Facility-Level Practices and Behaviors That Affect Performance of the Antiretroviral Medicine Supply Chain

October 2014

USAID
FROM THE AMERICAN PEOPLE

SIAPS
Systems for Improved Access to Pharmaceuticals and Services

Facility-Level Practices and Behaviors that Affect the Performance of the Supply Chain of Antiretroviral Medicines

Diana M. Bowser
Angela Y. Chang
Thomas J. Bossert
David Mabirizi

October 2014

This report is made possible by the generous support of the American people through the US Agency for International Development (USAID), under the terms of cooperative agreement number AID-OAA-A-11-00021. The contents are the responsibility of Management Sciences for Health and do not necessarily reflect the views of USAID or the United States Government.

About SIAPS

The goal of the Systems for Improved Access to Pharmaceuticals and Services (SIAPS) Program is to assure the availability of quality pharmaceutical products and effective pharmaceutical services to achieve desired health outcomes. Toward this end, the SIAPS result areas include improving governance, building capacity for pharmaceutical management and services, addressing information needed for decision-making in the pharmaceutical sector, strengthening financing strategies and mechanisms to improve access to medicines, and increasing quality pharmaceutical services.

Recommended Citation

Bowser, D. M., A. Y. Chang, T. J. Bossert, and D. Mabirizi. 2014. *Facility-Level Practices and Behaviors That Affect the Performance of the Supply Chain of Antiretroviral Medicines* . Submitted to the US Agency for International Development by the Systems for Improved Access to Pharmaceuticals and Services (SIAPS) Program. Arlington, VA: Management Sciences for Health.

Key Words

supply chain management, antiretroviral, facility, HIV, behaviors, practices

Systems for Improved Access to Pharmaceuticals and Services
Center for Pharmaceutical Management
Management Sciences for Health
4301 North Fairfax Drive, Suite 400
Arlington, VA 22203 USA
Telephone: 703.524.6575
Fax: 703.524.7898
E-mail: siaps@msh.org
Website: www.siapsprogram.org

CONTENTS

ACRONYMS AND ABBREVIATIONS

AIDS	acquired immunodeficiency syndrome
AMC	average monthly consumption
ANC	antenatal care
APMR	AIDS patient medical record
ART	antiretroviral therapy
ARV	antiretroviral
CAPR	Centre d'Approvisionnement Pharmaceutiques des Regionaux
CENAME	Centrale Nationale d'Approvisionnement en Médicaments Essentials et Consommables Médicaux
CMS	central medical store
EDT	Electronic Dispensing Tool
FEFO	first expired, first out
FIFO	first in, first out
HIV	human immunodeficiency virus
IDU	injecting drug user
IMAI	Integrated Management of Adolescent and Adult Illness
LIAT	Logistics Indicators Assessment Tool
LMIS	logistics management information system
LSAT	Logistics System Assessment Tool
M&E	monitoring and evaluation
MOH	Ministry of Health
MOHSS	Ministry of Health and Social Services
MoSH	months of stock on hand
MRMD	Multi Regional Medical Depot
MSH	Management Sciences for Health
MSM	men who have sex with men
PA	Pharmacy assistant
PEPFAR	President's Emergency Plan for AIDS Relief
PMTCT	prevention of mother-to-child transmission
RMS	regional medical store
SCMS	Supply Chain Management System
SIAPS	Systems for Improving Access to Pharmaceuticals and Services [Program]
SOP	standard operating procedure
SW	sex worker
UNGASS	UN General Assembly Special Session
USAID	US Agency for International Development
WHO	World Health Organization

ACKNOWLEDGMENTS

The authors would like to recognize individuals from each of the study countries who assisted us in understanding the logistic systems for antiretrovirals in their countries and provided assistance in gathering all relevant data for the analysis. In particular, we would like to thank the Ministries of Health of Cameroon, Namibia, and Swaziland and Country Project Directors, Principal Technical Advisors, and other staff members within the SIAPS office from each of the MSH offices in the study countries. The authors would also like to recognize meeting participants at USAID and SIAPS who provided helpful comments and advice on initial drafts of this manuscript.

The contributions of the following individuals are appreciated:

- Albert Chinhenzva, Technical Officer, SIAPS Swaziland
- Alemayehu Wolde, Senior Technical Advisor, SCMS Namibia
- Aline Kane, Senior Technical Advisor, SIAPS Cameroon
- Benjamin Ongeri, Senior Technical Manager, SCMS Namibia
- Catherine Mentou Tadzong, Senior Technical Advisor, SIAPS Cameroon
- Evans Sagwa, Country Project Director, SIAPS Namibia
- Gashaw Shiferaw, Senior Technical Advisor, SIAPS Swaziland
- Gege Buki, Country Project Director, SIAPS Cameroon
- Greatjoy Mazibuko, Senior Technical Advisor, SIAPS Namibia
- Harriet Kagoya, Senior Monitoring and Evaluation Advisor, SIAPS and SCMS Namibia
- Helene Kabembo, Regional Pharmacist, Karas Region, Namibia Ministry of Health and Social Services
- Khontile Kunene, Senior Technical Advisor, SIAPS Swaziland
- Lazarus Indongo, Deputy Director, Division Pharmaceutical Services, Ministry of Health and Social Services
- Rauna Shitaleni, Regional Pharmacist, Oshikoto Region Namibia
- Sifiso Dlamini, Senior Supervisor, SIAPS Swaziland

EXECUTIVE SUMMARY

In an effective supply chain there are timely and efficient flows of information (on commodities and patients) and quality products between the supplying units (central and regional medical stores [CMS/RMS]) and the health facilities. Although much has been learned about how to measure, monitor, and improve supply chain performance for antiretrovirals (ARVs) at the central and regional levels, less has been done to identify and measure "downstream factors" at the health facility that have an impact on the performance of the "upstream" (central) supply chain indicators.

The aim of this activity is to identify and define facility-level practices that have an impact on the supply chain, determine how these practices are linked with central-level supply chain performance measures, and propose a methodology and study design for a rigorous, empirical study to understand and estimate the impact on the identified facility-level behaviors and practices and central-level supply chain performance. Linking facility-level practices and behaviors to the "upstream" supply chain measures will substantially support efforts to improve the performance of the supply chain, such as the accuracy of quantification and forecasting activities.

We used a primarily qualitative research methodology, which took place in five phases. Phase I was an in-depth literature review of the published and gray literature on practices, behaviors, and performance at the facility level that have an impact on performance of the supply chain, with a specific focus on HIV and AIDS products and health outcomes.

Phase II involved developing a study design to measure facility-level behaviors and practices in select countries. The purpose of the study design was to choose facilities with good and below-expectation performance in reference to supply chain management, in different regions in the participating countries, to understand how behaviors and practices at the facility level interact and influence upstream supply chain measures and outcomes. The sample of facilities included hospitals and health centers/clinics from regions and/or areas within each participating country that were considered "good performing" and those that were considered "below expectation" on a selected number of performance indicators. Phase III involved the selection of countries for the assessment and instrument development. Three countries were identified: Namibia, Cameroon, and Swaziland. Based on the literature review and protocols for management of HIV and AIDS patients in the identified countries, instruments were developed to identify the practices and behaviors at the facility level, such as dispensing and inventory management-related practices, that have an impact on the performance of the supply chain for HIV and AIDS programs. Phase IV involved one-week country visits in January and February 2014 that included in-depth interviews with key informants in each country to collect the data. Phase V involved an analysis and synthesis of the country level data.

As part of the synthesis of the country-level studies, the country-level results were used to develop two tools that countries can use to understand 1) how the 30 identified facility-level behaviors and practices link with upstream, central-level indicators and 2) the indicators and measures that are currently collected, or that can be collected, to measure the 30 facility-level

behaviors and practices. These two tools are outlined in Tables 9 and 10. In the recommendation section, the information in the tools (Tables 9 and 10) is used to propose the next steps that need to be developed and empirically measure the link between these 30 behaviors and practice and upstream, central level performance.

Upon conclusion of the interviews, the authors identified repeating ideas and categories that overlapped with the practices and behaviors identified in the literature review. Through this process we were able to identify trends, patterns, and outliers in each of the key practice and behavior–related areas using integration and triangulation to provide context to the results. Where possible, we used comparative cross-country case analysis, using results from the three countries to synthesize the findings into key conclusions based on patterns that emerged in the analyses.

Using the results of the in-country interviews, we identified 30 specific practices and behaviors that can be linked to "upstream" indicators of the performance of the supply chain of ARVs within the following seven supply chain function areas: forecasting and quantification, warehousing and inventory management, prescribing and dispensing, communication, information management, infrastructure, and human resources.

Of these 30 specific practices and behaviors, trends and patterns were found in the following 14 practice and behavior areas that could be associated with better performance in at least one country:

1) Calculation of min-max buffer stock (forecasting and quantification)

2) Use of national guidelines or training materials as reference (forecasting and quantification)

3) Order verification before submission to the central/regional level (forecasting and quantification)

4) Late ordering of medicines (forecasting and quantification)

5) Frequency of issuing emergency orders (forecasting and quantification)

6) Actions taken when stocks received from CMS/RMS (forecasting and quantification)

7) Control of access to stock (warehousing and inventory management)

8) Decision on whether to redistribute short-dated stock (warehousing and inventory management)

9) Location of storage (warehousing and inventory management)

10) Whether ARVs are stored separately from other medicines (warehousing and inventory management)

11) Communication with higher-level supply chain management (communication)

12) Communication with affiliated facilities (communication)

13) Training on stock management (human resources)

14) Implementation of policies on prescribing and dispensing (human resources)

Eleven of the 30 practices and behaviors exhibited ambiguous patterns. This meant that we were not able to link any specific pattern of behavior or practices, either within country or across countries, with performance of the facility. The variation in patterns for these behaviors and practices indicated that either no best practice has been identified, or if a best practice has been identified in this area, not all the facilities were following it. For these areas, we recommend that the literature be reviewed in detail and guidelines developed for countries and facilities. These 11 practices and behaviors were:

1) Assigning responsibility of inventory management tasks (warehousing and inventory management)

2) Frequency of balancing stocks (warehousing and inventory management)

3) Change in prescription during stock-out (prescribing and dispensing)

4) Change in dispensing during stock-out (prescribing and dispensing)

5) Actions to ensure patient adherence (prescribing and dispensing)

6) Communication within the pharmacy team (communication)

7) Communication within the clinic (communication)

8) Communication with hospital executives (communication)

9) Leadership/management style of the pharmacy (human resources)

10) Leadership management style of the clinic (human resources)

11) Attitude to workload of pharmacy staff (human resources)

For the remaining practices and behaviors, there was minimal variation within and across countries, so we could not make any conclusions with regard to how the practices and behaviors linked with performance. This does not mean that these practices and behaviors were not identified as important. On the contrary, as they were included in our list of practices and behaviors they were patterns that were noted with consistency across facilities. In most cases, the lack of variation was also an important result. For example, it was of importance that for most facilities the information was there to calculate order fill rate, but no facilities were actually

doing this on a regular basis. Most facilities were calculating order fill rate only for reporting purposes. The following practices and behaviors showed minimal variation across and within countries:

- Use of electronic systems (forecasting and quantification)
- Order fill rate (forecasting and quantification)
- Patient monitoring (prescribing and dispensing)
- Interaction between clinical and dispensing/stock systems (information management)
- ART clinic/pharmacy separate from main pharmacy (infrastructure)

Two important tools were developed based on the results above. First, while this study did not empirically measure the relationship between the above identified 30 facility level behaviors and practices and "upstream" central level indicators, Table 9 below hypothesizes the link between 19 common central level indicators and each of these 30 behaviors and practices listed. Future research is needed to determine the magnitude and relative strength of each of these relationships. Second, Table 10 outlines measurable indicators for each of the 30 identified facility-level behaviors and practices identified during the literature review or developed by the study team. Some of these measurable indicators, under the categories of forecasting, quantification, and warehousing and storage, are standard indicators that are readily available from existing reports and tools and are often used in various country studies on supply chain management. Since these indicators are already available across different facilities and different countries, an empirical study could be developed testing the relationship between specific facility behaviors and practices and some of the central-level indicators. For other categories, such as prescribing and dispensing practices and communication with internal and external teams, there are few indicators that are currently being collected that measure the facility-level behaviors and practices in these categories. Table 10 proposes indicators that can be measured to capture the facility-level behaviors and practices in these categories.

While the relationship between facility and central-level indicators was not empirically measured in this study, we believe improvements in these behaviors and practices would lead to better performance at the central level. The identification of these behaviors and practices as well as development of new indicators provide policy makers with new approaches to improve facility-level performance, such as offering trainings related to communication with internal and external staff, development of new guidelines on how to adjust prescribing and dispensing patterns during shortages, or limiting access to ARVs in storage to selected staff at the facility.

The findings and recommendations will be used in supporting interested countries in making the best use of scarce resources to improve the efficiency and effectiveness of supply chains. This will have a direct impact on the quality of service provision and health outcomes. Further research is needed to more precisely understand the degree of impact these behaviors and practices have on the "upstream" indicators of supply chain performance and to identify key practices which, once changed, can have a significant positive effect on supply chain performance. This study serves as a first step in narrowing the range of possible factors into a manageable list, and provides measurable indicators to facilitate future research.

BACKGROUND

The Systems for Improved Access to Pharmaceuticals and Services (SIAPS) Program, funded by the US Agency for International Development (USAID), builds on the achievements of the Strengthening Pharmaceutical Systems (SPS) Program by working to assure the availability of quality pharmaceutical products and effective services to achieve desired health outcomes. The program promotes and uses a systems-strengthening approach that will result in sustainable health impact. The SIAPS approach includes empowering local governments and organizations and increasing country ownership.

In an effective supply chain, there are timely and efficient flows of quality products and information between the supplying units (central and regional medical stores) and the health facilities. Although much has been learned about how to measure, monitor, and improve supply chain performance for antiretrovirals (ARVs), less has been done in terms of measuring "downstream factors" at the health facility that have an impact on the performance of "upstream supply chain indicators." Currently, there are no indicators of behaviors and practices at the facility level that have an impact on the performance of the supply chain and there is no system in place to measure and monitor performance based on these indicators or to tie them into a continuous process of an improvement cycle.

The purpose of this assessment is to identify and define facility-level practices and behaviors that have an impact on the performance of the supply chain, explore their linkage with central-level supply chain performance measures, and develop indicators for measuring and tracking these factors. Linking such measures to the "upstream" supply chain measures will substantially contribute to performance improvement of the supply chain, including the accuracy of PEPFAR quantification and forecasting exercises.

The findings and recommendations of this assessment will be used in supporting interested countries in making the best use of scarce resources to improve the efficiency and effectiveness of supply chains. This will have a direct impact on the quality of service provision and health outcomes.

METHODOLOGY

We used a primarily qualitative research methodology that took place in five phases.

Phase I

Phase I was an in-depth review of the published and gray literature related to practices and behaviors at the facility level that have an impact on the management and performance of the supply chain, with a specific focus on products for HIV and AIDS programs. We focused mainly on supply chain metrics in low- and middle-income countries, but also searched for management literature in business journals, which included sources from higher-income countries.

In the literature review, we first define facility-level supply chain management activities to be those related to managing inventory at the point of service delivery performed by prescribers and dispensers. These facilities include public or private hospitals, health centers and clinics/dispensaries, pharmacies, medicine shops, and other informal outlets. We also refer to indicators at this level as "downstream" indicators. This is in comparison with the "upstream" indicators, which may include central- and regional-level indicators for institutions such as the Ministry of Health and central/regional medical stores. Figure 1 shows how different levels are connected; in this literature review we will focus on the downstream indicators and the relevant upstream indicators that are used in monitoring the performance of the supply chain.

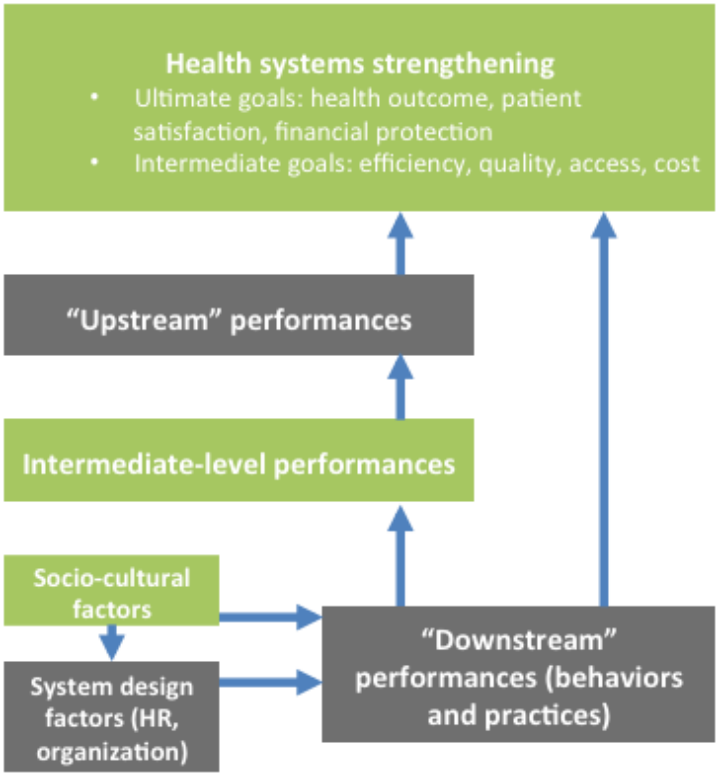


Figure 1. Mapping of indicators (gray: in-scope; green: out of scope)

The objective of the review was to identify indicators related to facility-level supply chain management performance and behavioral aspects, with a specific focus on the management of products for HIV and AIDS programs. While many reports and tools propose measurable indicators across various aspects of the supply chain, only a handful of research papers quantify the results of the assessments or seek to find causal mechanisms between indicators and performance. Our review began with a systematic literature search of published materials from the 1990s to 2013. PubMed, Web of Science, Google Scholar, and other available databases were used to search for literature. Official reports published by development agencies and nonprofit organizations, in particular, USAID, Management Sciences for Health (MSH), John Snow Inc. (JSI), and the World Health Organization (WHO), were also reviewed.

While the reviewed tools and reports, such as *MDS-3* (MSH), the *Logistics Indicators Assessment Tool* (USAID), and *The Logistics Handbook* (USAID), provided us with various ways of categorizing performance indicators, we chose to build on the SCMS *National Supply Chain Assessment*'s categorization of indicators, as proposed in the 2013 report, to consolidate facility-level performance indicators suggested by the published literature reviewed. The main rationale behind choosing the Supply Chain Management Systems (SCMS) proposed indicators is that the majority of these indicators originated from and consolidated various aspects of other major tools, thus serving as a good starting point for understanding the key "upstream" indicators of supply chain performance. It is important to note that while the existing tools are comprehensive and well designed, most do not clearly distinguish between upstream and downstream indicators—nor do they identify the links between them. We believe our report will fill this gap and contribute to further understanding the linkages between the two levels.

The full literature review is presented in Annex A.

Phase II

Phase II involved developing a study design. The purpose was to choose facilities with varying levels of performance in the supply chain management of ARVs in the different regions of the participating countries. As shown in Table 1, the study design incorporated hospitals, health centers, and clinics from regions within each county that were considered "good performing" and regions within each county that were considered "below expectation" in selected performance indicators.

Table 1. Study Design

Level	Region Performance			
Region/areas	Good		Below expectation	
Hospital / **Health center/clinic**	Good (N=1)	Below expectation (N=1)	Good (N=1)	Below expectation (N=1)
Total facility interviews	N=2	N=2	N=2	N=2

The performance indicators used for the selection of good and below expectation performance were chosen by the study team and country partners based on literature review and data availability. The definition of "good performing" and "below expectation–performing" was country-specific, as is shown in the following list:

- Performance indicators in Namibia: The following five supply chain–related indicators were used to determine regions and facilities with good and below expectation performance based on a previous support supervision visit.

    - Storage conditions of ARVs
    - Inventory management and quantification
    - Use of the Electronic Dispensing Tool (EDT) for stock management
    - Completeness of antiretroviral therapy (ART) reports
    - Adequate ART stock on hand

- Performance indicators in Cameroon: Local experts selected facilities using two measures:

    - Discrepancies between patient figures and stock records
    - Discrepancies between physical stock count and stock records

- Performance indicators in Swaziland: Swaziland is a small country with four regions in total. Most regions have only one hospital. For this reason, we were unable to compare hospitals within regions. Instead, hospitals were chosen based on their individual performance and were located in three regions rather than just two regions, as per the study designs in Namibia and Cameroon. As in Namibia and Cameroon, the facilities (hospitals and lower-level facilities) in Swaziland were classified as good-performing facilities and below-expectation facilities based on expert opinion and one performance-based indicator:

    - Months of stock on hand (MoSH)

For participating countries, country partners facilitated the identification of the hospitals, health centers, and clinics included in the study design. To identify the behaviors and practices in health facilities, interviews were conducted in "good-performance" and "below-expectation performance" facilities in each region. The total number of facility interviews in each country was designed to be eight, though due to differences in organization and practical factors, we were able to make comparisons across fewer facilities in some of the countries. In Cameroon, for example, we interviewed staff at two regional hospitals and four district hospitals, but not health centers, since they do not have proper ARV supply chain management. In Swaziland, we interviewed staff at eight different facilities (four hospitals and four health facilities), but the results from one health facility could not be compared to the other health facilities as they had more autonomy than the other health facilities in ordering their ARVs. One lower-level facility was not comparable to the other facilities in Namibia, as it did not order ARVs on its own.

Phase III

Phase III involved country identification and instrument development. Country selection was carried out by the SIAPS Program; selection involved four criteria: PEPFAR funded, African country, francophone and anglophone, and regional variation. The type of supply chain system, such as push or pull system, active or passive distribution, was not considered at this stage.

The SIAPS Program currently has portfolios that receive PEPFAR funding in 11 countries: Angola, Cameroon, Dominican Republic, Democratic Republic of the Congo, Ethiopia, Lesotho, Mozambique, Namibia, South Africa, Swaziland, and Ukraine. First, the team chose to focus on African countries for comparability. Second, one francophone and two anglophone countries were selected to capture the uniqueness of systems. Third, the team aimed for regional representation from East Africa (Ethiopia), Southern Africa (Swaziland), and West/Central Africa (Cameroon). Ethiopia was unable to participate in the assessment, thus the team substituted Ethiopia with Namibia as the second anglophone country. In Phase III, qualitative methods were used to gather information for each country's case study, including a further desktop review of the official, published, and gray literature on the supply chain of ARVs in each country.

Since all facilities that were chosen and included in the study were public facilities, we assumed minimal variation, and hence impact, from different health systems (organization, financing, payment, etc.).

Based on the literature review and protocols for the management of HIV and AIDS patients in the participating countries, instruments were developed to identify the practices and behaviors at the facility level that have an impact on the supply chain for ARVs. The instruments were developed to identify practices and behaviors within the following categories: prescribing, counseling, dispensing, clinical services, data generating activities, data analysis, data reporting, forecasting, ordering, handling of expired stock, behaviors if a stock-out happens, submission of reports and orders, placing emergency orders, communication within and between facilities, and more general practices and behaviors within and between the other departments and the pharmacy. Using these categories, interview instruments were developed for self-administered interviews at three levels within each country: national level, regional level, and facility level (Annex B). We identified relevant interviewees based on their assigned tasks and daily responsibilities in health facilities in the provision of ARVs and HIV services, instead of by their job titles. This ensured that we collected the right information from the people who provide services to HIV and AIDS patients.

Phase IV

Phase IV involved one-week country visits in January and February 2014 that included in-depth interviews with key informants in each country. Key personnel (pharmacist and health personnel) from each facility were contacted and interviews scheduled (Annex C lists the key informants). Both urban and rural facilities were visited. In addition to key personnel in each of the identified facilities, key informants at the national and regional levels were also interviewed

in each country. In Swaziland, because there are no relevant pharmaceutical officers in the regional health offices, regional interviews were not conducted. Interviews in each facility were held with healthcare personnel in the pharmacy as well as with healthcare personnel (if available) who treat or manage HIV and AIDS patients. Results of the interviews were captured verbatim in the interviewers' notes.

Phase V

Phase V involved analysis of the data. By analyzing data from the interviews, the authors identified repeating behaviors and practices that overlapped with the practices and behaviors identified in the literature review. Trends, patterns, and outliers were then identified in each of the key practice and behavior–related areas explored by using integration and triangulation to provide context to the results. Comparisons of practices and behaviors were made within countries and across countries, where applicable. The trends and patterns in practices and behaviors were then qualitatively associated with good- and below-expectation performance. The findings were also compared against best practices or guidelines identified in the literature, if available.

Since this was a qualitative study design, associations (rather than causality) were established. The following rules were applied to link patterns of practices and behaviors to performance:

- Strong association: If all "good-performing" facilities demonstrated similar practices and behaviors and all "below expectation" facilities did not demonstrate these same practices and behaviors

- Some association: If all "good-performing" facilities demonstrated similar practices and behaviors and one of the "below expectation" facilities also demonstrated a similar practice and behavior; the other "below expectation" did not demonstrate this same practice and behavior

- Some association: If all "below-expectation" facilities demonstrated similar practices and behaviors and one of the "good-performing" facilities also demonstrated a similar practice and behavior; the other "good performing" did not demonstrate this same practice and behavior

- No association: No clear pattern between performance and practice and behavior across facilities

Based on the literature and the individual country analyses, we identified 30 specific practices and behaviors that were hypothesized to be linked with upstream indicators of supply chain performance for ARVs in seven supply chain function areas: forecasting and quantification, warehousing and inventory management, prescribing and dispensing, communication, information management, infrastructure, and human resources. Table 2 lists best practices and guidelines of these practices and behaviors that were identified in the literature, as well as our hypotheses on how these practices and behaviors may affect supply chain performance.

Table 2. Potential Linkages Between Facility-Level Behaviors and Practices and Upstream Indicators of Supply Chain Performance

Category	Subcategory	Best Practices and/or Guidelines
Forecasting and quantification	Calculation of Min-Max buffer stock	• Average monthly consumption (AMC) is the average of the quantities of product dispensed to patients in the most recent 3 months, as appropriate. Because consumption fluctuates, analysts should not use data from one month only. To calculate the AMC, first calculate a simple average by finding the sum of a set of monthly consumption numbers and divide the total by the number of months used (USAID 2011a).
	Use of electronic systems	• Bossert et al. (2007) found that in both Ghana and Guatemala, better performance of the logistics management information system (LMIS) occurred when there was a more uniform LMIS, in contrast to those systems where local decisions led to different forms and reporting. They found that higher decision-making authority in the LMIS was associated with poorer performance. • We posit that electronic systems facilitate creating new monthly orders, reporting to regional/central offices, as well as keeping accurate stock records.
	Use of national guidelines or training materials as reference for estimation of needs and reporting	• Facilities with high decision space (i.e., not required to adhere to guidelines) in inventory control were more likely to have poorer performance (Bossert et al. 2007).
	Order verification before submission to the central/regional level	• We posit that fewer mistakes are made when an additional person verifies the orders.
	Order fill rate	• We posit that higher order fill rate reduces stock-outs.
	Late ordering of medicines	• We posit that late ordering increases fluctuation of stocks and probability of stock-outs.
Warehousing and inventory management	Actions taken when stock is received	• New entries are recorded on the stock-keeping record whenever products are received or issued. Entries are also recorded when stock is counted during a physical inventory, or as soon as a loss is noticed (USAID 2011a)
	Control of access to stock	• Imprinting containers, embossing tablets and capsules, hiring special security staff, constructing secure warehouses and storerooms, and regularly monitoring and auditing stock records are possible ways to prevent losses (MSH 2012).
	Assigning responsibility of inventory management tasks	• We posit that a trained manager assigned with full responsibility of managing ARVs, or a clear schedule and description of tasks for staff, lead to better performance.
	Frequency of balancing stocks (checking stock cards vs. physical count)	• Staff should regularly assess the stock status of each product in storeroom; consider assessing the stock status monthly for all products. Even if you only report or order quarterly, you should assess stock status more often to ensure that you are not at risk of a stock-out. Stock status should also always be assessed during quantification exercises (USAID 2011a)

Category	Subcategory	Best Practices and/or Guidelines
		• While conducting the physical inventory count, be sure that you compare the quantities on hand with the quantities that have been entered in stock-keeping records (e.g., inventory control cards). A physical inventory count enables you to confirm how much stock you have and whether forms are being completed correctly (USAID 2011a). • Stock-keeping records do not usually move; they stay where products are stored (e.g., the warehouse, pharmacy, or storeroom) (USAID 2011a).

Warehousing and inventory management	Location and condition of storage (whether all in one place or separate rooms)	• Good inventory control requires careful thought about the dimensions and design of the storage space, appropriate conditions for storage of different types of supplies, and the importance of stock rotation and systematic arrangement of stock, as well as attention to cleanliness, fire-prevention measures, and security within the store (MSH 2012).
		• Storage requirements:
		  ○ Stack cartons at least 10 cm (4 inches) off the floor, 30 cm (1 foot) away from the walls and other stacks, and not more than 2.5 m (8 feet) high.
		  ○ Arrange cartons so that arrows point up. Ensure that identification labels, expiry dates, and manufacturing dates are clearly visible.
		  ○ Store supplies in a dry, well-lit, well-ventilated storeroom out of direct sunlight.

	Stored separately from other medicines	• ARVs should be stored in separate storage sections/rooms from other medicines.
	Decision on whether to redistribute short-dated stock	• We posit that higher frequency of redistribution of short-dated stocks reduces the performance of supply chain management since it increases complexity.
	Frequency of issuing emergency orders	• We posit that higher frequency of emergency orders is an indication of poor performance.
Prescribing and dispensing	Change in prescription during stock-out	• We posit that written SOPs for the prescription process during stock-out to standardize actions among prescribers leads to better performance.
	Change in dispensing of ARVs during stock-out (e.g., give 1 month instead of 3 months)	• *MDS-3* recommends developing and using written SOPs for the dispensing process to improve consistency and quality of work, which can be used for both training and reference (MSH 2012). • We posit that written SOPs for the dispensing process during stock-out to standardize actions among dispensers leads to better performance.
	Actions to ensure patient adherence (e.g., pill count)	• We posit that written SOPs for monitoring adherence (e.g., whether to perform pill counting) to standardize actions for improving adherence to ARVs leads to better performance.
Communication	Communication within the pharmacy team	• We posit that scheduled weekly/biweekly internal meetings and good team dynamic lead to better performance.
	Communication within the clinic	• We posit that pharmacy staff should actively communicate with non-pharmacy staff regarding shortages and stock-outs to ensure consistency and

Category	Subcategory	Best Practices and/or Guidelines
		accurate recording of prescription.
	Communication with hospital executives	• We posit that the pharmacy staff should actively communicate with hospital executives regarding shortages and stock-outs, and hospital executives should facilitate communication with central or regional stores to ensure minimal adequate and timely supply of commodities.
	Communication with higher-level supply chain management offices	• We posit that good relationships with the regional and central offices are crucial in achieving good performance.
	Communication with affiliated facilities	• We posit that good communication with the affiliated facilities leads to more accurate reporting and forecasting at the main facility.
Information management	Interaction between clinical and dispensing/stock systems	• We posit that linkage between clinical and dispensing information systems facilitates accurate reporting and forecasting.
Infrastructure	ART clinic/pharmacy separate from main pharmacy	• We posit that a separate ART clinic/pharmacy leads to better performance (if the manager is solely responsible for the ART clinic/pharmacy).
	Leadership/management style of pharmacy	• We posit that good management style of the pharmacy manager leads to better performance.
Human resources	Leadership/management style of clinic	• We posit that strong support/guidance from upper management leads to better performance.
	Training on stock management	• In the management literature, Brauner et al. (2013) found that a person's technical competence, personality, and position within the supply chain had significant effects on his/her performance within the supply chain. • A study conducted by Matowe et al. (2008) found that problems with ART commodities-supply management existed widely in Kenya, Rwanda, Tanzania, and Uganda. Inadequate skills of human resources were cited as the main reason for the inability of the existing systems to adequately handle scale-up programs in all four countries. More specifically, the problems identified include lack of readiness of the workforce to efficiently use and manage large supplies of ARVs, inadequate capacity to quantify needs and distribute the medications, and inappropriate skill sets to advise patients on how to use medications appropriately.
	Guidelines for providers in event of a stock-out	• We posit that hospitals with strong policies around how to manage stock-outs have better performance.
	Attitude to workload of pharmacy staff	• We posit that greater workload leads to poorer performance in daily activities, including supply management.

We link these behaviors and practices to measurable indicators that were either identified during our literature review or were developed by the study team. Measurable indicators in some categories, such as forecasting, quantification, and warehousing and storage, are standard indicators that are readily available from existing reports and tools, and have often been used in

various country studies on supply chain management. Other categories, such as prescribing and dispensing practices, communication with internal and external teams, have rarely been identified as key behaviors and practices that may affect supply chain management in previous work.

Individual country results are presented first, followed by a summary of results across all three countries. Finally, the practices and behaviors and the indicators that they are linked to are presented at the end of this report.

FINDINGS IN NAMIBIA

ARV Supply Chain in Namibia

Namibia's Ministry of Health and Social Services (MOHSS) manages approximately 350 public health facilities in 14 regions and operates a central medical store (CMS) distribution system, with a CMS at Windhoek and two Multi Regional Medical Depots (MRMDs), located in Oshakati and Rundu. CMS directly distributes medicines and other pharmaceutical supplies to about 45 health facilities in central and southern Namibia, and to Rundu MRMD, located 760 kilometers northeast of Windhoek, and Oshakati MRMD, located 733 kilometers northwest of Windhoek. The facilities in turn distribute the products to the peripheral hospitals, health centers, and clinics throughout the country. Oshakati MRMD serves up to 87 facilities in four northwest regions (Oshana, Ohangwena, Oshikoto, Omusati) while Rundu MRMD serves 37 facilities in two northeast regions (Kavango and Zambezi). Rundu and Oshakati MRMD serve the most-populated part of Namibia, with approximately 40–50% of the population.

Selection Criteria

Five supply chain–related indicators were used to determine good- and below-expectation-performance regions and facilities. Facilities were evaluated during annual visits and ranked based on the following indicators:

- Storage condition: cleanliness, tidiness, appropriate arrangement of pharmaceuticals, and temperature monitoring practices (MOHSS Namibia 2013a)
- Inventory management and quantification: stock card use, cold chain management, and interim orders (MOHSS Namibia 2013a)
- Use of the EDT for stock management (MOHSS Namibia 2013a)
- Completeness of ART reports submitted to the MOHSS (MOHSS Namibia 2013b)
- Availability of adequate ART stock on hand (MOHSS Namibia 2013b)

For the purpose of our study, local experts calculated and ranked the average of these five indicators for all major facilities in the country, and created an aggregate score for each region. We chose the region with the lowest aggregate score (highest ranking) as the good-performing region (Region 1), and the region with the second-highest aggregate score (lowest ranking) as the below-expectation-performing region (Region 2). The region with the highest aggregate score had only one facility, and was therefore excluded from the study. Table 3 shows the ranking for each region. Table 4 shows detailed findings for facilities surveyed in Region 1 and Region 2.

Table 3. Region Selection Criteria and Ranking—Namibia

Region	Number of Facilities	Rank, Inventory Management	Rank, Adequate Stock on Hand	Rank, EDT Use in Stock Max	Rank, Storage	Rank, ART Report Completeness	Total	
Karas	4	1	5	1	1	1	9	Good performing
Hardap	3	2	8	1	7	7	25	
Otjozondjupa	4	3	4	6	4	8	25	
Caprivi	1	11	1	1	11	1	25	
Khomas	9	4	10	8	4	1	27	
Omaheke	1	7	6	5	10	1	29	
Erongo	4	4	3	5	9	9	30	
Ohangwena	5	9	6	9	7	1	32	
Omusati	6	8	9	4	6	11	38	
Kavango	5	9	2	12	3	12	38	
Kunene	3	6	11	10	3	9	39	
Oshikoto	3	12	13	11	12	1	49	
Oshana	3	13	12	5	12	13	55	Poor performing

Table 4. Facility Comparisons—Namibia

		Region 1		Region 2	
Category	**Subcategory**	**Hospital A (Good)**	**Hospital B (Below Expectation)**	**Hospital C (Good)**	**Hospital D (Below Expectation)**
Demand factors	Number of patients on ART	~ 900 patients	~ 1,200 patients	~1,500 patients	~8,000 patients
ART pharmacy staff size	Number of staff in the ART pharmacy	1 senior pharmacist, 2 pharmacy (PAs)	2 PAs	1 PA	1 senior pharmacist, 10 PAs
Forecasting and quantification (determination of quantity needed)	Calculation of Min-Max/buffer stock	Max 4 months, min 2 months (per recommended guideline); actual min 1.5 months	Max 6 months; only have 4 in stock; min not stated (not the recommended guideline)	Max 1.5 months, min 0.75 months (not the recommended guideline)	Max 3 months, min 1.5 months (not the recommended guideline)
	Use of electronic systems	Uses EDT and stock cards for ordering.			
	Use of national guidelines or training materials as reference for estimation of needs and reporting	Pharmacy receives daily hands-on supervision and training from regional pharmacist.	Knows of national guidelines; most recent formal training in 2011.	PA received SIAPS training, often refers to the training material.	Senior pharmacist uses WHO guidelines and training materials from online courses.

Category	Subcategory	Region 1		Region 2	
		Hospital A (Good)	Hospital B (Below Expectation)	Hospital C (Good)	Hospital D (Below Expectation)
Forecasting and quantification (determination of quantity needed)	Order verification before submission to the central/regional level	Orders verified by regional pharmacist and senior pharmacist.	Orders done, alternating months, by the 2 PAs; no verification.	Order verified by the regional pharmacist, who also serves as senior pharmacist of the facility.	Order done by senior pharmacist. No verification by regional pharmacist as required.
	Order fill rate	Order fill rate not reported, though data sufficient to report.			
	Late ordering of medicines	Not an issue.	Has been an issue once; CMS said their order book was late; impacted prescribing as physician could only take 2 weeks of ARVs for the field visit.	Not an issue.	
	Frequency of issuing emergency orders	Send emergency orders right away if order not filled; after every delivery.	Rarely uses emergency orders; redistributes first.	Send emergency orders right away if order not filled.	
Warehousing and inventory management	Actions taken when stocks are received	Unloaded to main area and then it is restocked to appropriate shelves when pharmacy staff has time; task is shared based on available time.	1 of 2 PAs receives the order and restocks the shelves when they have time; the two PAs trade off on this activity every other month.	PA clearly articulated the urgency of counting, storing, and recording new stocks that arrive.	Time delay in counting and storing new stocks. Not as diligent in verifying new arrivals.
	Control of access to stocks	Everyone has access to stock, especially since they are short staffed and always have people in and out helping.	Both PAs have access to stock on a daily basis; 2 PAs alternate updating of stock cards at the end of each month.	PA is very strict with who is allowed to go into the stockroom.	Every pharmacy staff member was allowed to go to the stockroom, take ARVs, update stock cards, and bring them to the dispensing area.
	Assigning responsibility of inventory management tasks	No fixed schedule for dividing up responsibility for tasks; regional pharmacist is there	Only 2 PAs; they alternate activities each month.	PA takes full responsibility for the stocks.	Senior pharmacist takes full responsibility for the stocks.

Category	Subcategory	Region 1		Region 2	
		Hospital A (Good)	Hospital B (Below Expectation)	Hospital C (Good)	Hospital D (Below Expectation)
		frequently to help out when understaffed.			
Warehousing and inventory management	Frequency of balancing stocks (checking stock cards vs. physical count)	Check at the end of the month with stock cards and EDT and the regional pharmacist randomly checks when she visits.	Check at the end of each month with stock cards and EDT.		
	Location and condition of storage (whether all in one place or separate rooms)	All ARVs stored in the same area.			
	Stored separately from other medicines	ARVs kept separately.			
	Decision on whether to redistribute short-dated stock	Call other facilities to see if they have stock; formal redistribution sheet.	Rely on redistribution and do this before they send emergency orders but no formal redistribution sheet.	Call other facilities to see if they have stock, rely on redistribution, and do this before they send emergency orders.	Actively asks nearby facilities to send short-dated stocks to their facility, since they have a larger patient load and can dispense more quickly.
Prescribing and dispensing	Change in prescription during stock-out (e.g., switch regimen)	Switches formula (same regimen) during stock-out (i.e., gives syrup vs. pill); switches back to original formula when drug is available; delays prescribing new regimen, giving current regimen until new regimen arrives.	Changes the dosage or gives shorter prescription and tells the patient to come back and refill.	Switches regimen during stock-out, does not switch back when the originally prescribed when drug is available.	
	Change in dispensing during stock-out (e.g., give 1 month instead of 3 months)	Not mentioned as a solution to the out-of-stock problem.	Gives 2 months instead of 3 months.	Give 1 month instead of 3 months	

Category	Subcategory	Region 1		Region 2	
		Hospital A (Good)	Hospital B (Below Expectation)	Hospital C (Good)	Hospital D (Below Expectation)
	Adherence (e.g., pill count)	Not mentioned in the interview.		Does pill count.	
Communication	Communication within the pharmacy team	Regional pharmacist had a strong presence and may have taken on some of the team leadership activities. Regional pharmacist is often on-site; assists in pharmacy.	Only 2 PAs in the pharmacy; teamwork in the sense of good understanding of shared roles; they alternate each month on activities; minimal oversight of each other; minimal oversight from regional pharmacist.	Only 1 PA, the only communication is with the regional pharmacist.	Senior pharmacist has a very strong and dominant presence, and this may prevent staff members from collaborating or raising questions and issues to the management.
	Communication within the clinic (with clinicians and other staff, in general and in stock-out situations)	There is supposed to be a therapeutic meeting each week wherein physicians and pharmacists can discuss issues with different medications, but sometimes this does not a happen; pharmacists sometimes send a note to the physician if there is a stock-out; however, physician reported learning about stock-out before note was sent.	Pharmaceutical meeting each month; very good informal communication; discuss problems; despite communication there are still shortages with certain medication when new medications have not been ordered on time.	PA proactively communicates with the physician to discuss about the alternative ways to prescribe ARVs.	Pharmacy communicates the changes passively to the clinicians: only when they receive prescriptions from patients that arrive at the pharmacy will the pharmacy staff call this specific prescriber about the need for change.
	Communication with hospital executives	Not mentioned in the interview.		Strong support from hospital management.	Not mentioned in the interview.
	Communication with higher-level supply chain management offices (e.g., regional, CMS)	Good communication; regional pharmacist is there almost every day as office is close.	Poor; regional pharmacist never visits or checks orders/stock.	Good communication; regional pharmacist is there almost every day as her office is close.	Poor; regional pharmacist never visits or checks orders/stock; conflicts in the past.

Category	Subcategory	Region 1		Region 2	
		Hospital A (Good)	Hospital B (Below Expectation)	Hospital C (Good)	Hospital D (Below Expectation)
Communication	Communication with affiliated facilities	Suboptimal; larger facilities complain that clinics do not do proper stock management; pharmacist goes and trains nurses in these facilities but they still do not maintain stock; the clinics just call when they are out of stock; they need additional support.	Physician brings most medications with him on outreach visits; if he prescribes and the patients run out of medication they have to come to the hospital to refill; facilities do not keep their own stock.	Not mentioned in the interview.	Works with several neighboring Integrated Management of Adult and Adolescent Illness (IMAI) sites, receives their orders daily.
Information management	Interaction between clinical and dispensing/ stock systems	EDT not linked to clinical data.			
Infrastructure	ART clinic/pharmacy separate from main pharmacy	ART clinic/pharmacy integrated with main pharmacy.		ART clinic/pharmacy separate from main hospital/pharmacy.	
Human resources	Leadership/management style of pharmacy	Leadership comes from the regional pharmacist, who oversees many of the activities.	Leadership is main-tained as a team with 2 PAs and physician; communicating and alternating on tasks.	Only one PA, receives guidance from regional pharmacist.	One senior pharmacist in charge of ART pharmacy; another senior pharmacist managing the main pharmacy. The two do not work together.
	Leadership/management style of clinic	One physician who attends to HIV patients, as well as other patients.		Collaborative—clinic coordinator supportive of pharmacy.	Not mentioned in the interview.
	Training on stock management	Had been trained and the regional pharmacist was checking pharmacy all the time.	Had received training from regional pharmacist in 2011.	PA previously received SIAPS training; interested in attending more trainings.	Senior pharmacist never attended national trainings; takes training courses online. Others said they attend regional trainings.

Category	Subcategory	Region 1		Region 2	
		Hospital A (Good)	Hospital B (Below Expectation)	Hospital C (Good)	Hospital D (Below Expectation)
	Attitude to workload of pharmacy staff	High workload reported; regional pharmacist covers to let pharmacists leave early and take breaks; when pharmacy closes and there is still a line, patients go to the emergency room pharmacy, which does not have its own ARV stock	Did not complain about being overworked; the 2 PAs take turns sharing the responsibility.	PA has high workload because a senior pharmacist just retired; receives support from regional pharmacist.	Complained that they do not have enough staff.

Hospitals

Hospitals in Good-Performing Region (Region 1)

In Region 1, we identified a good-performing facility, Hospital A, and a below-expectation performing facility, Hospital B. Not only were these two facilities different in terms of performance but they also differed in terms of many of the behaviors and practices identified in each of the supply chain–related functions evaluated. This section reviews these differences—also summarized above in Table 4.

Forecasting and Quantification

Use of National Guidelines or Training Materials as Reference for Estimation of Needs and Reporting: The proximity of Hospital A to the regional pharmacist's office led to almost-daily supervision and hands-on training from the regional pharmacist. National guidelines were enforced and any questions that came up on a daily basis were answered. Hospital B, on the other hand, was situated much farther from the regional pharmacist/regional office. Hospital B had reported knowing of the national norms and having had training in 2011, but received minimal additional on-the-job support and training on these supply chain–related issues arising in the day-to-day management of the pharmacy.

Order Verification before Submission to the Central/Regional Level: The verification of calculations, orders, and inventory stock also differed between the two Hospitals. In Hospital A, the regional pharmacist always verifies stock card records on visits to Hospital A. In Hospital A, even if the PA does inventory check and ordering, these are verified by the senior pharmacist. In Hospital B, the two PAs who work in the pharmacy take turns updating stock cards at the end of the month and making orders. When one does stock check and ordering, the other one does not verify. No senior pharmacists or regional pharmacists visit Hospital B to verify these calculations.

Late Ordering of Medicines: Late ordering was not an issue in Hospital A—perhaps linked to the proximity to the regional pharmacist—while in Hospital B they had recently been late in their orders to CMS.

Frequency of Issuing Emergency Orders: Hospital A would send emergency orders immediately if they saw any ARV order was not filled—and they reported this happened after every delivery. Hospital B rarely used emergency orders and relied almost always on redistribution of ARVs from other facilities in case of shortage.

Warehousing and Inventory Management

The two areas where Hospitals A and B differed in terms of warehousing and inventory management related to redistribution and emergency orders.

Decision on Whether to Redistribute Short-dated Stock: If Hospital A needed to rely on redistribution, they had a formal redistribution sheet they would fill out and then call and ask

other facilities about their stock levels. This was only after they formally sent an emergency order to CMS. Hospital B, on the other hand, often relied on redistribution. They did not have a formal mechanism to do this and often called other facilities to see if they had stock on hand before calling CMS.

Balancing Stocks and Control of Access to Stocks: Despite this higher level of vigilance in Hospital A, their scheduling of stock management is not as routine as in Hospital B. Since Hospital A is a high-volume hospital and the pharmacy is short staffed (one PA is on medical leave and the senior pharmacist was at a workshop the day of our visit), every staff member can touch the stock and restock the dispensing shelves. The regional pharmacist, while she does extra verification of stocks, is also in and out helping with the pharmacy when needed. In Hospital B, while they have fewer internal and external checks, they are on a fixed schedule whereby each PA is assigned to specific jobs (inventory check, ordering) each month.

Communication

Communication within Pharmacy Team: Patterns of communication between the pharmacists in the hospital and the different external and internal teams varied. In Hospital A, due to proximity to the regional health office where the regional pharmacist was stationed, they had regular contact with the regional pharmacist. In fact, when the pharmacy in Hospital A was short staffed, the regional pharmacist assisted in the dispensing area in order to reduce the workload at the pharmacy. The regional pharmacist, considered the manager of the pharmacy at the time, was also available frequently to check stock inventory, review stock cards for accuracy, and help with six-week orders. On the contrary, due to distance, the regional pharmacist makes infrequent visits to the pharmacy in Hospital B and communication between the pharmacy in Hospital B and the regional level is not as good as in Hospital A.

Communication within the Clinic: The pattern of communication between the pharmacists in each hospital and the physicians was the opposite. While Hospital A had close contact with the regional pharmacist, the communication with the ART physician in the ART clinic was weaker. While both the pharmacist and the physician reported scheduling therapeutic meetings each week, due to high workload for the pharmacist and ART clinic, the meetings did not always happen. They then would rely on informal communication that did not always happen, either. For example, the pharmacist in Hospital A reported sending notes or communicating directly with the physician if there was an ART medication that was low in stock or not available. However, the ART physician in this hospital reported that when a recent circular came out instructing the physicians to begin using a new HIV medication in place of another one, when he sent the patients to the pharmacy to fill their prescriptions the new medication was not available at the pharmacy. The problem was quickly resolved, as the pharmacist called him at this point and said they did not have AZT as yet and they would have it in one week. The physician prescribed the old medicine until the new medication came in. These results demonstrate that while communication with the regional pharmacist is important, strong communication with an interested and involved prescriber is equally important in the management of ARVs at the health facility level.

In Hospital B, while there was less communication with the regional pharmacist, there was more communication, both formal and informal, between the PA and the physician. Both the physician and the pharmacist reported that they had a pharmaceutical meeting each month to discuss new regimens and levels of stock as well as informal communication if an issue arises.

Communication with Higher-level Supply Chain: Another communication mechanism that differed between Hospital A and Hospital B was their communication with the CMS. In Hospital A, they reported that they send emergency/interim orders after every delivery to CMS if an order of ARVs is not delivered. They reported that this happens after every delivery. Hospital B reported that sending an emergency order after receiving CMS deliveries happens less frequently. They have only had to do about two interim orders in the last year. Instead, they rely on redistribution between other local facilities before they call CMS or send an interim order.

Human Resources

ARV Management Responsibility: The difference in leadership/management style in Region 1 was associated with location and size of Hospital A and B. Since Hospital A was so close to the regional offices and the regional pharmacist, they relied on the regional pharmacist as a leader and to help with management of the pharmacy. This was especially true most recently, as they had been short staffed and the regional pharmacist was helping to fill in when the pharmacists in Hospital A needed to take a break or leave early. The regional pharmacist had a strong presence, which assisted in the overall management of the pharmacy. In Hospital B, there was less evidence of one clear leader. Since there was no senior pharmacist in this facility, it appeared as if the two PAs split many of the tasks and coordinated activities together with the physician.

Hospitals in Below-Expectation-Performing Region (Region 2)

We denote the good performer as Hospital C and the below-expectation performer as Hospital D. The two district hospitals in Region 2 had many similar characteristics: the staff were equally committed to their jobs, staff turnover was low, and both considered they were understaffed. Hospital D had approximately nine times more HIV patients than Hospital C, but had two pharmacists and 10 PAs, while Hospital C only had two PAs. Both were using the wrong formula for calculating the minimum and maximum level of stocks required by the SOPs published by Division of Pharmaceutical Services at the MoHSS.

Warehousing and Inventory Management

Balancing Stock cards and Control of Access to Stocks/ARVs: Although both facilities balance the physical stock and stock cards on a monthly basis, access to the stockroom where the medicines are stored and the ability to update stock cards were different in the two facilities. At Hospital D, every pharmacy staff member, including pharmacists and PAs, was allowed to go to the stockroom, take ARVs, update the stock cards, and bring them to the dispensing area. This potentially allows for more frequent mistakes in updating stock cards in the event that staff are not properly trained, and creates additional challenge in tracking the right number of stocks. The PA at Hospital C, on the other hand, was very strict with who was allowed to go into the stockroom. Only when she is not at the facility are other staff members allowed to go in. She

emphasized that once she was back at the facility she would immediately balance the stock cards with physical stock. While she teaches others to update the stock cards, she understood that others may be busy, and took full responsibility in making sure stock cards were up-to-date.

Actions Taken When Stocks are Received from CMS/RMS: The two facilities differ in the timeliness of recording stocks received from the CMS truck. The PA at Hospital C clearly articulated the urgency of counting, storing, and recording new stocks that arrive. Usually, she would be notified about the shipment a day or two in advance, so she would clear the stockroom to make sure the old stocks are moved to the front, and there are spaces at the back for the new stocks. Although this was not observed directly, Hospital D is not as diligent in verifying new arrivals. Often the staff members are busy with other tasks, leaving the stock on the floor for a few days without comparing the actual commodities received with what is on the invoice and what was ordered. Staff stated that while this is infrequent, dispensers may even take medicines from the new stock, give them to patients, and leave notes on the box about how much they took.

Communication

Communication within the Pharmacy Team: It is important to note that Hospital D had a big team (12 staff in total) relative to Hospital C (2 PAs); thus the comparison of leadership and management style may not be as applicable. Nevertheless, Hospital D's pharmacist had a very strong and dominant presence, and this may have prevented staff members from collaborating or raising questions and issues to the management. The pharmacist was very confident in his team's ability to manage inventory, and suggested that all staff members knew how to use the EDT well. However, we spoke to three of them later on, and only one member was confident in handling the system. The pharmacist was very proactive in improving his inventory management skills, but stated that he does not go to trainings held at the national level. The PA in Hospital C, on the other hand, puts high value in training, and expressed interest in attending more in the future.

Communication within the Facility: How pharmacy members interact with non-pharmacy staff, including prescribers, counselors, and even the CMS and regional pharmacists, is an important factor influencing the performance of the supply chain. In terms of communication with clinicians, two facilities had different approaches in communicating with the prescribers about ARV shortages.[1] When she learns that there may be shortage of a particular medicine, the PA in Hospital C proactively communicates with the prescribing physician to discuss the alternative ways to prescribe ARVs, such as cutting the prescription period from three months to one month or switching from combination to single pills. Although she says the doctor often blames her and the pharmaceutical system for the inconvenience, she maintains a good relationship with the physician. Hospital D communicates the changes passively to the clinicians: only when they receive prescriptions from patients that arrive at the pharmacy will the pharmacy staff call this specific prescriber about the need for change. When another patient comes from another prescriber with similar needs, the staff will then call this second prescriber to notify change. While the ultimate usage of medicines will not be affected, we hypothesize that this behavior may serve as a proxy for the level of communication between prescribers and pharmacy staff, which may have effects in forecasting and quantification of ARV needs.

[1] It is important to note that Hospital D had about 10 prescribers (physicians and nurses), whereas Hospital C had only one physician.

Communication with Higher-level Supply Chain Management Offices: In terms of communication with CMS, we found that Hospital D has much more frequent contact with CMS with regard to stock shortages. According to the CMS, when there is a shortage at the central level, it distributes stock proportionally to what is ordered by the facilities. For example, if facility C orders 100 pills and facility D orders 200 pills, based on the level of shortage, the CMS may decide to fill 50% of all orders, in which facility C receives 50 pills and D receives 100 pills. While all facilities face some shortage due to lack of stock at the central level, some facilities call the CMS more often than others. Some suggest that this may be a sign that the frequent callers face more urgent shortages due to poorer inventory management at those facilities.

Finally, in terms of communication with the regional level, there was a significant difference in the relationship between the regional pharmacist and the two managers of the facilities. Hospital C is conveniently located right next to the regional office, and the regional pharmacist is currently supporting the pharmacy as a pharmacist. She frequently visits the facility and has strong connections not only with the pharmacy staff but also with the management and clinical staff. The PA in charge of the ARV clinic considers the regional pharmacist as a supervisor at the facility, and believes that she can go to her for any questions or problems. The principal medical officer at Hospital C also stated that whenever there is stock issue at the hospital, he immediately calls the regional pharmacist for help, and most of the time the regional pharmacist is already aware of the issue. Hospital D has much less interaction with the regional pharmacist. We learned during interviews that all district hospitals are expected to send the monthly order forms to the regional pharmacist for review, and only upon review would the regional pharmacist send the orders to the CMS. Yet it has been reported that Hospital D's order forms go directly to the CMS and are not reviewed at the regional level. Furthermore, Hospital D's staff suggested that although the regional pharmacist visits the facility every few months, she only visits the main pharmacy and not the ARV pharmacy. Our hypothesis is that having regional support can affect supply chain management performance through mechanisms such as better information on stock availability and communication of guidelines and protocols.

Health Centers

Based on the selection criteria described above, the local team identified four health centers for the study. However, upon arrival we learned that these facilities are actually not full health centers. Rather, they are Integrated Management of Adolescent and Adult Illness (IMAI) sites that only provide ARVs to patients who were already initiated on ART at other hospitals. They do not have full inventory management systems in place, and receive ARVs from the nearest district hospitals on a daily or weekly basis. IMAI sites are run by nurses, with no physicians, pharmacists, or PAs. They did, however, have fully developed systems to manage other non-HIV-related medicines and supplies. For these reasons, we did not include the IMAI sites in the overall findings in the comparison table (Table 4).

IMAI Sites in Good-performing Region (Region 1)

The health centers in Region 1 that were included in the study design were difficult to compare, as explored below, and summarized in Table 5.

Forecasting and Quantification, and Warehousing and Inventory Management

Facility E was not an ART-initiating site and therefore did not manage its own stock. It did have a separate storage for medications that was air-conditioned and the ART medication was in its own storage cabinet. The stock they had on hand had already been dispensed and labeled by the physician at Hospital A. As a facility, they were responsible for testing and counseling patients, and then they would refer them to be initiated on treatment at the hospital or when the physician from the hospital visited on outreach.

Facility F had been an IMAI site that was downgraded to a health center. However, the nurse in Facility F had, on her own initiative, been trained in how to initiate patients for HIV treatment, so she was currently initiating patients and keeping stock on the medications in the facility.

Communication

Facility E does voluntary testing and counseling and then sends any patient who needs ARVs to Hospital A for initiation and follow-up. Any patient who has been initiated on ART can be followed at Facility E. The nurse following the HIV patients monitors their regimens and sends their patient passports (document the patient keeps with them that tracks healthcare services received) to Hospital A when they need refills or refers the patients to Hospital A if the patient has developed complications.

The nurse at Facility F had close communication with the regional hospital in her area and could call at any time and ask the physician or the pharmacist about the treatment for an HIV patient in Facility F. The pharmacist from the regional hospital would come to Facility F on outreach days (once a week) in order to check stock levels and capture information on the HIV patients and their treatment regimens.

Human Resources

Even though Facilities E and F in Region 1 were different types of facilities (one was a downgraded health facility and one was an “outpost” facility), and therefore could not be compared per the study design, the two facilities did have some similarities. Both facilities had very devoted nurses. In Facility E, the premises were clean and the nurse took pride in her work monitoring the HIV patients. In Facility F, the nurse was intensely dedicated and devoted to maintaining the facility, especially in providing services for the HIV patients. She described how she had changed the voluntary testing and counseling schedule, once Facility F became an initiating facility, so that patients could come at any time, rather than the previously scheduled Tuesdays and Thursdays, for voluntary testing and counseling. She felt like this decreased stigma for the HIV patients and made them more willing to come to the facility.

Table 5. Health Center Comparisons in Region 1—Namibia

	Facility E	Facility F
Control of access to stocks	No access to stocks—"outreach" post.	"Outreach" facility with limited stock on hand.
Supervision	Not much communication with regional pharmacist; good communication with physician.	Not much communication with regional pharmacist; good communication with physician.
Quantification	Facility does not quantify any medication; quantification is done by the pharmacist at the regional hospital.	The nurse would like to begin quantifying on her own; all quantification happens at the hospital level.
Communication with clinician about prescription change	Nurse consults with physician and sends patient to the main hospital or waits for outreach visit.	More proactive; the nurse flags patients who she thinks need to change medications and then calls or consults physician at outreach.
Data management	Keeps a tally of patients (N=34).	Keeps a tally of patients and their mediations (N=700).
Attention to patients	Can come in daily for testing and counseling.	Can come in daily for testing and counseling; changed system to address stigma.

IMAI Sites in Below-Expectation-Performing Region (Region 2)

In Region 2, we visited two IMAI sites that received ARVs from the same district hospital. They followed similar processes for ordering medicines, had no formal inventory control system, and had equal staffing level (neither had a pharmacist or a PA). Table 6 summarizes the comparison of the two facilities.

Forecasting and Quantification

Both facilities order medicines from the same district hospital, but we observed that their ordering frequency, ordering for in-transit patients, and the reference period for ordering are different. Facility G only attends to HIV patients on Wednesdays and Thursdays, so they place an order every week. Since patient files show when patients are supposed to come back for follow-up, staff calculate how much to order based on the number of patients they expect will come the following week. For in-transit patients that do not have patient records; the nurses simply give out the spare medicines that come from defaulting or nonadherent patients. Facility H, on the other hand, places orders based on how many ARVs they dispensed that day, and sends the order form to the district hospital nearly every day. Thus, the in-transit patients' consumption is included in its ordering.

Warehousing and Inventory Management

While both centers are constrained by storage space, Facility G had a more inappropriate storage practice. All ARVs were in boxes on the floor of the dispensing room, there is no temperature control in the room, and anyone is able to access this room. For example, community counselors proudly described how they assist the dispensing nurse in finding medicines on the floor when

the nurse is busy. Facility H, on the other hand, has a locked, air-conditioned storage room where they store all other medicines, and has one locked closet with shelves to store ARVs. All nurses have keys to open the storage room.

Furthermore, we observed that none of the four nurses at Facility G had training on inventory control, and they did not seem interested in getting trained. Facility H had three nurses responsible for ARVs and one was trained in inventory control for general medicines. However, while this trained nurse seemed eager to learn and apply her knowledge, she was confused as to whether what she had learned for general medicines is applicable to ARV management.

Communication

One of the differences we observed was how the nurses coordinate patient care. For example, in managing non-adherent patients, each nurse at Facility G has her own "rule" in shortening the follow-up period. One nurse may shorten the period from three months to one month, while the other may shorten to six weeks. In comparison, Facility H had a clear and consistent rule of shortening the period from three months to one month. This rule was communicated during one of the weekly meetings.

Table 6. Health Center Comparisons in Region 2—Namibia

	Facility G	Facility H
Storage	Has one locked closet with shelves, in air-conditioned room.	No shelves, all boxes on the floor. No temperature control.
Control of access to stocks	Stocks are locked. All nurses can access.	Everyone can access stockroom, even community counselors.
Reference period of ordering stock	Places orders with the amount that was dispensed the exact day (e.g., if 5 patients received ARV today, then they would order the exact amount the 5 patients consumed to fill stock).	They review appoints for the following week and calculate the quantity of ARVs needed for patients visiting next week.
Frequency of ordering	Every day or every 2 days.	1week.
Ordering for in-transit patients	Orders the same/next day the patient arrives.	None, gives leftovers from defaulting or no-show patients.
Training	One nurse trained.	No one at the facility is trained on inventory control.
Coordination in patient care	Consistent rule communicated during meetings.	Each nurse has her own "rule" in managing poor adherence.

Conclusion and Recommendations for Namibia

Based on the qualitative description of the practices and behaviors given above, of these 30 identified practices and behaviors within the seven supply chain functions, we found trends and patterns in the following eight practice and behavior areas that were associated with the performance of the supply chain at health facilities in Namibia:

1) Calculation of Min–Max buffer stock (forecasting and quantification)

2) Use of national guidelines or training materials as reference for estimation of needs and reporting (forecasting and quantification)

3) Order verification before submission to the central/regional level of the order to the central level (forecasting and quantification)

4) Actions taken when stocks received from CMS/RMS (forecasting and quantification)

5) Late ordering of medicines (forecasting and quantification)

6) Frequency of issuing emergency orders (warehousing and inventory)

7) Communication with higher-level supply chain management (communication)

8) Communication with affiliated facilities (communication)

Eleven of the 30 practices and behaviors exhibited ambiguous patterns, meaning that we were not able to link any specific pattern of behavior or practices with facility performance:

1) Access to stock (warehousing and inventory management)

2) Assigning responsibility of inventory management tasks (warehousing and inventory management)

3) Decision on whether to redistribute short-dated stock (warehousing and inventory management)

4) Change in prescription during stock-out

5) Change in dispensing during stock-out

6) Communication within the pharmacy team (communication)

7) Communication within the clinic (communication)

8) Leadership/management style of the pharmacy (human resources)

9) Leadership management style of the clinic (human resources)

10) Training on stock management (human resources)

11) Attitude to workload of pharmacy staff (human resources)

For the remaining practices and behaviors, there was minimal variation across Namibian facilities:

1) Use of electronic systems (forecasting and quantification)
2) Order fill rate (forecasting and quantification)
3) Frequency of balancing stocks (warehousing and inventory management)
4) Location of storage (warehousing and inventory management)
5) Stored separately from other medicines (warehousing and inventory management)
6) Actions to ensure patient adherence (prescribing and dispensing)
7) Actions to ensure patient adherence (prescribing and dispensing)
8) Communication with hospital executives (communication)
9) Interaction between clinical and dispensing/stock systems (information management)
10) ART clinic/pharmacy separate from main pharmacy (infrastructure)
11) Implementation of policies on prescribing and dispensing (human resources)

We offer the following conclusions on the behaviors and practices associated with performance:

- *Calculation of Min–Max buffer stock:* Being able to calculate the maximum and minimum amount kept on stock in the facility was associated with better performance. In Namibia, the recommended guideline for maximum and minimum amount of stock in inventory was four months (max) and two months (min). In Namibia, we found that three of the four hospitals were able to state the maximum and minimum levels of stock that they keep in inventory. The staff in the "good-performing" hospital (Hospital A) in the "good-performing" region, knew the recommended guideline, but was actually keeping only 1.5 months of stock on hand as a minimum rather than two months. The two hospitals in the "below-expectation-performance" region were able to state what they calculated for maximum and minimum but were not using the recommended guideline for either maximum or minimum. The "below-expectation" facility in the "good" region stated that the maximum recommended amount should be six months, but noted that they were only keeping four months on the shelf. This facility did not state a minimum amount. It was noted that in all facilities there was confusion on the maximum and minimum calculation due to multiple trainings where different calculations were presented as well as the fact that the computer software used in quantification did not use the same calculation method.

- *Use of national guidelines or training materials as reference for estimation of needs and reporting:* Both of the "good-performing" facilities (in both the "good" region and the "below-expectation" region) seemed to be most familiar with the national guidelines and training material. The "good" hospital in Region 1 was located in close proximity to the regional pharmacist, who visited the facility and pharmacy frequently, reinforcing the national norms and provided hands on training. The "good" hospital in Region 2 had received training from SIAPS and referred to the training materials during the interview. The two "below expectation" facilities had the least amount of training. The senior pharmacist in the "below expectation" facility in Region 2 reported using "WHO guidelines" (which do not exist) rather than national guidelines and had received training from an online course.

- *Order verification before submission to the central/regional level:* In the two "good" facilities, regardless of region, the regional pharmacist verified orders before they were submitted. There was no verification in the "below-expectation" facilities.

- *Action taken when stocks are received:* There was some evidence linking "good" performers to better action taken when stocks received. The "good-performing" facility in the "below-expectation" region (Hospital C) showed the most urgency in the need to count, store, and record new stocks as they arrive. In the other three facilities, even in the "good" performer in the "good" region, there seemed to be less urgency or this was done on an alternating basis among the staff available.

- *Late ordering of medicines:* The only facility that had to submit a late order in the last few months was the "below-expectation" facility in the "good" region, suggesting a small association between "below-expectation" and late ordering.

- *Frequency of issuing emergency orders:* The only facility that does not use emergency orders was the "below expectation" facility in the "good" region, suggesting a small association between "below-expectation" and not using emergency orders.

- *Communication with higher-level supply chain management:* The best communication with higher-level, regional management (regional pharmacist) was in the two "good performing" facilities, regardless of region.

- *Communication with affiliated facilities:* This indicator showed evidence in the opposite direction. Those facilities classified as "below expectation" facilities (Hospitals B and D) had the better communication with their affiliated facilities. As mentioned above, staff at the "good" facility in region 1 complained that they go and train the personnel in their affiliated facilities, but they still do not maintain their stock correctly.

For the practice and behaviors where we could not associate a clear relationship between patterns of practices and behaviors and facility performance, we conclude that the results should be reviewed further in order to determine if additional guidelines are needed in these areas. For example, all facilities, regardless of performance, seemed to behave slightly differently in terms of who had access to stock. In the "good-performing" facility in the "good-performing" region, everyone had access to stock (Hospital A), while in the "good-performing" facility in the "below-expectation" region, the PA had strict rules on who was allowed access to stock. It is not clear from the study whether one practice is better than the other. Additional research is needed to understand this behavior; more or additional literature needs to be reviewed to determine best practices.

There was considerable ambiguity related to prescribing and dispensing practices. The results from this section suggest that the following five prescribing and dispensing practices need to be understood more fully before conclusions are drawn: changing formulation, changing the length of the prescription, changing the regimen and then changing back, changing the regimen and not changing back, and delaying prescribing the new regimen. Each of these prescribing and dispensing practices were mentioned by different Namibia facilities but did not link consistently

with facility performance. Each prescribing and dispensing practice needs to be understood for its clinical impact as well as impact on facility performance. An example of each type of practice is given below.

- *Changing the ART formulation:* A child comes to the facility to fill an ART prescription. The child normally takes the pill form of the prescription; however, the facility is out of the pill form so they prescribe the syrup formula instead.

- *Changing the length of the prescription:* The facility is short-stocked on an ART medication and the physician is planning an outreach session soon. In coordination with the pharmacy, the physician decides to prescribe only one month of each ART instead of two months and the patient can come back to the facility in one month to renew the prescription instead of in two months.

- *Changing regimens:* When a drug is stocked out, the prescriber changes the patient's regimen to another one during his first visit. If the drug is back in stock when the patient returns to refill the prescription, some prescribers will change the regimen back to the original regimen, while others simply continue the patient on the new regimen.

- *Delaying prescribing a new regimen:* The physician receives a circular on his/her desk from the MoHSS to prescribe a new medication. He/she prescribes the medication and then sends the patient to fill the prescription. The pharmacist calls his/her office telling her that the prescription is not in. The physician prescribes the old regimen and tells the patient to come back to get the new regimen.

- While redistribution was used by all facilities when they had short-dated stock, each facility undertook the process of redistribution slightly differently. Hospital A had a formal redistribution sheet that showed how much stock they had requested and received from other facilities. Hospitals B and C also rely on redistribution but did not have a formal sheet documenting these exchanges. Hospital D proactively calls other facilities and asks them for short-dated stock because they have such a large patient load and need lots of medications.

In the case of Namibia, there was significant variation across facilities, not related to performance, in the communication within the pharmacy team, communication with clinical team, and the leadership functions. Communication and leadership should link with performance, and these practices and behaviors need to be examined in further detail. Guidelines should be offered to facilities in both of these areas.

Most of the practices and behaviors that demonstrated minimal variation will not be considered closely in this study because there was no clear link to facility or upstream performance. However, some of these practices and behaviors need to be examined in more detail because they are important practices and behaviors for a functioning supply chain system. For example, for order fill rate, all facilities reported that they knew how to do this calculation and they had the data to do this calculation—but they only calculated order fill rate when it was needed for a

report. If this is an important indicator to track performance, it should be calculated more frequently by facilities.

Other practices and behaviors that demonstrated minimal variation showed the influence of donors and certain guidelines for influencing behavior. For example, all facilities had a separate storage area for ARVs. This was mostly due to donor requests when ARVs were first introduced in Namibia and these structures and procedures have remained in place.

Recommendations

- The understanding and the ability to calculate maximum and minimum amounts of stock, two important behaviors for maintaining the right amount of stock and lowering the number of stock-outs are key behaviors that need to be monitored. Facilities need to be monitored not only for the ability to perform the actual calculation, but for understanding the maximum and minimum calculation and the importance of this calculation.

- National guidelines need to be standardized and communicated to all facilities. Trainings need to be offered in all facilities throughout the country regardless of proximity to regional offices.

- One of the themes throughout the results in Namibia is the link to improved performance if the regional pharmacist is involved or linked with the practices. Regional pharmacist involvement was linked to better performance in the use of national guidelines and training, order verification, and communication with higher supply chain management. In the facilities not visited frequently by the regional pharmacist, performance was lower.

- The impact of prescribing and dispensing practices needs to be understood clinically (if these practices impact the health outcome of the patient) as well as in terms of impact on performance of the facility and any on upstream performance. Five different prescribing and dispensing practices were noted in the study and need to be examined in more detail.

- The practices of redistribution and emergency orders need to be examined. Currently, these two behaviors happen simultaneously and are inadequately guided, and they often occur as informal agreements between facilities. This implies that MOHSS Division Pharmaceutical Services is not aware of these transactions and CMS is not aware of what has been redistributed and where while they are preparing emergency orders. The pros and cons of a mechanism for monitoring redistribution and emergency orders should be discussed and guided.

FINDINGS IN CAMEROON

ARV Supply Chain in Cameroon

Cameroon is a Central African country with approximately 22 million inhabitants. It is divided into 10 administrative regions, each with a regional medical store, CAPR (Centres d'Approvisionnement Pharmaceutique Regionaux). CAPR is a functional unit at a regional level responsible for provision of medicines to health facilities within the region. While the operation of each CAPR varies from region to region, they all receive stock of ARVs from the central medical store, CENAME (Centrale Nationale d'Approvisionnement en Médicaments Essentials et Consommables Médicaux), based in Yaounde (Eghan and Daniel 2011).

The HIV and AIDS program is guided by the National AIDS Commission, and the day-to-day operation is the responsibility of the national program manager. The manager is responsible for quantification of national needs, development and implementation of HIV-related policies, and strategies and training of staff. ARVs are provided free of charge to patients in both the public and private sectors, though private facilities may request additional service charges. According to Eghan and Daniel (2011), there are 124 ART clinics in Cameroon, and ARVs are provided only through these health facilities. ARVs are procured by CENAME. Once received, they are distributed to CAPRs. CAPRs distribute to ART sites based on the needs of the specific clinics but when there is a national stock-out or limited quantities at the national level, ARVs are provided to all facilities on a rationed basis – "push system".

Selection Criteria

While there is no report that directly compares the performance of regions based on supply chain indicators, local experts recommended the increase in the number of patients on second-line regimens during 2013 as a proxy indicator of regional performances of the supply chain. The justification was based on the high stock-out rate of first-line regimens, and if facilities do not manage the supply of ARVs well, patients will have intermittent supply of ARVs, with the negative consequence of increased risk of HIV drug resistance and poor response to ART and will be consequently switched to second-line medicines. In Cameroon, some regions had a steady number of patients on second-line regimen, whereas others experienced significant increases. In this study, we consider the region with the lower increase in second-line regimen patients as a good-performing region.

When reviewing our findings below, it is important to note that the two regions may vary in terms of how much stock they receive from CENAME. The two regional hospitals have very different patient populations (such as differing socioeconomic status, with one hospital located in the Anglophone region of the country and the other in the francophone region) and receive different support and supervision from their regional management.

Within each region, local experts selected facilities with good and below-expectation performance using two measures: the discrepancies between patient figures and stock records, and the discrepancies between physical stock count and stock records.[2]

Comparison between the Two Regional Hospitals

It is important to note that the two regional hospitals are located in very different regions, and therefore may vary in terms of how much stock they receive from CENAME, patient populations (such as socioeconomic status and anglo- or francophone regions), and receive different support and supervision from its regional management. For this reason, we did not include the findings from comparing the two regional hospitals in the comparison table and final results, but provide descriptions of the two hospitals below.

We denote the regional hospital in the "good-performing" region as Hospital I, and the regional hospital in the "below-expectation" region as Hospital J. The two hospitals shared several common characteristics. For example, both hospitals have a separate building for the ART clinic, and have weekly Therapeutic Committee meetings that are attended by almost all staff members in the clinic. The clinic coordinators seemed to have very close relationship with the pharmacy managers, and regularly communicate on the stock status of ARVs in their facility. Both management teams seemed to be well trained and strict about who can access stocks or update stock cards. Both pharmacy technicians update the number on the stock cards and physical counts on a weekly basis. Both pharmacies are mainly managed by pharmacy technicians, though Hospital I also has a pharmacist who is sometimes involved in ARV management.

Forecasting and Quantification

Ordering Formula: The formula used for ordering stocks was the same in the two hospitals: both use three-month data to get the average monthly consumption level, and review the total number of patients on each regimen. However, they differ in the level of buffer stocks they order: Hospital I keeps at least two weeks of stock as buffer, whereas the manager at Hospital J said there is no standard approach in determining the right level of buffer stock.

Warehousing and Inventory Management

Control of Access to Stocks, Location, and Condition of Storage(s): Hospital I had two storage spaces for ARVs: one locked room and an open corridor at the back of the pharmacy managers' offices. Although they state that access to stock is very strict and only the manager and the pharmacist are allowed to move stocks, the open corridor is accessible to almost anyone. In addition, ARVs are not put in one same room or same section, but are in multiple sections of an open room. Hospital J's storage room was under renovation, and therefore it was hard to judge how organized it could be without the interruptions due to renovation work.

[2] It is important to note that data were not available for all facilities, and the research team does not have access to these facility indicators.

Table 7. Facility Comparisons—Cameroon

Category	Subcategory	Region 1		Region 2	
		Hospital K (Good Performing)	Hospital L (Below Expectation)	Hospital M (Good Performing)	Hospital N (Below Expectation)
Demand factors	Number of patients on treatment	~ 1,200 patients (only first-line)	~ 800 patients (only first-line)	~ 1,300 patients (both first- and second-line)	~ 2,400 patients (both first- and second-line)
ART pharmacy staff size	Number of staff	1 nurse and 1 assistant	1 nurse as manager; 3 assistants	1 PA	1 dispenser, 1 counselor
Forecasting and quantification (determination of quantity needed)	Min–Max buffer stock calculation	No Min–Max. Calculates average monthly consumption level (average of the most recent 3 months in which they did not experience stock-outs) minus current stock level.	No Min–Max. Takes the number of all patients on each regimen in the previous month, and adds the number of new patients they received this month. Does not take into account the current stock level, and even if they do, they may not have accurate numbers on the stock cards since they are balanced only every 3 months before CAPR's supervisory visits.	No Min–Max. Looks at 3-month average consumption from 3 latest typical (no stock-out) months by each regimen, minus current physical stock for forecasting. The staff is able to get the monthly data from the statistician who keeps track of the number of patients on each regimen.	No Min–Max. Staff stated that the numbers fluctuate significantly every month and therefore has difficulty in getting the number of patients on each regimen. Despite the challenge, they still use the number that is reported, take an average of the monthly consumption level from the past three months, and add a few containers to each order.
	Use of electronic systems	No			
	Use of national guidelines or training materials as reference for estimation of needs and reporting	No		No guideline; training material from national training.	
	Order verification before submission to central/regional level	Verified by hospital coordinator.			

Category	Subcategory	Region 1		Region 2	
		Hospital K (Good Performing)	Hospital L (Below Expectation)	Hospital M (Good Performing)	Hospital N (Below Expectation)
Forecasting and quantification (determination of quantity needed)	Order fill rate	Do not calculate order fill rate, but claim that most orders have low order fill rate (sometimes less than 50%).	Often less than 50%.	Do not calculate order fill rate, but claim that most orders have low order fill rate.	
	Late ordering of medicines	Not an issue.			
	Frequency of issuing emergency orders				
Warehousing and inventory management	Actions taken when stock received	Not applicable (done by main pharmacy)	Goes to CAPR to collect stocks and checks physical count at CAPR. Updates the stock cards immediately upon arrival, but does not check physical count upon return to facility.	Goes to the regional store to collect stocks, checks physical count, and checks invoice at regional store. Transports, receives, and updates stock card with quantity and expiration dates immediately upon returning to hospital.	
	Control of access to stocks	Only the nurse in charge of ARVs has access.	Since ARVs are kept with other medicines, all clinicians and staff members have access to the rooms.	Stockrooms were locked and only a few staff members have access (but not limited to ARV management staff).	
	Assigning responsibility of inventory management tasks	1 nurse in charge of ARVs.	2 nurses in charge of ARVs.	1 trained staff (not pharmacist, PA, nor nurse) to manage ARVs.	
	Frequency of balancing stocks (checking stock cards vs. physical count)	ARV nurse places internal orders to the main pharmacy daily or every 2 days, and usually orders 2 cartons. Uses stock	Balances stock every 3 months; does not count what is in the dispensing room; stock cards kept in dispensing room and not storage.	Keeps stock cards in the dispensing room, but uses two cards for each medicine—one to keep track of the stock level in the dispensing room,	Keeps two stock cards for each medicine, but keeps one card in the dispensing room and another in the storage. The cards are updated

Category	Subcategory	Region 1		Region 2	
		Hospital K (Good Performing)	Hospital L (Below Expectation)	Hospital M (Good Performing)	Hospital N (Below Expectation)
		cards both at the main pharmacy and the dispensary, but both cards are kept at the dispensary. At the end of the week she summarizes how much she ordered in a book. Never checks actual physical count.		and the other for the storage room. The staff updates the cards at the end of the each day based on how much was dispensed. Physical count at the dispensing room and the storage is checked every day.	every time ARVs are taken to the dispensing room, and all cards are balanced every two weeks.
Warehousing and inventory management	Location and condition of storage (whether all in one place or separate rooms)	Keeps all ARVs in one single storage room; no temperature control.	Keeps ARVs in multiple stockrooms that are located in different corners of the campus; no temperature control, all ARVs in boxes and not on shelves.	Keeps all ARVs in one single storage room; no temperature control, all ARVs in boxes and not on shelves; requested a thermometer.	Keeps all ARVs in a single storage room.
	Stored separately from other medicines	Yes	No, stored with other medicines.	Yes	
	Decision on whether to redistribute short-dated stock	No			
Prescribing and dispensing	Change in prescription during stock-out (e.g., switch regimen)	Changes length of prescription; if hospital coordinator learns that quantity of one drug is low, she will ask all prescribers to prescribe 10 days rather than 1 month, and asks patients to come back. If aware that both CAPR and CENAME have a shortage, then	Delay new regimen due to current stock; first asks patients if they have some pills left at home—if yes, they postpone the appointment to a later date. If not, they change regimen after discussing with doctor.	When stock-outs occur and patients are switched to a new regimen, patients will be changed back to the old regimen as soon as the old regimen becomes available.	

Category	Subcategory	Region 1		Region 2	
		Hospital K (Good Performing)	Hospital L (Below Expectation)	Hospital M (Good Performing)	Hospital N (Below Expectation)
		switches regimen. All doctors do the same, change to same regimen, same number of days.			
Prescribing and dispensing	Change in dispensing during stock-out (shorten length of prescription period)	Shortens from 1 month to 2 weeks.			
	Actions to ensure patient adherence (e.g., pill count)	Does not do pill counts; the nurse claims she trusts patients and either asks them to go back and finish the drug, or gives half of whatever is missing in the regimen; always registers as 1 full bottle given even if only half given; no systematic way of tracking how much given during pill count.	Does not do pill counts.	Clinicians used to perform pill counting, but stopped doing so a while back. If the patients bring their old pill bottles to the hospital, the staff will simply extend their appointment and ask them to come back 3 days before they finish the treatment.	The pharmacy performs pill counting, records the number of pills left in the patient record, and expends the appointment to whenever they are expected to finish the treatment.
Communication	Communication within the pharmacy team	Only 1 nurse in charge of ARVs.	Only 1 nurse in charge of ARVs; there is a senior pharmacist in charge of all drugs, but he seems disengaged with ARV management. The senior pharmacist claimed that everyone in the pharmacy was trained on stock management, but the ARV nurse said she was never trained, and	Only 1 staff in charge of ARVs.	

Category	Subcategory	Region 1		Region 2	
		Hospital K (Good Performing)	Hospital L (Below Expectation)	Hospital M (Good Performing)	Hospital N (Below Expectation)
			stock cards were not used for ARVs prior to her arrival.		
Communication	Communication within the clinic (with clinicians and other staff, in general and in stock-out situations)	Has strong relationship with the coordinator and feels comfortable raising concerns or questions. Attends weekly therapeutic committee meeting where all dispensers attend with physicians. The dispensers report stock availability. Even if some physicians didn't attend, the coordinator will inform other prescribers.	Good communication	An HIV counselor (and not ARV management staff) reports the stock level to the coordinator only when the stock is close to 0 (they did not have a clear definition of what "shortage" means). The staff first calls the regional office to see if they have stock, and only if the regional office is also out of stock will she then communicate this to the coordinator.	Reports the level of stock every morning to the coordinator during the morning meetings, and works with the coordinator to decide which medicines are in shortage. Compared to Hospital M, the staff at Hospital N seemed to have a closer relationship with the coordinator.
	Communication with hospital/clinic executives	Received strong support from the hospital coordinator and seem to have regular communication with clinicians with regard to stock level.		Good communication.	
	Communication with higher-level supply chain management offices (e.g., regional office, CMS)	When there are stock-outs or issues that need to be communicated to the regional office, the nurse first communicates to the hospital coordinator, who will then contact CAPR.	The nurse directly calls CAPR without going through the hospital coordinator.	Calls the regional office before placing an order to check their stock level and updates the stock cards immediately upon receiving the physical stock from the regional office.	
	Communication with affiliated facilities	No affiliated facilities.			

Category	Subcategory	Region 1		Region 2	
		Hospital K (Good Performing)	Hospital L (Below Expectation)	Hospital M (Good Performing)	Hospital N (Below Expectation)
Information management	Interaction between clinical and dispensing/ stock systems	None			
Infrastructure	ART clinic/ pharmacy separate from main pharmacy	Separate			
Human resources	Perception of team dynamic	Good relationship with other hospital staff.			
	Training on stock management	None		Attended national/SIAPS training.	
	Implementation of policies on prescribing and dispensing	Articulated clear policy of not letting patients go home without any medicines. Both the nurse and hospital coordinator mentioned that this is often emphasized during weekly therapeutic meetings.	None		
	Attitude to workload of pharmacy staff	Nurse complained that she has many other tasks in addition to managing ARVs, and often feels she is not performing all tasks as well as she hopes.	Nurse is comfortable with the workload she is assigned because she is not responsible for any other work at the facility.	Staff is happy with the workload she is assigned.	Staff considers her workload as heavy, especially because she is also responsible for counseling patients.

Both hospitals had poor storage space—there were no shelves and no temperature control. All ARVs were in boxes, one piled above another in the small space. As mentioned above, Hospital I kept stock cards in the storage room, but not Hospital J.

Use of Stock Cards, Balancing Stocks: In terms of stock cards, Hospital I maintains two sets of stock cards, one in the storage and one at the dispensing room, which are updated every day. Hospital J keeps only one set of stock cards for both dispensing and storage rooms, and keeps the cards in the manager's office. Comparing the practices to the standard "good" practice of keeping just one in the storage room, neither hospital is meeting the standard. However, both managers were strict and diligent in updating and balancing the cards.

Prescribing and Dispensing

Change in Prescription during Stock-out: One of the biggest differences was the practice of changing/switching patients to different regimens when there is a shortage. While both hospitals change/switch patients to another first-line or second-line regimen when there is shortage, Hospital I does not change/switch patients back to the old regimen when it is available again. In other words, patients will continue with the new regimen unless there are clinical side effects. Hospital J, on the other hand, changes/switches the patients back to the old regimen. Both practices have a significant impact on the analysis of consumption patterns and predictability of requirements, significantly contributing to oscillations in consumption patterns.

Actions to Ensure Patient Adherence: Another observed difference is whether staff members do pill counts. Hospital I does not do pill counts, and rely on the patient's appearance or other clinical signs to check adherence. Pill counting in Hospital J is performed by registration staff, but not everyone does it since it increases their workload. The method in which the pharmacy technician gives out medicines based on pill counts is as follows: if the patient comes with the registration staff with less than half a month of medicines, she gives a full one-month prescription and extends the next appointment to a date that is three days before he/she runs out of medicines. If the patient has more than half a month of stock, she changes the next appointment to an earlier date.

Implementation of Policies on Prescribing and Dispensing: Hospital I has a very strict policy that emphasizes that no patients should leave the facility without medication. All staff members stated this policy during our communications and stated that this was a position the higher-level management of the hospital had communicated. This means that a patient will take home some medicines even if he/she had to switch or change to a new regimen. This kind of policy was not present in Hospital J.

Good-Performing Region (Region 1)

The two district hospitals in the good-performing region shared many similarities. Instead of pharmacists or PAs, nurses were in charge of dispensing and managing ART supplies, and neither had a registration clerk referred to as a "statistician" for keeping dispensing records. Both hospitals used stock cards and kept them in the offices and not the storage rooms. Both pharmacies received support from the hospital coordinators and seem to have regular

communication with clinicians with regard to stock level. We identified four categories of behaviors and practices that varied between the two facilities: stock management, staff workload, communication with the regional pharmacy, and hospital policy of whether to let patients go home without any medicines.

We denote the good-performing hospital as Hospital K and the below-expectation-performing one as Hospital L. The hospitals have roughly 1,200 and 800 ART patients, respectively.

Forecasting and Quantification, Warehousing, and Inventory Management

Balancing Stocks, Control of Access to Stocks: First, neither nurse had received any training on inventory management (though the senior pharmacist in Hospital L stated that he had trained every dispenser and pharmacy manager). The nurse in Hospital K places internal drug orders to the main pharmacy every day (or whenever they run out of ARVs at the dispensary), and usually orders two cartons each time. She said that stock cards are used both at the main pharmacy and the dispensary, though both sets of stock cards were seen at the dispensary. At the end of the week, she summarizes how much was ordered in a book. The nurse never checks actual physical counts at the pharmacy/storage, because she "trusts the pharmacist at the main pharmacy, and the pharmacist trusts [her]." At Hospital L, on the other hand, stock cards are also kept at the dispensary, and the nurse updates the stock cards whenever she moves the drugs from the storage to the dispensing room. However, she does not know how much is at the dispensary. This is further complicated by the fact that Hospital L keeps ARVs in multiple storages that are located in different rooms and corners of the facility where medicines are stored. Since ARVs are kept with other medicines, all clinicians and staff members have access to the rooms. They only balance stocks (compare physical stock to the numbers on stock cards) once every three months, right before scheduled supervisory visits by CAPR.

Ordering Formula: In terms of ordering from the regional pharmacy, Hospital K orders the average monthly consumption level, calculated by taking the average of the most recent three months in which they did not experience stock-outs, minus current stock level. Hospital L, on the other hand, takes the number of all patients on each regimen in the previous month, and adds the number of new patients they received this month. They do not take into account the current stock level, and even if they do, they may not have accurate numbers on the stock cards since they are balanced only every three months, right before CAPR's supervisory visits.

Communication

Communication within the Facility, Changes in Prescribing and Dispensing Patterns: At Hospital K, every Tuesday there is a Therapeutic Committee meeting where all four dispensers attend with the physicians. The dispensers report stock availability. Even if some doctors did not attend, the coordinator will inform other prescribers about available products and thus the recommended change in prescription. If the coordinator learns that quantity is low, they will prescribe 10 days rather than one month, and ask patients to return before they run out of medications. If the coordinator is aware that there is a shortage of specific ARVs at the CAPR and CENAME, she will coordinate with the prescribers to switch/change patients to another regimen for a fixed number of days. The nurse in charge of managing ARVs will dispense 10

days to two weeks of medicines during shortages, based on stock availability and the number of patients that are on the regimen.

Communication with Higher-Level Supply Chain Management Offices: When there are stock-outs or issues that need to be communicated to the regional office, the nurse at Hospital K first communicates to the hospital coordinator, who will then contact CAPR. The nurse at Hospital L, on the other hand, directly calls CAPR without going through the hospital coordinator. The difference in the communication approach may have an effect on the relationship between the facility and CAPR and the information and stocks the hospitals receive, though we were not able to assess which approach is more beneficial and practical to the health workers providing ART services.

Human Resources

Attitude to Workload and Team Dynamics: The nurse at Hospital K complained that she has many other tasks in addition to managing ARVs, and often feels she is not performing all tasks as well as she hopes. The nurse in charge of managing ARVs at Hospital L says that she is comfortable with the workload she is assigned because she is not responsible for any other work at the facility. She has a good relationship with the coordinator and is comfortable raising concerns or questions.

Implementation of Policies on Prescribing and Dispensing: Hospital K had a very clear policy of not letting patients go home without any medicines. Both the nurse and hospital coordinator mentioned that this is often emphasized during weekly therapeutic meetings. This was not mentioned at Hospital L.

Hospitals in Below-Expectation-Performing Region (Region 2)

We denote the better-performing hospital as Hospital M, and the lower-performing one as Hospital N. The hospitals have roughly 800 and 2,500 ART patients, respectively.[3]

Each hospital had a trained staff (not pharmacist or PA) to manage ARVs. Although neither of them had SOPs or guidelines that they referred to, they showed us the training materials they received from previous trainings conducted by SIAPS and MOH. Perhaps for this reason, we observed many similarities in their practices. Both staff call the regional office before placing an order to check their stock level and update the stock cards immediately upon receiving the physical stock from the regional office. The stockrooms were locked and only a few staff members have access. When stock-outs occur and patients are given/switched to a new regimen, they will make sure that these patients are changed back/ switched back to the old regimen as soon as the old regimen becomes available.

[3] Our original intent was to select two public hospitals for comparison; however, during our interview with the regional NAAC office we learned that Hospital M is a private hospital and Hospital N is a faith-based public hospital. Furthermore, the NAAC staff suggested that the two hospitals have similar performances in terms of ARV management, but Hospital N performs slightly better than M, which is contradictory to our initial assumption.

Forecasting and Quantification

Ordering Formula: The two hospitals ordered ARVs differently. To estimate the monthly order, Hospital M reviewed average consumption from three latest typical (no stock-out) months by each regimen, minus current physical stock. The staff is able to get the monthly data from the "statistician" (data clerk) who keeps track of the number of patients on each regimen. Hospital N, however, has difficulty in getting the number of patients on each regimen. The staff stated that the numbers fluctuate significantly every month and therefore they have difficulty tracking the right number. Despite the challenge, they still use the number that is reported, take an average of the monthly consumption level from the past three months, and add a few containers to each order (roughly 100 units as a buffer for each medicine).

Warehousing and Inventory Management

Balancing Stocks and Control of Access to Stocks: With regard to the use of stock cards, Hospital M keeps the cards in the dispensing room, but uses two cards for each medicine—one to keep track of the stock level in the dispensing room, and the other for the storage room. The staff updates the cards at the end of the each day based on how much was dispensed. Physical count at the dispensing room and the storage is checked every day. Hospital N also keeps two stock cards for each medicine, but keeps one card in the dispensing room and another in the storage area. The cards are updated every time ARVs are taken to the dispensing room, and all cards are balanced every two weeks.

Prescribing and Dispensing

Actions to Ensure Patient Adherence: The staff at Hospital M stated that the clinicians used to perform pill counting, but stopped doing so a while back. If the patients bring their old pill bottles to the hospital, the staff will simply extend their appointment and ask them to come back three days before they finish the treatment. The pharmacy at Hospital N performs pill counting, records the number of pills left in the patient record, and expends the appointment to whenever they are expected to finish the treatment.

Communication

Communication within the Facility: Hospital M reports the stock level to the coordinator only when the stock is close to zero (they did not have a clear definition of what "shortage" means). The staff first calls the regional office to see if they have stock, and only if the regional office is also out of stock will she then communicate this to the coordinator. A HIV counselor was present at both interviews we conducted at Hospital M, one with the coordinator and another with the ARV staff. The counselor seemed to have a very good relationship with both the coordinator and the ARV staff, and we learned that it was the counselor, not the ARV staff, who communicates the ARV stock level to the coordinator. Hospital N reports the level of stock every day to the coordinator during the morning meetings, and works with the coordinator to decide which medicines are in shortage. Compared to Hospital M, the staff at Hospital N seemed to have a closer relationship with the coordinator.

Human Resources

Attitude to Workload: The staff at Hospital M said she is happy with the workload she is assigned, whereas the staff at Hospital N considers her workload as heavy, especially because she is also responsible for counseling patients.

Conclusion and Recommendations for Cameroon

Based on the qualitative description of the practices and behaviors given above, of these 30 identified practices and behaviors within the seven supply chain functions, we found trends and patterns in the following seven practice and behaviors that were associated with performance of the supply chain at the health facility level in Cameroon:

1) Actions taken when stocks received from CMS/RMS (forecasting and quantification)
2) Control of access to stock (warehousing and inventory management)
3) Location and condition of storage (warehousing and inventory management)
4) Storing ARVs separately from other medicines (warehousing and inventory management)
5) Communication with higher-level supply chain management (communication)
6) Training on stock management (communication)
7) Implementation of policies on prescribing and dispensing (human resources)

Eight practices and behaviors exhibited ambiguous patterns, meaning that we were not able to link them with any performance of the supply chain at health facility level:

1) Calculation of Min-Max/buffer stock (forecasting and quantification)

2) Use of national guidelines or training materials as reference for estimation of needs and reporting (forecasting and quantification)

3) Frequency of balancing stocks (warehousing and inventory management)

4) Change in prescription during stock-out

5) Adherence (prescribing and dispensing)

6) Communication within the clinic (communication)

7) Communication with hospital management (communication)

8) Attitude to workload of pharmacy staff (human resources)

Interestingly, some of the practices and behaviors that we consider best practices were performed in the below-expectation facilities rather than the good-performing facilities. This is likely due to the limitation in selecting facilities, based on insufficient evidence, as described above.

There was minimal variation across facilities in Cameroon for the remaining practices and behaviors:

1) Use of electronic systems (forecasting and quantification)

2) Order verification before submission to the central/regional level (forecasting and quantification)
3) Order fill rate (forecasting and quantification)

4) Late ordering of medicines (forecasting and quantification)

5) Frequency of issuing emergency orders (forecasting and quantification)

6) Assigning responsibility of inventory management tasks (warehousing and inventory management)

7) Decision on whether to redistribute short-dated stock (warehousing and inventory management)

8) Change in dispensing during stock-out

9) Communication within the pharmacy team (communication)

10) Communication with affiliated facilities (communication)

11) Interaction between clinical and dispensing/stock systems (information management)

12) ART clinic/pharmacy separate from main pharmacy (infrastructure)

13) Perception of the team dynamic (human resources)

14) Existence of lack of training or orientation programs (human resources)

Our conclusions on the behaviors and practices at the health facility level that are associated with accomplishment of supply chain functions include the following:

- Actions taken when stocks received from CMS/RMS: There was some evidence linking below-expectation performers to less ideal actions taken when stocks received. The below-expectation-performing facility in Region 1 does not check physical count of the received stock from the regional office, whereas the other facilities check physical count immediately upon returning to the hospital.

- Storage access and location: At the below-expectation-performing facility in Region 1, ARVs were stored in multiple locations at the facility and all clinicians, including non-ART physicians and nurses, had access to ARVs. Other facilities maintain strictly controlled access to ARVs.

- Communication with higher-level supply chain management: Comparing the two facilities in Region 1, the good performer contacts the regional office through the hospital coordinator, whereas the nurse at the below-expectation-performing facility directly contacts the regional office whenever there is shortage. In Region 2, both facilities call the regional office on a monthly basis before placing an order to check the regional office's stock level.

- Training on stock management: No one in the two facilities in Region 1 was trained on ARV stock management, whereas staff in the two facilities in Region 2 attended trainings conducted by SIAPS.

- Articulation and implementation of policies on prescribing and dispensing: The staff at the good-performing facility in Region 1 clearly articulated the hospital policy of not letting patients go home without any medicines. Both the nurse and hospital coordinator mentioned that this is often emphasized during weekly therapeutic meetings.

For the practice and behaviors where we could not associate a clear relationship between patterns of practices and behaviors and facility performance, we conclude that the results should be reviewed further in order to determine if additional guidelines are needed in these areas, which include the following:

- *Calculation of Min-Max buffer stock buffer stock:* none of the facilities had a well-defined method of calculating maximum and minimum level of stock, and each had its own way of forecasting how much to order each month.

- *Use of national guidelines or training materials as reference for estimation of needs and reporting:* none of the facilities use the national guideline, but the two facilities in Region 2 use the training materials provided by MSH in recent trainings.

- *Frequency of balancing stocks:* The frequency with which the staff balances the numbers on the stock card to the physical stock varies between facilities, but it is interesting to note that the good-performing facility in Region 1 never balances stocks, which is against what is described as best practice.

- *Change in prescription during stock-out:* While the practice of shortening the prescription performed by the dispensers (pharmacy) is consistent across facilities, the way in which prescribers (physicians) adjust prescription during stock-outs varies significantly.

- *Actions to ensure patient adherence:* Region 2's below-expectation-performing facility is the only one that conducts pill counts, though in general we are unclear of the extent to which performing pill count to check patient adherence affects ARV stock management.

- *Communication within the clinic and with hospital executives:* In Region 1, pharmacy staff at the good-performing facility maintains a strong relationship with the clinic coordinator and feels comfortable raising concerns or questions. They attend weekly therapeutic committee meetings where the pharmacy reports stock availability. The

pharmacy staff at the below-expectation facility also has a good relationship with the coordinator but communication was not as systematic. In Region 2, however, it was the below-expectation facility that had closer relationship with the coordinator.

- *Attitude to workload of pharmacy staff:* The evidence here is mixed. In Region 1, the nurse at the good-performing facility complained about her workload, stating that she is assigned to many other tasks in addition to managing ARVs, and feels that she is not performing the tasks as well as she would like. The nurse at the below-expectation facility is happy with the workload because she is not assigned to other tasks. In Region 2, the staff at the good-performing facility is satisfied with the workload, whereas the staff at the below-expectation facility complained about the workload, especially because she not only manages ARVs but is also responsible for counseling patients

Most of the practices and behaviors that demonstrated minimal variation will not be considered closely in this study because there was no clear link to facility or upstream performance. However, some of these practices and behaviors need to be examined in more detail because they are important practices and behaviors for a functioning logistics system.

Recommendations

- Four of the behaviors and practices that were linked with performance related to strengthening norms and behaviors around order verification, control and access to stock, location and condition of storage, and where ARVs are stored. Not following norms around these behaviors and practices was linked with poorer performance. **Best practices and guidelines around these four activities should be developed and reviewed at the facility level.**

- Due to the frequent stock-outs of ARVs, prescribers and dispensers often have to decide on changing the regimen and dosages for patients. We found huge variations in the adjustments they make, how the adjustments are communicated between groups, and how changes are recorded. Because there is no national SOP for dealing with shortages or stock-outs, facilities are often left to make these decisions on their own. **National trainings or guidelines on regimen switches and how to handle shortages should be developed for both prescribers and dispensers.**

- As in Namibia, there is a link to improved performance with more regional contact. In Cameroon, if this contact is enhanced through a hospital coordinator, performance was also improved. The role of the hospital coordinator should be reviewed to understand how performance is improved.

- There was confusion in the facilities on record keeping and the books required for this task. **The record-keeping process should be simplified or additional training is needed on record keeping. We recommend that policy makers and donors consider the adoption of a standard electronic system for the management of pharmaceutical records and information along with trainings and mentorship to improve ordering and reporting processes.**

While the findings from the comparisons between selected regions and facilities in Cameroon are informative and interesting, we should caution about the accuracy of our results due to flaws in the process of selecting regions and facilities. First, we were not able to find any report that directly compares inventory management performances at the regional level. Even though local experts suggested one region as better performing than the other, the national-level officials did not agree and stated that the performance of both regions was similar and therefore less likely to show a significant difference in practices and behaviors. The decision to consider one region as better performing than the other was also reversed several times before the final decision was made, suggesting that the difference in performance was not minimal. Second, the local team was not able to provide facility-level data to determine which facility was considered better performing, and similar to the region-level comparison, the regional pharmacist was not able to determine which selected facility performed better than the other. With these caveats in mind, we are limited in making statements on what supply chain–related behaviors and practices contribute to better/poorer inventory management. However, these broader observations and recommendations should still provide some insights for policy makers when considering how to improve the supply chain of ARVs in Cameroon.

FINDINGS IN SWAZILAND

ARV Supply Chain in Swaziland

Swaziland operates an integrated supply chain for medicines and medical supplies, with laboratory commodities stored separately. The CMS, a government entity, oversees the procurement, storage, and distribution of all pharmaceuticals and clinical supplies for use in public health facilities in the country, including ARVs. The Ministry of Health in Swaziland manages approximately 224 public health facilities, including 8 hospitals, 5 health centers, 8 public health units, and about 218 clinics. CMS distributes ARVs directly to about 45 ART-initiating hospitals and health facilities on a staggered monthly schedule. The hospitals and health centers are then responsible for delivering to their (feeder) "baby" clinics.

Selection Criteria

An assessment of the ARV supply chain was conducted at the facility level in Swaziland. Unlike Namibia and Cameroon, because of Swaziland's smaller size, we were unable to select facilities based on the performance of the region. Instead, facilities were chosen based on their individual performance and were located in three regions compared to two regions in the Namibia and Cameroon study designs. The second and third regions were close together and are referred to as Region 2 in the analysis below. In addition, Swaziland only has four regions in total and two of the regions chosen for inclusion in the study only have one hospital, making a comparison of hospitals within these regions impossible. As shown in Table 8, the facilities were classified as good-performing facilities and below-expectation-performing facilities based on expert opinion and performance for the following indicator: months of stock on hand (MoSH).

Comparison of the Four Hospitals in Swaziland

Since Swaziland is a small country, it was difficult to compare facilities across different regions; and the supply chain of ARVs has been in flux most recently. For this reason, it was also difficult to classify facilities as good performers or facilities that needed to improve their performance in certain areas as some of these indicators had changed most recently. For example, one of the facilities that had been classified as having good performance, based on the months of stock on hand (MoSH) prior to our visit, was one of the facilities that most recently had some stock-outs and failed to submit their order on time to CMS, which would have then classified them as a facility that needed to improve their performance. For these reasons, the comparison in Swaziland is made across all hospitals rather than across hospitals within regions.

Table 8. Facility Comparisons—Swaziland

Category	Subcategory	Region 1		Region 2	
		Hospital O (Good)	Hospital P (Below Expectation)	Hospital Q (Good)	Hospital R (Below Expectation)
Demand factors	Number of patients on ART	~ 9,000 HIV patients; 11 baby clinics	~ 6,000 HIV patients; 20 baby clinics	~ 9,000 HIV patients; 20 baby clinics	~10,000 HIV patients; 10 baby clinics
ART pharmacy staff size	Number of staff	1 senior pharmacist, 4 pharmacy technicians, 4 orderlies	2 pharmacists	1 senior pharmacist, 1 nurse dispenser	1 senior pharmacist, 2 pharmacists, 8 pharmacy technicians, 3 storeroom clerks
Forecasting and quantification (determination of quantity needed)	Calculation of Min–Max buffer stock/buffer stock	Max 3 months, Min 1 month; some confusion on Min	Max 3 months, Min 1 month	Nurse dispenser did not use Min/Max and based ordering on consumption in last month; senior pharma-cist checks orders.	Max 3 months, Min 1 month, and uses monthly consumption from pharmacy electronic system.
	Use of electronic systems	Patient electronic record and prescription linked to pharmacy electronic system, RxSolution, AIDS Patient Medical Record (APMR); backlog in APMR from baby clinic prescriptions and HRH.	Patient electronic record and prescription linked to pharmacy electronic system, RxSolution (APMR); no backlog, but pharmacist has questions on APMR.	Patient electronic record and prescription linked to pharmacy electronic system, RxSolution (APMR), but physician does not initiate patient file with electronic system, but passes paper forms to nurse dispenser and data clerks input; backlogged due to temporary computer problem.	Patient electronic record and prescription linked to pharmacy electronic system, RxSolution (APMR); backlog due to staff shortages.
	Use of national guidelines or training materials as reference for estimation of needs and reporting	Training focused on pharmacy electronic system (APMR); quarterly training with MSH and government.			
	Order verification before submission to the central/regional level	Order done by senior pharmacist in coordination with team.	Orders done by 1 of the 2 pharmacists in this facility; no verification.	Orders done by nurse dispenser; verified by senior pharmacist.	Orders done by ARV pharmacist, verified by senior pharmacist .

Category	Subcategory	Region 1		Region 2	
		Hospital O (Good)	Hospital P (Below Expectation)	Hospital Q (Good)	Hospital R (Below Expectation)
Forecasting and quantification (determination of quantity needed)	Actions taken when stock received	Boxes unpacked 2–3 days after they arrive at the pharmacy, when team has time.	Boxes unpacked as they arrive, when pharmacist has time.	Boxes unloaded to a separate storage area in town and then dispensed to the facility as needed on a daily basis.	Boxes unloaded and unpacked by storeroom clerks when they arrive.
	Order fill rate	Not calculated; about 1 (out of 15) ARV not filled in last order (December 2013).	Not calculated; had to send 3 emergency orders in last 6 months.	Not calculated, reported that it used to be 100% now closer to 60–100%.	Not calculated; about 2 (out of 16) ARVs not filled in last order (December 2013).
	Late ordering of medicines	Late order on most recent order due to backlog on data input from baby clinics.	No late order; had all information from baby clinics.	No late order; had backlog of data input from baby clinics but used monthly consumption estimations to get order in on time.	Late order; backlog from baby clinics and staff shortages.
Warehousing and inventory management	Access to stock	Storeroom is locked and there is a fixed schedule of who has access on certain days/times.	Senior pharmacist has access at all times.	Storage is in a separate facility and they have a storeroom clerk who goes and gets stock; senior pharmacist has access too.	Storeroom managed by 3 storeroom clerks who rotate on different storeroom tasks (unloading, updating stock cards, etc.).
	Assigning responsibility of inventory management tasks	Fixed schedule and people have certain tasks assigned.	One pharmacist in charge at all times; shares tasks with other pharmacist.	Nurse dispenser in charge of day-to-day operation with senior pharmacist monitoring.	Some type of schedule based on job description; tasks shared with larger team.
	Frequency of balancing stocks (checking stock cards vs. physical count)	Every time stock moved from storage.		When storeroom clerk takes stock from storeroom.	
	Location and condition of storage (whether all in one place or separate rooms)	New storeroom, upstairs, air-conditioned.	Small storeroom, in facility.	Separate storage area, off-site, in town.	New storeroom, separate from pharmacy, air-conditioned.

Category	Subcategory	Region 1		Region 2	
		Hospital O (Good)	Hospital P (Below Expectation)	Hospital Q (Good)	Hospital R (Below Expectation)
Warehousing and inventory management	Stored separately from other medicines	All in same storeroom.	All in same storeroom.	Could not verify.	All in same storeroom.
	Decision on whether to redistribute short-dated stock/anticipate stock-out	Only mentioned emergency orders; did not mention redistribution.	Assistance with redistribution is sometimes provided through support from donors (e.g., MSF)	Redistribution from baby clinics while senior pharmacist makes emergency order.	Redistribution among other facilities after emergency order.
	Frequency of issuing emergency orders	Calls CMS, sends emergency order; has sent 1 emergency order in last 6 months.	Calls CMS, sends emergency order.	Calls CMS.	Calls CMS, sends emergency order.
Prescribing and dispensing	Change in prescription during stock-out	Changes length of prescription based on patient's situation (ability to come back).	Changes formulation: uses syrup or breaks up adult tablet.	Do not change prescription with stock-out; relies on dispenser to locate drugs with redistribution.	Change regimen with stock-out; relies on dispenser to locate drugs with redistribution.
	Change in dispensing during stock-out	Gives 1 month instead of 3.	No reported changed in dispensing during stock-out.		
	Actions to ensure patient adherence (e.g., pill count)	They all do pill count.			
Communication	Communication within the pharmacy team	Large team, senior pharmacist in charge, there are set internal meetings and specific tasks are assigned to each individual.	Small facility with 2 pharmacists; 1 senior pharmacist and 1 assistant, minimal team effect mentioned.	Nurse dispenser in charge of daily operations, senior pharmacist in charge of overall management but is located in larger pharmacy in different location within the hospital.	Large team, senior pharmacist in charge; leads internal meeting every Thursday.
	Communication within the clinic (with clinicians and other staff, in general and in stock-out situations)	Some communication; some frustration on part of physician for lack of data input; there are	Pharmacist communicates with physician if there is a stock issue; no formal communication, no	Weekly meeting with clinicians; nurse dispenser did not report whether senior pharmacist attends.	Weekly meetings among clinical staff, but pharmacist does not attend or had not been invited recently.

Category	Subcategory	Region 1		Region 2	
		Hospital O (Good)	Hospital P (Below Expectation)	Hospital Q (Good)	Hospital R (Below Expectation)
		weekly meetings, but pharmacists do not attend (as reported by physician).	weekly meeting; some noted frustration with physicians from pharmacist (i.e., how prescription filled out).		
Communication	Communication with hospital/clinic managers	This type of communication was not mentioned in Swaziland.			
	Communication with higher-level supply chain management offices (e.g., regional office, CMS)	If they stock-out they call CMS, send in emergency form; have only had 1 stock-out in last 6 months (as of December 2013).	If they need stock, they call CMS first, then call donors (MSF) to help source stock from their reserves.	If they need stock, senior pharmacist calls CMS, nurse dispenser calls baby clinics for supply.	If they need stock, calls CMS, sends emergency order, calls other facilities, changes dosage if necessary.
	Communication with affiliated facilities	Frustration with baby clinics for late orders.	Close communication with baby clinics has improved on-time ordering.	Frustration with baby clinics for backlog of data input.	Close communication with baby clinics has improved on-time ordering.
Information management	Interaction between clinical and dispensing/stock systems	Systems are linked but lots of backlog on prescription input.	Systems are linked but some confusion on reconciling inputting errors on pharmacy electronic system.	Systems are linked but lots of backlog on prescription input.	Systems are linked but lots of backlog on prescription input due to HR issues.
Infrastructure	ART clinic/pharmacy separate from main pharmacy	ART clinic/pharmacy integrated with main pharmacy.		ART clinic/pharmacy separate from main pharmacy.	ART clinic/pharmacy integrated with main pharmacy.
Human resources	Leadership/management style of pharmacy	Senior pharmacist in charge but works with pharmacy team	Two pharmacists who work together; one is clearly in charge and enthusiastic about her work.	Nurse dispenser in charge on a daily basis, senior pharmacist overseas.	Senior pharmacist is in charge of a large team with one pharmacist working specifically on ARV.
	Leadership/management style of the clinic	A number of physicians attending to HIV and regular patients in the same clinic.	Physician working in HIV clinic.	A number of physicians attending to HIV patients in an HIV clinic.	Did not visit the clinic.

Category	Subcategory	Region 1		Region 2	
		Hospital O (Good)	Hospital P (Below Expectation)	Hospital Q (Good)	Hospital R (Below Expectation)
Human resources	Team dynamic	Senior pharmacist and large team; rotate responsibilities.	Senior pharmacist in charge; she does most activities.	Nurse dispenser is supervised by senior pharmacist.	Senior pharmacist in charge of large team with one pharmacist working specifically on ARV.
	Training on stock management	No in-service training; most of the pharmacists had been trained in pre-services pharmacy school.	Senior pharmacist had been recently trained by MSH; enthusiastic to be working in the pharmacy rather than seeing patients.	Nurse dispenser had minimal formal training.	Pharmacy school training for most on pharmacy team.
	Implementation of policies on prescribing and dispensing	Not addressed during interview.	Not addressed during interview.		
	Attitude to workload of pharmacy staff	Workload split between team with specific schedule; senior pharmacist managed schedule.	Senior pharmacist does all activities.	Nurse dispenser does day-to-day management of pharmacy; senior pharmacist does ordering and overseeing.	Workload divided into clear responsibilities outlined through each individual job description and coordinated by senior pharmacist.

Forecasting and Quantification

Interestingly, all of the hospitals included in the study were performing similarly with regard to some of the main logistic supply activities related to the supply chain for ARVs, such as calculation of Min-Max buffer stock, use of national guidelines and training, order verification, order fill rate, and receiving stock. This revealed two important findings. First, the MOH, in coordination with donors, has been successful in training the hospital pharmacists in the main activities related to supply chain for ARV management. Secondly, since there was minimal variation in these forecasting and quantification functions, the variation in the other activities discussed below are important for tracking performance.

Use of Electronic Systems: Swaziland has been transitioning facilities to electronic records. They use two linked systems. The APMR is the electronic medical record system used to manage clinical data, while RxSolution is the stock management system used to track prescriptions issued and for management of stock. All four hospitals had been experiencing different types of technical problems with the two systems. All facilities had different levels of backlog in updating information into the system, which was causing problems related to ordering. Each facility reported slightly different problems and different reasons for the backlog. Hospital O, for example, reported backlog because they had just lost one of their main data clerks, who had been funded initially by the Global Fund and then was not absorbed by the government at the end of the contract in December 2013. In addition, they had a considerable amount of data from their baby clinics that needed to be updated into the system. They were trying to figure out how to task shift within their team to accommodate this gap. Hospital P, the smallest of the hospitals and with the smallest pharmacy team, had the least amount of backlog but did have some other technical questions regarding how to operate the computer and software. The pharmacist in Hospital P had reported calling the MOH's IT officers for help but not having much response. Hospital Q had some temporary backlog due to high volume of patients and having some short-term technical problems with the computer. Hospital R, reported backlog in their system due to human resources shortage.

Although not listed in the table above, the variation in the different data management issues at the hospital level impacted the facilities' immediate performance with regard to whether they submitted their most recent ARV order on time. Hospitals O and R, which had the greatest challenges with their electronic systems due to staff shortages and delays in receiving data from their baby clinics, reported that they had not submitted their most recent ART orders (January 2013). Hospitals P and Q, which also had some backlog issues and data issues but no human resources issues, had submitted their most recent orders to CMS. In both cases (Hospital P and Q), they had used the old written (not computer-generated) LMIS form to submit their orders and used consumption data from the previous month (November) instead of relying on the data from the electronic systems.

Warehousing and Inventory Management

Similarly, there was minimal variation across facilities for many of the warehousing and inventory management functions. The function that varied the most was what facilities did if they needed stock.

Decision on Whether to Redistribute Short-dated Stock: There was some variation across facilities with regard to their actions in terms of redistribution of short-dated stock. It is important to note that facility activities with regard to short-dated stock are similar to how they handle stock-outs. All facilities would call CMS. In this regards, each facility performed slightly differently. Hospital O would call CMS and then they would also send in an emergency order form with a van to pick up the order when it was ready. Hospital P would call CMS and then they would call organizations, such as MSF, to see if they had extra stock. Hospital Q would call CMS and then the nurse dispenser would call their baby clinics to see if they had extra stock. Hospital R would call CMS, send an emergency order, and then call other facilities. Overall, there was a general sense of commitment, especially in Hospital Q, that any patient arriving at a facility should not leave without their ARVs, and each facility would perform these actions to acquire the medication.

The final behavior that varied slightly across hospital pharmacies was what actions they took in response to stock-outs. All pharmacists in the hospitals reported that they would call CMS and then send in an emergency order if CMS said they had the medicine in stock. All pharmacists also said that they would dispense differently in coordination with the physician. For example, in Hospital Q they were currently stocked out of lamivudine for children. Instead of giving them the soluble pill formula, they were dispensing syrup or the adult tablet split in four parts according to the weight of the child. Other facilities reported giving only a one-month dose of a product until more stock arrived. The standard practice in the country is to dispense three months of stock for all patients who have been on treatment for longer than six months and are adherent to treatment. The nurse dispenser in Hospital Q also said that while they waited for CMS to let them know whether to deliver the emergency order, they would call their baby clinics to determine if they had any surplus of the product.

Communication

The most interesting results of the study and the area that needs to be investigated further relates to the level of communication within and across entities and how this impacts performance.

Communication within the Pharmacy Team: This aspect of communication varied across facilities and also was associated with the size of the facility and pharmacy team. If the team was larger (as in Hospital O and R), there tended to be a senior pharmacist who was in charge and the different members of the team had specific functions and roles. The smallest facility, Hospital P, only had two pharmacists on duty and there was less sense of a team. Hospital Q was a large facility, but since the ART pharmacy was not yet integrated within the larger pharmacy, the staff operated on their own under the overall indirect supervision of the senior pharmacist, with daily management accomplished by a nurse dispenser.

Communication within the Facility: Communication within the facility, between the pharmacy and clinical staff, was poor. There are weekly clinical meetings but the pharmacists rarely attend. There is minimal formal communication. The pharmacists rely on ad hoc communication as problems/issues arise.

Communication with Higher Levels of Supply Chain Management : This was discussed above as well; results show that all facilities communicate formally and when needed with CMS, but due to the slow response by CMS they sometimes then initiate other activities (reaching out to donors, baby clinics, or to other facilities) to obtain stock before CMS responds.

Communication with Affiliated Facilities (Baby Clinics): Each facility had a slightly different relationship with their baby clinics. Hospitals O and Q both complained of data issues and backlog on inputting prescription and patient file data caused by their baby clinics. The pharmacies in these hospitals expressed frustration that their baby clinics were not submitting orders on time. On the other hand, the teams at Hospitals P and R (even though Hospital R also had some backlog of data input) had reported that they had worked with their baby clinics in order to help them place their orders in on time. The head nurse at the ART clinic in Hospital R reported that they had helped the baby clinics understand the schedule for submitting their order and made sure that the driver was available to pick up their orders. The pharmacist in Hospital P said that their order submission rate had increased last year from 63% to 100% because they were able to work with the baby clinics to help them get their orders in on time.

Human Resources

Each facility had their own story to tell about how they were overworked and there were not enough personnel for all the tasks they had to accomplish. Each facility also handled the workload slightly differently. The common theme noted across all facilities, especially the larger ones, was that they were overworked because many of the facilities had lost workers due to nonrenewal of employment contracts for staff who were contracted under the Global Fund.

ARV Management Responsibility: In each hospital visited, there was one person in charge of the overall functioning of the pharmacy. In the two larger facilities, Hospitals O and R, there was a person with the title of senior pharmacist who was in charge of a team. In each of these facilities, Hospital O and R, the senior pharmacist developed a set schedule of tasks for the pharmacy team. In Hospital P, there was a senior pharmacist who did most of the tasks with help from the other pharmacist; however, there was no clear set schedule. In Hospital Q, there was a senior pharmacist in the main pharmacy who oversaw all the activities in the ART pharmacy, which was located in the ART clinic and managed by a head nurse dispenser. Similar to Hospital Q, there was no set schedule and the nurse dispenser did most of the day-to-day managing of patients and medications with close supervision from the senior pharmacist.

Leadership/Management Style: The leadership/management style that governed each of the pharmacies varied as well. As mentioned above, in each pharmacy there was clearly someone who was in charge. In Hospital O, the senior pharmacist was in charge of the other pharmacist and pharmacist technicians. The senior pharmacist in Hospital O, for example, allowed two of the pharmacy technicians to answer questions from our interview on their own before joining us to clarify certain issues. If the two pharmacy technicians were unsure of the answer to a question they said we should wait and ask the senior pharmacist, demonstrating her value as a leader in the pharmacy. In Hospital P, the senior pharmacist was in charge of all activities, but again, not in a domineering way. Rather, she was enthusiastic about her job and sharing some of the tasks with the other pharmacist in the facility. Since Hospital Q had not yet fully integrated their ART

pharmacy into the main pharmacy, the senior pharmacist in this location was managing the main hospital pharmacy as well as the ART pharmacy. The senior pharmacist allowed a nurse dispenser, who had been working in the ART clinic for many years, to manage the day-to-day operations in the ART dispensary, while the senior pharmacist oversaw and supervised these activities. In Hospital R, it was difficult to truly judge the leadership style of the senior pharmacist, as she was at a workshop and we did not meet her. However, the pharmacist interviewed from this facility deferred some questions to the senior pharmacist because she was unsure of the answers, having just been transferred to this facility from Hospital O.

Comparison of Three Baby Clinics in Swaziland

In Swaziland, we were able to make comparisons between three baby clinics. The fourth baby clinic that had been selected had just become an independent health facility, ordering ARVs directly from CMS rather than their mother hospital, so it could not be compared to the other baby clinics that order through their hospitals.

Similarly to the hospital analysis, the baby clinics had certain activities in which they were all behaving in a similar manner. For example, there was minimal variation with regard to many of the logistics supply chain activities, such as ordering, calculating Min-Max, inventory management, and availability of a storeroom for pharmaceutical stock. There were differences across baby clinics for the following behaviors/practices: communication with their mother facility, data transfer to the mother facility, internal schedule, emergency orders, and independence.

Communication with the Mother Facility: Communication with the mother facility is essential for many of the upstream indicators as the mother facility is the one that provides the baby clinics with ARVs and where the baby clinic submits their orders and has the most contact. Of the three baby clinics, Baby Clinics A and C had the best communication with their mother facility. They reported being able to call immediately if there was a question on stock level, prescribing, or a clinical issue with the patient. Baby Clinic B had not had a good system of communication with their mother facility, which in this case was a health center and not a hospital, over the last year. There was minimal communication and transfer of patient data and most recently Baby Clinic B was having stock-outs of certain medications because their mother facility was delivering less than they had ordered or not delivering at all.

Data Transfer to the Mother Facility: Similarly to the pattern above, Baby Clinics A and C had worked out a clear system of data transfer of patient information from baby clinic to the mother facilities. For example, in Baby Clinic A, they send new patient files every fourth day to the mother facility. A driver from the mother facility would come and pick up the files. In Baby Clinic B, the nurse dispenser in charge reported that they had not sent patient records to their mother health center for almost a year.

Internal Schedule: In Baby Clinics A and C, there was a nurse who was either in charge of the other nurses and set the schedule for who would be working on which activities (Baby Clinic A) or a nurse who was assigned to all the logistics functions for ART (Baby Clinic C). In these two baby clinics, the schedule was understood by everyone and if someone was not there, someone

else was in charge of the activities related to ART prescribing, dispensing, and logistics. In Baby Clinic B, there seemed to be less of a schedule. The day we went to visit this baby clinic, the head nurse was not there and the nurse in charge of the facility and the expert clients seemed uncomfortable answering questions related to the supply chain and practices and behaviors regarding ARVs.

Issuing of Emergency Orders: If there was an issue with a particular stock, all three facilities called their mother facilities. Baby Clinics A and C, who had better communication with their mother facilities, had a specific mechanism in place to submit their emergency order. Baby Clinic A used a plain piece of paper with the order and an official stamp from their baby clinic. Baby Clinic C sends an LMIS reporting form with just the order for that medication signed by the person requesting the order from the baby clinic. Baby Clinic B reported calling for their order, but it was not clear what type of official paperwork accompanied this call. Baby Clinic B reported that most recently these emergency orders were not granted.

Independence: Those baby clinics with the best communication with their mother clinics did not desire to become independent and begin ordering their ART supplies directly from CMS. Baby Clinic B on the other hand, when asked what practice/behavior they thought would improve their performance (i.e., less stock-outs, getting emergency orders filled) responded that being able to order directly from CMS would help them perform better and keep their stock within the necessary Min/Max levels.

Conclusions and Recommendations for Swaziland

There was much more ambiguity in the results for Swaziland compared to Namibia or Cameroon. One potential reason for this was that facilities did not vary as much as in Namibia or Cameroon with regard to the one performance indicator that was used to classify facilities (MoSH). For this reason, it was more difficult to associate behaviors with facility performance.

Based on the qualitative description of the practices and behaviors given above, of these 30 identified practices and behaviors within the seven logistical function areas, we found trends and patterns in the following three practice and behavior areas that showed a strong association with performance in Swaziland:

1) Order verification before submission to the central/regional level (forecasting and quantification)

2) Decision on whether to redistribute short-dated stock/anticipate stock-out (warehousing and inventory management)

3) Communication with affiliated facilities (communication).

Fifteen of the 30 practices and behaviors exhibited ambiguous patterns, meaning that we were not able to link any specific pattern of behavior or practices with facility performance. In

Swaziland, each of the facilities demonstrated slightly different patterns/some association for the following practices and behaviors, making it difficult to draw any firm conclusions:

1) Calculation of Min-Max buffer stock (forecasting and quantification)

2) Actions taken when stocks received from CMS/RMS (forecasting and quantification)

3) Late ordering of medicines (forecasting and quantification)

4) Control of access to stock (warehousing and inventory management)

5) Assigning responsibility of inventory management tasks (warehousing and inventory management)

6) Issuing emergency orders (warehousing and inventory)

7) Change in prescription during stock-out

8) Change in dispensing during stock-out

9) Communication with higher-level supply chain management (communication)

10) Communication within the pharmacy team (communication)

11) Communication within the clinic (communication)

12) Leadership/management style of the pharmacy (human resources)

13) Leadership management style of the clinic (human resources)

14) Training on stock management (human resources)

15) Attitude to workload of pharmacy staff (human resources)

For the remaining practices and behaviors, there was minimal variation/no association across Swaziland facilities:

1) Use of national guidelines or training materials as reference for estimation of needs and reporting (forecasting and quantification)

2) Use of electronic systems (forecasting and quantification)

3) Order fill rate (forecasting and quantification)

4) Frequency of balancing stocks (warehousing and inventory management)

5) Location of storage (warehousing and inventory management)

6) Stored separately from other medicines (warehousing and inventory management)

7) Actions to ensure patient adherence (prescribing and dispensing)

8) Communication with hospital executives (communication)

9) Interaction between clinical and dispensing/stock systems (information management)

10) ART clinic/pharmacy separate from main pharmacy (infrastructure)

11) Implementation of policies on prescribing and dispensing (human resources)

We offer these conclusions on the behaviors and practices associated with performance:

- *Order Verification before Submission to the Central/Regional Level:* In three out of the four hospitals included in the Swaziland study, there was a larger pharmacy team where work was supervised by a senior pharmacist in the team. This team environment allowed for orders to be verified and reviewed before submission. The "below expectation" hospital in Region 1 was the only facility where there were only two pharmacists on duty and orders were not verified before submission.

- *Decision on Whether to Redistribute Short-dated Stock/Anticipate Stock-out:* There was a small association between not having to distribute short-dated stock and good performance. If the "good" facilities in Region 1 (Hospital O) did not receive all their stock in an order, they would call CMS and send in an emergency order form, but did not call other facilities or donors to receive stock more quickly. If the other three facilities did not receive all their stock in an order, they would call CMS and send in an emergency order, but also either call donors to see if they had stock (Hospital P), call their baby clinics to see if they had stock (Hospital Q), and/or call other facilities nearby (Hospital R).

- *Communication with Affiliated Facilities:* The results for communication with affiliated facilities were interesting. Those facilities that were rated as "below expectation" facilities (Hospitals P and R) actually reported having better communication with their affiliated baby clinics. The "good" performing facilities expressed more frustration with their baby clinics for not submitting their orders on time (Hospital O) and contributing to the backlog of data (Hospital Q).

For ambiguous patterns—patterns that were not consistent enough to allow any conclusion to be drawn regarding the link with facility performance—we offer the following conclusions:

The majority of practices and behaviors in Swaziland demonstrated mixed results, or results that were not consistent with "good" or "below-expectation" performance. This could be for two reasons. First, there was minimal variation in performance across facilities, which led to

difficulties in linking differences in practices and behaviors to performance. Secondly, Swaziland is a country with a high level of donor support and a strict process of inventory management of ARVs due to the large investment. To ensure that personnel working in ARV clinics and dispensary are adequately skilled in managing, ordering, and dispensing a high volume of ARVs As a result, Swaziland has developed a logistics system that functions fairly well across all facilities, and minimal association with performance was detected.

For example, we could not make any conclusions on whether the practice and behavior for calculating maximum and minimum was linked with performance. This was because three out of the four facilities used the three-month maximum, one-month minimum guideline. The fourth facility, which was classified as the "good" facility in Region 2, did not use the three-month maximum, one-month minimum, but still had enough stock on hand and the senior pharmacist verified the calculations.

Leadership style and communication within the pharmacy team and with the ART clinical staff/ART clinic, varied in Swaziland but not in a way that linked with performance.

In regard to practices and behaviors that demonstrated minimal variation, we offer the following conclusions:

Some of the practices and behaviors that did not demonstrate any variation in Swaziland need to be examined further to determine if these behaviors need to be changed. For example, all the facilities responded in the same manner when asked about the use of national guidelines and training. All the facilities had been trained most recently on the electronic medical record system that was being implemented and none had reported receiving training on some of the basic logistics function areas.

All facilities responded the same way with order fill rate as well: no one calculated it, but the data were available to determine order fill rate. Calculating order fill rate should be encouraged as it is important for monitoring performance.

Recommendations

- Order verification and redistribution of stock were two key practices and behaviors that linked with positive performance for facilities in Swaziland. **Best practices and guidelines around these behaviors should be developed and applied to all facilities and examined for potential best practices across countries.**

- **The results from Namibia, where more practices and behaviors were linked to performance, should be analyzed for their relevance and application to Swaziland**.

- There were many practices and behaviors in Swaziland that were ambiguous or exhibited minimal variation. Additional research needs to be conducted to understand how these practices and behaviors can be analyzed further to understand their association with performance in Swaziland and also to understand how facility performance may be linked with other factors. A broader, more empirical study design is needed for this.

SYNTHESIS OF COUNTRY FINDINGS AND OVERALL CONCLUSIONS

This study is one of the few country comparisons conducted to better understand the factors that contribute to better supply chain management performance. This is also one of the few studies that seek to understand facility-level practices and behaviors that may affect central-level performances. As shown in the individual country results above, based on the literature and the individual country analyses, we identified 30 specific practices and behaviors that were hypothesized to be linked to performance in the logistics supply chain for ARVs within the following seven logistic supply chain function areas: forecasting and quantification, warehousing and inventory management, prescribing and dispending, communication, information management, infrastructure, and human resources.

Of these 30 specific practices and behaviors, we found trends and patterns in the following 14 practice and behavior areas that could be associated with performance in at least one country:

1) Calculation of Min-Max buffer stock (forecasting and quantification)

2) Use of national guidelines or training materials as reference for estimation of needs and reporting (forecasting and quantification)

3) Order verification before submission to the central/regional level (forecasting and quantification)

4) Late ordering of medicines (forecasting and quantification)

5) Issuing emergency orders (forecasting and quantification)

6) Actions taken when stocks received from CMS/RMS (forecasting and quantification)

7) Control of access to stock (warehousing and inventory management)

8) Decision on whether to redistribute short-dated stock (warehousing and inventory management)

9) Location of storage (warehousing and inventory management)

10) Storage of ARVs separately from other medicines (warehousing and inventory management)

11) Communication with higher-level supply chain management (communication)

12) Communication with affiliated facilities (communication)

13) Training on stock management (human resources)

14) Implementation of policies on prescribing and dispensing (human resources)

Eleven of the 30 practices and behaviors exhibited ambiguous patterns. This meant that we were not able to link any specific pattern of behavior or practices, either within country or across countries, with performance of the facility. However, this did not signify that the results were null. On the contrary, the variation in patterns for these behaviors and practices indicated that either no best practice has been identified, or if there has been a best practice identified in this area, not all the facilities were following this best practice. For these areas, we recommend that the literature be reviewed in detail and guidelines developed for countries and facilities. These 11 practices and behaviors were:

1) Assigning responsibility of inventory management tasks (warehousing and inventory management)

2) Frequency of balancing stocks (warehousing and inventory management)

3) Change in prescription during stock-out (prescribing and dispensing)

4) Change in dispensing during stock-out (prescribing and dispensing)

5) Actions to ensure patient adherence (prescribing and dispensing)

6) Communication within the pharmacy team (communication)

7) Communication within the clinic (communication)

8) Communication with hospital executives (communication)

9) Leadership/management style of the pharmacy (human resources)

10) Leadership management style of the clinic (human resources)

11) Attitude to workload of pharmacy staff (human resources)

For the remaining practices and behaviors, there was minimal variation within and across countries, so we could not make any conclusions with regard to how the practices and behavior linked with performance. This does not mean that these practices and behaviors were not identified as important. On the contrary, as they were included in our list of practices and behaviors, they were patterns that were noted with consistency across facilities. In most cases, the lack of variation was also an important result. For example, it was of importance that for most facilities the information was available to calculate order fill rate, but no facilities were actually doing this on a regular basis. Most facilities were calculating order fill rate only for reporting purposes. The following practices and behaviors showed minimal variation across and within countries:

1) Use of electronic systems (forecasting and quantification)
2) Order fill rate (forecasting and quantification)
3) Patient monitoring (prescribing and dispensing)
4) Interaction between clinical and dispensing/stock systems (information management)
5) ART clinic/pharmacy separate from main pharmacy (infrastructure)

More research is needed to more precisely understand which behaviors and practices affect the performance of supply chain management at the facility level. This study serves as a first step in narrowing the range of possible factors into a manageable list, and provides measurable indicators to facilitate future research.

Of the 14 specific practices and behaviors, we identified an association in at least two countries for the following four behaviors. For each of these, we list the two countries that demonstrated consistent association with behavior and a further description of this association:

1) Order verification before submission to the central/regional level (Namibia and Swaziland)

2) Actions taken when stocks received from CMS/RMS (Namibia and Cameroon)

3) Communication with higher-level supply chain management (Namibia and Cameroon)

4) Communication with affiliated facilities (Namibia and Swaziland)

In Namibia and Swaziland, those facilities that had one individual or a team working on their monthly order and then another individual verifying the order tended to have better performance. Those facilities that did not incorporate any type of order verification (no one to verify, lack of communication with higher authority on verification) tended to have lower performance.

In Namibia and Cameroon, quicker and more diligent action taken when stocks were received was associated with better performance. In one of the good-performing facilities, it was noted that the "PA clearly articulated the urgency of counting, storing and recording new stocks that arrive." Those facilities that delayed counting, storing, recording new stock, and immediately checking physical count when stock is received were below-expectation facilities.

In Namibia and Cameroon, communication with the regional pharmacist on a regular basis was associated with better performance. While this mechanism was not noted in Swaziland, as there was no regional pharmacist, key informants indicated that a regional pharmacist would be helpful.

In Namibia and Swaziland, while all facilities communicated with their lower-level facilities, in the good-performing facilities, more was expected from their affiliated facilities and complaints were made if facilities did not abide by rules for submitting documents and communicating with the higher-level facilities. In below-expectation facilities, additional effort was made to coordinate outreach and assist their affiliated facilities with abiding by the rules.

As part of synthesis of the country finding, two tools were developed to guide the next phase of the analysis. This study is one of the few country comparisons conducted to better understand the factors that contribute to better supply chain management performance. This is also one of the few studies that seeks to understand facility-level practices and behaviors that may affect central-level performances. The development of these tools (outlined in Tables 9 and 10) will facilitate

the next phase of the analysis that should focus on measuring the magnitude of association between facility-level behaviors and practices and central-level indicators.

The first tool is outlined in Table 9. Table 9 identifies 19 common central-level indicators and possible links between these indicators and the 30 behaviors and practices identified in the three country analyses. The central-level indicators in Table 9 are taken from the key literature in the field, including USAID's *Measuring Supply Chain Performance* (2010) and *Logistics Indicators Assessment Tool* (LIAT) (2008), as well as SCMS's *National Supply Chain Assessment* tool (2013). The link between the 30 identified behaviors and practices and the 19 central-level indicators is based on literature review and the results of the three country case studies. Some of the behaviors and practices are linked with more than one central-level indicator. The tool can be used to understand how to improve specific central-level indicators through specific facility-level behaviors.

Future research is needed to determine the magnitude and relative strength of each of these relationships. For example, if the country team is interested in improving forecasting accuracy at the central level, the forecasting accuracy for a number of facilities could be measured; the level of forecasting accuracy could then be ascertained by assessing the degree to which facilities perform the following behaviors that may be linked to this central-level indicator: calculation of Min-Max buffer stock, use of national guidelines or training materials as reference for estimation of needs and reporting, actions taken when stocks are received from CMS/RMS, communication with affiliated facilities, and training on stock management. The identification of these behaviors and practices as well as development of new indicators provides policy makers with new approaches to improve facility-level performance, such as offering trainings related to communication with internal and external staff, development of new guidelines on how to adjust prescribing and dispensing patterns during shortages, or limiting access to ARVs in storage to selected staff at the facility.

The second tool is presented in Table 10 (also discussed in Recommendation 2). Table 10 links the 30 behaviors and practices identified in this study to measurable indicators that were either identified during our literature review or developed by the study team (in bold). Measurable indicators in some categories, such as forecasting, quantification, and warehousing and storage, are standard indicators readily available from existing reports and tools, and have often been used in various country studies on supply chain management. Other categories, such as prescribing and dispensing practices, communication with internal and external teams, have rarely been identified as key behaviors and practices that may affect supply chain management in previous work. The identification of these behaviors and practices as well as development of new indicators provide policy makers with new approaches to improve facility-level performances, such as offering trainings related to communication with internal and external staff, developing new guidelines on how to adjust prescribing and dispensing patterns during shortages, or ensuring ARV storages are only accessible by the manager and not all hospital staff.

RECOMMENDATIONS

There are four recommendations based on the results of this study. The first two recommendations use the results from the tools developed in Tables 9 and 10 to lay the ground work for the next potential phase of research in this study. Recommendations 3 and 4 present some interesting results of the study that need further investigation and can be used to motivate for some smaller, descriptive studies on the importance of communication in supply chain function and the variation in dispensing and prescribing practices.

Recommendation 1

Use the results in Table 9 to identify the key mechanisms by which the 30 identified facility-level behaviors and practices can lead to better central-level performance. Table 9 below identified the link between 19 common central level indicators and each of these 30 behaviors and practices listed. Based on the literature review and the results of the three country case studies, we have identified possible links between central-level indicators and the 30 identified behaviors and practices. Some of the behaviors and practices may be linked with more than one central-level indicator. Future research is needed to determine the magnitude and relative strength of each of these relationships. The research design used in the analysis above characterized facilities as "good" and "below-expectation" performers based on several varying performance indicators. A more rigorous study design would examine in detail specific central-level indicators and track how the different proposed behaviors and practices impact these central-level indicators. For example, if the country team is interested in improving forecasting accuracy as measured at the central level, forecasting accuracy for a number of facilities could be measured and then the level of forecasting accuracy could be examined by comparing facility behaviors for the following behaviors that may be linked to this central level indicator: calculation of Min-Max buffer stock, use of national guidelines or training materials as reference for estimation of needs and reporting, actions taken when stocks received from CMS/RMS, communication with affiliated facilities, and training on stock management. The identification of these behaviors and practices as well as development of new indicators provide policy makers with new approaches to improve facility-level performance, such as offering trainings related to communication with internal and external staff, development of new guidelines on how to adjust prescribing and dispensing patterns during shortages, or limiting access to ARVs in storage to selected staff at the facility.

As part of this recommendation, we also suggest defining more concretely the definition of central-level indicators. Based on our observation, the central-level indicators currently used in the literature can be categorized into two types: the first type measures the performance of supply chain management practices at central medical stores (for example, the stock-out rate at CMS), whereas the second type simply aggregates performance indicators of facilities into a national indicator (for example, percentage of facilities that experienced stock-outs in the past six months in the country). **We believe it is crucial for policy makers and researchers to differentiate the two types of central-level indicators and determine which type is of greater interest**. This differentiation is key to the next phase of the analysis. Using only central medical

store indicators requires an empirical analysis across a number of countries. Using aggregated central-level indicators that can be measured at the facility level allows for an in-depth, in-country analysis.

Recommendation 2

Review the indicators that are currently being collected to measure the 30 behaviors and practices identified in this study and investigate how to use the recommended indicators for further measurement. One of the main outcomes of this research has been to identify 30 facility-level behaviors and practices that link to supply chain performance. Table 10 outlines the related measurable indicators that were either identified during our literature review or were developed by the study team. Measurable indicators in some categories, such as forecasting, quantification, and warehousing and storage, are standard indicators readily available from existing reports and tools, and have often been used in various country studies on supply chain management. Other categories, such as prescribing and dispensing practices, and communication with internal and external teams, have rarely been identified as key behaviors and practices that may affect supply chain management in previous work. The availability of these measures needs to be investigated and verified for a number of countries.

The next step of this study should be a downstream indicator assessment (using indicators listed in Table 10) and cross-walk to relevant upstream central-level indicators (using the central level indicators in Table 9). A database can be created, depending on data availability, within a country or across countries to test some hypotheses with empirical data for how certain behaviors and practices link to upstream, central-level performance. This database should be robust and include measures that control for other facility-level characteristics (i.e., patient load, type of facility, etc.) .

Recommendation 3

The facility behaviors and practices related to communication need to be investigated further to understand the importance of and type of communication that improves facility performance. The results above showed that communication is important and potentially linked to performance, and needs to be measured in different ways. We identified four different types of behaviors linked to communications: (1) communication with the pharmacy team, (2) communication within the facility, (3) communication with higher-level hospital/clinic executives, (4) communication with higher-level supply chain, and 5) communication with affiliated facilities. We identified the strongest link to performance as better communication with higher-level authorities, especially regional pharmacists, as well as communication with affiliated facilities on a daily basis. While the area of communication has been measured and studied more frequently in the hospital management and organizational fields, less has been done examining how communication and different types of communication can impact supply chain functions. This area needs to be explored further. In Table 10, we have identified a number of new indicators that can be used to measure different aspects of communication and how they impact facility-level and central-level supply chain outcomes.

Recommendation 4

The facility behaviors and practices related to prescribing and dispensing practices need to be investigated further to understand their importance and how variations in these practices affect facility performance. The results of this research demonstrated that more needs to be done to understand how prescribing and dispensing practices and behaviors impact performance. Based on the results of our surveys, four prescribing and dispensing practices were identified at the facility level: (1) changing formulation (i.e., giving a child the pill form of a medication instead of the syrup), (2) changing the length of a prescription (i.e., giving an individual one month instead of two months depending on stock availability), (3) switching/changing regimens (i.e., changing a regimen due to stock levels and then deciding whether to switch this individual back to the original regimen when stock returns or keeping the individual on the new regimen), and (4) delaying the prescription of a new regimen. All four of these prescribing and dispensing practices were discovered through our key informant interviews. Additional research needs to be done to understand if these prescribing and dispensing practices are discussed in the literature, how frequently they are practiced, and their impact on health outcomes, adherence to ART, and the management of the supply chain.

Table 9. Proposed Links between Central-Level Supply Chain Indicators and Facility-Level Behaviors and Practices

	Central-level indicators	Definition	Associated facility-level behaviors and practices
Key indicators	Stock-out rates	Percentage of facilities that experienced a stock-out of one or more tracer commodities during a defined reporting period	All indicators
	Stocked according to plan	Percentage of facilities with stock levels above the established minimum level and below the established maximum level for a set of tracer commodities, over a given reporting period	
Forecasting and supply planning	Forecasting accuracy	Percentage of difference between forecasts previously made for a year and the actual consumption or issues data for that year	*Stronger evidence* • Calculation of Min-Max buffer stock • Use of national guidelines or training materials as reference for estimation of needs and reporting • Actions taken when stocks received from CMS/RMS • Communication with affiliated facilities • Training on stock management *Ambiguous evidence* • Change in prescription during stock-out • Change in dispensing during stock-out • Actions to ensure patient adherence • Communication within the clinic
	Percentage of forecasts and updates completed as per SOPs	Percentage of supply plans that are updated according to the established SOPs	*Stronger evidence* • Calculation of Min-Max buffer stock • Use of national guidelines or training materials as reference for estimation of needs and reporting • Training on stock management *Ambiguous evidence* • Assigning responsibility of inventory management tasks

	Central-level indicators	Definition	Associated facility-level behaviors and practices
Forecasting and supply planning	Planned versus emergency orders and planned versus unplanned orders	Percentage of emergency or unplanned orders in comparison to the total number of orders placed	*Stronger evidence* • Calculation of Min-Max buffer stock • Use of national guidelines or training materials as reference for estimation of needs and reporting • Frequency of issuing emergency orders *Ambiguous evidence* • Change in prescription during stock-out • Change in dispensing during stock-out • Actions to ensure patient adherence • Communication within the clinic • Leadership/management style of the pharmacy • Leadership management style of the clinic
	Percentage of emergency orders issued in the last 12 months	Percentage of purchase orders (POs) or contracts that are issued as emergency orders compared to all POs or contracts placed during a defined period of time	*Stronger evidence* • Calculation of Min-Max buffer stock • Use of national guidelines or training materials as reference for estimation of needs and reporting • Frequency of issuing emergency orders • Implementation of policies on prescribing and dispensing *Ambiguous evidence* • Change in prescription during stock-out • Change in dispensing during stock-out • Actions to ensure patient adherence • Communication within the clinic • Leadership/management style of the pharmacy • Leadership management style of the clinic
Warehousing and inventory management	Percentage of total stock that expired in previous reporting period	The quantity and value of tracer commodities deemed unusable because of expiry as a percentage of the total quantity and value available for use at the central medical store. Expiration is	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Actions taken when stocks received from CMS/RMS

Central-level indicators	Definition	Associated facility-level behaviors and practices
	determined by the product label date of expiry	• Decision on whether to redistribute short dated stock *Ambiguous evidence* • Frequency of balancing stocks • Actions to ensure patient adherence
Order fulfillment rate	The number of units of product issued by the warehouse compared against the number of items ordered	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Late ordering of medicines • Communication with higher level supply chain management
Percentage of storage facilities meeting acceptable storage condition	Percentage of storage facilities meeting acceptable storage condition	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Access to stock • Location of storage • Stored separately from other medicines • Training on stock management
Percentage of facilities with up-to-date stock cards	Percentage of facilities surveyed that have up to date stock cards or electronic WMS systems	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Actions taken when stocks received from CMS/RMS • Access to stock • Decision on whether to redistribute short dated stock • Stored separately from other medicines • Training on stock management *Ambiguous evidence* • Assigning responsibility of inventory management tasks • Frequency of balancing stocks • Actions to ensure patient adherence

Central-level indicators	Definition	Associated facility-level behaviors and practices
		• Communication within the pharmacy team • Leadership/management style of the pharmacy
Inventory accuracy rate	Whether stock balances recorded on a stock ledger, bin card, or in an automated system match the actual inventory on hand	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Actions taken when stocks received from CMS/RMS • Access to stock • Decision on whether to redistribute short-dated stock • Location of storage • Stored separately from other medicines • Training on stock management *Ambiguous evidence* • Assigning responsibility of inventory management tasks • Frequency of balancing stocks • Actions to ensure patient adherence • Communication within the pharmacy team • Leadership/management style of the pharmacy
Order entry accuracy	Percentage of orders placed by facilities that were entered completely correctly into the records, whether paper or electronic, out of the total number of orders placed within a defined period of time	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Order verification before submission to the central/regional level • Communication with higher-level supply chain management • Training on stock management *Ambiguous evidence* • Assigning responsibility of inventory management tasks
Value of unusable stock	Total value of stock that was unusable, due to damage or expiry, as a percentage of total items purchased during a defined period of time	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Order verification before submission to the central/

Central-level indicators	Definition	Associated facility-level behaviors and practices
		regional level • Actions taken when stocks received from CMS/RMS • Access to stock • Decision on whether to redistribute short-dated stock • Location of storage • Training on stock management *Ambiguous evidence* • Frequency of balancing stocks • Actions to ensure patient adherence
Value of unaccounted stock	Total value of stock that is missing or unaccounted for as a percentage of total items purchased during a defined period of time	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Actions taken when stocks received from CMS/RMS • Access to stock • Decision on whether to redistribute short-dated stock • Location of storage • Training on stock management *Ambiguous evidence* • Frequency of balancing stocks • Actions to ensure patient adherence
Inventory holding/warehousing costs	The annual cost of carrying inventory at a specific facility, calculated by adding up all capital and noncapital costs of carrying products	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Order verification before submission to the central/regional level • Actions taken when stocks received from CMS/RMS • Access to stock • Decision on whether to redistribute short-dated stock • Location of storage • Stored separately from other medicines

	Central-level indicators	Definition	Associated facility-level behaviors and practices
			• Communication with affiliated facilities • Training on stock management *Ambiguous evidence* • Frequency of balancing stocks • Actions to ensure patient adherence
	Order lead time	The average amount of time it takes from when an order is placed from a lower-level facility to a higher-level facility to when the ordering facility receives its shipment	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Late ordering of medicines • Communication with higher-level supply chain management • Training on stock management *Ambiguous evidence* • Assigning responsibility of inventory management tasks
	Order turnaround rate	The average amount of time it takes for a facility to fill an order, from the date each order is received by the facility until the date the order is shipped to the customer	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Order verification before submission to the central/regional level • Late ordering of medicines • Communication with higher-level supply chain management • Training on stock management *Ambiguous evidence* • Assigning responsibility of inventory management tasks
Data and information	Percentage of required reports submitted on time and complete to the central level	Facility reporting rates within the LMIS system to the central level and the completeness of the reports	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting

	Central-level indicators	Definition	Associated facility-level behaviors and practices
			• Communication with higher-level supply chain management • Training on stock management *Ambiguous evidence* • Assigning responsibility of inventory management tasks • Leadership/management style of the pharmacy
Human resources	Staff turnover rate	The rate at which staff leave an organization in comparison to the total number of staff employed during a specific period of time	*Stronger evidence* • Use of national guidelines or training materials as reference for estimation of needs and reporting • Communication with higher-level supply chain management • Training on stock management • Implementation of policies on prescribing and dispensing *Ambiguous evidence* • Assigning responsibility of inventory management tasks • Communication within the pharmacy team • Communication within the clinic • Communication with hospital executives • Leadership/management style of the pharmacy • Leadership management style of the clinic • Attitude to workload of pharmacy staff

Table 10. Proposed Indicators for Behaviors and Performances Affecting Facility-level Supply Chain Management Performance (Newly Developed Indicators in Bold)

Behaviors and performances category	Behaviors and performances sub-category	Measurable related indicators
Forecasting and quantification	Ordering formula, calculation of Min-Max buffer stock	• What standard formulas are used to calculate order quantities? What techniques are used to adjust initial estimates to conform to budget realities? (MSH 2012) • Is the minimum or safety stock level set according to the frequency of delivery and average consumption? (MSH 2012) • Is the average monthly consumption calculated correctly? (USAID Supervision & OJT 2011) • Is the order quantity/issue quantity calculated correctly? (USAID Supervision & OJT 2011)
	Use of electronic systems	• Does the facility use logistics data to forecast orders? (Bossert et al. 2002) • Is quantification done manually or by computer? If computers are used, which offices have computers, and what software program is used for quantification? (MSH 2012)
	Use of national guidelines or training materials as reference for estimation of needs and reporting	• Is there a standard inventory control system at health facilities? (MSH 2012) • Does the facility have a copy of the SOPs manual? (USAID Supervision & OJT 2011) • ***When was the last official training received on forecasting and quantification from the Ministry?*** • ***When was the last official training received on forecasting and quantification from another entity?***
	Order verification before submission to the central/ regional level	• Do a formal work plan and schedule for quantification exist? (MSH 2012) • What are the average order entry time and order entry accuracy? (USAID 2010) • ***Who verifies orders before they are sent?*** • ***Is the order verified by someone other than the person who filled the order?***
	Order fill rate	• What is the average order fill rate in the last year? (USAID 2010, Bossert et al. 2002) • What is the percentage of last 4 orders received according to schedule? (Bossert et al. 2002)
Warehousing and inventory management	Actions taken when stock received	• What are the average put-away accuracy and put-away time? (USAID 2010) • ***Is there someone assigned to the task of putting away stock upon arrival?*** • ***Is there a procedure to verify when stock arrives and who puts it away?***
	Access to stock	• ***Who has access to the storage(s)?*** • ***Who has access to the stock cards?***
	Frequency of balancing stock (checking stock cards vs physical counts)	• What is the percentage of stock records that correspond with physical counts? (SCMS 2013, MSH 2012) • Are stock cards or stock books used for every movement of stock in or out of the facility storeroom? (SCMS 2013, MSH 2012) • Does the stock card record regular physical inventories? (USAID Supervision & OJT 2011) • Is there a discrepancy report form? Over the past year, has it been used? (MSH 2012)

Behaviors and performances category	Behaviors and performances sub-category	Measurable related indicators
		• ***How many times per month does the facility check the discrepancies between stock cards and physical counts?***
	Location and condition of storage, (whether all in one place or separate rooms)	• Does the storage meet the acceptable storage conditions, defined by LIAT? (LIAT, Bossert et al.. 2002) ○ Products that are ready for distribution are arranged so that identification labels and expiry dates and/or manufacturing dates are visible. ○ Storage area is secured with a lock and key, but is accessible during normal working hours; access is limited to authorized personnel. ○ Products are stored at the appropriate temperature according to product temperature specifications. ○ Storeroom is maintained in good condition (clean, all trash removed, sturdy shelves, organized boxes). ○ The current space and organization is sufficient for existing products and reasonable expansion (i.e., receipt of expected product deliveries for foreseeable future). ○ Products are stacked at least 10 cm off the floor. ○ Products are stacked at least 30 cm away from the walls and other stacks. ○ Products are stacked no more than 2.5 meters high. • Is there a refrigerator? Is its temperature regularly recorded? (MSH 2012) • Is the storeroom dry, clean, well ventilated, and between +15 and +25 degrees? (MSH 2012) • ***Are ARVs all stored in one location?***
	Stored separately from other medicines	• ***Are ARVs stored separately from other non-HIV medicines?***
	Decision on whether to redistribute short-dated stock	• ***Is the facility involved in the redistribution of short dated stocks with other facilities?***
Prescribing and dispensing	Change in prescription during stock-out (eg, switch regimen)	• Physician practice – If physicians are perceived to be professionally competent, pharmacy staff may model their behavior on physician prescribing patterns. Presence of some medical malpractice could also influence the pharmacy staff's behavior (Goel et al. 1996) • ***Is there a standard procedure or formal communication among prescribers to adjust prescriptions during stock-outs?*** • ***If patients are switched to another regimen due to stock-outs, are they switched back to the old regimen or kept on the new regimen when the drug becomes available?*** • ***Are changes in prescriptions recorded at the pharmacy?***
	Change in	• ***Is there a standard procedure or formal communication among pharmacy staff regarding***

Behaviors and performances category	Behaviors and performances sub-category	Measurable related indicators
	dispensing during stock-out (shorten length of prescription period)	***the amount to dispense during stock-outs?*** • ***Are the changes in dispensing recorded?*** • ***Are there discrepancies in what was prescribed and dispensed?*** • ***If one of the drugs in a regimen is stocked out, what happens to the other drugs? (e.g., are they thrown out, are they given to someone else)*** • ***Do stock-outs for pediatric formulation affect management of adult ARV stocks?***
	Actions to ensure patient adherence (e.g., pill count)	• Is pill counting conducted? (MSH 2012) • ***How is pill counting conducted, and how are the changes in dispensed drugs recorded?***
Communication	Communication within the pharmacy team	• ***Is there a weekly/biweekly meeting for the pharmacy staff? Does the ARV manager report stock-outs/shortages in the meeting?*** • *Team dynamics*—What is the authority structure at the pharmacy/facility? (For example, pharmaceutical assistants with their minimal pharmacy education may not have much authority to question store policy established by better-trained pharmacists. If the assistants are those actually advising pharmacy clients, and their knowledge of the proper treatment of an illness is poor, store policies may lead to an unchallenged acceptance of treatment norms and the perpetuation of clinically inappropriate treatment behaviors.) (Goel et al. 1996)
	Communication within the facility (with clinicians and other staff, in general and in stock-out situations)	• ***Does pharmacy staff attend weekly/biweekly therapeutic meetings? Do they report stock-outs in the meeting?*** • ***Does pharmacy staff communicate about shortages/stock-outs actively or passively?***
	Communication with hospital/clinic executives	• ***Does the pharmacy staff have good relationships with facility coordinator or executives?*** • Does the ARV manager think he/she receives good supervision and support from facility coordinator or executives? (USAID 2011c)
	Communication with higher-level supply chain management offices (e.g., regional office, CMS)	• ***Does the ARV manager/coordinator have good relationships with the regional office?*** • ***How frequent is their communication (times/month, times/year)?*** • ***How frequently does the regional office "check" on each pharmacy (times/month, times/year)?*** • ***Does the pharmacy have good relationships with the central medical store, if any?*** • ***Does the ARV manager think he/she receives good supervision and support from the regional pharmacist?***
	Communication with affiliated facilities	• ***What type of communications occur between the facility and its affiliated facilities (e.g., outreach sites, baby clinics)?*** • ***How do affiliated facilities place orders?***

Behaviors and performances category	Behaviors and performances sub-category	Measurable related indicators
		• ***How frequently do affiliated facilities place orders with the higher level facility (times/month, times/year)?***
Information management	Interaction between clinical and dispensing/stock systems	• ***Are the clinical system and pharmacy system linked? Are patient information shared between the two systems?***
Infrastructure	ART clinic/pharmacy separate from main pharmacy	• ***Is the ART clinic integrated or separated from the main facility?*** • ***Is the ART pharmacy integrated or separated from the main pharmacy?***
Human resources	ARV management responsibility	• What is the number of personnel assigned to manage logistics tasks? (Bossert et al. 2002) • ***How was the management responsibility assigned? (e.g., assigned as permanent position or rotated among pharmacy staff)*** • ***Is the person managing ARVs solely responsible for ARV management (and not other assignments)?***
	Training on stock management	• What is the percentage of facility staff trained in logistics? (Bossert et al. 2002) • ***What is the percentage of staff in ART pharmacy trained in logistics?***
	Implementation of policies on prescribing and dispensing	• ***Does the facility have policies related to not letting patient return without medicines?***
	Attitude to workload of pharmacy staff	• How heavy is the workload of the pharmacy staff? (In busier pharmacies during periods of higher workload, pharmacy staff may have less time for adequately communicating with their clients) (Goel et al. 1996). • ***Is the pharmacy staff satisfied with his/her workload?***

REFERENCES

Ali, D., M. Bwembya, E. Collins, D. Papworth, E. Ronnow. 2008. Zambia: *Family Planning Quantitative and Qualitative Logistics System Assessment, March 2008.* Arlington, VA: USAID | DELIVER PROJECT, Task Order 1.

Bossert, T. .J., D. M. Bowser, and J. K. Amenyah. 2007. Is Decentralization Good for Logistics Systems? Evidence on Essential Medicine Logistics in Ghana and Guatemala. *Health Policy and Planning* 22(2):73–82.

Bossert, T. J., D. M. Bowser, J. Amenyah, D. Aronovich, J. Bates, K. Quam. 2002. *Impact of Decentralization and Integration on the Performance of Health Logistics Systems: Concept Paper and Applied Research Protocol.* Arlington, VA: John Snow, Inc./DELIVER for USAID.

Brauner P., S. Runge, M. Groten, G. Schuh, M. Ziefle. 2013. "Human Factors in Supply Chain Management." In *Human Interface and the Management of Information: Designing Information Environments,* S. Yamamoto, ed. New York: Springer.

Chalker, J., T. Andualem, O. Minzi, J. Ntaganira, A. Ojoo, P. Waako, and D. Ross-Degnan. 2008. Monitoring Adherence and Defaulting for Antiretroviral Therapy in 5 East African Countries: An Urgent Need for Standards. *Journal of the International Association of Physicians in AIDS Care* 7(4):193–9.

Daniel, G., H. Tegegnework, T. Demissie, R. Reithinger. 2012. Pilot Assessment of Supply Chains for Pharmaceuticals and Medical Commodities for Malaria, Tuberculosis and HIV Infection in Ethiopia. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 106(1):60–2.

Eghan K., and G. Daniel. 2011. *Assessment of the Pharmaceutical Management System in Cameroon.* Submitted to the US Agency for International Development by the Strengthening Pharmaceutical Systems (SPS) Program. Arlington, VA: Management Sciences for Health.

Forrester J.W. 1961. Industrial Dynamics (Vol. 2). Cambridge, MA: MIT press.

Goel, P., D. Ross-Degnan, P. Berman, and S. Soumerai. 1996. Retail Pharmacies in Developing Countries: A Behavior and Intervention Framework. *Social Science & Medicine* 42(8):1155–61.

John Snow Inc. (JSI) 2005. A Review of PEPFAR, GFATM and Country Specific Requirements and Indicators. Arlington, VA: JSI.

Joint UN Programme on HIV/AIDS (UNAIDS). 2008. *Core Indicators for National AIDS Programmes: Guidance and Specifications for Additional Recommended Indicators.* Geneva: UNAIDS.

Lee, H. L., V. Padmanabhan, and S. Whang. 1997. Information Distortion in a Supply Chain: The Bullwhip Effect. Management Science . Volume 43, Number 4, 546–55

Management Sciences for Health (MSH). 1995. *Rapid Pharmaceutical Management Assessment: An Indicator-based Approach*. Arlington, VA: MSH.

Management Sciences for Health (MSH). 2012. *MDS-3: Managing Access to Medicines and Health Technologies.* Arlington, VA: MSH. http://www.msh.org/resources/mds-3-managing-access-to-medicines-and-health-technologies

Matowe, L., P. Waako, R. O. Adome, I. Kibwage, O. Minzi, and E. Bienvenu, 2008. A Strategy to Improve Skills in Pharmaceutical Supply Management in East Africa: The Regional Technical Resource Collaboration for Pharmaceutical Management. *Human Resources for Health* 6(1):30.

Ministry of Health (MOH), Republic of Namibia. 2013a. *National Supportive Supervision Report, 2013.* Draft. Windhoek: MOH Namibia.

Ministry of Health (MOH), Republic of Namibia. 2013b. *ART PMIS Quarterly Feedback Report for the Period July to September 2013—Namibia.* Windhoek: MOH Namibia.

Ministry of Health (MOH), Republic of Uganda. 2007. *Health Facility-level Indicators for Monitoring the National HIV/AIDS Antiretroviral Therapy Programme in Uganda.* Kampala: MOH Uganda.

Petti, C. A., C. R. Polange, T. C. Quinn, A. R. Ronald, and M. A. Sande. 2006. Laboratory Medicine in Africa: A Barrier to Effective Health Care. *Clinical Infectious Diseases.* 42:377–82.

Systems for Improving Access to Pharmaceuticals and Services (SIAPS) Program – Cameroon. 2013. *Rapport de revue trimestrielle N 1 des données sur la gestion des patients et des intrants VIH/SIDA : février à avril 2013.* Yaounde, Cameroon.

Supply Chain Management System (SCMS). 2013. *National Supply Assessment: Capability Maturity Model Diagnostic Tool (CMM) and National Supply Chain Key Performance Indicator Assessment (KPIS)—User's Guide.* Arlington, VA: SCMS.

US Agency for International Development (USAID). (2006). *Monitoring and Evaluation Indicators for Assessing Logistics Systems Performance.* Arlington, VA: DELIVER for USAID.

US Agency for International Development (USAID). 2008. *Logistics Indicators Assessment Tool (LIAT).* Arlington, VA: DELIVER for USAID.

US Agency for International Development (USAID). 2010. *Measuring Supply Chain Performance: Guide to Key Performance Indicators for Public Health Managers.* Arlington, VA: DELIVER for USAID.

US Agency for International Development (USAID). 2011a. *The Logistics Handbook: A Practical Guide for the Supply Chain Management of Health Commodities.* Arlington, VA: DELIVER for USAID.

US Agency for International Development (USAID). 2011b. *Guide to Conducting Supply Chain Assessments Using the LSAT and LIAT.* Arlington, VA: DELIVER, for USAID.

US Agency for International Development (USAID). 2011c. Supervision and On-the-Job Training for Supply Chain Management at the Health Facility. Arlington, VA: DELIVER, for USAID.

Waako, P. J., R. Odoi-adome, C. Obua, E. Owino, W. Tumwikirize, J. Ogwal-okeng, W. W. Ankbonggo, L. Matowe, O. Aupont. 2009. Existing Capacity to Manage Pharmaceuticals and Related Commodities in East Africa: An Assessment with Specific Reference to Antiretroviral Therapy. *Human Resources for Health* 7(1):21.

World Heath Organization (WHO). 2005. *National AIDS Programmes: A Guide to Indicators for Monitoring and Evaluating National Antiretroviral Programmes.* Geneva: WHO.

World Heath Organization (WHO). 2007. Monitoring and Reporting on the Health Sector's Response towards Universal Access to HIV/AIDS Treatment, Prevention, Care and Support 2007–2010. Geneva: WHO.

World Heath Organization (WHO). 2011. *Harmonized Monitoring and Evaluation Indicators for Procurement and Supply Management Systems.* Geneva: WHO.

Windisch, R., P. Waiswa, F. Neuhann, F. Scheibe, and D. de Savigny. 2011. Scaling Up Antiretroviral Therapy in Uganda: Using Supply Chain Management to Appraise Health Systems Strengthening. *Globalization and Health* 7(1):25.

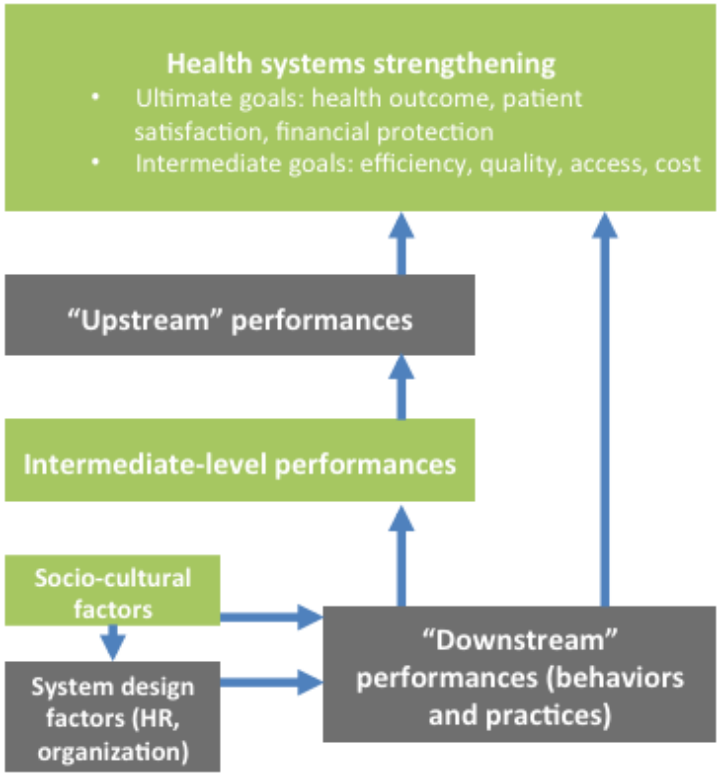
Yadav, P. 2010. In-Country Supply Chains: The Weakest Link in the Health. *Global Health Magazine* Issue 5:18.

ANNEX A. REVIEW OF LITERATURE ON FACILITY-LEVEL SUPPLY CHAIN MANAGEMENT INDICATORS

I. Distinction between "Facility-" and "Central-level" Supply Chain Management

We define facility-level supply chain management activities as those related to managing inventory at the point of service delivery performed by prescribers and dispensers. These may include public hospitals and health facilities, private hospitals and health facilities, pharmacies, medicine shops, and other informal outlets. We also refer to indicators at this level as "downstream" indicators. This is in comparison with the "upstream" indicators, which may include central- and regional-level indicators for institutions such as the Ministry of Health and central/regional medical stores. Figure A1 shows how different levels are connected, and in this literature review we will focus on the downstream indicators and the relevant upstream performance and system design factors.

Figure A1. Mapping of indicators (Gray: in-scope; Green: out of scope)



Examples:

- **Health systems indicators:** % of patients on ART who are adherent to ARV medicines, % of HIV-positive pregnant women seen in the PMTCT or ANC clinic who are enrolled in general care or ART at the clinic, % of health facilities that offer ART.
- **Upstream/central level:** On-time delivery, stock-out rate, order fill rate, order lead time, facility reporting rates information accuracy rate, stock wastage rate
- **Downstream/health facility level:** Order entry accuracy, order entry time, order lead time, % staff trained in logistics, average length of time in current logistics position
- **Sociocultural factors:** Literacy rate, average education level, number of primary/secondary schools, prescribing patterns (both systems design and sociocultural)
- **System design factors:** employees' average wage, existence of local medicines list, requirement to develop procurement plan, HR availability, location of facilities and pharmacies, prescribing patterns

II. Literature Review Method

The objective of the review is to identify existing indicators related to facility-level supply chain management performances and behavioral aspects, with a specific focus on the management of HIV/AIDS products and health outcomes. While many reports and tools propose measurable indicators across various aspects of the supply chain, only a handful of research papers quantify the results of the assessments or seek to find causal mechanisms between indicators and performances.

Our review began with a systematic literature search of published materials from the 1990s to 2013. PubMed, Web of Science, Google Scholar, and other available databases were used to search for literature. Official reports published by development agencies and nonprofit organizations—in particular, USAID, Management in Science (MSH), John Snow Inc. (JSI), and WHO—were also reviewed. In Section III, we summarize the structure and categorization of indicators proposed in these tools. We conclude that the SCMS framework best suits our purpose and customize it to include aspects particular to HIV and AIDS care. In Section IV, we discuss the specific indicators relevant to this project using this framework.

III. Highlights from Major Publications/Tools

Bossert et al. (2002), Impact of Decentralization and Integration on the Performance of Health Logistics Systems: Concept Paper and Applied Research Protocol

This paper observed the degree of choice of functions in health logistics systems that are allowed by decentralization and studied the impact of that range of choice on the performance of the logistics system. The logistics functions assessed are product selection, forecasting and procurement, inventory management storage and distribution, and product use or serving customers. The importance of this research is that it began to look at some of the system design issues that impact both downstream and upstream performances, though these two levels were not differentiated in a clear manner.

Goel et al. (1996), Retail Pharmacies in Developing Countries: A Behavior and Intervention Framework

This paper presented a behavior and intervention framework to analyze factors that may affect retail pharmacy prescribing. The authors propose that pharmacy staffing and organizational patterns, client characteristics, physician practice, and regulatory factors are the four sets of important factors for understanding pharmacy prescribing behavior:

- Pharmacy staffing and organizational patterns: Factors include the availability and role of professional staff, sources of information on pharmaceuticals, economic incentives, staff training/education, workload, expected efficacy of a pharmaceutical product, pharmacy ownership, authority structure, location, and competition.

- Client characteristics: Client demand for particular pharmaceutical products may be

affected by clients' knowledge about their illness or the expected efficacy of the product. In developing countries, however, only a few studies have differentiated between pharmaceuticals requested by clients and those dispensed on a pharmacy staff's recommendation.

- Physician practice: Retail pharmacies exist and function in a medical milieu dominated by physicians, practicing both in hospitals and in private clinics. If these physicians are perceived to be professionally competent, pharmacy staff may model their behavior on physician prescribing patterns. Presence of some medical malpractice could also influence the pharmacy staff's behavior.

- Regulatory factors: Six regulatory factors could influence retail pharmacy behavior. These are number and types of products available in the private sector, staff education requirements, scheduling of pharmaceuticals over-the-counter, freedom to substitute, requirements for providing information, and control of profit margins which specify how much profit pharmacies can add to their procurement cost.

The authors point out that interrelationships between these factors could also be important determinants of retail pharmacy behavior. For example, staff training/education staff may be affected by physician practice and influence of regulatory factors may vary by location. They also present four types of interventions, which could be used for changing the behavior of pharmacy staff: information alone, persuasion, incentives, and coercion.

John Snow Inc. (2005), A Review of PEPFAR, GFATM and Country Specific Requirements and Indicators

The President's Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund for AIDS, TB, and Malaria (GFATM) have developed indicators for their reporting requirements for HIV medicines and diagnostics supply management. John Snow Inc. (JSI) reviewed and compared their reporting requirements in 2005. According to JSI, PEPFAR requires reporting of only one direct indicator, which measures the consumption or use of different types of HIV-related diagnostics (number of tests performed at US government–supported laboratories during the reporting period). Compared to PEPFAR, GFATM has eight direct indicators, which focus on product availability, inventory management, product pricing, supply chain training, and availability of guidelines. In general, the indicators measure a combination of process and outcomes for supply chain functions, and do not differentiate between upstream and downstream performance. In addition to the direct indicators, there are a total of three and five indirect indicators that country or program recipients are likely using as indirect measures of supply chain management by GFATM and PEFPAR, respectively. Due to the small numbers of direct indicators that are specific to supply chain management of HIV and AIDS–related commodities, the indirect indicators are likely the ones capturing performance/achievement by those organizations involved in supply chain management. These indicators focus primarily on service delivery information (i.e., number of people receiving a particular HIV and AIDS–related commodity with a particular intervention).

Lee, Padmanabhan, and Whang (1997), Information Distortion in a Supply Chain: The Bullwhip Effect

Brauner et al. (2013), Human Factors in Supply Chain Management—Decision Making in Complex Logistic Scenario

It is important to first point out that these papers and related discussions were published in management journals in developed countries, but the observations and solutions may be relevant for our project. Forrester (1961) first simulated the demand amplification by identifying both information and material delays in the chain and the feedback loops in the decision making process. Lee and colleagues (1997) extends the concept and discusses the "bullwhip effect," which they describe as "the phenomenon where orders to the supplier tend to have larger variance than sales to the buyer, and the distortion propagates upstream in an amplified form." Information transferred in the form of orders tends to be distorted and misguides upstream members in their inventory and production decisions. In particular, as demonstrated in the famous "beer game" developed by the Massachusetts Institute of Technology and other studies, the variance of orders may be larger than that of sales, and the distortion tends to increase as one moves upstream.

Brauner et al. (2013) state that typical symptoms caused by the bullwhip effect are: first, excessive inventory and safety stocks, which—while lowering the amplitude of the bullwhip effect—result in additional costs for storing goods. Second, production forecasts are poor, resulting in unsatisfactory production planning. Third, production capacities are insufficiently utilized. Finally, service rates descent, meaning that requested products are not delivered in time. According to Lee and colleagues (1997), key reasons of the bullwhip effect are the existence of lead times of information and material in a supply chain. A member of the supply chain will not be able to follow a change of the final demand directly, because of the following three reasons: First, s/he will not receive the information immediately, as information is not delivered in real time. Second, safety stocks along the supply chain also delay the information flow. Third, supply chain members are not able to adapt their capacity, demands, and deliveries immediately. Suggested solutions include granting the manufacturer access to the demand data at the retail outlet, allocating the supply in proportion to the retailer's market share in the previous period, reducing the need for order batching by lowering the transactions cost, and reducing the frequency as well as depth of manufacturers' trade promotions.

Furthermore, using a supply chain experimental game in studying the decisions of different stakeholders within the chain, Brauner et al. (2013) found the following results:

- Position within the supply chain had a significant effect on the total cost to a player and the average costs increase along the supply chain: retailers accumulated less costs than wholesalers, distributors, and factory players.

- Gender and technical self-efficacy influenced performance, with women and persons with lower self-efficacy performing worse. As gender and technical self- efficacy are connected, the lower performance of women can be referred to their lower self-efficacy levels.

- The "need for security" subscale of the personality inventory shows significant differences with players with a high need for security having a higher spread (the difference between the maximum and minimum stock level in a week) than players with a low need for security.

Management Sciences for Health (2012), MDS-3: Managing Access to Medicines and Health Technologies

MDS-3 (originally, *Managing Drug Supply*) is one of the leading references on how to manage essential medicines in developing countries. In chapters related to procurement, quantification, distribution, inventory management, and pharmaceutical management for health facilities, we identified several important indicators for measuring performance at the facility level.

Management Sciences for Health (1995), Rapid Pharmaceutical Management Assessment: An Indicator-Based Approach

This manual presents a set of 46 indicators of performance for three different levels of the healthcare system—central, regional, and facility—and are grouped under eight areas of pharmaceutical management:

1) Policy, legislation, and regulation
2) Formulary/essential drugs lists and drug information
3) Ministry of Health budget and finance
4) Ministry of Health pharmaceutical procurement
5) Ministry of Health pharmaceutical logistics
6) Patient access and drug utilization
7) Product quality assurance
8) Private sector pharmaceutical activity

Each topic is covered by a subset of indicators. Thirty-four of the indicators are quantitative and 12 are qualitative. Proposed facility-level indicators from this manual are listed by category in section IV.

Ministry of Health, the Republic of Uganda (2007), Health Facility-level Indicators for Monitoring the National HIV/AIDS Antiretroviral Therapy Programme in Uganda

With the support from USAID, the Ministry of Health of Uganda introduced the Quality of Care (QoC) initiative for HIV and AIDS in November 2005 with the main purpose of institutionalizing quality improvement as part of the effort in improving HIV/AIDS health services delivery. Through this initiative, the MOH developed indicators for monitoring the ART programs at the national, district, and facility levels. At the time this report was published, they stated that these health facility–based indicators "have been field tested over two years in 89 facilities, and results so far obtained are encouraging and will go a long way in helping the MOH to monitor the performance of the National ART program."

This report provides good indicators on all aspects of managing an ART program under these categories:

- Patient assessment and screening for art
- Reproductive health/family planning
- TB assessment among HIV-positive persons
- Laboratory indicators
- Patient treatment with art
- Prevention of opportunistic infections
- Referral and follow-up of patients
- Health facility logistics and capacity
- Pediatric care for HIV and AIDS

SCMS (2013), National Supply Chain Assessment: Capability Maturity Model Diagnostic Tool (CMM) and National Supply Chain Key Performance Indicator Assessment (KPIS) – User's Guide

As mentioned above, this framework best fits the purpose of our research. The report suggests that it is important to evaluate and monitor both capability maturity and performance that define the ability of a health supply chain to ensure access and availability to health commodities. While some indicators are used to measure downstream or upstream performance, others are less clearly articulated. In our report, we wish to improve on this point and provide clear assignment to the two levels:

- Capability maturity: defines the state of the infrastructure, processes, management information systems and human resources across the functions of a supply chain

- Performance: defines the performance of a supply chain within each function, as defined by key indicators

The report also proposes that all measures included should cover outcome- and process-level indicators.

One of the key components of the National Supply Assessment (NSA) is the Capability Maturity Model (CMM) Diagnostic Tool, which was developed to evaluate a wide range of capabilities within the key supply chain functional areas. These capabilities are each tagged as a cross-cutting enabler that impact across the supply chain functional areas. These tags allow analysis of the capability maturity for specific functional areas for each cross-cutting enabler.

- *Supply Chain Functional Areas:* The CMM uses traditional supply chain functional areas as an organizing construct for the implementation of the diagnostic tool. Together, these interdependent functional areas ensure that health programs can supply the essential commodities needed. Each functional area is broken down into a number of capabilities or activities that are required for a supply chain to operate and that can be measured and strengthened. Functional areas addressed in the tool include: product selection; forecasting and supply planning; procurement; warehousing and inventory management; transportation; dispensing; waste management; and lab issuing.

- *Cross-cutting Enablers:* The enablers support and facilitate activities within the supply chain that ultimately determine the maturity, performance and sustainability of the functions.

- *Processes and tools* are a collection of tasks for conducting a particular activity within a supply chain function. For each functional area there must be well thought-out, documented, and standardized processes to allow for repeatable and measureable results.
- *Management information* refers to the management, acquisition, processing, storage, and dissemination of information within the supply chain. The capabilities within management information are those that support the hardware and software that stores the information as well as the security to protect it.
- *Infrastructure* provides the physical framework on which a supply chain operates. It includes the basics requirements of buildings, utilities (including communications), office and warehouse equipment, and delivery vehicles. Infrastructure also includes security to ensure a safe and protected environment for employees and health commodities. The need for infrastructure varies greatly among the different functional areas.
- *Human resources* have a profound impact on the supply chain. Consistent across all functions within the supply chain, human resources include aspects of leadership, budget allocation, policies, organization and workforce planning, job descriptions, performance assessments, supporting workforce performance, and in-service training opportunities.

We should note that majority of the indicators proposed in this report originate from other tools, such as USAID's *Measuring Supply Chain Performance* (2010), USAID's *Logistics Indicators Assessment Tool (LIAT)* (2008), and WHO's *Harmonized Monitoring and Evaluation Indicators for Procurement and Supply Management Systems* (2011).

Another proposal made in this report is the completion of an environmental profile, which aims to provide a comprehensive picture of the environment in which the supply chain operates, a health sector overview, a health sector strategy, supply chain policies and regulations, demographics and epidemiology, financing the health sector, culture and social dynamics, availability and skill level of human capital, an economic overview, supply base, climate and geography, national infrastructure and services, and financing of supply chain.

UNAIDS (2008), Core Indicators for National AIDS Programmes: Guidance and Specifications for Additional Recommended Indicators

This report presents the 40 core national indicators that provide minimum necessary information for national-level monitoring of the HIV epidemic and response. These are organized into three categories: national commitment and action, national knowledge and behavior, and national impact. For our purposes, we are interested in the supply and demand side of an AIDS program, such as the percentage of health facilities that offer ART (supply) and the percentage of adults and children with advanced HIV infection receiving ART (demand).

USAID (2008), Logistics Indicators Assessment Tool

USAID (2011b), Guide to Conducting Supply Chain Assessments Using the LSAT and LIAT

The *Logistics Indicators Assessment Tool* (LIAT) and the *Logistics System Assessment Tool* (LSAT) are two of the most commonly used assessment tools in evaluating health commodity supply chains in low- and middle-income countries. Developed by USAID's DELIVER project, the tools are designed to facilitate a comprehensive assessment of the separate components within a logistics system and how well the system is functioning. The tools categorize key activities related to managing a health commodity supply chain into 11 elements: organization and staffing; logistics management information systems; product selection; forecasting; procurement; inventory control procedures; warehousing and storage; transport and distribution; organizational support; product use; and finance, donor coordination, and commodity security planning.

USAID (2010), Measuring Supply Chain Performance: Guide to Key Performance Indicators for Public Health Managers

This report argues that focusing on only one type of indicator may actually have a negative impact on product availability; therefore it recommends analysts to view these indicators holistically, to make sure they are harmonized and not working against each other, and to identify the tradeoffs required to strategically improve overall supply chain performance. The four dimensions of supply chain performance include:

- *Quality:* These indicators are often the simplest to implement and measure. Typically, they tell you how well you are performing a specific activity—a common logistics indicator in this classification is accuracy—such as order accuracy, inventory accuracy, picking accuracy.

- *Time:* These indicators focus on the time it takes to complete specific activities. They show where saving time during specific activities can improve the overall supply chain performance.

- *Financial:* These indicators help managers identify the supply chain cost drivers and help them move toward a more efficiently managed supply chain.

- *Productivity:* These indicators examine how well resources are used. For example, filling vehicles to their capacity, instead of sending out vehicles half-full, could reduce costs and improve efficiency.

This report also serves as a good summary of USAID's more function-focused reports, such as the *Procurement Performance Indicators Guide* (2013) and *Monitoring and Evaluation Indicators for Assessing Logistics Systems Performance* (2006).

USAID (2011b), The Logistics Handbook: A Practical Guide for the Supply Chain Management of Health Commodities

This book suggests categorizing indicators by their purpose:

- Inputs: Set of resources—human, financial, and capital—needed to implement a program/activity

- Processes/activities: Set of interventions that use inputs to achieve objectives and desired results
- Outputs: Results obtained at the program level
- Outcomes: Results obtained at the population level following interventions (i.e., what changed as a result of the activities)
- Impact: Results that reflect the long-term or ultimate outcomes at the population level

WHO (2011), Harmonized Monitoring and Evaluation Indicators for Procurement and Supply Management Systems

This document presents 12 core indicators for monitoring and evaluating procurement and supply management (PSM) at the national level. Each core indicator is tied to a PSM stage, and six of the 12 indicators are defined as early-warning indicators of stock-outs and overstocking of ARVs and medicines to treat tuberculosis and malaria. The goal of the PSM early-warning and performance indicators is to provide a harmonized structure for monitoring and evaluation (M&E) that will provide timely, critical information on PSM efficiency and stocks at different levels of the supply system, particularly at the heath facility level. The PSM stages are product selection, prescribing and use, forecasting, consumption, procurement efficiency, supplier performance and port clearance, quality control, distribution, inventory control, loss, minimum stock level and inventory control, and availability.

WHO (2005), National AIDS Programmes: A Guide to Indicators for Monitoring and Evaluating National Antiretroviral Programmes

This manual provides guidance on indicators relevant to M&E of national programs for the scaling up of access to ART. It presents a list of core indicators and one additional indicator. For each indicator this manual provides: (a) guidance on its definition; (b) the rationale for its use and what it measures; (c) its measurement and the tools used for measurement; (d) the frequency of measurement; and (e) its strengths and limitations. In proposing indicators, the manual stated that existing indicators were taken into account. Although this document was intended to inform the main M&E efforts at the national level by HIV and AIDS program managers, many of the data necessary for calculating the indicators originate from health facilities. Therefore, this manual is also of value to more local, facility levels.

WHO (2007), Monitoring and Reporting on the Health Sector's Response towards Universal Access to HIV/AIDS Treatment, Prevention, Care and Support 2007–2010

In 2007, WHO established a framework for global monitoring and reporting, which proposed a core set of indicators to monitor and report on global progress in the health sector's response toward universal access of ART. It included indicators to monitor the scale-up of priority health sector interventions for HIV prevention, treatment, care, and support, as well as policy and programmatic questions related to the national response. It built upon other ongoing international efforts for monitoring and reporting, and brought together a broad spectrum of indicators to

cover the health sector responses. The indicators overlap with UNGASS, UNICEF/WHO's Inter Agency Task Force on Prevention of Mother-to-Child Transmission (PMTCT), and other WHO programs.

IV. Facility-Level Indicators

While the tools and reports provide various ways of categorizing performance indicators, we choose to build on SCMS's categorization of indicators proposed in its 2013 report to consolidate facility-level performances indicators proposed by published literature reviewed above. The main rationale behind choosing SCMS's structure is that the majority of the indicators proposed in this report originated from and consolidated various aspects of other major tools, thus serving as a good starting point for our purposes. It is important to note that while the existing tools are comprehensive and well designed, most do not clearly distinguish upstream and downstream indicators, nor do they identify the links between them. We believe our report will fill this gap and contribute to further understanding of the linkages between the two levels.

The two main categories of indicators are the supply chain functional areas and the cross-cutting enablers. SCMS proposes a matrix view of these two areas, but to simplify the categorization process, we decided to list indicators specifically related to supply chain functional areas in their respective groups, and list the overarching enabling functions, such as overall human resources issues and LMIS, under the cross-cutting enablers. The separation between the two categories also allows us to take into account facility-level behaviors and practices specific to supply chains for HIV and AIDS care. We reviewed indicators related to the demand side of HIV and AIDS programs, perceptions and behaviors of providers, patients, and the public, the "bullwhip effect" factors, and other relevant environmental factors. Here is the final framework used to assess downstream-level indicators related to HIV and AIDS supply chain management:

Supply Chain Functional Areas:

1) Product selection
2) Forecasting and supply planning
3) Procurement
4) Warehousing and inventory management
5) Transportation
6) Dispensing
7) Waste management
8) Lab Issuing

Cross-cutting Enablers and Behavioral Factors:

1) Management Information: the management, acquisition, processing, storage and dissemination of information within the supply chain

2) Infrastructure: the physical framework on which a supply chain operates, including

the basics requirements of buildings, utilities, office and warehouse equipment, and delivery vehicles

3) Human resources: includes aspects of leadership, budget allocation, policies, organization and workforce planning, job descriptions, performance assessments, supporting workforce performance, and in-service training opportunities

4) Demand factors, behaviors and practices, and perceptions related to HIV/AIDS treatment: prevalence of the disease in the population, perceptions and behaviors of patients and the public

5) Relevant environmental factors

1. Product Selection

Papers that address how product selection is conducted at the facility level in developing countries are scarce. This is likely because the decisions on product selection occur mostly at the central or regional level, based on official documents such as standard care and treatment guidelines, national formularies, and essential medicines list—although the rigor of the enforcement of these guidelines can vary.

A study conducted by Bossert, Bowser, and Amenyah (2007) explored the impact of decentralization on the logistics management performance of essential health products in Guatemala and Ghana. To measure the level of decision-making authority for product selection, they defined a facility to have a “high” level of decision space if they made their own decisions about product selection and had their own essential medicines list. In Guatemala, the study found a fairly high level of selection decision space for all administrative levels in the public service: all hospitals and Health Area Offices (except one) selected their own medicines for their essential drug lists. In Ghana, on the other hand, under the National Drug Policy, it was recommended that each health facility develop a shorter list of medicines, a formulary, tailored to the particular needs and the health problems prevalent among its clients. Selection of contraceptives and vaccines, however, were done only at the central level and all products offered in the national programs are expected to be available at all levels.

A study conducted by Waako et al. (2009) in East Africa highlighted that health workers involved in the management of ARVs lack the knowledge and practices in selection of medicines.

Table A1 summarizes indicators related to product selection that have been collected from the literature review.

Table A1. Indicators for Product Selection

Downstream Indicator	Source
Percentage of average international price paid for last regular procurement of a set of indicator drugs	MSH (1995); USAID (2010)
Percentage by value of MOH drugs purchased through competitive tender	MSH (1995)
Product selection based on National Essential Medicines List	USAID (2010)
Percentage of procured products registered In-country	
Percentage of products that undergo quality testing	
Percentage of procured products that meet stringent regulatory authority (SRA) or WHO standards	
Percentage of facilities who order according to a defined list	Bossert et al. (2002)
Is there a local list?	
Average number of products on the list, national or local	
Number of products beyond standard list	
Percentage of health facilities with post-exposure prophylaxis available (disaggregated by exposure [occupational, nonoccupational] and sector [public, private])	WHO (2007)

2. Forecasting and Supply Planning

Accurate forecasting and supply planning help improve financial management and facilitate the procurement of adequate quantities of each product, thereby reducing the likelihood of wastage or shortage and increasing the likelihood of meeting customer needs with available products. The ability to perform good forecasting depends on having detailed record keeping on the quantities ordered and in stock. For example, Windisch et al. (2011) found that one of the main barriers in forecasting ARV needs in Uganda was the lack of data needed for forecasting.

Brauner et al. (2013) state that typical symptoms caused by the bullwhip effect are as follows: First, excessive inventory and safety stocks, which—while lowering the amplitude of the bullwhip effect—result in additional costs for storing goods. Second, production forecasts are poor, resulting in unsatisfactory production planning. Third, production capacities are insufficiently utilized. Finally, service rates descent, meaning that requested products are not delivered in time. Brauner and colleagues' findings are consistent with what was described by Lee and colleagues (1997).

Table A2 summarizes indicators related to forecasting and supply planning that have been collected from the literature review.

Table A2. Indicators for Forecasting and Supply Planning

Downstream Indicator	Source
Forecasting accuracy	USAID (2010); Bossert et al. (2002)
Percentage of facilities using logistics data to forecast requirements	Bossert et al. (2002)
Do the facilities have current and accurate records of medicine usage?	MSH (2012)
Do a formal work plan and schedule for quantification exist?	
Percentage of supply plan updates completed per SOPs	SCMS (2013)
Is quantification done manually or by computer? If computers are used, which offices have computers, and what software program is used for quantification?	MSH (2012)
What quantification methods are used to forecast pharmaceutical and budget needs?	
Are actual procurement quantities and costs compared at the end of each year against the initial quantification estimates?	
What information is used to predict procurement costs? If last year's prices are used, how are they adjusted?	
What standard formulas are used to calculate order quantities? What techniques are used to adjust initial estimates to conform to budget realities?	
Percentage of supply plan updates completed per SOPs	SCMS (2013)
Planned versus emergency orders	
Planned versus unplanned orders	

3. Procurement

Procurement involves the purchasing process for essential medicines, starting from placing orders with suppliers based on forecasting results and paying for those products. The study by Bossert and colleagues (2007) found that a higher level of decision-making authority in procuring essential medicines was associated with better performance for procurement in Guatemala, but not in Ghana. Due to the large difference in the procurement functions in the two countries, the study defined the level of decision-making authority and performance indicators separately for the two systems. For Ghana's "cash and carry" procurement system, facilities were expected to use their "revolving drug funds" to purchase essential medicines from public medical stores, though in some cases the medical stores were allowed to reject orders they deemed inappropriate (too much in volume for the target population of a facility, or nonessential medicines for that facility level, or if the facility did not have personnel skilled in use of that medicine). The stores were sometimes not able to provide the medicines because they did not have them in stock. In this case, they were to issue a "Certificate of Non-Availability," which authorized the facility to purchase drugs from private providers. Facilities could decide to purchase from the private sector or reorder at a later date, or they could do nothing. In some cases, facilities procured from the private sector without authorization, and if caught, they could be reprimanded by higher authorities. The study found that some facilities had more logistics decision space than others, meaning they reported preparing their own annual procurement plans, and a higher-level decision making authority did not change the plans. Performance indicators for these functions were the cash and stock balances and stock-outs at the time of the visit. If plans and budgets were effective, then their cash and stock balances should have been high and stock-outs low. The study found that, in Ghana, those facilities that had a high logistics decision

space and did not change the work plan/budget, even after it was reviewed, had a higher increase in cash and stock balances. Increases in cash and stock balances were related to fewer stock-outs at the time of the visit. In addition, the study hypothesized that facilities that purchased more from outside the public sector would be more likely to purchase medicines that are not on the National Essential Drug List (NEDL), since the public sector only supplies medicines that are not on the list, and viewed buying off the NEDL as poor performance. Those facilities that purchased from the private sector were more likely to purchase medicines off the list, thus concluding that the decentralization of procurement led to poorer performance.

On the other hand, in Guatemala's "open contract" system, a higher level of decision-making authority was associated with better performance. Under this system, the right to determine the types and quantities of medicines to buy through the "open contract" was delegated to the hospitals and Health Area Offices, which then procured medicines from their suppliers every three months. Suppliers on the "open contract" ship the products directly to the purchasers or the purchaser's designated recipients. The study assigned high logistics decision space to those districts and facilities that reported making their own procurement decisions for medicines rather than having higher administrative levels make procurement decisions, making purchases off the NEDL within the "open contract," and making purchases off the "open contract." The performance indicator we used for this function was the "order fill rate" a logistics system indicator defined as the percentage of products that the facility receives above or below the quantity that they ordered. They found that those facilities with high decision space in making their own procurement decisions were more likely to be in the good range for the order fill rate (between–5% and 5%) for medicines.

Another study in Uganda reported that some physicians are alleged to reroute essential medicines to private clinics and pharmacies, and then send public patients to these outlets to purchase their medicines. The physicians may also underprocure medicines to cause a shortage, which is then covered by the private market (Windisch et al. 2011).

Table A3 summarizes indicators related to procurement that have been collected from the literature review.

Table A3. Indicators for Procurement

Downstream Indicator	Source
Commitment to established procurement plan	USAID (2010)
Percent of contracts issued as framework contracts	
Lead time for contract/purchase order issue	
Lead time for contract award	
Percentage markup on products in cost recovery system (profit margin)	
Ratio of unit prices paid through an emergency procurement vs. competitive bidding process	
Fixed order cost	
Average number of orders processed per full-time employee in procurement	
Percentage of purchase orders/contracts issued as emergency orders (percentage of emergency orders issued in the last 12 months)	
Percentage of product provided by NGOs	Bossert et al. (2002)
On-time payment to vendor	SCMS (2013)

4. Warehousing and Inventory Management

MDS-3 (MSH 2012) calls inventory management "the heart of the pharmaceutical supply system." It involves the ordering, receiving, storing, issuing, and then reordering of the items. An inventory control system informs the manager when to order or issue, how much to order or issue, and how to maintain an appropriate stock level of all products to avoid shortages and oversupply (USAID 2010). In many countries, poor inventory management in the pharmaceutical supply system leads to waste of financial resources, shortages of some essential medicines or overages of others resulting in expiration, and decline in the quality of patient care. Warehousing, on the other hand, ensures the physical integrity and safety of products and their packaging until they are dispensed to clients. The complexity of warehousing varies based on the volume of products to be managed, storage facility size, as well as particular requirements, such as cold storage (USAID 2010).

The study by Bossert, Bowser, and Amenyah (2007) found that facilities in Ghana and Guatemala with high decision space in inventory control were more likely to have poorer performance. In Ghana, they found that although there were explicit guidelines on inventory control, facilities were not consistently required to adhere to the guidelines. The study investigated how having or not having guidelines influenced behavior related to inventory control. Some facilities reported that they had received no guidelines and were instead expected to have formulated their own. In addition, since the "stock cards" were a key inventory control document provided from the central level as part of guidelines for inventory control, districts and facilities that had chosen not to use them were also assigned a higher logistics decision space. The study found that those facilities that did not use stock cards were less likely to have their stock levels for medicines within the required Min-Max levels. In Guatemala, those facilities that calculated their needs based on an inventory control system different from the Min-Max system were less likely to use stock cards for medicines.

Inventory shortage is one of the most straightforward indicators in measuring the performance of inventory control. In Uganda's Iganga district, Windisch et al. (2011) found that ARV shortages affected all ART-providing facilities, resulting in considerable fluctuations in capacities to take up new patients. ARVs were available at 83%, diagnostic kits at 70%, and pediatric ARVs at less than one-half of the health facilities surveyed. Stock-outs also occurred for antibiotics, including amoxicillin and co-trimoxazole dispensed as prophylaxis for opportunistic infections in HIV-positive patients. Effects included problems in patient follow-up and in the provision of ART. Patients were advised to buy missing medicines in private pharmacies. Switches to more complex and different drug regimens were frequent to avoid treatment interruptions. Strategies to cope with stock-outs included lending and borrowing among facilities, duo-therapy, late initiation of ART for new patients, and treatment interruption. ARV regimens from 10 different manufacturers were found, and health workers reported insufficient knowledge regarding safe medicine substitution and a general lack of guidance to deal with shortages of ARVs. They faced difficulties in forecasting needs given the lack of data. National level surveys substantiate that provision of ARVs suffers from both over- and undersupply. According to findings from 2007, only a one-quarter of facilities receive ARVs on a monthly basis, the required frequency for consumption reporting. Test kits, prophylactic treatment, and pediatric ARVs are especially affected by short supply: according to a health facility survey in 2005 fewer than 25% of

facilities were maintaining adequate stock levels on nevirapine, HIV test kits, and antibiotics to treat opportunistic infections and sexually transmitted infections. Health facilities on average reported one month of stock-outs of testing kits per year in 2005. Undersupply of test kits was mainly caused by unexpected supply disruptions from two donors and resulted in rationing with a focus on PMTCT clients instead of the general population. They cite a health facility survey conducted in 2008 which found that some facilities faced shortages over several months. Only about 15% of patients in need could be tested as a consequence. Another 2004 national laboratory assessment indicated that, due to a lack of reagents, one-half of the regional hospitals could not perform confirmatory diagnostics for opportunistic infections (OIs) and 20–30% of district hospitals could not perform basic diagnostic tests for sexually transmitted infections (STIs) and OIs.

However, not all stock-outs are supply chain management–related or due to mismanagement at the facility level. Many other elements of service delivery may result in lack of medicines and supplies that are not directly related to supply chain management—including, for example, adequacy of infrastructure and human resources in general. A 2006 health facility survey found most health facilities lack essential laboratory equipment. According to another survey, only 17% of the counseling rooms for HIV patients complied with national guidelines. While all health centers providing PMTCT and voluntary counseling and testing have laboratories for testing, technicians were not always available (Windisch et al. 2011).

In Ethiopia, Daniel et al. (2012) found that the availability of essential medications and other medical supplies in the facilities was variable: roughly 20% of surveyed facilities did not have malaria, TB, or HIV medicines, even though these facilities provided services to manage such patients. A study in Mali found that, on average, healthcare facilities receive only about 26.6% of products they request. Emergency orders are frequent at Referral Health Centers and Community Health Centers, reaching 50% and 45.8%, respectively, at these levels. Furthermore, stock-outs are frequent, and recommended inventory levels are not respected (USAID 2013).

Good inventory control requires careful thought about the dimensions and design of the storage space, appropriate conditions for storage of different types of supplies, and the importance of stock rotation and systematic arrangement of stock, as well as attention to cleanliness, fire-prevention measures, and security within the store. The same Ethiopia study also found that storage guidelines are rarely respected: no center respects 80% of guidelines, and only 8 of 43 centers (18.6%) respect 70% of these guidelines (USAID 2013).

An LSAT study for family planning logistics system in Zambia found the percentage of facilities meeting acceptable storage conditions at the health facility level was slightly more than half. Health facilities faced challenges for storage conditions such as rodent and bat infestation, lack of temperature regulation, and insufficient storage space (USAID 2008).

Table A4 summarizes indicators related to warehousing and inventory management that have been collected from the literature review.

Table A4. Indicators for Warehousing and Inventory Management

Downstream Indicator	Source
Percentage of days that any essential HIV medicine is out of stock (not including ARVs)	Uganda MOH (2007)
Percentage of days in a month when HIV test kits are available	
Stock-out rate	USAID (2010); MSH (2012); USAID (2010)
Average percentage of time out of stock for a set of indicator medicines in health facilities	MSH (1995); MSH (2012)
Order fill rate	USAID (2010); Bossert (2002)
Order fulfillment rate	USAID (2010)
Weighted average percentage of inventory variation for a set of indicator medicines in facilities	MSH (1995)
Average percentage of individual variation for a set of indicator medicines in health facilities	
Average percentage of stock records that corresponds with physical counts for a set of indicator medicines in health facilities	
Stocked according to plan	USAID (2010)
Adequate shelf life	
Average percentage of a set of unexpired indicator medicines available in health facilities	MSH (1995)
Percentage of total stock that expired in previous reporting period	SCMS (2013)
Stock wastage due to expiration or damage	USAID (2010)
Plan in place for predictable change in demand	
Order entry accuracy	
Invoice accuracy	
Order entry time	
Order turnaround time	
Order lead time	
Inventory holding cost	
Value of unusable stock	
Value of unaccounted stock	
Average response cost	
Inventory turnover rate	
Inventory velocity	
Ratio of order interval to actual order frequency	Bossert et al. (2002)
Percentage of reported stock-outs due to insufficient amount ordered	
Percentage of reported stock-outs due to insufficient amount received	
Percentage of last 4 orders/procurements received according to schedule	
Average number of days of stock-out duration	
Stock status: percentage of facilities maintaining stock according to established levels	
Percentage of health facilities dispensing ARVs that experienced a stock-out of at least 1 required ARV in the last 12 months (disaggregated by sector [public, private]); Percentage of ARV storage and delivery points experiencing stock-outs in the preceding 6 months	WHO (2007); WHO (2005); JSI (2005)
Percentage of stock records that correspond with physical counts, at a sample of warehouses and facilities	MSH (2012)
Is there a standard inventory control system at health facilities?	
Percentage of facilities with up-to-date stock cards (Are stock cards or stock books used for every movement of stock in or out of	MSH (2012); SCMS (2013)

Downstream Indicator	Source
the facility storeroom)	
Are pharmaceuticals reordered according to a consumption-based system?	MSH (2012)
Is the minimum or safety stock level set according to the frequency of delivery and average consumption?	
Are used stock cards, ledgers, or regulation books kept for a defined period?	
Are procedures manuals for inventory management available in the health facility?	
Over the past year, have expired medicines been used?	
Put-away accuracy	USAID (2010)
Picking accuracy rate	
Warehouse accident rate	
Defined security measures	
Warehouse order processing time	
Customs clearance cycle	
Put-away time	
Total warehousing cost	
Value of product damaged in the warehouse	
Storage space utilization	
Units moved per person hour	
Percentage of storage space dedicated for handling	
Storage condition indicators defined in LIAT	Bossert et al. (2002)
Percentage of facilities meeting cold chain storage conditions	
Percentage of ARV storage and delivery points meeting the minimum quality criteria (in addition to having no stock-outs)	WHO (2005)
Have the stock storerooms been sized according to any formula?	MSH (2012)
Is there a receiving area? Is there an unpacking area?	
Is there a discrepancy report form? Over the past year, has it been used?	
Is the storeroom dry, clean, well ventilated, and between +15 and +25 degrees Celsius?	
Is there a refrigerator? Is its temperature regularly recorded?	
When medicines or supplies are unpacked, are they stored according to FEFO or FIFO order?	
Are liquids for internal use kept separate from liquids for external use?	

5. Transportation

Fundamental to the success of a health logistics system is the ability to reliably move commodities through the supply chain so they are available for use at health facilities when needed. Yadav (2010) stated that the most challenging part of such distribution systems (often called “last-mile logistics”) is making deliveries to small clinics and health centers that are remote and have poor road access. In such instances, the clinic and health center staff themselves travel to the district or regional medical store to receive their medicine supplies using their own means of transport (e.g., cars, motorbikes), in the process taking away extremely crucial health-care worker time from the primary health system. When there is a system to distribute from the districts to the clinics, there is often a shortage of staff at the health centers that are trained to carry out the tasks of stock keeping, ordering, and requisitioning. Poor last mile logistics imply lack of consumption data from the service dispensing point, which should be the backbone of all planning in the upstream system.

A study in Mali suggested that equipment to ship products on the operational level is insufficient, and at times antiquated; financial means for maintaining the existing equipment is inadequate (USAID 2013).

Bossert and colleagues (2007) found that the level of decision-making authority at the facility level in Ghana was generally high for medicines and contraceptives (because they could select any form of transportation) but low for vaccines. They hypothesized that favorable decision making in transportation leads to prompt deliveries or pick-ups and improves product availability in the logistics system through lower stock-out levels and shorter order lead times. However, the study did not find a significant relationships between transportation decision space and performance indicators, including average order lead time for medicines, mean percentage of medicines stocked out at the time of the visit, and mean percentage of medicines stocked out in the last six months.

The study in Guatemala, on the other hand, asked the question of what facilities do if their normal transportation does not arrive, and defined the level of decision making authority as "high" if they contract private transportation or use public transportation, and "low" if they wait until the regular transport arrives. As expected, facilities that could use private or public transport if normal transport did not arrive had a higher percentage of facilities that reported no problems with transportation, and those that waited for the regular transport reported having transportation problems. However, similar to the findings in Ghana, no relationship was found between the transport decision space indicator and the percentage of stock-outs due to late delivery for all products.

Table A5 summarizes indicators related to transportation that have been collected from the literature review.

Table A5. Indicators for Transportation

Downstream Indicator	Source
On-time arrivals (percentage of vendor on-time delivery)	USAID (2010)
On-time delivery rate	SCMS (2013)
Percentage of shipments where quantity dispatched equals quantity received	USAID (2010)
Percentage of shipments arriving in good conditions	
Percentage (by value) of products lost during transport	SCMS (2013)
Kilometers between accidents	USAID (2010)
Time between accidents	
Average delivery time	
Average vehicle loading/unloading time	
Vehicle turnaround time	
Total transportation cost	
Average transportation cost per kilometer/volume/weight	
Ratio of transportation cost to value of product	
Vehicle use availability	
Container capacity utilization	
Fleet yield	
Average number of stops per route	
Percentage of facilities with facility-managed vehicle for product pick-up/delivery	Bossert et al.

Downstream Indicator	Source
Percentage of facilities with an alternative means of transport	(2002)
Ratio of facilities that collect own products vs. receive a delivery	
Percentage of reported stock-outs due to late delivery	
Percentage of reported stock-outs due to inability to pick up products	
What methods of communication are available and actually used between each node in the distribution system (telephone, fax, radio link, physical visit)?	MSH (2012)
Frequency of delivery	
Number of emergency deliveries	
Average lead time from suppliers and from warehouses to facilities	

6. Dispensing

Good dispensing practices ensure that an effective form of the correct medicine is delivered to the right patient, in the correct dosage and quantity, with clear instructions, and in a package that maintains the potency of the medicine. Dispensing includes all the activities that occur between the time the prescription is presented and the time the medicine or other prescribed items are issued to the patient (MSH 2012). *MDS-3* recommends developing and using written SOPs for the dispensing process to improve consistency and quality of work and which can be used for training and reference. The framework for such SOPs may be based on the six major areas of activity: receive and validate the prescription, understand and interpret the prescription, prepare and label items for issue, make a final check, record the action taken, and issue medicine to the patient with clear instructions and advice.

The dispensing activity, in theory, should have an effect in the performance of supply chain management. For example, records of issues to patients are critical in verifying the stocks used in dispensing and to track the remaining stocks. Or changes in dispensing practices that reflect medicine substitution or switching regiments would affect quantifications and forecasts. However, we were not able to identify any literature that explores the link between dispensing practices and logistics management performances.

Table A6 summarizes indicators related to dispensing that have been collected from the literature review.

Table A6. Indicators for Dispensing

Downstream Indicator	Source
Treatment guidelines and utilization manuals developed and available at service	
Dispensing staff available	SCMS (2013)
Dispensing staff trained	
Is pill counting conducted?	MSH (2012)

7. Waste Management

Facilities should have systems in place to ensure the safe handling, movement, storage, and disposal of waste, including expired medicines and diagnostics, unusable products, and used kits. In 2008, the estimated the value of expired ARVs in Uganda was in the range of 1.3–2 million US dollars (USD). A total of 58% of government facilities reported holding expired ARVs, compared to 29% of NGO facilities (Windisch et al. 2011). A study in Ethiopia, after reviewing the significant waste in pharmaceutical supply chain management, also concluded that the occurrence of expired drugs in surveyed health facilities highlighted the need for safe disposal of expired pharmaceutical products (Daniel et al. 2012).

Table A7 summarizes indicators related to waste management that have been collected from the literature review.

Table A7. Indicators for Waste Management

Downstream Indicator	Source
SOPs policy and content for waste management	SCMS (2013)
Identification, segregation, and storage of unusable pharmaceuticals	
Handling and internal transport of unusable pharmaceuticals	

8. Lab Issuing

Laboratory services are a critical, yet often neglected component of essential health systems in resource-limited countries. Laboratories play a central role in public health, in disease control and surveillance, and in individual patient diagnosis and care, yet many millions of people still do not have access to reliable, basic, diagnostic laboratory services (Petti et al. 2006). While the *MDS-3* states that a "functioning, good-quality equipment and uninterrupted supplies of test kits, reagents, and other consumables are mandatory", most health facilities failed to give attention and resources to meet the needs of laboratories. The report suggests that there is a lack of updated standard international guidance for managers to procure and manage laboratory supplies (MSH 2012).

For ART in particular, there has been a growing recognition of this importance, given the number of laboratory tests required to effectively diagnose AIDS and monitor its treatment (USAID 2008). However, we were not able to identify studies that explore the link between the availability or quality of laboratory services and logistics management performances for treatment services.

Table A8 summarizes indicators related to lab issuing that have been collected from the literature review.

Table A8. Indicators for Lab Issuing

Downstream Indicator	Source
Percentage of predetermined operational days that the CD4 machine performs CD4 tests	Uganda MOH (2007)
Percentage of time that the CD4 machine is functional	
Percentage of samples referred that are acceptable for testing	
Percentage of samples received from other health facilities that are acceptable for testing.	
Number of tests performed at US Government–supported laboratories during the reporting period	JSI (2005)

9. Management Information—Logistics Management Information Systems

Management of information is an essential part for effective logistics systems. Without good information on needs and inventory, it is difficult for each level to perform its other functions well.

The assessment conducted in Uganda's Iganga district revealed a range of parallel information processes due to external initiatives requesting separate forms and systems (Windisch et al. 2011). Different coding systems and discontinued files also contributed to misinterpretation of medicine consumption rates, needed to inform medicine orders. Instructions on new patient files and documentation remained poorly communicated to succeeding programs. The Iganga surveys also showed poor local compliance with information requirements. Three out of five sites handled the filing of patient cards poorly. Files were not kept in a way that allows easy retrieval and had to be sorted before assessment. The district as a consequence is missing the data needed for its supply forecasts, including patients lost to follow-up. National-level surveys corroborate these findings. One highlights a general lack of stationery, outdated forms, superfluous and duplicated reporting requirements, incoherence in indicators as well as inconsistency between systems that rely partly on computers, partly on manual filing. Effects are weak processes; incomplete record keeping, file keeping, and reporting; the loss of data as it is being aggregated from district to national level; and non-use of composed information. Another survey specifies weak inventory management of laboratory commodities; one-half of the facilities did not use any report forms and only about one-quarter used stock cards. Other research shows distorting effects such as oversupply in cases where MOH and PEPFAR-funded NGO projects deliver medicines to the same facilities and patients.

A study in Mali found that logistics data are generally collected by the staff responsible for inventory management but not transmitted to the higher level (USAID 2013).

Bossert, Bowser, and Amenyah (2007) found that in both Ghana and Guatemala, better performance of LMIS occurred when there was a more uniform LMIS, in contrast to those systems where local decisions led to different forms and reporting. They found that higher decision-making authority in LMIS was associated with poorer performance. In Ghana, those facilities that developed their own LMIS forms were less likely to submit monthly reporting of medicine availability. In Guatemala, those facilities that created their own reporting form for medicines were less likely to report on time. These results suggest that stricter guidelines on LMIS may lead to a more efficient information system.

Table A9 summarizes indicators related to management information that have been collected from the literature review.

Table A9. Indicators for Management Information

Downstream Indicator	Source
Percentage of orders placed through electronic ordering system	USAID (2010)
Facility reporting rates (percentage of required reports reported on time and complete to the central level)	
Percentage of facilities reporting that send reports according to schedule	Bossert et al. (2002)
Percentage discrepancy between usable stock according to stock card vs. LMIS report	
Percentage of reports and requisitions that are done on time for ARVs	Uganda MoH (2007)
Percentage of drug distribution nodes reporting on stock status (repletion, shortage, consumption, quality, losses) on a monthly basis	JSI (2005)
Average percentage of inventory variation in the stock record-keeping system, at a sample of warehouses and facilities	MSH (2012)
Sufficient office equipment including computers	SCMS (2013)

10. Infrastructure

Infrastructure refers to the physical framework on which a supply chain operates. It includes the basic requirements of buildings, utilities (including communications), office and warehouse equipment, and delivery vehicles. Infrastructure also includes security to ensure a safe and protected environment for employees and health commodities. The need for infrastructure varies greatly among the different functional areas.

A 2006 health facility survey in Uganda found most health facilities lack essential laboratory equipment. According to another survey, only 17% of the counseling rooms for HIV complied with national guidelines. While all health centers providing PMTCT and voluntary counseling and testing have laboratories for testing, technicians were not always available (Windisch et al. 2011).

MDS-3 reported that in one Central African country, a hospital pharmacist routinely allowed for losses of 80–90% on certain medicines when she placed her orders to ensure that she received enough supplies to treat hospital patients. In an extremely poor southeast Asian country, losses caused by theft are estimated to be more than 30% of the total pharmaceutical supply, despite theoretically strict accounting requirements for medicines. The government medical store in an East African country is reported to have placed an order for more than 100,000 USD worth of pharmaceutical cocaine, which vanished from the wharf when it arrived. In a Central American country, inventory records showed that stock levels of oral ampicillin, antibiotic eye ointment, and dozens of other products were intentionally overstocked because government buyers received special “commissions” for their purchase. In addition, theft of antibiotics for black market sale and treatment of STIs is common in many countries (MSH 2012).
In some cases, no additional costs are specifically attributable to security control. Several methods for preventing security breaches serve a dual purpose, because they are also necessary

for the effective procurement and distribution of pharmaceuticals: establishment of a pharmaceutical selection committee, quality assurance, inventory control and forecasting, and checking of receipts. Other security measures, however, may be quite costly but are worth the investment. Imprinting containers, embossing tablets and capsules, hiring special security staff, constructing secure warehouses and storerooms, and regularly monitoring and auditing stock records all can be expensive. Those expenses must be weighed against the potential savings in resources and in health from reduced theft, bribery, and fraud.

Table A10 summarizes indicators related to infrastructure that have been collected from the literature review.

Table A10. Indicators for Infrastructure

Downstream Indicator	Source
Housekeeping	SCMS (2013)
Storage and security of controlled substances	
Building and power	
Temperature and humidity control	
Environmental conditions	
Cold chain temperature control equipment (skip if no refrigerated or frozen pharmaceutical is dispensed)	
Security	

11. Human Resources

Despite significant increase in the supply of health commodities provided by international initiatives, such as PEPFAR and the Global Fund, personnel skills remain limited in managing health commodity supply chains. A study conducted by Matowe et al. (2008) found that problems with ART commodities supply management existed widely in Kenya, Rwanda, Tanzania, and Uganda. Inadequate skills of human resources were cited as the main reason for the inability of the existing systems to adequately handle scale-up of programs in all four countries. More specifically, the problems identified include lack of readiness of the workforce to efficiently use and manage large supplies of ARVs, inadequate capacity to quantify needs and distribute the medications, and inappropriate skill sets for advising patients on how to use medications appropriately. The authors concluded that the main challenge faced by the programs was a severely understaffed academic system, and highlighted the need to include additional institutions to support training and further build the skills of junior staff members. A similar conclusion was made by Waako et al. (2009), who stated that training on HIV and AIDS mainly focused on the clinical management and few workers had received training on pharmaceutical management for HIV and AIDS programs. The assessment showed a need for training in ARV supply management and clear and concise guidelines on the supply management and use of ARVs.

Another study, conducted in Ethiopia, stated that although public and private sector medicine outlets and service providers are regulated by the Regional Health Bureaus and the Ethiopian Food, Health, Medicine Administration and Authority, no established standardized job

descriptions or on-the-job training requirements for these providers exist (Daniel et al. 2011). Uganda's national-level data also confirms a severe lack of human resources in the area of supply chain management. While the public sector in Uganda has about 350 qualified pharmacists, it is estimated that at least 14,000 are needed. One of the reasons for the gap is a high turnover of pharmacists, who go abroad or work in the private sector. A perception at national level is, for example, that PEPFAR recipients have attracted the best health workers from the government systems, especially doctors and higher cadre nurses (Windisch et al. 2011).

The Mali study concluded that financial resources are insufficient to support supervision and training activities (USAID 2013).

In the management literature, Brauner et al. (2013) found that a person's technical competence, personality, and the position within the supply chain had significant effects on his/her performance within the supply chain.

Table A1 summarizes indicators related to human resources that have been collected from the literature review.

Table A11. Indicators for Human Resources

Downstream Indicator	Source
Percentage of key positions filled	SCMS (2013)
Average number of personnel assigned to each facility of the same level to manage logistics tasks	Bossert et al. (2002)
Percentage of staff trained in different areas	
Average length of time in current logistics position	
Average number of months since conducted last supervisory visit	
Average number of months since received last supervisory visit	
Percentage of visits where logistics tasks were assessed	
Percentage of visits include on-the-job training	
Percentage of staff trained in logistics	
Number of staff who report learning logistics form use during training or on-the-job training	
Percentage of staff participating in at least one communications meeting in past year	
Number of staff who report learning logistics form use during training or on-the-job training	
Percentage of health workers providing HIV and AIDS services who feel satisfied that they have adequate training to provide quality services	Uganda MOH (2007)
Percentage of health workers who have had comprehensive training in HIV and AIDS	
Percentage of health workers providing HIV and AIDS services who believe they have adequate essential materials to provide quality services	
Number of health workers trained on ART delivery in accordance with national or international standards	WHO (2005)
Number of FTE healthcare providers trained in and providing HIV care, treatment, and prevention, per 1,000 clients on ART	WHO (2007)
Staff attendance rate and sick time used	MSH (2012)
Staff turnover rate	SCMS (2013)

12. Demand Factors, Behaviors and Practices, and Perceptions Related to HIV and AIDS Treatment

Demand factors: Proper understanding and forecasting of demand can facilitate the planning and use of resources at facilities. Managers should collect demand data within the community and conduct the prediction, projection, or estimation of expected demand over a specified future time period. Despite the importance of demand indicators, we were not able to find papers linking demand indicators to supply chain management in low-resource settings.

Behavior and Practices: Chalker et al. (2008) performed a cross-sectional survey in 24 systems of care providing ARVs in Ethiopia, Kenya, Rwanda, Tanzania, and Uganda to examine current practices in monitoring rates of treatment adherence and defaulting. Their findings showed that only 20 of 48 facilities reported routinely measuring individual patient adherence levels; only 12 measured rates of adherence for the clinic population. The rules for determining which patients were included in the calculation of rates were unclear. Fourteen different definitions of treatment defaulting were in use. Facilities routinely gather potentially useful data, but the frequency of doing so varied widely. The authors concluded that individual and program treatment adherence and defaulting are not routinely monitored; when these are monitored, the operational definitions and methods varied widely, making comparisons across programs unreliable.

Management literature suggests that the causes of the bullwhip effect are related to behavioral factors and perception, such as misperceptions of feedback and time delays, panic ordering reactions after unmet demand, perceived risk of other players' bounded rationality, misuse of base-stock policies by providers, and so on. (Lee, Padmanabhan, and Whang 1997, Brauner et al. 2013). Furthermore, using a supply chain experimental game in studying the decisions of different stakeholder within the chain, Brauner et al. (2013) found the following results:

- The position within the supply chain had a significant effect on the total cost of a player and the average costs increase along the supply chain: retailers accumulated lower costs than wholesalers, distributors, and factory players.

- Gender and technical self-efficacy influenced performance, with women and persons with lower self-efficacy performing worse. As gender and technical self-efficacy are connected, the lower performance of women can be referred to their lower self-efficacy levels.

- The "need for security" subscale of the personality inventory shows significant differences with players having a high need for security having a higher spread (the difference between the maximum and minimum stock level in a week) than players with a low need for security.

Perceptions: One of the greatest challenges is to change the way in which providers, patients, and the public view and use pharmaceuticals. Potential factors that may affect the performance of logistics management include the prescribing and dispensing incorrect, harmful, or unnecessary medicines; failure by patients to use needed medications correctly; and wasteful or harmful self-medication practices (MSH 2012).

Table A12 summarizes indicators related to demand factors that have been collected from the literature review.

Table A12. Indicators for Demand Factors

Downstream Indicator	Source
Percentage of adults and children with advanced HIV infection receiving ART (disaggregated by sex [female, male] and age [<15, 15+[)	WHO (2007)
Percentage of HIV-infected pregnant women who received ARVs to reduce the risk of mother-to-child transmission	
Percentage of estimated HIV-positive incident TB cases that received treatment for TB and HIV (disaggregated by sex [female, male])	
Percentage of infants born to HIV-infected women who are started on co-trimoxazole prophylaxis within 2 months of birth	
Percentage of people with advanced HIV infection receiving ARV combination therapy	
Percentage of individuals who are still on treatment and who are still prescribed a standard first-line regimen after 6, 12, and 24 months from the initiation of treatment	WHO (2005)
Survival at 6, 12, 24, 36, etc., months after initiation of treatment	
Percentage of most-at-risk populations (IDU, MSM, SW) who are HIV-infected (disaggregated by sex [female, male] and age [<25, 25+])	WHO (2007)
Percentage of infants born to HIV-infected mothers who are infected	
Percentage of adults and children with HIV still alive and known to be on treatment 12 months after initiation of ART (disaggregated by sex [female, male] and age [<15, 15+])	
Percentage of HIV-positive patients enrolled in the clinic and receiving general care who have been assessed for ART eligibility at every visit	Uganda MOH (2007)
Percentage of HIV-positive women of reproductive age seen in the clinic who have been screened for pregnancy at every clinic visit	
Percentage of HIV-positive patients seen in the clinic who are in general care and/or receiving ART who are assessed for active TB at every visit	
Percentage of patients newly receiving ART who have met the ART eligibility criteria prior to starting their regimen	
Percentage of HIV-positive patients who are eligible and ready to start on ART	
Percentage of HIV-positive patients who are eligible and ready for ART and who have been started on ART	
Percentage of ART-naive HIV-positive patients who are eligible and ready for ART who are started on first-line ART	
Percentage of patients on ART who have switched from first- to second-line therapy	
Percentage of patients on ART who have been switched from first- to second-line therapy because of toxicity or adverse side effects	
Percentage of HIV-positive pregnant women seen in the PMTCT or ANC clinic who are enrolled in general care or ART at the clinic	
Percentage of HIV-positive patients on ART with documented contact tracing information	
Percentage of patients on ART who are adherent to ARV medicines	
Percentage of patients on ART who have died (month)	
Percentage of patients on ART for the past 6 months who have shown clinical improvement	
Percentage of patients on ART who obtain a CD4 test at least once every 6 months	
Percentage of patients with 2 CD4 tests within the past 12 months who have had an increase in their CD4 count	
Median increase of CD4 among patients with an increase CD4 count	
Percentage of HIV-positive patients on ART who have missed their scheduled appointment this month	

Downstream Indicator	Source
Percentage of HIV-positive patients on ART who are lost to follow-up	
Percentage of most-at-risk populations reached with HIV prevention programs in the past 12 months	WHO (2007)
Percentage of HIV-positive patients seen in the clinic (general care or receiving ART) who are prescribed daily co-trimoxazole	Uganda MoH (2007); WHO (2007)
Percentage of HIV-positive patients on co-trimoxazole who are adherent	
Percentage of children <18 months born to HIV-positive mothers who are prescribed daily co-trimoxazole	
Percentage of HIV-positive children >18 months who are prescribed daily co-trimoxazole	
Percentage of newly registered TB patients who are recorded to be HIV-positive, who were started on or continued on co-trimoxazole preventive therapy	WHO (2007)
Percentage of individuals newly enrolled in HIV care starting isoniazid preventative therapy (IPT)	
Percentage of individuals enrolled in HIV care who were screened for TB at last visit	
Percentage of women and men aged 15–49 who received an HIV test in the last 12 months and who know their results (disaggregated by sex [female, male] and age [15–19, 20–24, 25–49])	
Percentage of sexually active young women and men aged 15–24 who received an HIV test in the last 12 months and who know their results (disaggregated by sex [female, male] and age [15–19, 20–24])	
Percentage of most-at-risk populations (IDU, MSM, SW) who received an HIV test in the last 12 months and who know their results (disaggregated by sex [female, male], and age [<25, 25+])	
Percentage of TB patients who had an HIV test result recorded in the TB register (disaggregated by sex [female, male], age [0–4, 5–14, 15 and above], and HIV status [positive, negative])	
Percentage of infants born to HIV-infected women who received an HIV test within 12 months (disaggregated by type/timing of testing [virological testing within 2 months, virological testing between 2 and 12 months or antibody testing between 9 and 12 months])	
Percentage of HIV-positive patients in general care who are referred for CD4 testing once every six months	Uganda MoH (2007)
Percentage of pregnant women who were tested for HIV and who know their results (disaggregated by service type [ANC, labor and delivery, postpartum])	WHO (2007)
Number and percentage of health facilities where testing and counseling is available	
Percentage of health facilities that provide virological testing services (e.g., PCR) for infant diagnosis on site or through dried blood spots	
Number (and percentage) of people age 15 years and over who receive HIV testing and counseling and know the result	
Percentage of women and men aged 15–49 years who received an HIV test in the last 12 months and who know their results	
Proportion of sexually active young people 15–24 years who had an HIV test in the last 12 months and who know their results	
Percentage of pregnant women who know their HIV status	
Percentage of most-at-risk population(s) who received an HIV test in the last 12 months and who know their results	
Percentage of TB patients who had an HIV test result recorded in the TB register	
Percentage of people 15–49 years who know their HIV status	WHO (2007)
Percentage of the general population receiving an HIV test, the results, and pot-test counseling in the last 12 months	JSI (2005)
Surveys calculated adherence rates for the clinic population	Chalker et al.

Downstream Indicator	Source
The use of varying definitions of "treatment defaulting" in ART programs • Nonattendance at clinic visits: for 6 months, for 4 months, for 3 months, for 2 months, for 1 month • Missed appointments: 1 appointment, 2 appointments, 3 appointments • Number of days after missed appointment: 2 days, 3 days, 7 days, 14 days • One week without medicines • Patient never classified as defaulting • Not defined or not clear	(2008)
Records data useful for monitoring adherence • Adherence measures: patient self-reported adherence , provider assessment of patient adherence, data from patient medication calendar, pill counts with patient, reported reasons for nonadherence • ARV regimen and dispensing data: prescribed dosing schedule for ARVs, number of pills of ARVs dispensed, number of days of ART dispensed • Visit schedule: date of next scheduled visit, dates of actual vs. scheduled visit • Clinical measures: viral load counts, CD4 counts, lymphocyte counts	

13. Relevant Environmental Factors

SCMS's *National Supply Assessment* tool (2013) proposed that an environmental profile should be completed prior to any type of assessment. This is important because a supply chain's capability maturity and performance are influenced and constrained by the environment.

Table A13 summarizes indicators related to environmental factors that have been collected from the literature review.

Table A13. Indicators for Environmental Factors

Downstream Indicator	Source
Health sector overview and strategy	SCMS (2013)
Supply chain policies and regulations	
Demographics and epidemiology	
Financing of the health sector	
Financing of supply chain	
Culture and social dynamics	
Availability and skill level of human capital	
Macroeconomic overview	
Supply base	
Climate and geography	
National infrastructure and services	

ANNEX B. INTERVIEW GUIDE

Interview Guide—National Level

General Questions about Supply Chain for ARVs

- Let's begin by having you tell us a bit about the system for treating HIV patients in your country?
- What is the involvement of the different levels (national, regional, lower level) in treating HIV patients?
- Are there protocols for treating HIV and AIDS patients?
- Are there protocols for prescribing practices for HIV and AIDS patients?
- What are the ARVs that are used in this country that have been in shortage?
- Can you describe the procurement system for these ARVs?
- Are there protocols/guidelines for supply chain functions for ARVs?
- Which regions are doing better/worse in ARV management?

General Issues on Procuring, Storing, and Maintaining

- What are the problems with procuring, storing, and maintaining the right level of ARVs at the national level?
- What are the problems with procuring, storing, and maintaining the right level of ARVs at the regional level?
- What are the problems with procuring, storing, and maintaining the right level of ARVs for hospitals?
- What are the problems with procuring, storing, and maintaining the right level of ARVs for health centers?
- What is your definition of "stock-out"?
- When there is drug shortage at the facility level, how do they communicate with CMS or regional stores? Which facilities (characteristics) communicate more/less?
- Are there good performers and poor performers in terms of those who procure, store, and maintain the right level of ARVs in their facilities?
- What are the potential factors that distinguish the "good performers" from the "poor performers"?
- What is the relationship/interaction between the national level and health facilities?
- What is the relationship/interaction between the regional level and health facilities?

Specific Practices and Behaviors

In this next section we will be asking about specific practices and behaviors that happen at the hospital and facility levels that might impact procurement, storage, and maintenance of ARVs.

Please discuss the specific behaviors and practices as they pertain to each of the areas (procurement, storage, maintenance).

- What are some of the practice and behaviors of physicians/nurses/(any prescriber) at the hospital and health facility level that impact the procurement, storage, and maintenance of ARVs?
- What are some of the practice and behaviors of pharmacists/pharmacy assistants/(any dispenser) at the hospital and health facility level that impact the procurement, storage and maintenance of ARVs?
- Are there other health cadres or other personnel at any of these levels that impact the procurement, storage and maintenance of ARVs?
- What do you think are the reasons for stock-outs of ARVs at the hospital and facility levels?
- Are there specific prescribing practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific counseling practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific dispensing practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific clinical practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific adherence practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific information sharing practices in this facility that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- How does the support given to HIV patients impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Does patient monitoring impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific data generating activities in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific data analysis activities in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- How are data reported and how does this impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- To whom are data reported and how does this impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there any other practices and/or behaviors that happen at the hospital or facility level that we have not discussed that you feel impact procurement, storage, and maintenance of ARVs at either the facility or hospital level?

Interview Guide—Regional level

General Questions about Supply Chain for ARVs

- What is your involvement in the facilities' treatment of HIV patients? More specifically, what is your involvement in the specific facilities we are visiting (name them)?
- What are the problems with procuring/forecasting, storing, and maintaining the right level of ARVs at the regional level?
- What are the problems with procuring/forecasting, storing, and maintaining the right level of ARVs for hospitals?
- What are the problems with procuring/forecasting, storing, and maintaining the right level of ARVs for health centers?
- Are there good performers and poor performers in terms of those who forecast, store, and maintain the right level of ARVs in their facilities?
- Please discuss the difference in the level/number of emergency requests from some facilities versus others?
- What do you think are the reasons for stock-outs of ARVs at the hospital and facility levels?
  - Why are the "good performers" good performers?
  - Why are the "poor performers" poor performers?

Specific Practices and Behaviors

In this next section we will be asking about specific practices and behaviors that happen at the hospital and facility levels that might impact procurement, storage, and maintenance of ARVs. Please discuss the specific behaviors and practices as they pertain to each of the areas (procurement, storage, maintenance).

- What are some of the practice and behaviors of physicians/nurses (any prescriber) at the hospital and health facility level that impact the procurement, storage, and maintenance of ARVs?
- What are some of the practice and behaviors of pharmacists/assistants/(whoever is managing supplies) at the hospital and health facility level that impact the procurement, storage, and maintenance of ARVs?
- Are there other health cadres or other personnel at any of these levels that impact the procurement, storage, and maintenance of ARVs?
- Are there specific prescribing practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific counseling practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific dispensing practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific clinical practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?

- Are there specific adherence practices undertaken in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific information sharing practices in this facility that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific data generating activities in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- Are there specific data analysis activities in this country that impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- How are data reported and how does this impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?
- To whom are data reported and how does this impact the procurement, storage, and maintenance of ARVs at the hospital and/or facility level?

Interview Guide—Facility-level Focus Groups

General Questions about Supply Chain for ARVs

Let's begin by having you tell us a bit about the system for treating HIV patients in this facility? How many HIV patients do you have? How many in-transit? How many patients are off-site?

- Probe on how to get patient numbers
- Registry—ART registry and dispensing registry. Who writes what? When is it filled?
- Role of statistician
- Are there protocols for treating HIV and AIDS patients that you following in this facility?
- Are there protocols for prescribing practices for HIV and AIDS patients that are used in this facility?
- Can you describe the forecasting and ordering system for these ARVs for this facility (forecasting and ordering in this sense can be as broad as you define it: storage, monitoring, ordering, etc.; i.e., how do you procure ARVs for this facility)?
- Are there protocols or rules for the supply chain or forecasting and ordering system for ARVs? If so, please explain?
- Who is responsible for each of these components of the system that you describe?
- Does the forecasting and ordering system for ARV different significantly from the forecasting and ordering systems for other medications? If so, explain?
- Are there any feedback loops within these components (i.e., who collects, sends, analyzes specific data related to ARV supply chain)?
- What is the interaction between your facility and the regional/district pharmacist?
- What is the interaction between your facility and the central medical store?

Facility Performance

Forecasting accuracy

- Do you forecast? If yes, how many months do you forecast?

- Subjectively, what is the accuracy of your forecast? On a scale of 1 to 10 (1 lowest and 10 highest)
- Do you rely on your forecast? Yes/No
- If yes/No—why?

Order fill rate

- What is the proportion of total quantity ordered in the last quarter (last six months) that was issued by the central medical stores?
- What was the number of ARV products ordered on each order? What about the number of items that were received?
- What were the quantities of ARV products ordered on each order? What about the quantities received?
- What is your order fill rate?

Percentage of total stock that expired in previous reporting period (verify from stock records)

- Have you calculated your percentage of ARVs wasted due to expiry? Yes/No
- What is your percentage of ARVs wasted due to expiry?

Percentage of required reports submitted on time and complete to the central level (verify from quarterly reports and support supervision records)

- What is the number of ART reports submitted in last quarter?
- What is the number of ART reports submitted on time in last quarter?

Percentage of emergency orders issued in the last 12 months (verified from order records)

- How many emergency/unplanned orders did you make in the past 12 months? How many planned/scheduled orders did you make to the central medical stores in the past 12 months?

Inventory accuracy rate (verified from stock cards)

- On physical inventory, what is the percentage of inventory that matches with physical stock?

Order lead time

- In reference to the last order, what is the date of the order and the date the order was received?

Stock-out rate

- Number of ARV stock-out reports in the last 12 months for the first-line ART regimens
- Number of days of stock-out in last 12 months for first-line ARVs

General Issues on Procuring (Forecasting, Ordering), Storing, and Maintaining

- What are the problems with procuring, storing, and maintaining the right level of ARVs in this facility? Of these that you have listed, what are the largest?
- What are some of the practice and behaviors of physicians/nurses/(any prescriber) in this facility that help affect the forecasting and ordering, storage, and maintenance of ARVs?
- What do you think are the reasons for stock-outs (not meeting the monthly Min-Max requirement) of ARVs in your facility?

Specific Practices and Behaviors

In this next section we will be asking about specific practices and behaviors that happen at the hospital and facility levels that might impact forecasting and ordering, storage, and maintenance of ARVs. Please discuss the specific behaviors and practices as they pertain to each of the areas (forecasting and ordering, storage, maintenance).

- Tell me a bit about the prescribing practices for ARV patients?
- Are there specific prescribing practices undertaken in this facility that impact the forecasting and ordering, storage, and maintenance of ARVs at the facility level?
- What are your prescribing practices if there is stock-out of ARVs? [Probe on communication between prescribers and pharmacy staff when there is shortage or change in guideline.]
- Tell me a bit about the counseling practices for ARV patients?
- Are there specific counseling practices undertaken in this facility that impact the forecasting and ordering, storage, and maintenance of ARVs at the facility level?
- Tell me a bit about the dispensing practices for ARV medications?
- Are there specific dispensing practices undertaken in this facility that impact the forecasting and ordering, storage, and maintenance of ARVs at the facility level?
- Tell me a bit about the clinical practices for ARV patients?
- Are there specific clinical practices undertaken in this facility that impact the forecasting and ordering, storage and maintenance of ARVs at the facility level?
- Tell me a bit about the adherence practices for ARV patients? [Probe on pill counts, if they do it, how they do it, and how the change in drugs are captured in the system.]
- Are there specific adherence practices undertaken in this facility that impact the forecasting and ordering, storage, and maintenance of ARVs at the facility level?
- Tell me a bit about the information sharing when treating ARV patients?
- Are there specific information sharing practices in this facility that impact the forecasting and ordering, storage, and maintenance of ARVs at the facility level?
- Tell me a bit about how HIV patients are monitored when taking ARV medications?
- Does patient monitoring impact the forecasting and ordering, storage, and maintenance of ARVs in this facility?
- Tell me a little bit about what data are used and generated related to ARV medications? (How are data used, where are they sent to, when, what is feedback time.)

- Are there specific data-generating activities in this facility that impact the forecasting and ordering, storage, and maintenance of ARVs at the facility level?
- Are there specific data analysis activities in this facility that impact the forecasting and ordering, storage, and maintenance of ARVs at the facility level?
- How are data reported and how does this impact the forecasting and ordering, storage, and maintenance of ARVs in this facility?
- To whom are data reported and how does this impact the forecasting and ordering, storage, and maintenance of ARVs in this facility?
- What are the feedback loops with respect to the data generated? Where is it sent and how analyzes it? Do you see these results?
- What are other general behaviors and practices that impact forecasting and ordering, storage, and maintenance of ARVs in this facility that we should know about?

ANNEX C. LIST OF INTERVIEWEES

Namibia

Organization/Affiliation	Title
Ministry of Health	ART Logistics Pharmacist Senior Principal Pharmacist
Central Medical Store	Acting Chief Pharmacist Distribution Pharmacist
Regional Office (Region 1)	Regional Pharmacist
Regional Office (Region 2)	Regional Pharmacist
World Health Organization	Head of Disease Prevention and Control Head of Child and Adolescent Health Officer
Hospital A	Pharmacy Assistant HIV/AID clinician
Hospital B	Pharmacy Assistant HIV and AIDS Clinician
Hospital C	Principal Medical Officer Surgery Manager Nurse Manager Registered Nurses Pharmacy Assistant
Hospital D	ART Pharmacist Senior Principal Pharmacist Pharmacist Assistants
Facility A	Nurse
Facility B	Head Nurse
Facility C	Chief Nurse ARV Nurse
Facility D	Nurses Community Counselor

Swaziland

Organization/Affiliation	Title
Central Medical Stores	Head of CMS
Hospital O	Senior Pharmacist 2 Pharmacy Assistants
Hospital P	Senior Pharmacist
Hospital Q	Nurse Pharmacist Senior Pharmacist via phone
Hospital R	Pharmacist in charge of HIV and AIDS
Baby Clinic A	Head Nurse
Baby Clinic B	Head Nurse Assistant Nurse
Baby Clinic C	Head Nurse

Cameroon

Organization/Affiliation	Title
National AIDS Control Committee (NAAC) Region 1 Office	Region 1 Focal Point
NAAC Region 2 Office	Region 2 Focal Point
Regional Office (Region 1)	Regional Manager ARV Pharmacist
Regional Office (Region 2)	Regional Pharmacist
ICAP	Country Representative Technical Director M&E Officer
Regional Hospital I	HIV Clinic Coordinator Pharmacy Manager Pharmacy Assistant
Regional Hospital J	HIV Clinic Coordinator Pharmacy Assistant
Hospital K	Hospital Coordinator Dispensing Nurses
Hospital L	Hospital Coordinator Dispenser Nurse ARV Manager Senior Pharmacist
Hospital M	Hospital Coordinator Pharmacy Assistant
Hospital N	Health Center Director Dispenser Counselor