and distribution (Dowling 2011) can be a particular problem when multiple programs and partners are brought together to manage operations jointly. Staff at various health programs and agencies as well as the different levels of government may not completely trust one another, which can manifest as parallel and uncoordinated forecasts, parallel distribution capacity, and resource hoarding.

Misalignment of partner objectives. Supply chains perform best when the individual entities that make up the supply chain are jointly oriented toward a common goal such as value to the end consumer. However, in the case of public health supply chains, partners may work toward individual goals without consideration of the overall environment. Performance monitoring may be focused on internal operations and financial elements rather than total supply chain performance.

Known solutions – Leadership and governance

Institution of logistics management units (LMUs) is one supply chain leadership solution (see section on information systems and inventory management for a description of LMUs). Typically these units have responsibility for oversight of LMIS data and coordination of stakeholders for important efforts such as quantifications and system redesigns. They typically do not have a health program focus, and instead serve as counterparts to external development partners supporting the public health supply chain (USAID | DELIVER 2010). LMUs are able to provide relatively objective technical and managerial oversight and serve as stewards of the public health supply chain.

Establishing supply chain master plans can help align partners. Supply chain master plans include the development of a common vision for the public health system and an agreed-upon medium-term approach for reaching that vision. The effort helps to align stakeholders to common goals and metrics. Ethiopia's public health supply chain has followed a supply chain master plan since 2006.

Active risk management can help supply chain leadership improve understanding of threats to achievement of performance goals. Collaborative identification of relevant risks to the supply chain, as well as their likelihood and impact of occurrence, can give stakeholders a sense of which risks should be monitored, mitigated, or avoided.

NTD Perspective – Leadership and governance

In terms of leadership and governance, the individual NTD disease programs have historically been implemented vertically. Each country generally has an umbrella NTDCP, yet vertical programs also exist for LF, trachoma, soil-transmitted helminthes (STHs), schistosomiasis, and onchocerciasis. In many contexts integration is more aspirational than reality. As a result, the NTDCP may advocate for a fully integrated NTD drug supply chain but this may not be the plan or wish of the constituent programs.

MDAs can likely perform more cost effectively if last mile logistics efforts are coordinated to pool resources where it makes sense. LMUs, where they exist, could provide this coordination effort between central and lower level partners to communicate timing and identify capacity gaps. Multiple interviewees emphasized the need for this type of planning to tap existing capacity and execute MDAs.

Partners should also advocate for NTD representation at supply chain master plan development initiatives to ensure that the program's logistics requirements are not overlooked.

Finally, interviewees agreed that in general the MOH or NTD program should provide the overall leadership or stewardship of the NTD supply chain, even if operational execution is conducted by external partners.

Applying Proven Supply Chain Practices to NTD Programs

Several decades of public health supply chain strengthening in developing countries has produced significant improvements at the country and global levels, as well as a number of promising practices that have not yet gone to scale.

Not surprisingly, progress across countries and health programs within countries is not uniform. Economic development has grown at different rates resulting in varied amounts of external assistance being awarded for health supply chain strengthening. Research findings on challenges and solutions reflect these funding patterns—more assessments and evaluations have been conducted and more interventions have been implemented within family planning supply chain systems than for TB systems, for example. Therefore, the quantity and public availability of documentation on these efforts reflect the funding patterns and number of organizations with mandates and support to evaluate interventions and publish findings.

Many of the historically common approaches presented here also potentially reflect continuation of solutions that were first successful for a limited range of commodities when local infrastructure was even less reliable. Any potential solution must be considered in terms of current local resource capacity and available technologies.

Finally, the challenges presented here are common to many developing countries, but they are not universally applicable. Individual countries face unique challenges based on characteristics such as educational system, geography, infrastructure, political system, and conflict or post-conflict status. As a result, country health program supply chains perform at varying levels of proficiency and have different levels of supply chain process maturity (McCord 2011). Because of variability among countries, interventions and supply chain strengthening solutions that are considered applicable to NTD programs should be selected carefully.

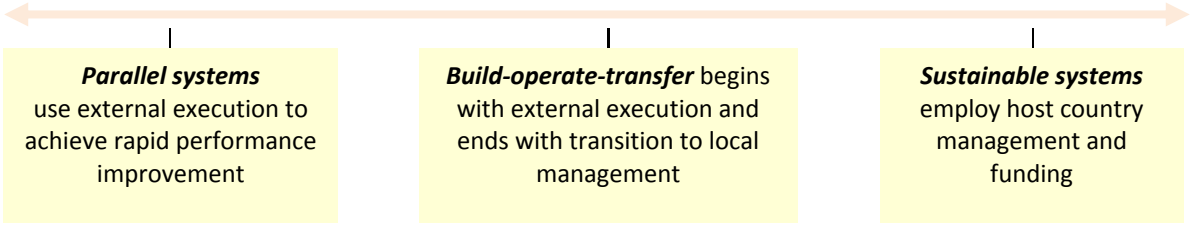
The ‘NTD Perspective’ boxes above enable the contemplation of these potential interventions, pioneered via non-NTD programs, from the standpoint of each supply chain functional component. In this way, it is possible to focus on overlaps that exist between NTD and non-NTD programs, determining effective ways to synergize and “piggy back” appropriately on existing mechanisms. It is also important to be mindful of key differences. Though the global development community has spent years scaling up and refining programs for non-neglected diseases and it would be remiss to negate the encyclopedic body of evidence it has built, in many cases it may not be prudent to apply certain approaches to NTDs. For example, NTDs are uniquely focused on near-term elimination and generally operate only once a year, thus there are no “one size fits all” methods. Key informant interviews, excerpted above, substantiate these notions and lend expert insight into the feasibility of applying non-NTD approaches to NTD initiatives.

Key Considerations for Identifying Appropriate Solutions

Imagine scenarios where public health systems don't procure and distribute commodities effectively. In one case, a system lacks infrastructure and operating funds to execute activities. In another, there is a lack of technical capacity to manage programs according to best practices even though there is sufficient funding. If an external funder were to try to improve these situations, a critical strategic decision would be whether to hire international or local private-sector capacity to establish a "parallel" system or to invest in strengthening the existing system, either independently or with support from external advisors and contractors.

Many potential solutions presented in this document fall somewhere along the continuum exemplified by these scenarios. Several factors, such as the level of trust between a host government and an external funder, affect conciliation between these two extremes. Most often, decisions are determined by the external funder and the host government's degree of emphasis on "sustainability" for the solution. In some cases the supply chain in question is supporting a critical but potentially temporary health need or aggressive morbidity reduction target (e.g. malaria treatment). In other cases, the supply chain supports a routine health service that will be provided for the foreseeable future (e.g., family planning, essential medicines). In the former case, establishment of privately managed and externally-funded delivery channels allows stakeholders—or most specifically, the funder—to rapidly achieve their objectives with reduced risk but little likelihood of sustainability once external funding is no longer available. In the latter case, long-term success is the objective, although progress can be slow and subject to disruption. Figure 2 depicts this continuum. Somewhere between the two extremes might be the "build-operate-transfer" approach, which is characterized by a mutually-agreed timeline that begins with externally managed improvements and ends with transition to host country management.

Figure 2. Continuum of Supply Chain Strengthening Intervention Sustainability



Interviewees for this paper suggested that in general, given the time-bound nature of the problem and the strong requirement for high performance, parallel systems would be a good fit for NTD MDAs. However, one interviewee suggested that a hierarchy existed, such that the first choice should be public-sector leadership and execution, and only if the public infrastructure and capacities could not be trusted should public-private partnerships and parallel systems be considered.

Following selection of a basic system strengthening strategy, supply chain stakeholders can identify solutions that respond to the system's capability requirements. Understanding the factors behind these requirements helps decision makers identify whether they need to build and operate highly responsive,

flexible supply chains—which might be the case for outbreak response support—or relatively efficient routine systems for services like family planning.

Support for NTD programs currently has a global orientation focused on the London Declaration's goals of controlling or eliminating several specific diseases by 2020. Under this approach, the assumption is that if this goal is achieved, countries will no longer have to dedicate the same scale of public health resources to this effort. Rapid scale-up of services, followed by rapid tapering-down after reaching targets suggests that stakeholders might be willing to consider prioritizing rapid program success over long-term sustainable system improvements, making NTD supply chains more similar to HIV and AIDS and malaria supply chains than family planning supply chains.

Given the characteristics of the targeted NTDs, control and elimination are pursued through MDAs organized by the public health system targeting specific diseases and locations based on disease prevalence rates. The following table is a characterization of country-level NTD supply chains according to the design factors adapted from Allain et al (2010). Design factors are the major drivers or influencers of supply chain requirements, and understanding them can help guide stakeholders' sense of how their supply chain should operate (and subsequently what changes need to be made). For example, a supply chain that delivers fresh fruit to set of 10 urban grocery stores will require a drastically different design than a system that distributes mosquito nets to rural communities across an entire country. Likewise, NTD supply chains have a common set of requirements that should be enumerated when considering potential strengthening efforts.

Design Factors	***Comparative Case of NTDs***	***Supply Chain Functional Component***
Commodity shelf life: Products with a short shelf life require shorter in-country pipelines (e.g., test kits, laboratory reagents).	***MEDIUM-TO- LONG***. In terms of the commodities themselves, most of the drugs have shelf lives of 3-5 years, although diethylcarbamazine (DEC) in capsule containers has a 2-year shelf life and does not require cold chain. This puts NTD commodities in line with many other essential medicines, meaning that short in-country pipelines are not necessarily needed, but a lack of stock status visibility can inhibit stock transfers and result in expiration of donated and purchased medicines.	Medical products, technologies, manufacturing, and design

Design Factors	*Comparative Case of NTDs*	*Supply Chain Functional Component*
Predictability of demand: Predictability of service demand is affected by the agreed package of routine services, the need to respond to disease outbreaks, periodic disease management campaigns, and incidence and prevalence of diseases and health conditions in the country. When service demand has low variability, simple inventory control systems can be used, and efficient distribution (as opposed to flexible distribution) can be pursued.	***HIGH***. Although poor-quality data for determining demand reduces predictability of required quantities, the fact that campaigns are planned and fluctuations in capacity requirements are predictable draws a parallel between NTD supply chains and other programs that use campaigns, such as non-routine immunization programs and nutrition support programs.	Demand quantification including requirements forecasting and supply planning
Supply constraints: The length and predictability of supplier lead times influences when supply planning and forecasting must be completed. When local private sector suppliers can provide certain commodities, the public sector supply chain may not need to stock those commodities.	***VARIABLE, BUT OFTEN CONSTRAINED***. NTD supply chains are similar to other programs such as HIV and AIDS, malaria, and immunization programs that rely on international suppliers. NTD supply chains have been constrained by long procurement lead times, port clearance challenges, and improper supply planning. At this time, however, global supply is not considered a constraint.	
Seasonality of demand: When service demand has clear peaks and troughs, distribution requirements will similarly rise and fall, indicating a need for flexibility.	***HIGH***. On a seasonal basis, resources are mobilized to move commodities from the central level to health clinics and communities based on prevalence rates and treatment strategies designed to reach coverage rates in targeted communities.	
Commodity handling requirements: Commodity characteristics influence how they are handled in the supply chain. For example, some commodities require cool or cold chain support, while others are heat stable.	***FEW.*** NTD drugs do not have unusual handling requirements. Like most essential medicines they must be kept at moderate temperatures and away from harmful conditions.	Commodity transport
Accessibility of service delivery points: Prepositioning inventory may be needed when factors that are more or less predictable, such as geography, weather, and insurgency influence the ability to reach some facilities throughout the year.	***MIXED, BUT OFTEN CONSTRAINED***. MDAs are conducted in both urban and rural settings and each has unique constraints. However remote settings pose communication and transportation challenges that are minimized in urban settings.	Commodity transport

Design Factors	*Comparative Case of NTDs*	*Supply Chain Functional Component*
Priority of health service or "cost" of supply chain failure: Higher operating costs can be tolerated to achieve higher performance for priority, life-saving, or critical commodities (e.g., antiretroviral medicines).	***HIGH*.** Although many commodities are donated and most are relatively inexpensive on a per-treatment basis, the public health 'cost' of supply chain failure for NTDs is high. Having a campaign canceled or disrupted because of supply chain problems can result in missed targets and reversed progress toward disease elimination, effectively undoing previous effort.	Funding for routine operations and system strengthening /leadership and governance
Health system tiers supported: The size and location of health facilities influence the resources they receive. For example, the proportional distribution of resources per case treated would be more for a large urban hospital than a rural health post.	***PRIMARY AND COMMUNITY***. NTD supply chains are similar to community health supply chains and the supply chains for most disease programs. NTD programs must provide service at the primary and community levels, meaning that drugs must physically reach and information must be collected from what are often remote locations.	Leadership and governance

Promising Supply Chain Approaches and Interventions to Achieve London Declaration Goals

Given the findings presented in this paper, there is a strong likelihood that these general supply chain strengthening approaches will contribute to achieving London Declaration goals:

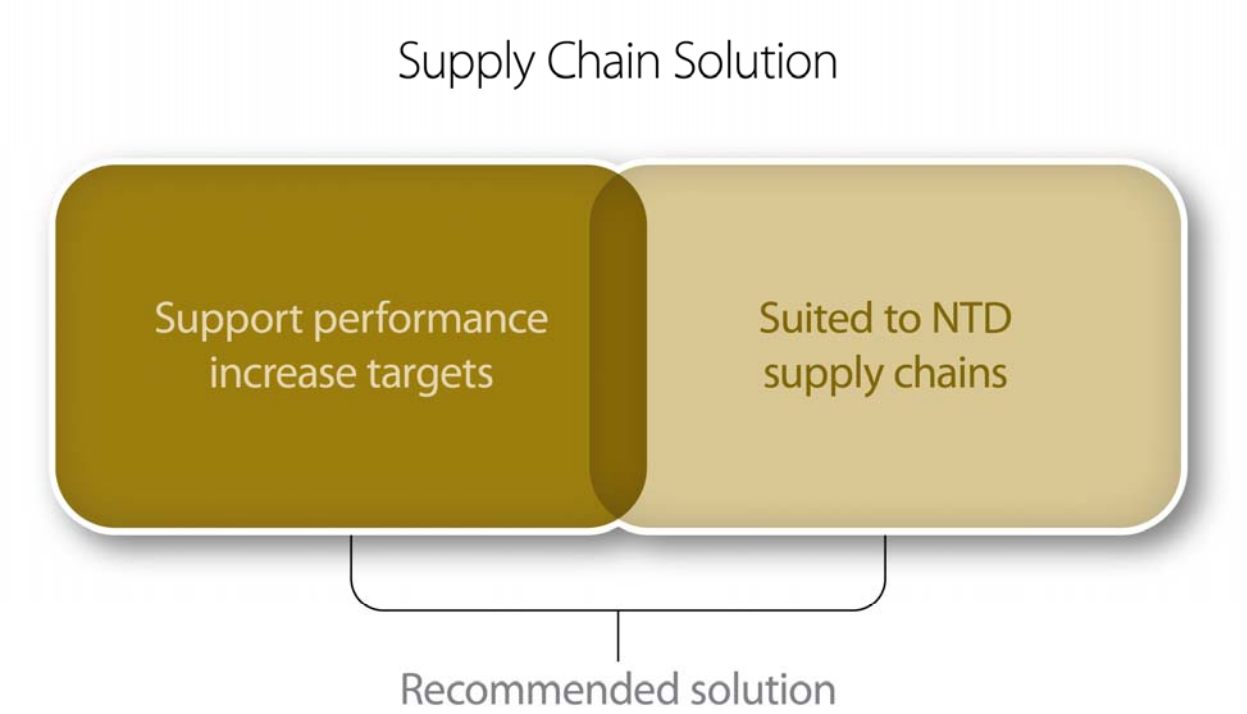
- **Emphasize rapid scale-up** of logistics system capacities to achieve performance goals instead of emphasizing sustainability of the supply chain solutions.
- **Mobilize cost-effective and adequate storage, transport, and commodity management capacity for MDA campaigns**. Identify the best use of public, NGO, and commercial capacities to mitigate bottlenecks and sustain the coverage rates to control and eliminate NTDs.
- **Reduce and sustain procurement lead-time variation** to ensure that MDAs are not delayed or canceled due to late receipt of commodities at the central level.
- **Expand visibility into stock status during campaigns** to quickly correct stock imbalances and ensure that drugs remaining after MDAs are returned to higher levels for re-programming. Consider rapid scale up of basic mHealth reporting using SMS messaging as a means to both improve the timeliness and utility of reporting.
- **Increase forecasting accuracy** by using stock information, particularly in-country stock balances.
- **Strengthen human resources** for NTD programs, recognizing that these programs rest on the shoulders of the volunteer cadre (CDDs) and front-line health worker (FLHWs). Most essentially, strengthen the design and implementation of cascade training; improve supervision and feedback loops (necessary for "mop-up" and reporting); invest in improving standard training

and reference materials appropriate for the literacy and training levels of FLHWs and CDDs; and conduct operations research on the most resource-effective ways to improve performance.

- **Optimize medical products, technologies, manufacturing, and design** to promote product quality and logistics management. In particular, improvements in packaging size should be considered for NTDCPs because large volumes of drugs are entrusted to the volunteers for handling and distribution. Bottles containing 500 and even 1,000 tablets lead to high levels of wastage when volunteers are poorly trained or unmotivated to return or reuse the remaining drugs after campaigns.

These approaches represent a selection of the general strengthening approaches known to logistics experts that should be considered for strengthening NTD supply chains. These approaches reflect the time-bound imperatives of the London Declaration as well as the specific characteristics of NTD supply chains and the general performance status of NTD supply chains globally (see Figure 3). Put another way, these approaches were selected for their potential ability to bring NTD supply chains from where they are today to where they need to be by 2020.

Figure 3. Supply Chain Solution



Drawing on the experience of non-NTD public health supply chains presented in this document, specific interventions have been identified to advance these approaches. Each intervention addresses one or more approach, linking known challenges with promising solutions as shown in Figure 4.

Figure 4. Supply Chain Interventions for NTD Programs

This compilation of interventions addresses the core supply chain strengthening approaches listed above. When implemented systematically, they have the ability to achieve lasting success for NTD supply chains.

Based on this analysis of the current state of non-NTD supply chains—both at global and national levels—these proposed solutions should be thoroughly considered for their potential to contribute to achieving the goals of the London Declaration, and to save lives in at-risk communities.

Annex A: Highlights from the history of public health supply chain strengthening

The current understanding of developing country public health supply chain challenges and solutions draws on decades of global experience. Since the establishment of Ministries of Health (MOHs), public health agencies, central medical stores (CMS), and drug revolving funds during the 20th century, developing countries have formalized the need for health commodities at service delivery points (SDPs), and subsequently the need for systems that support the availability of these commodities. In many countries, this capacity was drawn from public sector pharmacists and many of the systems themselves predate the conceptualization of logistics or supply chain management as distinct disciplines (Watson 2013). Over time, developing country governments have, to varying degrees, invested in strengthening their systems.

Over the past several decades, bilateral and multilateral development agencies have also invested in strengthening developing country public health supply chains. An immediate benefit was improved 'return' on the investment of health commodity donations by increasing the likelihood that commodities would actually reach the service-delivery level in a usable condition rather than suffer from one of many potential supply chain failures, such as poor storage, long country commodity pipelines, or failure to deliver the required products and quantities needed along the way (MSH 1997).

Over time however, these system strengthening investments also provided additional forms of value:

- Systems for reporting demand data allow for greatly improved forecasting, which reduces the likelihood of national shortages or overstocks.
- Generation and sharing of demand data improve timing of orders and production for the manufacturer, which improves asset use throughout the system.
- Formalization of record keeping and reporting on commodities improve transparency and discourage fraud and corruption.
- Knowledge of true commodity requirements empowers local stakeholders to advocate for commodity and operations funding.
- Availability of commodities at the SDP potentially supports population uptake of public health services.

For many years, donor agencies have supported specific requirements such as warehouses or information systems for commodity management, and they have also turned to multi-year supply chain development projects.

Public health supply chain strengthening partners leveraged developments in the commercial and academic sectors and began strengthening performance of the entire supply chain beyond the basic functional elements of data and delivery systems. Over time and with sustained investment, a public health supply chain passes through stages of process maturity, from an 'ad hoc' state in which processes and roles are not formally designed or documented to an 'organized' state in which individual functions

are executed according to SOPs and job descriptions. Looking across developing countries and health programs within a country at any given time, one can see a range of performance and process maturity that reflects the level and type of supply chain investment as well as other health system and country contextual factors.

Family planning programs in developing countries have received this type of formal external country-level support for several decades, beginning with the Family Planning Logistics Management project and continuing through its successor the USAID | DELIVER PROJECT. Over time, DELIVER also began to provide support for malaria control programs, HIV testing systems, TB systems, and outbreak response programs. In 2005, the PEPFAR-funded SCMS project began providing HIV and AIDS supply chain strengthening and support to countries. Additionally, the Global Fund to Fight AIDS, TB and Malaria has supported country-level supply chain strengthening typically directly to a principal recipient such as a host government agency.

Vaccine programs have also historically benefited from system strengthening projects. In 1974 the WHO launched the Expanded Programme on Immunization (EPI), which supported the country health systems responsible for scaling up coverage of six major vaccines. The GAVI Alliance was started in 2000 to improve coverage and provide support for the delivery of new vaccines. GAVI and United Nations Children's Fund (UNICEF) continue to provide system strengthening for vaccine supply chains at global and country levels (UNICEF 2014). Newer system strengthening projects for vaccine programs include the Bill & Melinda Gates Foundation-funded Project Optimize from 2007 to 2013. The United States Agency for International Development (USAID)- and CDC-funded Making Medical Injections Safer project provided health worker training and supply system strengthening using an end-to-end approach beginning with procurement of injection devices with reuse prevention features and ending with final disposal of used injection devices and equipment such as safety boxes.

In 2012, several bilateral and unilateral donors committed support for strengthening supply chains that deliver life-saving maternal, neonatal, and child health commodities through the UN Commission on Life-Saving Commodities under the Every Woman Every Child initiative.

Although these and other projects have provided support in overlapping technical areas, it should be noted that the level, location, and method of support have varied according to donor and host country priorities. The types of supply chain solutions implemented (and included in this document) reflect these factors as well as the nature of the commodities being handled and patterns of demand for commodities exhibited by the various health services.

References

Akhlaghi, L., Mwencha, M. & Printz, N. 2011. *Strengthening HIV/AIDS Commodity Forecasting: Factors and Considerations for Increasing Accuracy*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

Allain, L., Goentzel, J., Bates, J. & Durgavich, J. 2010. *Reengineering Public Health Supply Chains for Improved Performance: Guide for Applying Supply Chain Segmentation Framework*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

Aronovich, D. G. & Kinzett, S. 2001. *Kenya: Assessment of the Health Commodity Supply Chains and the Role of KEMSA*. Arlington, VA: USAID | DELIVER PROJECT.

Arvis, J., Mustra, M. A., Ojala, L., Shepherd, B. & Saslavsky, D. 2012. *Connecting to Compete 2012: Trade Logistics in the Global Economy: The Logistics Performance Index and its Indicators*. Washington, D.C.: The International Bank for Reconstruction and Development/The World Bank.

Cameron, A., Ewen, M., Ross-Degnan, D., Ball, D. & Laing, R. 2009. *Medicine Prices, Availability, and Affordability in 36 Developing and Middle-Income Countries: A Secondary Analysis*. The Lancet, 373(9659):240-249.

Chandani, Y., Noel, M., Pomeroy, A., Andersson, S., Pahl, M. K., Williams, T. 2012. Factors Affecting Availability of Essential Medicines Among Community Health Workers in Ethiopia, Malawi, and Rwanda: Solving the Last Mile Puzzle. *American Journal of Tropical Medicine and Hygiene*, 87 (5):120-126.

Cohen, J., Reeh, C. & Neroutsos, K. 2010. *Building effective, sustainable systems for procuring essential reproductive health supplies*. Seattle, WA: PATH.

Diack, A., Seiter, A., Hawkins, L. & Dweik, I. S. 2010. *Assessment of governance and corruption in the pharmaceutical sector: lessons learned from low and middle income countries*. Washington, DC.: World Bank.

Dickens, T. 2011. *The World Medicines Situation 2011: Procurement*. Geneva, Switzerland: World Health Organization.

Dicko, M. 2008. *Optimize: Immunization Systems and Technologies for Tomorrow*. Denver, CO: CSCMP Annual Global Conference.

Dowling, P. & Rosen, J. E. 2014. *Ghana Healthcare Supply Chain & Commodity Security Strategic Review*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 4.

Durgavich, J. 2009. *Customs Clearance Issues Related to the Import of Goods for Public Health Programs*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

Focus Regions Health Project. 2013. *Supply Chain Early Warning System for Commodities using Mobile Phone Technology Shows Promise*. Cape Town, South Africa: ICT for Development Conference.

Gilmore, D. 2011. "How many supply chains do you need?". Retrieved from: http://www.scdigest.com/assets/FirstThoughts/11-10-14_Supply_Chain_Segmentation.php?cid=5067 (accessed October 2011).

Govindaraj, R. & Herbst, C. H. 2010. *Applying Market Mechanisms to Central Medical Stores: Experiences From Burkina Faso, Cameroon and Senegal*. Washington, DC: World Bank.

Halfa, Wadi. 2013. Transport in Africa: Get a move on. Africa's Booming Economy Needs Modern Trade Routes. London, England: *The Economist Newspaper Limited.* Retrieved from: http://www.economist.com/news/middle-east-and-africa/21571920-africas-booming-economy-needs-modern-trade-routes-get-move.

Immunization Basics. 2008. *Cold Chain and Logistics Management: An Essential Part of Safe and Effective Vaccination Programs*. Snapshots, Volume 8. Arlington, VA: John Snow, Inc.

Institute for Reproductive Health, Georgetown University (IRH/GU), John Snow Inc. (JSI), and Population Services International (PSI) for the Reproductive Health Supplies Coalition (RHSC). 2012. *A Forecasting Guide for New & Underused Methods of Family Planning: What To Do When There Is No Trend Data?* Washington, DC: IRH/GU, JSI, and PSI for the RHSC.

Karim, A. M. 2005. *The Influence of Family Planning Logistics Systems on Contraceptive Use*. Arlington, VA: Arlington, VA: USAID | DELIVER PROJECT.

Lalonde, B. J. & Pohlen, T. L. 1996. *Issues in supply chain costing. International Journal of Logistics Management*. 7 (1): 1--12. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.197.5582&rep=rep1&type=pdf.

Management Sciences for Health. 2012. *MDS-3: Managing Access to Medicines and Health Technologies.* Arlington, VA: Management Sciences for Health.

Mansoor, O. D., Kristensen, D., Meek, A., Zipursky, S., Popova, O., Sharma, I., Mir, A, G., Millogo, J. & Lasher, H. 2013*. Vaccine Presentation and Packaging Advisory Group: a Forum for Reaching Consensus on Vaccine Productaattributes*. Bulletin of The World Health Organization, 91(1):75--78. Retrieved from: http://www.who.int/bulletin/volumes/91/1/12-110700/en/index.html.

PAHO. 2011. *PAHO Revolving Fund*. Retrieved from: http://www.paho.org/hq/index.php?option=com_content&view=article&id=1864&Itemid=4135.

PATH & World Health Organization. 2011. *Outsourcing the Vaccine Supply Chain and Logistics*
PATH Project-Optimize & World Health Organization. (2012). Building next-generation vaccine supply systems. PATH Project-Optimize & World Health Organization. [online] Retrieved from: http://www.path.org/publications/files/TS_opt_evm_hermes_fs.pdf.

PATH Project-Optimize & World Health Organization. 2012. *Cool Innovations for Vaccine Transportation and Storage.* PATH Project-Optimize & World Health Organization. Retrieved from: http://www.path.org/publications/files/TS_opt_cool_innov.pdf.

PATH. 2009*. Procurement Capacity Toolkit: Tools and Resources for Procurement of Reproductive Health Supplies.* Seattle, WA: PATH.

PATH. 2010*. Vaccine Technologies at PATH*. Seattle, WA:PATH.

Ramana, G. N., Chepkoech, R. & Workie, N. W. 2013. Kenya - Improving Universal Primary Health Care by Kenya: A Case Study of the Health Sector Services Fund*. Universal Health Coverage (UNICO) Studies Series*, No. 5. Washington, DC: World Bank.

Silve, B. & Ouedraogo, A. 2013. Professionalizing Health Logistics in Burkina Faso: Challenges, Implementation and Sustainability. *Public Health Research*, 3(6): 157-161.

Steele, P. 2013. What In-Country Public Health Supply Chain Factors Affect the Availability of Medical Products at the Service Delivery Point in Developing Countries: A Systematic Literature Review. Doctorate in Business Administration. *Cranfield University School of Management.*

Supply Chain Council. 2014. *SCOR*. Retrieved from: https://supply-chain.org/scor.

Supply Chain Management System (SCMS). 2012. *Six Years of Saving Lives Through Stronger Public Health Supply Chains: A Report on SCMS Contributions to PEPFAR Results*. Arlington, VA: The Partnership for Supply Chain Management.

Supply Chains 4 Community Case Management (SC4CCM). 2013. *Making Products Available in the Community: Update on SC4CCM's Key Project Learnings.* Arlington, VA: JSI Research & Training Institute, Inc. for the Bill & Melinda Gates Foundation.

Supply Chains 4 Community Case Management (SC4CCM). 2013. *Standardized Procedures Strengthen Community Level Supply Chain Performance in Rwanda.* Arlington, VA: JSI Research & Training Institute, Inc. for the Bill & Melinda Gates Foundation.

Supply Chains 4 Community Case Management. (n.d.). *Malawi.* Retrieved from: http://sc4ccm.jsi.com/countries/malawi.

System to the Private Sector: The Western Cape Experience in South Africa. Seattle, WA: PATH.

The 6th Global Health Supply Chain Summit, LOGIVAC: Development of a training program in Health Supply Chain Management. Philippe JAILLARD, AMP, November 18 -20, 2013. Addis Ababa, Ethiopia. Quoted Oct. 2006 at TFI Members Briefing, Harare. PowerPoint presentation.

The Global Alliance for Vaccines & Immunization (GAVI). 2005. *Scaling up Immunization to Meet the Millennium Development Goals (MDGs)*. GAVI. Retrieved from: http://rih.stanford.edu/kane/resources/GAVI%20and%20MDGs.pdf.

UNICEF. 2014. *Immunization*. United Nations International Children's Emergency Fund. Retrieved from: http://www.unicef.org/immunization.

United Nations Foundation 2013. *Amoxicillin Product Profile*. Retrieved from: http://www.everywomaneverychild.org/resources/un-commission-on-life-saving-commodities/life-saving-commodities/amoxicillin.

USAID | DELIVER PROJECT, Task Order 1. 2010. *Delivering Family Planning One Village at a Time: 20 Years of Supply Chain Work in Bangladesh*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

USAID | DELIVER PROJECT, Task Order 1. 2010. *Emerging Trends in Supply Chain Management: Outsourcing Public Health Logistics in Developing Countries.* Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

USAID | DELIVER PROJECT, Task Order 1. 2010. *Logistics Management Units: What, Why, and How of the Central Coordination of Supply Chain Management*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

USAID | DELIVER PROJECT, Task Order 1. 2010. *The Procurement Planning and Monitoring Report: Reducing Contraceptive Stockouts Through Data and Partnerships*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

USAID | DELIVER PROJECT, Task Order 3. 2009*. Improving Monitoring and Supervision at the Health Facility Level Through End-Use Verification and Mobile Technology*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 3.

USAID | DELIVER PROJECT, Task Order 4. 2011. *Using Last Mile Distribution to Increase Access to Health Commodities*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 4.

USAID | DELIVER PROJECT, Task Order 4. 2013. *Human Resource Capacity Development in Public Health Supply Chain Management: Assessment Guide and Tool*. Arlington, VA: USAID | DELIVER PROJECT, Task Order 4.

Village Reach. 2012*. Starting at the Last Mile: Rethinking Medical Supply Chains in Low Income Countries.* Seattle, WA: Village Reach.

Watson, N. & McCord, J. 2013. *Alternative Public Health Supply Chains: Reconsidering the Role of the Central Medical Store.* Arlington, VA: USAID | DELIVER PROJECT, Task Order 4.

World Health Organization. 2007. *Task shifting: Rational Redistribution of Tasks Among Health Workforce Teams: Global Recommendations and Guidelines*. Geneva, Switzerland: World Health Organization. Retrieved from: http://data.unaids.org/pub/Manual/2007/ttr_taskshifting_en.pdf.

World Health Organization. 2013. Drug Supply Choices: What Works Best? *Essential Drugs Monitor*. 25&26: 7-9. Geneva, Switzerland: World Health Organization.

World Health Organization. 2013. *World Malaria Report 2013 Shows Major Progress in Fight Against Malaria, Calls for Sustained Financing.* Retrieved from: http://www.who.int/mediacentre/news/releases/2013/world-malaria-report-20131211/en/index.html.

Yadav, P., Tata, H. L. & Babaley, M. 2011. *The World Medicines Situation 2011: Storage and Supply Chain Management*. Geneva, Switzerland: World Health Organization.