Access, Bottlenecks, Costs, and Equity

ABCE Project Cross-Country Protocol

January 28, 2015

This protocol was prepared by the Institute for Health Metrics and Evaluation (IHME). This work is intended to help policymakers understand the costs of health service delivery, facility-based characteristics of antiretroviral therapy (ART) programs, patient perspectives, and health facility performance across different service-delivery settings. This document draws from individual country protocols to provide an overarching guide to the Access, Bottlenecks, Costs, and Equity (ABCE) project.

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About

About IHME

The Institute for Health Metrics and Evaluation (IHME) is an independent global health research center at the University of Washington that provides rigorous and comparable measurement of the world's most important health problems and evaluates the strategies used to address them. IHME makes this information freely available so that policymakers have the evidence they need to make informed decisions about how to allocate resources to best improve population health.

To express interest in collaborating or request further information on the Access, Bottlenecks, Costs, and Equity (ABCE) project, please contact IHME:

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About the ABCE Project Cross-Country Protocol

Access, Bottlenecks, Costs, and Equity: ABCE Project Cross-Country Protocol provides an overarching guide to ABCE project development and implementation across countries involved in the multicountry study. This guide was created to provide accessible documentation of the broader ABCE project. Protocols specific to each country were developed for internal use during the ABCE project implementation phases for relevant data-collection sites. This document is meant to represent all ABCE countries, but because project implementation and data collection are still ongoing in many places, most of the content presented here is from four countries (Ghana, Kenya, Uganda, and Zambia). *Access, Bottlenecks, Costs, and Equity: ABCE Project Cross-Country Protocol* will be updated as more phases of data collection and analysis are completed.

The ABCE project is funded through the Disease Control Priorities Network (DCPN), a multiyear grant from the Bill & Melinda Gates Foundation to comprehensively estimate costs and cost-effectiveness for a range of health interventions and delivery platforms. A separate grant from the Bill & Melinda Gates Foundation funded the antiretroviral therapy (ART)-specific components of the ABCE projects in Kenya, Uganda, and Zambia. UNICEF provided financial support for data collection in Ghana.

About ABCE country collaborators

The ABCE project was led by a number of country collaborators, whose expertise, work, and dedication are directly reflected in the quantity and quality of data collected for the overarching ABCE project. In the present version of the *Access, Bottlenecks, Costs, and Equity: ABCE Project Cross-Country Protocol*, for which the focus is on four countries in sub-Saharan Africa, we wish to highlight the ABCE country collaborators in Ghana, Kenya, Uganda, and Zambia. Coordinated by IHME, the ABCE project was led by the Ghana Health Service (GHS), Ministry of Health (MOH), and UNICEF in Ghana (with Kwakye Kontor of Ghana's MOH, Bertha Garshong of GHS, and Anirban Chatterjee and Jane Mwangi of UNICEF as the in-country principal investigators [PIs]); Action Africa Help-International (AAH-I) in Kenya (with Caroline Kisia of AAH-I as the in-country PI); the Infectious Diseases Research Collaboration (IDRC) in Uganda (with Jane Achan of IDRC as the in-country PI); and the University of Zambia (UNZA) in Zambia (with Felix Masiye of UNZA as the in-country PI).

In each country, the ABCE project also greatly benefited from key inputs and support from government entities, nonprofit organizations, and international agencies. For Ghana, the Ghana UNICEF office, Instituto Nacional de Salud Pública, and the Clinton Health Access Initiative (CHAI) provided critical feedback and support. In Kenya, the country's Ministry of Medical Services (MOMS) and Ministry of Public Health and Sanitation (MOPHS) gave indispensable content knowledge and ongoing support. For Uganda, the country's MOH and Makerere University served as vital collaborators. In Zambia, the MOH and Churches Health Association of Zambia (CHAZ) provided important inputs and generously facilitated data access.

It is because of these ABCE project collaborators and their contributions that we are able to present findings today and continue working together to generate the evidence base for providing equitable, cost-effective health services worldwide.

About the ABCE team

IHME has coordinated ABCE project activities since 2011. At IHME, the PIs are Christopher Murray and Emmanuela Gakidou, with Herbert Duber, Michael Hanlon, and Santosh Kumar providing key faculty and research leadership. Kelsey Moore has led much of the project management and implementation for the ABCE project, with vital support from Aubrey Levine and Annie Haakenstad. Nancy Fullman leads policy translation efforts for the ABCE team, linking research findings to relevant health programs and policies.

In-country PIs received critical support from a number of individuals. For the ABCE project in Kenya, Pamela Njuguna of AAH-I served as the research coordinator, and Ann Thuo, Dinah Nioroge, and Umar Baba also provided team support. Tom Achoki (now of IHME) also provided assistance in interpreting findings. In Uganda, Gloria Ikilezi (now of IHME) served as the research coordinator at IDRC, and received additional support from James Okello, Paul Bazongeere, Grace Akalo, Florence Alanyo, Gertrude Abbo, and Stella Namuwaya. In Zambia, Chrispin Mphuka and Mashekwa Maboshe led many UNZA-based activities for the ABCE project.

Data collection, management, and analyses were jointly conducted by a number of in-country and IHME researchers, including Miriam Alvarado (now of Chronic Disease Research Centre of Barbados), Ian Bolliger (now of the University of California-Berkeley), Benjamin Brooks (now of Zillow), Roy Burstein, Anthony Bui, David Chou (now of Columbia University), Ruben Conner (now of PATH), Emily Dansereau, Brendan DeCenso (now of RTI International), Kristen Delwiche, Laura Di Giorgio, Anne Gasasira, Michael Freeman (now of the University of Washington's Information School), Gloria Ikilezi, Carly Levitz, Grégoire Lurton, Samuel Masters (now of UNC-

Chapel Hill), Thomas Odeny (now of the University of Washington's Department of Epidemiology and the Kenya Medical Research Institute [KEMRI]), Emelda Okiro (now of KEMRI-Wellcome Trust), Hannah Peterson (now of Boston University), Allen Roberts, Thomas Roberts (now of Stanford University), and Alexandra Wollum.

This cross-country protocol was developed by Aubrey Levine, with contributions from Nancy Fullman.

Acronyms

AAH-I	Action Africa Help-International
ABCE	Access, Bottlenecks, Costs, and Equity
ACT	Artemisinin-based combination therapy
AIDS	Acquired immunodeficiency syndrome
ART	Antiretroviral therapy
CAPI	Computer Assisted Personal Interviewing
CHAI	Clinton Health Access Initiative
CHAZ	Churches Health Association of Zambia
CHPS	Community-based health planning and services
DCPN	Disease Control Priorities Network
DEA	Data Envelopment Analysis
DHMT	District Health Management Team
DHT	District Health Team
DHS	Demographic and Health Survey
EMR	Electronic medical record
GHS	Ghana Health Service
GHDx	Global Health Data Exchange
HIV	Human immunodeficiency virus
IAC	International AIDS Conference
IDRC	Infectious Diseases Research Collaboration
iHEA	International Health Economics Association
IHME	Institute for Health Metrics and Evaluation
IRB	Institutional Review Board
MCDMCH	Ministry of Community Development, Mother, and Child Health
MOH	Ministry of Health
MOMS	Ministry of Medical Services
MOPHS	Ministry of Public Health and Sanitation
NACC	National AIDS Control Council
NGO	Non-governmental organization
PI	Principal investigator
PMTCT	Prevention of mother-to-child transmission (of HIV)
RA	Research associates
RMSE	Root-mean-square error
SAG	Sector Advisory Group
SBA	Skilled birth attendance
TMQ	Topics-metrics-questions
UNAIDS	The Joint United Nations Programme on HIV/AIDS
UNICEF	The United Nations Children's Fund
UNZA	University of Zambia
VCT	Voluntary counseling and testing
WHO	World Health Organization

Introduction

Background

The performance of a country's health system ultimately shapes its population's health outcomes, influencing the ease or difficulty with which individuals can seek care and facilities can address their needs. At a time when international aid is plateauing and countries have prioritized expanding many of their health systems, identifying health system efficiencies and promoting the delivery of cost-effective interventions has become increasingly important.

Assessing health system performance is crucial to optimal policymaking and resource allocation; however, due to the multidimensionality of health system functions, comprehensive and detailed assessment seldom occurs. Rigorously measuring what factors are contributing to or hindering health system performance – access to services, bottlenecks in service delivery, costs of care, and equity in service provision throughout a country – provides crucial information for improving service delivery and population health outcomes.

The existing evidence landscape concerning health system performance and costs of care is, at best, incomplete. First, most sources of administrative data on facility capacity, service provision, and costs are not fine-grained enough to properly capture the range of service experiences within a health system. Further, these data generally reflect theoretical or predicted costs of care under ideal conditions of operational efficiency, while in reality, costs of service production can widely vary in accordance with facility-based resources and patient volumes. For example, reaching the underserved, rural poor in low-resource settings may require the expansion of existing primary care and local hospital infrastructure, but the diseconomies of scale from such expansions are only partially captured by existing data sources and methodologies.

Second, few sources of data consider how facility-based factors (supply-side) interact with patient perspectives (demand-side) in the provision of health services. Understanding these linkages is critical to improving population health, as the optimal delivery of care cannot occur without aligning both supply- and demand-side characteristics within a health system.

The Access, Bottlenecks, Costs, and Equity (ABCE) project was launched in 2011 to address these gaps in information. Led by the Institute for Health Metrics and Evaluation (IHME) and numerous country collaborators, multiple phases of data collection, analysis, and interpretation have taken place for the ABCE project. The ABCE team has harnessed information from distinct but linkable sources of data, drawing from nationally representative samples of health facilities for each country to create large and fine-grained databases of facility attributes and capacity, patient characteristics and outcomes, and measures related to a range of specific programs. By capturing the interactions between facility characteristics and patient perceptions of care, the ABCE team has been piecing together what factors drive or hinder optimal and equitable service provision in rigorous, data-driven ways.

The ABCE project has taken place in seven countries (Colombia, Ghana, Kenya, Lebanon, Uganda, Zambia, and six states in India), and the ABCE team plans to expand project activities to Bangladesh and Mozambique in 2015. These nine countries have been purposively selected for the overarching ABCE project as they capture the diversity of health system structures, composition of providers (public and private), and disease burden profiles.

For a subset of countries, an additional component was conducted to quantify aspects of facility-based HIV/AIDS programming. These countries were selected to represent the range of antiretroviral therapy (ART)-specific delivery mechanisms. Prior to the ABCE project, minimal information had been comprehensively collected on what facility factors are related to improved outcomes for ART patients in the settings where they actually receive care. By sampling a broad range of facility types with ART programs across countries and collecting a range of patient outcome information, the ABCE project will have the data to better ascertain facility determinants of ART outcomes under routine conditions.

Findings from each country's ABCE work provide actionable data to inform their own policymaking processes and needs. Further, continued cross-country analyses will yield more global insights into health service delivery and costs of health care. The ABCE project contributes to the global evidence base on the costs of and capacity for health service provision, aiming to develop data-driven and flexible policy tools that can be adapted to the particular demands of governments, development partners, and international agencies.

Research questions

The ABCE project strives to answer these critical questions facing policymakers and health stakeholders in each country, which are also of high relevance to global health and development actors:

- What health services are provided, and where are they available?
- How much does it cost to produce health services?
- Who is receiving these health services?
- What are the largest barriers to accessing care and who is most affected?

For the subset of countries involved in the ART arm of the ABCE project, the following questions guided ART-specific data collection and analyses:

- What is the cost per completed year of ART, and what is the average annual cost to be on ARTs?
- What facility and patient characteristics are associated with lower costs and better outcomes?
- How much would it cost to scale up ART programs further?

In consultation with each in-country collaborator and targeted stakeholders, the ABCE team has also tailored analyses to answer policy-relevant questions that emerged during the course of project implementation. Because of their extensive nature, ABCE datasets are uniquely positioned to provide the information needed for evolving health policy settings.

Approach

The ABCE project uses a multipronged approach to support the decision-making needs of policymakers and stakeholders in achieving improved and more equitable population health outcomes. The ABCE team brings together existing data sources and conducts primary data collection at health facilities as needed, which includes in-depth facility surveys and facility inventories across a range of service-delivery platforms. In addition, patient exit interviews and clinical chart extractions are conducted at sampled facilities to learn more about patient experiences and outcomes. With these data, facility-level analyses on efficiency, costs of care, and the bottlenecks that impede service are conducted.

We focus on the facility because health facilities are the main points through which most individuals interact with a country's health system or receive care. Understanding the capacities and efficiencies within and across different types of health facilities unveils the differences in health system performance at the level most critical to patients – the facility level. We believe this information is immensely valuable to governments and development partners, particularly for decisions on budget allocations. By having data on what factors are related to high facility performance and improved health outcomes, policymakers and development partners can then support evidence-driven proposals and fund the replication of these strategies at facilities throughout sub-Saharan Africa.

With its large, fined-grained datasets from multiple countries, the ABCE project provides an optimal analytical environment to improve upon and develop new statistical methods for estimating health system efficiencies and costs. For instance, researchers are currently honing modified Data Envelopment Analysis (DEA) methods to better pinpoint the frontiers of health service production. These data will be made publicly available, alongside other dissemination activities such as policy workshops, presentations, reports, and journal articles.

All data collected through the ABCE project contribute to an overarching study, the Disease Control Priorities Network (DCPN) project. The DCPN project strives to generate standardized estimates for the cost-effectiveness of different interventions and intervention packages across a range of settings. These data will ultimately support policy tools and recommendations for optimal resource allocation. To learn more about the DCPN project, go to www.healthdata.org/dcpn.

Study design

Overview

For each country involved in the ABCE project, we collected any relevant data that already existed in the country's health system and conducted primary data collection as needed. Primary data collection took place with two complementary approaches:

1. A comprehensive facility survey administered to a nationally representative sample of health facilities (the ABCE Facility Survey).
2. Interviews with patients as they exited sampled facilities (the Patient Exit Interview Survey).

District health offices, district health management teams, or their equivalents received a modified version of the ABCE Facility Survey. For a subset of countries, a sample of facilities that provided ART services received an ART-specific module alongside the ABCE Facility Survey. The ABCE field team also extracted clinical records from the charts of HIV-positive patients at these facilities. Additional patient exit interviews were conducted for patients seeking HIV services as well.

Not every instrument was implemented across countries involved in the ABCE project. Table 1 summarizes which data-collection efforts took place in the four sub-Saharan African countries covered by this cross-country protocol, as well as the timing of primary data collection and organizational leads for the ABCE field teams. Future editions of the cross-country protocol will provide more information on the other ABCE countries.

Table 1. ABCE data collection components and final samples, by country

ABCE data-collection component	Ghana	Kenya	Uganda	Zambia
Data collection instrument				
ABCE Facility Survey	240 facilities	254 facilities	247 facilities	188 facilities
Patient Exit Interview Survey (non-HIV patients)		3,263 patients	3,902 patients	2,319 patients
ART Module (in the ABCE Facility Survey)		51 facilities	47 facilities	46 facilities
Clinical Chart Extraction		15,853 charts	8,233 charts	8,528 charts
Patient Exit Interview Survey (HIV patients)		1,029 patients	890 patients	402 patients
Data collection implementation				
Field team	GHS	AAH-I	IDRC	UNZA
Timing of data collection	June-October 2012	April-November 2012	April-October 2012	September 2011-April 2012

For each country, ABCE instruments were modified to reflect the given country's context and to better ensure the proper measurement of indicators relevant to each country's health system. As a result, the specific content and order of each instrument component may vary country to country. For this cross-country protocol, we aim to provide the most generalizable content, as well as specific examples, for each instrument used.

As of January 2015, all survey instruments and their corresponding data for Ghana, Kenya, Uganda, and Zambia are publicly available through IHME's Global Health Data Exchange (GHDx): http://ghdx.healthdata.org.

Sampling

To construct a nationally representative sample of health facilities for each country involved in the ABCE project, we used a two-step stratified random sampling process. This was considered the optimal approach to create a facility-driven database that represented the full spectrum of a country's health system, capturing the variation in delivery platforms, geography, ownership, and services provided.

Across countries, the first step was to create a sampling frame from which subnational geographic units (districts for Ghana, Uganda, and Zambia; counties for Kenya) would be drawn. Based on consultation with in-country collaborators, the larger categories of subnational geographic units were formed in two different ways:

1. **Regions:** for Ghana and Uganda, districts were grouped by 10 regional boundaries commonly used by household surveys such as the Demographic and Health Survey (DHS). Each district was designated rural or urban based on previous survey classifications. Then, from each of the 10 regions, one rural and one urban district were randomly selected. Some districts were purposely added to the district selection process, due to their health policy relevance and population size (e.g., in Ghana, the Accra Metropolitan Area from Greater Accra and the district of Kumasi from the region of Ashanti were also included in the district sampling frame, above and beyond the districts randomly selected from the country's 10 regions).

2. **District-performance indicators:** for Kenya and Zambia, districts were grouped into unique categories based on three district-level performance indicators derived from previously conducted household surveys, censuses, and expenditure surveys. Examples of indicators included malnutrition rates (low [less than 20% prevalence of malnutrition], middle [20% to 30% prevalence], and high [greater than 30% prevalence of malnutrition]); average levels of household wealth (poorest, middle, and wealthiest); coverage of skilled birth attendance (SBA) (low, middle, and high); and population density (rural, semi-dense, and dense). Subnational units (counties for Kenya and districts for Zambia) were grouped into each of the unique categories, and then one subnational unit was randomly selected from each category. For instance, in Kenya, one county was randomly selected from each of the 27 unique malnutrition-health expenditures-population categories that were populated. Some subnational units were purposely added to the selection process due to their health policy relevance and population size (e.g., in Zambia, Lusaka district was automatically included, along with districts randomly selected through the facility sampling frame).

The second step entailed sampling facilities from selected districts or counties across the range of platforms identified for each country. For the ABCE project, a "platform" was defined as a channel or mechanism by which health services are delivered. Although countries showed some similarities in facility types, platforms were defined in accordance with each country's health system. Table 2 provides a summary of the platforms from which facilities were sampled for each country, as well as the original source for each facility sampling frame.

This two-step sampling process resulted in 18 to 22 districts or counties selected through the district or county sampling frame, and approximately 250 to 270 facilities selected through the facility sampling frame. For each country, a predetermined number of facilities were randomly selected from each platform category. Facility sampling procedures for Uganda are described on the following page to give an example of how facility sampling could take place. Each country's sampling processes – both in terms of geography and facilities – varied in accordance with the specific country context and health system structure.

More detail is provided about each country's sampling procedures in their respective policy reports, which can be downloaded at www.healthdata.org/dcpn/publications.

Table 2. ABCE project platforms, by country

	Ghana	Kenya	Uganda	Zambia
Facility type				
Hospitals	Teaching hospitals, regional referral hospitals, public [district] hospitals	National hospitals, provincial hospitals, district hospitals, sub-district hospitals (public, private, and NGO-owned)	National referral hospitals, regional referral hospitals, district hospitals (public, private, and NGO-owned)	Level 3 hospitals, level 2 hospitals, level 1 hospitals (public, private, and mission-owned)
Primary care	Health centers, CHPS	Health centers, clinics, dispensaries	Health centers (VI, III, and II), clinics	Health centers (urban and rural), health posts
Other health service outlets	Maternity clinics, pharmacies/drug stores	Maternity homes, VCT centers, pharmacies/drug stores	Pharmacies/drug stores	Dental clinics, pharmacies/drug stores
District health agency	DHMT	DHT	DHMT	DHMT
Facility sampling frame source	2011 MOH Needs Assessment	2011 MOH facility inventory	2011 MOH facility inventory	2010 MOH facility list

ART module and clinical chart extraction. Of the facilities offering ART services that were selected for ABCE Facility Survey implementation, we randomly sampled 60 facilities to receive an additional survey module that collected information on facility-level ART program characteristics, service provision, and costs. This ART-focused module was administered alongside the ABCE Facility Survey at these facilities in Kenya, Uganda, and Zambia; the ABCE project in Ghana did not include this additional ART component.

For a sub-sample of these facilities with ART services, information from up to 250 clinical records for ART patients was extracted. Inclusion criteria permitted the use of records for patients aged 18 years or older who had initiated ART treatment between six and 60 months before the date on which chart data were collected. All patient identifiers were removed, and access to the secure database with patient chart data was limited to specific ABCE research team members.

Patient exit interviews. Based on a subset of sampled facilities, a maximum of 30 patients or attendants of patients were interviewed per facility. Among facilities that offered ART services and were included in the ART component of the ABCE project, an additional 30 patient exit interviews were conducted in an effort to capture information from patients who had specifically sought HIV care (a total of 60 patient exit interviews). Patient exit interviews were not conducted in Ghana.

Patient selection was based on a convenience sample. Members of the ABCE field team approached potential respondents and screened them prior to completing the consent process and exit interview, and then repeated the process with the next patient exiting the facility. At facilities with high patient volumes, interviewers sometimes intentionally skipped potential respondents in an effort to distribute the patient sample throughout the day. For example, after the completion of an exit interview at a high-volume facility, ABCE interviewers may wait for three patients to pass before approaching the next potential respondent. In situations where this technique was used, skipping patterns were determined by facility patient volume, as assessed by facility administrators prior to conducting patient exit interviews, and frequency of skipping patterns were assigned during the production of country-specific protocols.

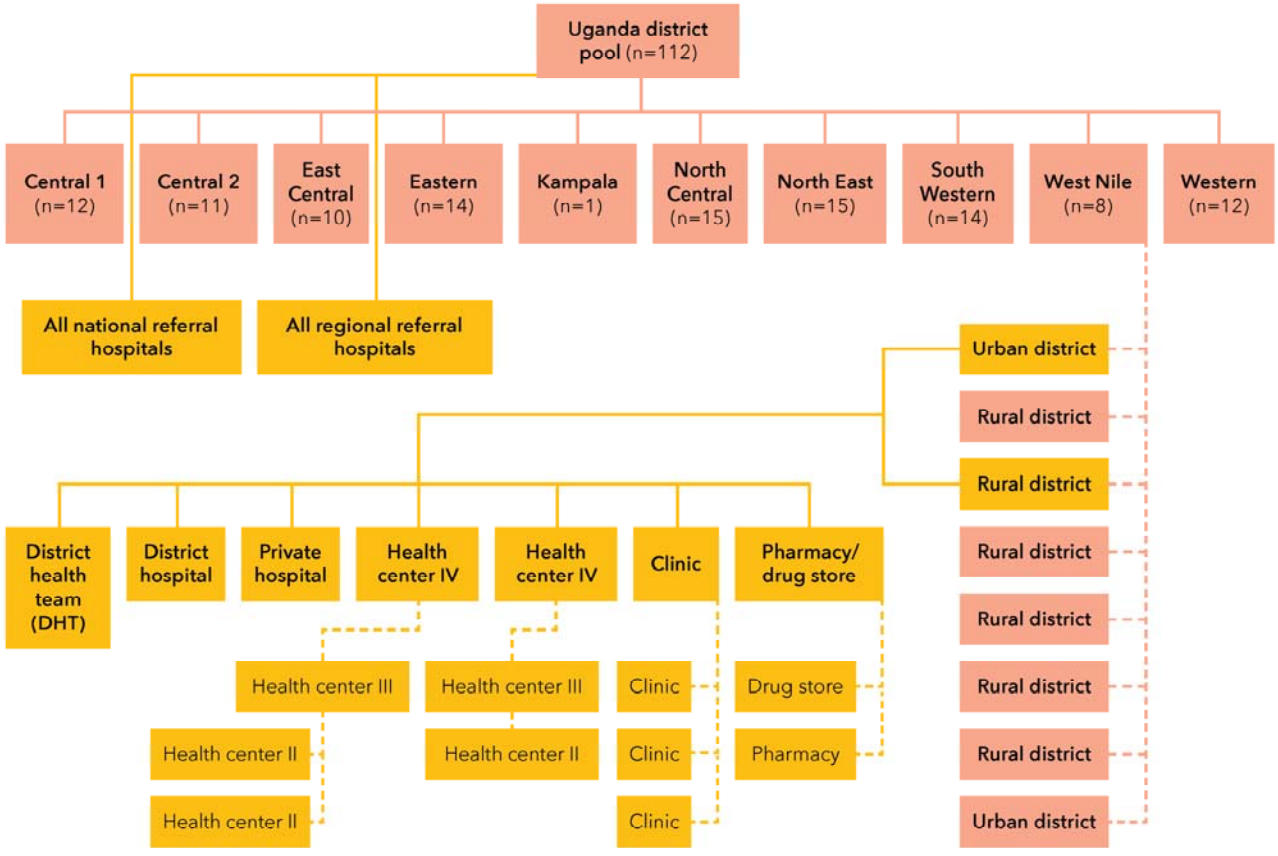
EXAMPLE OF ABCE FACILITY SAMPLING STRATEGY: UGANDA

In Uganda, a total of 19 districts were selected through the district sampling frame (nine rural and 10 urban), and 273 facilities (excluding DHTs) from those districts were selected through the facility sampling frame:

- All known hospitals within the selected district.
- All known health center IVs within the selected district.
- Up to two health center IIIs that fell under supervision of selected health center IVs.
- Up to three health center IIs that fell under the supervision of selected health center IIIs.
- Two pharmacies or drug stores.
- Up to three clinics.

Within each selected district, we also included the DHT in our sample. All national or regional referral hospitals were included in the final facility sample, irrespective of their location. This means that additional districts were included in the final ABCE sample if national or regional referral hospitals were located in a non-sampled district. However, no other facilities were selected from these non-sampled districts, as they were not drawn from the district sampling frame. Figure 1 depicts this two-step sampling process in Uganda, and Figure 2 displays the districts and facilities ultimately sampled for the ABCE project in Uganda.

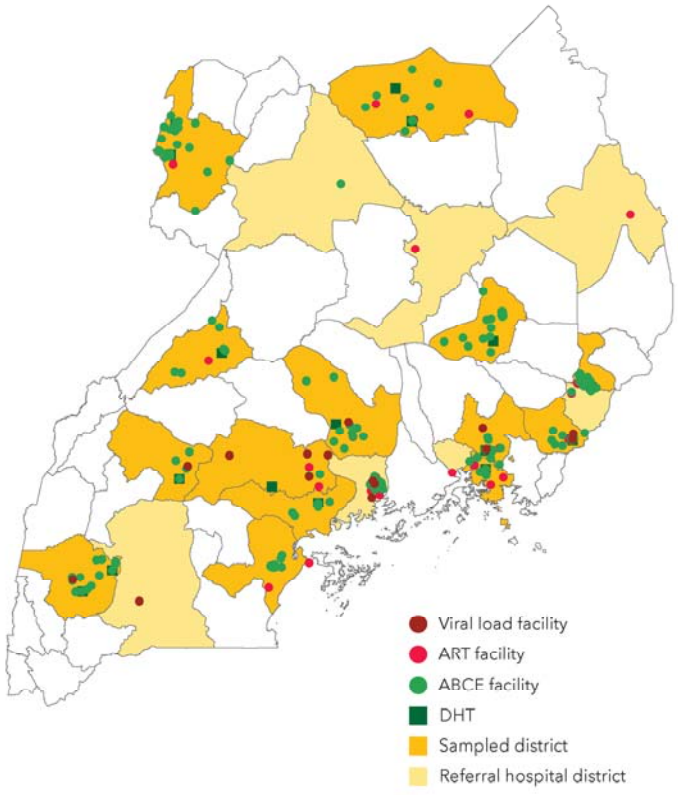
Figure 1. Sampling strategy for the ABCE project in Uganda



Note: Boxes that are orange reflect the regions considered for the district sampling frame. Districts that are yellow represent those selected through this district sampling process. Solid lines indicate inclusion from the previous sampling step, while dashed lines indicate that a random selection of districts or facilities took place.

EXAMPLE OF ABCE FACILITY SAMPLING STRATEGY: UGANDA *(continued)*

Figure 2. Districts and facilities sampled for the ABCE project in Uganda



Note: Each "Viral load facility" refers to a facility included in a pilot study that occurred in tandem with the ABCE project in Uganda.

Occasionally, a facility was selected through the ABCE project sampling process but then was unable to participate in the study or was later determined ineligible. Although every effort was made to avoid this situation, there were a limited set of circumstances wherein a facility was dropped or replaced from the original facility sample:

1. **Replacing a facility:** facility-based data on expenses and revenues from a hospital or ART facility were limited to only one year and the facility had been operational for at least two years; facility-based data on expenses and revenues from a private facility were limited to only one year, the facility had been operational for at least two years, *and* the one year of data were unreasonable or incomplete.
2. **Dropping a facility:** no facility-based financial data were available at the facility following two weeks of follow-up efforts conducted by the ABCE field team.

Data collection instruments

ABCE Facility Survey

For each country involved in the ABCE project, the ABCE Facility Survey was administered to a representative sample of health service platforms and directly collected data on the following indicators:

- **Inputs:** the availability of tangible items needed to provide health services, including infrastructure and utilities, medical supplies and equipment, personnel, and non-medical services.
- **Finances**: expenses incurred, including spending on infrastructure and administration, medical supplies and equipment, and personnel. Facility funding from different sources (e.g., government, development partners) and revenue from service provision were also captured.
- **Outputs:** volume of services and procedures produced, including outpatient and inpatient care, emergency care, laboratory and diagnostic tests, and pharmaceuticals dispensed.
- **Supply-side constraints and bottlenecks:** factors that affected the ease or difficulty with which patients received services they sought, including bed availability, pharmaceutical availability and stock-outs, cold-chain capacity, personnel capacity, and service availability.

Table 3 provides more information on the specific indicators included in the ABCE Facility Survey administered in Kenya. The precise content varied slightly by country, but Kenya's version is representative of the typical content found across countries. The questions included in the survey given to DHMTs or DHTs were similar to those in the ABCE Facility Survey, only it was truncated version. Table 4 details the indicators in the DHMT Survey conducted in Kenya as example of what information may be collected through this instrument.

The ABCE Facility Surveys used for Ghana, Kenya, Uganda, and Zambia are available through IHME's GHDx: http://ghdx.healthdata.org.

Table 3. Modules included in the ABCE Facility Survey in Kenya

Survey module	Survey category	Key indicators and variables
Module 1: Facility finances and inputs	Inputs	Input funding sources and maintenance information
		Availability and functionality of medical and non-medical equipment
	Finances	Salary/wages, benefits, and allowances; sources of funding
		Total expenses for infrastructure and utilities; medical supplies and equipment; pharmaceuticals; administration and training; non-medical services; personnel (salaries and wages, benefits, allowances); investments
		Performance and performance-based financing questions
	Revenues	User fees; total revenue and source
	Personnel characteristics	Total personnel; volunteer, directly and externally funded personnel; personnel dedicated to HIV/AIDS-specific services
		Funding sources of personnel; education and training of medical and non-medical personnel
		Health services provided and their staffing; administrative and support services and their staffing
Module 2: Facility management and direct observation	Facility management and infrastructure characteristics	Facility hours, characteristics of patient rooms, and beds; electricity, water, and sanitation; facility meeting characteristics
		Guideline observation
	Direct observation	Latitude, longitude, and elevation of facility
		Facility hours, characteristics, and location; waiting and examination room characteristics
Module 3: Lab-based consumables, equipment, and capacity	Facility capacity	Lab-based tests available
	Medical consumables and equipment	Lab-based medical consumables and supplies available
Module 4: Pharmaceuticals	Facility capacity	Pharmacy information; cold chain characteristics and supplies
	Pharmacy-based medical consumables and equipment	Drug kit information; buffer stock information
		Essential pharmaceutical availability, prices, and stock-out information
		Pharmaceutical ordering system; pharmaceuticals ordered, received, and costs to patients
Module 5: ART pharmaceuticals	ART pharmaceuticals	Essential HIV/AIDS-specific pharmaceutical availability, prices, and stock-out information
		ART pharmaceutical ordering system; pharmaceuticals ordered, received, and costs to patients
Module 6: General medical consumables, equipment, and capacity	Medical consumables and equipment	Availability and functionality of medical furniture, equipment, and supplies
		Inventory of procedures for sterilization, sharp items, and infectious waste
		Inventory of personnel
Module 7: Facility outputs	Facility capacity	Referral and emergency referral infrastructure
	General service provision	Inpatient care and visits; outpatient care and visits; home or outreach visits
		Care and visits for specific conditions, including emergency visits and HIV care
		Vaccinations administered
		Laboratory and diagnostic tests

Note: Indicators for finances, personnel, and outputs reflect the previous five completed fiscal years; all other indicators reflect the status at the time of the survey.

Table 4. Indicators included in the DHMT Survey in Kenya

Survey module	Survey category	Key indicators and variables
DHMT finances and inputs	Finances	Salary/wages, benefits, and allowances Total expenses for infrastructure and utilities; medical supplies and equipment; pharmaceuticals; administration and training; non-medical services, personnel (salaries and wages, benefits, allowances) DHMT-specific program expenses: immunization campaigns, promotional campaigns, medical trainings
	Revenues	Total revenue and source
	Personnel characteristics	Total personnel
DHMT direct observation	Latitude, longitude, and elevation of the DHMT	
Additional information on sampled facilities within each county, as reported by the DHMT	Finances	Financial summary for sampled facilities
	Personnel characteristics	Total personnel at sampled facilities

ART Module and Clinical Chart Extraction

Administered alongside the ABCE Facility Survey, the ART Module collected information on facility-level ART program characteristics, service provision, and costs. Table 5 provides more information on the specific indicators included in the typical ART module, as drawn from the ABCE project in Uganda.

Table 5. ART indicators collected in the ABCE Facility Survey in Uganda

Survey module	Survey category	Key indicators and variables
Module 1	Facility capacity	Essential HIV/AIDS-specific pharmaceutical availability and stock-out information HIV-related outreach care and prevention services HIV care dedicated personnel
Module 3	General service provision	HIV-related medical consumables and care available HIV-related tests and services available ART services HIV-related laboratory and diagnostic tests
Module 7	Service provision	HIV outpatient care ART initiations; pre-ART and ART patient visits Prevention of mother-to-child transmission (PMTCT) services Male circumcision services HIV testing and counseling

Table 6 details the types of data extracted from clinical charts and electronic record databases from Uganda as an example of what information was extracted from patient records. Inclusion criteria permitted the use of records for patients 18 years or older who had initiated ART treatment between six and 60 months before the date on which chart data were collected. All patient identifiers were removed, and access to the secure database with patient chart data was limited to specific ABCE team members. For the countries where clinical

chart extractions took place, between about 8,200 and 15,900 were ultimately extracted across facilities in each country.

The Clinical Chart Extraction instruments used in Kenya, Uganda, and Zambia can be found through IHME's GHDx: http://ghdx.healthdata.org.

Table 6. Indicators extracted from clinical charts of HIV-positive patients currently enrolled in ART (from ABCE Uganda)

Survey module	Survey category	Key indicators and variables
Clinical chart extraction	Patient information	Age, sex, height, weight Care entry point (i.e., PMTCT, voluntary counseling and testing [VCT]) Other demographic information
	ART initiation	Pre-ART and ART initiation date
	Care information	Tests conducted, results, and corresponding dates ART regimen information Opportunistic infections
	Patient outcomes	Alive and retained in care, lost to follow-up, deceased, transferred Adherence to treatment, treatment failure

Patient Exit Interview Survey

The main purpose of the Patient Exit Interview Survey was to collect information on patient perceptions of the health services they received and other aspects of their facility visit (e.g., travel time to facility, expenses incurred during the facility visit). This information fed into quantifying the "demand-side" constraints to receiving care (as opposed to the facility-based, "supply-side" constraints and bottlenecks measured by the ABCE Facility Survey).

The questions asked in the Patient Exit Interview were organized into five main categories:

- Expectations for the facility.
- Circumstances of and reasons for the particular facility visit.
- Time and costs associated with the facility visit.
- Satisfaction with services.
- Patient demographic information (e.g., educational attainment).

This instrument was administered in Kenya, Uganda, and Zambia, with minor modifications as needed to adjust the instrument for each country's context. Patient exit interviews were not conducted in Ghana. Table 7 provides more information on the specific questions included in the Patient Exit Interview Survey from Zambia. All Patient Exit Interview Surveys implemented in the field are available through IHME's GHDx: http://ghdx.healthdata.org.

Eligibility for participation in the exit interviews was determined by age (whether the patient was considered of consenting age [18 years or older in Kenya and Uganda, 15 years or older in Kenya], or if younger than the consenting age, was accompanied by an attendant who met the age requirement) and responsiveness (whether the patient or attendant was able to respond to questions). All data collected through patient interviews were kept confidential.

Table 7. Types of questions included in the Patient Exit Interview Survey in Zambia

Survey category	Types of key questions and response options
Direct observation of patient	Sex of patient (or patient's attendant if surveyed)
Direct interview with patient	Scaled-response demographic questions (e.g., level of education attained) Scaled-response satisfaction scores (e.g., satisfaction with facility cleanliness: (1) very bad; (2) bad; (3) average; (4) good; (5) very good) Open-ended questions for circumstances and reasons for facility visit, as well as visit characteristics (e.g., travel time to facility) Reporting costs associated with facility visit (user fees, medications, transportation, tests, other), with an answer of "yes" prompting follow-up questions pertaining to amount

Patients who reported seeking HIV services during their facility visit were then asked about the types of HIV services sought (e.g., counseling, testing, routine check-up, report collection). In Kenya and Uganda, patients were also asked about their ART status. If a patient indicated that they were enrolled in ART, they were asked an additional set of questions to gather ART-specific information, including the following:

- Length of time enrolled in ART.
- State of health since ART initiation.
- Whether HIV appointments had ever been missed, and if so, why.
- Ease with which ART drugs were obtained.
- Health complications related to ART regimen.
- Side-effects or consequences experienced since ART initiation (e.g., ability to work, social engagement).

Approximately 2,700 to 4,700 patients were interviewed in each country where the Patient Exit Interview Survey was conducted.

Supplementary data

In some cases, additional administrative data were sought to supplement the primary data collected by the ABCE field teams. These data sources were generally sought to supplement financial data, particularly in cases wherein additional expenditures were incurred at higher levels on behalf of facilities (and thus the facilities were unlikely to have comprehensive records of such spending). Examples of supplementary data sources included the following:

- **Salaries:** in cases where facilities do not pay staff directly, staff numbers in each category were recorded for the previous five years instead. Salary data were then collected for each pay bracket and then applied to estimate the total staff costs incurred on behalf of the facility. In some countries, this data situation frequently occurred in public facilities, where all MOH salaries are paid directly from the national level, or at facilities where staff are paid externally through nonprofits or religious organizations.

- **Pharmaceuticals:** in cases where facilities do not exclusively purchase pharmaceuticals directly from outlets, additional information may be collected on the value of pharmaceuticals donated to the facility or purchased on behalf of the facility. In some countries, this data situation is likely to arise if national institutions procure pharmaceuticals for a given administrative unit (i.e., provinces, regions, districts, counties), which in turn distribute pharmaceutical supplies to facilities within their administrative boundaries.
- **Medical supplies and equipment:** akin to some pharmaceutical procurement systems, medical supplies and equipment are sometimes acquired via an external entity (and not the facility itself). In some countries, this data situation was addressed by seeking supplemental data on the value of medical supplies and equipment provided to a given facility, irrespective of the acquisition source.

Project implementation

To date, the ABCE project takes place in seven countries throughout the world. Since its inception in 2011, the ABCE team has prioritized proper survey development and adaption for each country involved in the ABCE project, recognizing that the design and execution of any primary data collection instrument is an iterative and adaptive process.

Here we provide an overview of ABCE project implementation procedures across four countries (Ghana, Kenya, Uganda, and Zambia). For additional information or inquiries about specific country activities, please contact IHME at comms@healthdata.org.

Survey development and adaptation

Topics-Metrics-Questions (TMQ)

Developed by IHME, the "topics-metrics-questions" (TMQ) matrix has emerged as a critical tool for identifying which indicators should be captured by a given survey, and through which questions. The TMQ matrix uses the following columns to guide survey development:

- **Topics:** the broader topic area
- **Metrics:** the specific indicators and corresponding units relevant for each topic area
- **Questions:** the specific questions or record extraction used to capture specific indicators

Table 8 provides an example of how a TMQ matrix could be used for ABCE-relevant topics; note that this not the actual TMQ matrix for the ABCE project, which was carefully developed by research team members and ABCE country collaborators. Whenever possible, the ABCE team drew from survey questions vetted and used in previous data instruments, either at IHME or from other well-established organizations.

TABLE 8. TMQ example, as potentially used for the ABCE project

Topic	Metric	Question
Facility inputs	Artemisinin-based combination therapy (ACT) is currently in stock at the time of facility visit	Direct observation: ask facility administrator to show facility stock of ACTs at the time of facility visit
Facility outputs	Number of inpatient bed-days per month during the previous 12 months	Extracted from facility records: number of inpatient bed-days that occurred per month during the previous 12 months
Patient perspectives	Reported travel time, in minutes, to a facility	"How long did it take you to get to *[facility x]*?"

Master survey development

Using the TMQ matrix, the ABCE team created master surveys from which country-specific instruments would be adapted. These master surveys included the ABCE Facility Survey, the truncated district office (or equivalent) survey derived from the ABCE Facility Survey, the Clinical Chart Extraction instrument, and the Patient Exit Interview Survey.

The following components guided all master survey development:

1. **Identify the respondent for each question:** for each instrument, a different person may be the most knowledgeable to provide the most relevant answers to a given question. For instance, at a health facility, a nurse might have the best understanding of medical equipment functionality, whereas a facility administrator might have the best knowledge of the last time medical supplies were ordered. Key considerations include how information should be elicited from a given respondent; whether physical documentation of desired information exists or self-report is necessary; and what scientific literature indicates about different recall periods and biases associated with self-report.
2. **Identify the order of respondents (as applicable):** for each instrument and set of questions, it is important to consider whether interviewing certain individuals before others may affect responses. For instance, at a health facility, interviewing medical staff prior to speaking with a facility administrator may be disrespectful or inappropriate; on the other hand, it is important to consider interview timing and logistics, particularly if delays in follow-up may affect the content of responses.
3. **Identify logical ordering of questions:** for each instrument, the ordering of questions is critical for establishing rapport and interview tone, reducing bias, and ensuring that the highest-priority questions are answered if respondent fatigue occurs. In particular, reviewing question content and determining whether content could lead or prompt certain answers are of high priority. For instance, an interviewer should not describe to a facility administrator the vaccines that a facility should stock, and then ask which vaccines they carry.
4. **Assemble the survey:** for each instrument, compile all survey questions, identify response options, and format the survey document. As instrument layout and question ordering are developed, it is important to review the survey multiple times with the view of administering the survey to intended respondents and in the settings where they would receive the survey. This is the stage at which team members identify areas in the survey that are particularly context-specific, assume previous knowledge of practices or logistics in the field, or may require cognitive testing of field team members.
5. **Identify triggers and logic**: for each instrument, the specific set of trigger questions, skip patterns, answer restrictions, data verifications, and programming notes are reviewed and confirmed. These survey components are critical to survey administration and can significantly affect data quality. For instance, pre-programming plausible value ranges for a given question (such as measures for height and weight) can help prevent data-entry errors and reduce the resources needed for future data-verification procedures.

Cognitive testing

For each ABCE instrument, a process called cognitive testing took place to review surveys for country-specific relevance. Cognitive testing was led by ABCE team leadership from country collaborators and IHME. This process ideally occurred during early stages of survey development and adaptation for each country, well before survey pre-testing.

Cognitive testing involved reviewing all questions and responses within the country's context, as well as considering survey administration and logistical needs. Key concerns typically included whether both interviewers and respondents would understand certain terminology; response questions appropriately captured all known answer options; and survey administration was likely to proceed as smoothly as possible. In addition, cognitive testing involved reviewing question wording and applicability, response options, and other contextual factors.

Translation

In some countries involved in the ABCE project, having survey instruments available in the local language was needed. This meant that all instruments were either developed and programmed in the local language, which was preferred whenever possible, or translated after development and programming. If the latter was necessary, significant efforts took place to ensure that the meaning of survey questions was not altered or lost.

All translated materials were verified through internal review processes by native speakers or by translating the instruments back into English and comparing the resulting text to the original surveys (known as back-translating).

Electronic programming

After survey content was finalized, ABCE team members at IHME programmed instruments into an electronic platform (Computer Assisted Personal Interviewing [CAPI]), which was used for survey administration. Through CAPI, programming logic allowed for a number of data restrictions to reduce potential data-entry errors. For instance, CAPI allowed for question skip patterns that prevented interviewers from accidentally asking inapplicable questions and for data validation processes that flagged implausible values, selection of mutually exclusive responses, or missed questions.

Testing and piloting

The ABCE team extensively tested all instruments before each survey was formally launched, which included the following:

1. **Internal testing:** ABCE team members at IHME reviewed data collection software to ensure proper functionality, logic, and aesthetic performance. This type of testing included self-testing, peer testing, and final review from ABCE team leadership.
2. **Pre-testing:** country collaborators tested surveys internally among ABCE team members, and then among non-sampled facilities and respondents. This type of testing included reviewing both English and translated versions of surveys for acceptability, feasibility, question flow, and administration time. This step also included recruiting and training a pre-test field team. All efforts were made to ensure that no major revisions were made after this stage.
3. **Piloting:** During ABCE field team training, interviewers conducted expanded survey testing with a broader range and number of facilities. It was during the piloting stage that the ABCE field team sometimes discovered new forms or revisions of data types at facilities, which would prompt

modifications to improve instrument use. Further, this was the stage at which ABCE field team members would learn more about health system intricacies beyond what was covered in training. Field team procedures and actual team composition were also solidified during the piloting stage.

Fieldwork

Four main instruments were implemented as part of the ABCE project: (1) the ABCE Facility Survey; (2) the truncated district office (or equivalent) survey derived from the ABCE Facility survey; (3) Clinical Chart Extractions; and (4) the Patient Exit Interview Survey. In general, these instruments were administered simultaneously by a single ABCE field team per data-collection site. Field plans were designed to maximize efficiency in terms of team bandwidth, availability of survey respondents, and travel time; at the same time, field plans also built in some flexibility, allowing for team decision-making based on information gathered in the field. Details about each instrument's field implementation are as follows:

1. **ABCE Facility Survey:** prior to starting facility data collection, ABCE field team members met with the facility's manager or administrator to receive consent. Depending on requirements of the country's local ethical review board, facility respondents gave verbal or written consent for the ABCE study. Whenever possible, facilities were contacted prior to the ABCE field team's arrival, in order to notify staff of the visit and determine optimal scheduling.

   Once consent was obtained, data collection began with the facility manager and individual(s) recommended by the facility manager to respond to each survey module. In smaller facilities, the same individual was often best suited to answer more than one survey module. If the recommended respondent was not available, ABCE field staff made every effort to reschedule interviews. In cases when rescheduling interviews was not possible, ABCE field staff made an appointment for a follow-up facility visit at later date (also known as a mop-up facility visit).

2. **District (or the equivalent) Office Health Survey:** prior to starting data collection at district (or the equivalent) offices, ABCE field staff sought to make contact with the health officer overseeing the office. Upon receiving permission to conduct the survey with the district (or equivalent) health officer, data collection began, with the health officer also recommending the appropriate individuals to respond to each survey module.

   Some ABCE field teams found it useful to visit the district (or the equivalent) office upon arriving in each sampled district. In doing so, they sought permission to work within the district, verification of facility operations, and additional information about facility locations and staff contacts. Prior to visiting districts, ABCE field teams obtained letters of support from the country's MOH (or equivalent).

3. **Clinical Chart Extractions:** before the teams could start chart extraction, facility managers had to explicitly agree to participate in this ART component of the ABCE project (which was described to them ahead of time). The number of charts extracted for each facility varied by their patient volume, or the total number of existing ART patients, records from deceased patients, and charts for patients lost to follow-up. The ABCE field team sought to extract at least 250 eligible records (as described in the ABCE

Study Design section), or if a facility had fewer than 250 ART patients, all available records. If facilities had electronic medical record (EMR) systems, all eligible charts were downloaded for review later.

To facilitate chart extraction, ABCE field staff used an ART Pre-Chart Extraction tool, which gathered information about the total number of ART patient charts and number of eligible records. The tool then estimated the appropriate number of records for random sampling.

4. **Patient Exit Interview Survey:** as patients left sampled facilities, ABCE field staff approached them to briefly describe the study and invite their participation if eligibility criteria were met (as described in the ABCE Study Design section). ABCE field staff took prospective participants to a less public area away from the facility (e.g., trees, a bench away from the facility entrance) to obtain consent and conduct the exit interview. All interviews were conducted in the language that was deemed most comfortable for the respondent, which occasionally required additional translation assistance.

Beyond the main survey instruments, the ABCE field staff collected additional information, including the following:

- **Facility mapping:** GPS readings were taken at all study locations to ensure proper facility mapping within the country. In addition, these data could contribute to geospatial analyses, such as determining distance to facilities and assessing other physical barriers to facilities.
- **Vaccine storage equipment temperature readings:** ABCE field staff used thermometers or, whenever possible, continuous temperature monitoring devices, to assess cold-chain capacity and adherence to vaccine storage guidelines at facilities that reported storing vaccines.

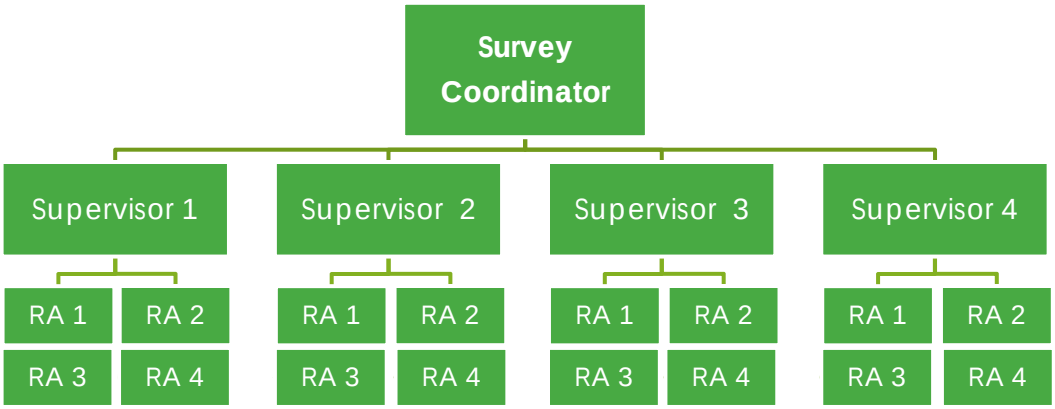
Team structure, recruitment, and training

Country collaborators led survey implementation in each country involved in the ABCE project, with IHME providing coordination support. ABCE field team structures were developed in terms of maximizing both efficiency and accuracy. For the most part, a central Survey Coordinator oversaw multiple survey teams, each composed of multiple research associates (RAs) and a field supervisor (Figure 3). Field team structures and titles of staff occasionally varied across countries.

ABCE field staff were recruited based on previous experience with facility surveys, willingness and commitment to work away from home, interpersonal communications skills, fluency in relevant languages, and ability to understand survey procedures and ethics. Whenever possible, an additional 10% of the required number of field staff were recruited and trained, allowing the Survey Coordinator to retain the highest-performing trainees for the final field team.

Prior to survey implementation, country collaborators and IHME hosted one-week training workshops for the RAs, where they received extensive training on the electronic data-collection software (DatStat), the survey instruments, the country's health system organization, and interviewing techniques. Each RA received ABCE Field Manuals and detailed plans for survey implementation during these workshops, which included classroom lectures, group discussions, role-plays, and practice interviews in the field.

Figure 3. Sample ABCE field team structure



Supervisors received specific training on survey team management, monitoring of team performance in the field, and data management. This additional training was viewed as important as the field team supervisors were responsible for ensuring that RAs worked efficiently and accurately, as well as the overall quality of collected data.

Ongoing training and re-training of RAs occurred on an as-needed basis throughout the course of data collection, and if necessary, RAs were replaced.

Ethical issues

All data were identified and linked using unique facility identification numbers. Whenever possible, the collection of identifying data was minimized.

Each country's protocol was adapted for its context and data-collection sites, along with revised and/or translated recruitment scripts and consent forms. Institutional Review Boards (IRBs) hosted by the University of Washington (the University of Washington Ethics Committee) and each country involved in the ABCE project had to review and fully approve protocols and instruments before data collection could begin. Any amendments or modifications were also reviewed and approved by the appropriate IRBs prior to implementation.

Confidentiality of survey respondent information was of highest priority to the ABCE teams. ABCE field teams received training on numerous techniques to ensure data security and confidentiality, and field supervisors continuously monitored RA performance. In addition, efforts were made to ensure that RAs were assigned to areas of the country where they were unlikely to know potential patient populations. RAs also were never assigned to interview respondents or review clinical charts of individuals they knew personally.

All data were collected electronically, and RAs were instructed never to take notes, keep copies of any records, or contact respondents. Clinical charts were accessed only once, and the ABCE field team was not supposed to return to facilities to acquire additional data if the original records were incomplete.

All data files were stored on restricted networks hosted by IHME, and only a subset of authorized ABCE team members had access to study data during collection.

Project data, analysis, and dissemination

Data management

Primary data collection for the ABCE project took advantage of a number of survey platforms, equipment, and technologies. Improvements in data-collection methods continue, as data collection for the ABCE project remains ongoing. At present, laptop computers, handheld GPS units, direct file transfer, automated form extraction, thermometers, and continuous temperature-logging devices have been used for primary data collection.

Each sampled facility receives a unique identification number, which allows for linkages of data across survey instruments without directly identifying facility names.

Whenever ABCE field team members had access to the Internet (or daily, if Internet access was readily available), collected data were uploaded to a secure server at the University of Washington. Upon receiving the data from the server, ABCE team members catalogued the data and conducted thorough verification and cleaning procedures.

Programming and verification

Throughout primary data collection, a number of programming and data-verification techniques were used to continuously monitor incoming data, minimize data-entry issues, and improve the quality of data collected.

CAPI was the primary method for capturing data, which restricted the number of possible values that could be manually entered. Surveys were programmed to include a number of range and structure checks, as well as internal consistency checks. Examples include limiting manually entered data to realistically feasible values and checking any values that appear to be contradictory.

To ensure broader data quality, ABCE team members performed extensive data-verification procedures on a continual basis, or at least as data became available. Reports were developed facility-by-facility, displaying graphs of time-series data, tabulations of indicators of interest, and other relevant visualizations to cross-check data veracity.

Some instruments had tailored verification processes. For example, data from the Patient Exit Interview Surveys were aggregated and verified across a number of strata, including geography and name of the research associate responsible for data collection. This approach allowed for monitoring survey administration accuracy for each research associate, and assisted with identifying any instances of data falsification.

Whenever possible, the ABCE field team was contacted about identified errors. They then coordinated data corrections or, as needed, returned to facilities to recollect data. These verification efforts also were used to identify possible ABCE field team needs, which included determining whether particular research associates required additional training.

ABCE team members based at IHME had regular check-in calls with the ABCE field teams, usually a minimum of once a week throughout data collection. The frequency of check-ins was often higher immediately following survey implementation. Issue Sheets were used to document any issues that arose, as well as their subsequent resolution. These weekly check-ins also served as a mechanism to receive feedback on ABCE instruments and

how they aligned with the country's health system. Such regular feedback allowed for timely instrument modifications, if they were needed, and supported the collection of qualitative contextual information that proved critical for interpreting data trends.

ABCE team members also tracked all incoming data to ensure that data were properly collected and uploaded without any data loss. They also assisted with documenting reasons for missing data or any issues that arose concerning facility consents or dropouts.

Data cleaning and imputation

In order to finalize all incoming data from ABCE field teams, a four-step procedure took place:

1. **Collect and edit all data:** all raw data files from survey modules were reshaped as necessary and appended to create a master dataset for each survey. All feedback acquired during data collection, verification processes, and other correspondence were then included in each master dataset.
2. **Format data**: each master dataset was formatted, which included removing clear data-entry errors (e.g., incorrectly used skip patterns, character variable issues), constructing new variables using combinations of directly collected data, consistently labeling all variables and values, and removing unnecessary variables.
3. **Assess data plausibility:** data tests were conducted to detect any potential outliers or data oddities. For example, we analyzed the difference between subcomponents and totals reported for a given indicator, and ran ratio outlier detection analyses for these variables. In addition, any supplemental data were incorporated into the master datasets as necessary.
4. **Impute data as necessary:** there were some cases for which data remained missing, despite efforts during the previous three steps. These instances often occurred because the data were not available at sampled facilities or implausible values were removed during earlier steps. To improve the utility of the larger datasets, missing data for a subset of variables were imputed. Data imputation harnesses existing data within and across facilities to then estimate the most probable values for any missing data points. This approach is used in various research settings to address data missingness. A number of predictive models are tested to determine which one performed the best under out-of-sample simulations, including the following:
    - Linear regression
    - Multilevel mixed-effects linear regression
    - Negative binomial regression
    - Generalized linear model with gamma distribution
    - Generalized linear model with Poisson distribution
    - Generalized linear model with negative binomial distribution
    - Amelia (package in R)
    - Others to be determined

    Out-of-sample testing entails randomly selecting facility-years to be removed from a simulation dataset and running the imputation model on the remaining facility-years. The root-mean-square error (RMSE) term is then calculated for each of the predictive models, comparing the model predictions to the data held out from the original model fitting. The RSME values are standardized and compared across

models. In general, if a model is robust and is not substantially affected by randomly removing a subset of observations, it is viewed as a better-performing model.

Imputation results and selected models slightly varied by country. Final results and model selection are described with greater detail in the Data Cover Sheets that accompany each country's dataset found in IHME's GHDx: http://ghdx.healthdata.org.

Analysis and dissemination

Analysis

The datasets collected and generated through the ABCE project are both vast and fine-grained, providing essentially endless opportunities for analysis and methods development. The results currently available through ABCE policy reports, presentations, and academic papers are far from exhaustive; rather, we have sought to prioritize analyzing the data that align with each country's identified priorities for health service provision, the explicit goals set forth by national strategic plans, and the questions about cost and equity of health care delivery.

Further, based on feedback from country-level and global stakeholders following dissemination activities, the ABCE team is undertaking additional analyses and methods refinement to inform emergent health system information gaps. We view this iterative, demand-driven approach to analyzing data collected through the ABCE project as an effective way to ensure that findings align with the policy needs of governments, development partners, and international agencies.

More details on the methodologies, analysis, and models used to produce results are provided in academic articles, working papers, presentations, and ABCE policy reports, which can be downloaded at www.healthdata.org/dcpn/publications.

Dissemination

As with any endeavor involving primary data collection, the efforts and time required to complete data collection, oversee all proper verification and cleaning procedures, and then conduct analyses can be time- and resource-intensive. Methods refinement continues, and analyses are ongoing, largely in response to feedback from stakeholders and demands for additional findings. Here we provide highlights of dissemination efforts thus far, as well as plans for ongoing outreach and engagement.

Country-specific dissemination activities. For the countries covered in this document, dissemination has been phased in accordance with the instruction and guidance from country collaborators. The majority of formal dissemination events took place in 2013 and 2014, as described below:

1. **Ghana:** after primary data collection was completed in 2012, the ABCE team continually worked with collaborators from GHS, UNICEF, and Ghana's MOH to hone analyses and identify the topics of highest priority for Ghana's health policy landscape. The ABCE team ultimately targeted the 2013 Ghana Health Summit, which took in place in April of that year, as its launch of country-specific preliminary findings. A formal presentation was given at the annual meeting, followed by numerous meetings with Ministry officials, UNICEF representatives, and other Ghanaian health stakeholders. Feedback from these meetings was brought back to the ABCE team, which in turn applied this information to refining analyses for ABCE Ghana, as well as for the other ABCE project countries in sub-Saharan Africa. The final ABCE

Ghana report was made publicly available in January 2015, significantly expanding upon the original 2013 report's contents.

2. **Kenya**: primary data collection was finished in late 2012 for the ABCE project in Kenya, after which the ABCE team worked with country collaborators from AAH-I, MOMS, and MOPHS to determine the optimal blend of findings to report on. Several methodological improvements were made in 2013 and 2014, particularly pertaining to efficiency and cost estimation. Coordinated by IHME and AAH-I, the ABCE policy report for Kenya was completed in June 2014 for in-country dissemination efforts. Between June and August 2014, collaborators presented these results to ministry officials, as well as leadership at Kenya's National AIDS Control Council (NACC). The final ABCE Kenya report was made publicly available in October 2014. Additional presentations and report distribution occurred in November 2014, with AAH-I leadership presenting on ABCE Kenya findings at the Amref conference in Nairobi and IHME's Director of African Initiatives presenting on key results to ministry officials.

3. **Uganda:** after primary data collection was completed in late 2012, the ABCE team worked with country collaborators from IDRC, Makerere University, and the MOH to assemble the optimal set of analyses and results. Data collection for the Viral Load Pilot Study (http://www.healthdata.org/dcpn/viral-load) took place in 2013, which then extended the analysis period through 2014. Coordinated by IHME and IDRC, the ABCE policy report for Uganda was completed in June 2014 for in-country dissemination efforts. A policy workshop was hosted in Kampala by the Director General of Health Services, with numerous high-level ministry officials and health stakeholders from CHAI, the World Health Organization (WHO), NACC, and district health offices in attendance. Local media coverage included interviews with IHME's Director, Dr. Christopher Murray, who presented at the workshop. District-level outreach has continued, largely led and coordinated by IDRC. Facility-level reports were also produced and distributed to facilities involved in the ABCE Uganda project, alongside the final policy report.

4. **Zambia:** primary data collection was finished in mid-2012, after which the ABCE team worked closely with country collaborators from UNZA and the MOH to put together the most relevant combination of analyses and findings. Several meetings discussing preliminary results took place with the Zambian MOH in 2013, which supported a very effective feedback mechanism for prioritizing types of results and honing research methods. Coordinated by IHME and UNZA, the ABCE policy report for Zambia was completed in June 2014 for in-country dissemination efforts. A policy workshop occurred soon after the official launch, with UNZA leadership presenting results to a number of high-level ministry officials, district health officers, and other health stakeholders. ABCE results were also presented and discussed at the June 11 Sector Advisory Group (SAG) meeting in Zambia, a bi-yearly meeting chaired by the MOH Permanent Secretary and attended by ministry officials, development partners, civil society leaders, and other health stakeholders. In response to ABCE Zambia results, the WHO Zambia office and the Ministry of Community Development, Mother, and Child Health (MCDMCH) have sought guidance in how to use the ABCE framework to improve their measurement of facility-level equipment and readiness.

   Province- and district-focused outreach efforts took place throughout the remainder of 2014, with UNZA leadership traveling from district to district to distribute the final policy report and discuss relevant findings with DHMTs. An ABCE Zambia presentation was also given at a Provincial Health Meeting in July 2014.

International dissemination activities. The dissemination of ABCE results has largely focused on country-specific activities to date, but in parallel, several global dissemination efforts have also taken place. ABCE team

members have presented results at numerous conferences, including the annual congress of the International Health Economics Association (iHEA) and the yearly International AIDS Conference (IAC). Further, targeted presentations and discussions focused on ABCE results have occurred with leadership at a number of global agencies and development partner organizations, including the following:

- The Global Fund to Fight AIDS, Tuberculosis and Malaria
- The Joint United Nations Programme on HIV/AIDS (UNAIDS)
- Gavi, the Vaccine Alliance
- The Bill & Melinda Gates Foundation

Future dissemination activities. With the January 2015 launch of ABCE datasets, survey instruments, and the expanded policy report suite, the ABCE team is generating both short- and longer-term dissemination plans that span heightened local-to-global engagement in the project. These activities include developing topic-specific policy briefs, hosting technical and policy workshops on the use of ABCE data and results, expanding outreach and engagement with multilateral agencies, governments, and development partners, and exploring dynamic data tools to help visualize different health service packages and policy options. Follow-up data collection is currently occurring at a subset of facilities in Uganda and Zambia, which will allow the ABCE team to directly assess areas of success or in need of improvement for health facility performance in these countries.

To learn more about upcoming ABCE dissemination efforts, please contact IHME at comms@healthdata.org.

We also welcome any feedback, questions, and requests for more information about the ABCE project in general, implementation, data, or results.

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