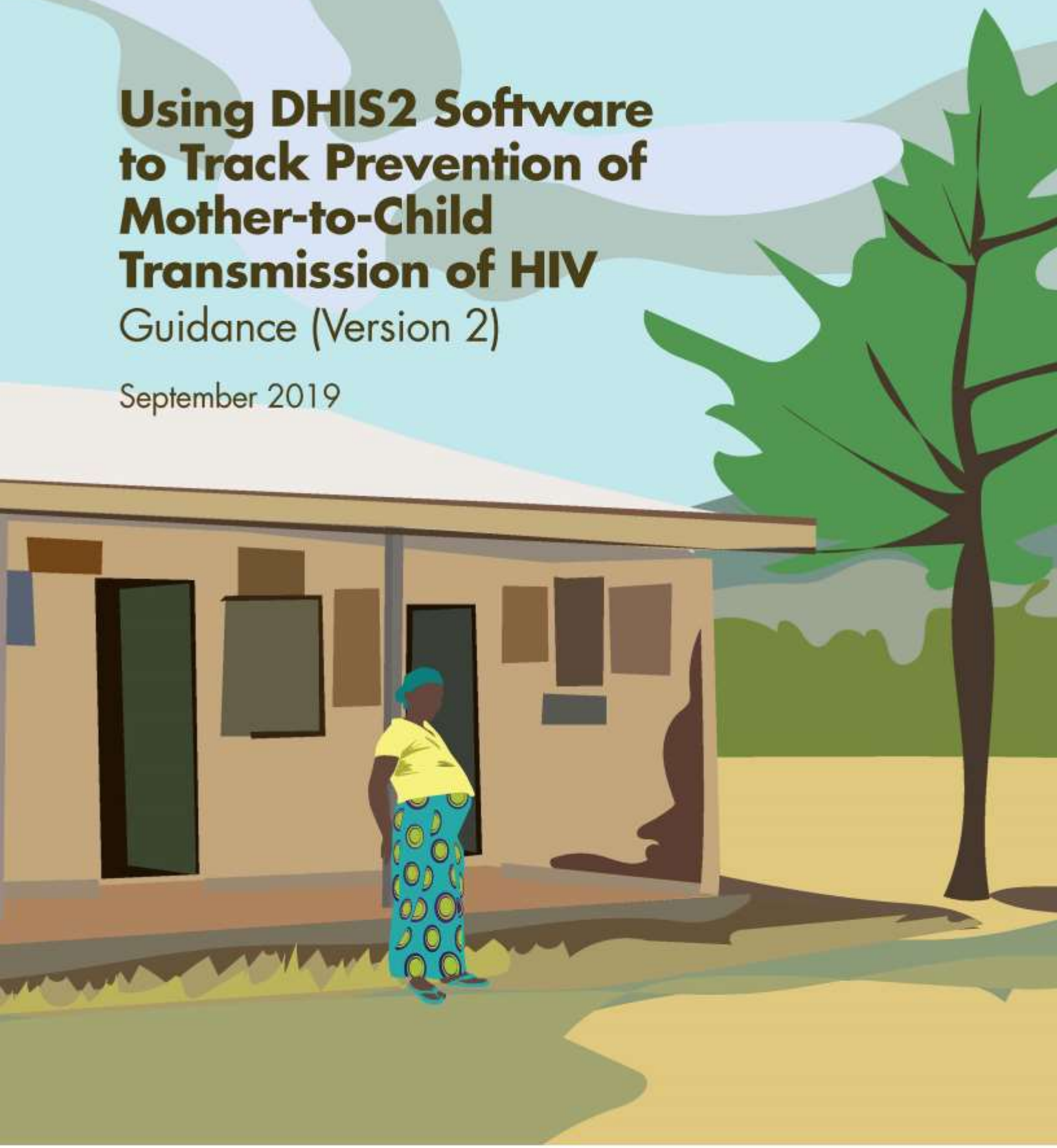
Using DHIS2 Software to Track Prevention of Mother-to-Child Transmission of HIV

Guidance (Version 2)

September 2019



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MEASURE Evaluation

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This publication was produced with the support of the United States Agency for International Development (USAID) under the terms of MEASURE Evaluation cooperative agreement AID-OAA-L-14-00004. MEASURE Evaluation is implemented by the Carolina Population Center, University of North Carolina at Chapel Hill in partnership with ICF International; John Snow, Inc.; Management Sciences for Health; Palladium; and Tulane University. Views expressed are not necessarily those of USAID or the United States government.
MS-18-127 Revised September 2019

ISBN: 978-1-64232-200-2

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ACKNOWLEDGEMENTS

We thank the United States Agency for International Development (USAID) for its support of this publication.

Many individuals were consulted during the development of this document. We would like to thank the following people for sharing the knowledge of the DHIS2 Tracker with us: Prosper Buhumbiize (Health Information Systems Program Uganda), Pierre Dane (MomConnect), Shurajit Dutta (Health Information Services, Lasalle), John Mukulu (University of Dar es Salaam, Tanzania), Scott Russpatrick (Akros), Graham Smith (Population Services International), Randy Wilson (Management Sciences for Health), and Anna Winters (Akros). They all provided technical information and insight on the DHIS2 program, in conversations with authors throughout the development of this document.

We would also like to thank our MEASURE Evaluation colleagues, Denise Johnson (ICF), Manish Kumar (University of North Carolina at Chapel Hill [UNC]), Annah Ngaruro (ICF), Eva Silvestre (Tulane University), and Sam Wambugu (ICF), for reviewing early drafts of this report and providing additional technical insight on DHIS2 and electronic health information systems.

We appreciate inputs from Lwendo Moonzwe Davis (MEASURE Evaluation, ICF) and Fran Scott (Qebo, Ltd), who were involved in pilot testing our sample PMTCT Tracker in Zimbabwe. The valuable lessons learned from that pilot have been used to update this guidance document.

In addition, we would like to thank Emily Bobrow (MEASURE Evaluation, UNC) for her insights on prevention of mother-to-child transmission service delivery in low-resource settings, and Ana Scholl (USAID) for her careful review and input into the final draft.

Finally, we thank Cindy Young-Turner, of ICF, for editing this report and the knowledge management team at MEASURE Evaluation, UNC, for editing, design, and production services.

Suggested citation: de la Torre, C., Johnson, S., & Schmale, A. (2019). Using DHIS2 Software to Track Prevention of Mother-to-Child Transmission of HIV: Guidance (Version 2). Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina at Chapel Hill.

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ABBREVIATIONS

ANC	antenatal care
API	application programming interface
ART	antiretroviral therapy
ARV	antiretroviral
DATIM	Data for Accountability, Transparency, and Impact
DHIS2	District Health Information Software version 2
EMR	electronic medical record
HMIS	health management information system
LMP	last menstrual period
M&E	monitoring and evaluation
PCR	polymerase chain reaction
PEPFAR	President's Emergency Plan for AIDS Relief
PMTCT	prevention of mother-to-child transmission
PNC	postnatal care
SMS	Short Message Service
UIC	unique identifier code
UNAIDS	Joint United Nations Programme on HIV/AIDS
USAID	United States Agency for International Development
USSD	Unstructured Supplementary Service Data
WHO	World Health Organization

EXECUTIVE SUMMARY

This report provides guidance on developing an electronic solution to track patients across the prevention of mother-to-child transmission (PMTCT) continuum of care to increase retention of mothers and their infants through the pregnancy and breastfeeding periods, and to improve linkages and referrals across services. We examine how the DHIS2 Tracker software can be used for this purpose and discuss general advantages and limitations of this technology. This guidance is customized to address the complexities related to the PMTCT continuum of care, but the approaches for planning, designing, and configuring a patient tracker in DHIS2 are applicable to any health program.

Preventing infections in infants requires adherence to a strict treatment regimen for the mother during pregnancy and for the mother and child after delivery. Many challenges exist in tracking mothers and their infants across the continuum of care, such as cumbersome paper-based systems that rely on multiple registers to track services, the fact that women seek services at different clinics over the course of their pregnancy, and the inability of clinicians to properly identify HIV-exposed infants in child wellness services. The PMTCT Tracker proposed in this report aims to solve these and common challenges facing PMTCT clinicians and program managers. The authors opted to use the DHIS2 Tracker software because it has many functions that lend itself to this purpose, it is open-source and free software that can be used out of the box, and many countries already have individuals skilled in working with DHIS2.

Following the introduction and background, the guidance in this report is divided into three main sections, which are described as follows.

The first section, **Assessing the Environment,** outlines an assessment plan intended to compile information about the PMTCT program and the context in which it will operate. Areas of investigation include understanding (1) the paper and electronic tools that are used to monitor the PMTCT program; (2) the treatment protocols in place for PMTCT and how women move across different providers for PMTCT services; (3) the policy environment, particularly as it pertains to data hosting and sharing; and (4) the infrastructure environment that will affect hosting and connectivity for the DHIS2 program. These areas of investigation are pertinent and can be adapted to the development of any tracker system, regardless of the health program.

The second section, **Planning for Tracker Development,** is intended for PMTCT program managers and describes decisions that must be taken during the planning stage to inform the design and configuration of the PMTCT Tracker. The guidance discusses the importance of defining the scope of the PMTCT Tracker and the minimum data elements needed to meet the Tracker's objectives. It discusses the need for a governance structure to guide decisions and provide oversight to the Tracker development and implementation as well as the need to be accountable for the security of patient data. Finally, it discusses issues related to the design of the data collection process, such as deciding which tools to use, implementing a system for generating unique identifier codes, and defining data collection, entry, and management processes that include the persons responsible for these tasks.

The third section, **System Design and Configuration,** is intended for technical staff and describes in detail how to configure a PMTCT Tracker in DHIS2. It outlines the key principles that should be

followed when configuring DHIS2 and how these shape the specific programs, program stages, and data elements that are required for PMTCT patient tracking. It recommends an overall structure for a PMTCT Tracker that includes two separate but linked programs for the mother and her infant that track their movement across a predefined set of services. This section also provides information about hosting for DHIS2, managing confidentiality and data security, configuring an organizational hierarchy in DHIS2, handling dates in the DHIS2 Tracker program, assigning user access, sharing data through DHIS2, and selecting different technological options for data entry and retrieval.

To help technical staff better understand the general guidance presented in this chapter, a sample PMTCT Tracker configuration solution is included in Appendix A.[1] This sample configuration meets many key objectives of a PMTCT Tracker, including monitoring adherence to the PMTCT continuum of care, flagging missed appointments, tracking patients across facilities, and linking child and mother records for improved follow-up of HIV-exposed infants. It was field tested in Zimbabwe to ascertain its feasibility.[2] This sample configuration is one example of many possible configurations that could be produced using the guidance in this report, and it provides technical staff with a concrete, practical example of *how* to implement the recommendations in the System Design and Configuration section. Appendix A provides detailed instructions for configuring every aspect of this sample tracker, including setting up patient registration, defining services and potential outcomes of specific visits, setting up repeatable programs when multiple visits are required, enabling different facilities to schedule appointments or mark them as completed, setting up notifications, creating prompts for creating a new child program, configuring and generating reports, and creating PMTCT indicators from the data collected.

The fourth section, **Training Guidance,** presents the recommended steps to conduct a training for the PMTCT Tracker. It can be used together with the PMTCT Tracker User Manual,[3] which takes the user step-by-step through data collection, dashboards, reports, and troubleshooting for the Tracker, to facilitate the training.

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[1] PMTCT Tracker Metadata XML file: https://www.measureevaluation.org/resources/pmtct-tracker/PMTCT Tracker metadata.xml/at_download/file

[2] Scott, F., Schmale, A., Moonzwe Davis, L., Johnson, S., & de la Torre, C., (2019). Testing a Client Tracker for the Prevention of Mother-to-Child Transmission of HIV in Zimbabwe: Findings and Lessons Learned. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina.

[3] Schmale, A., Moonzwe Davis, L., Scott, F., Johnson, S., & de la Torre, C., (2019). Using DHIS2 Software to Track Prevention of Mother-to-Child Transmission of HIV: User Manual for the DHIS2 PMTCT Tracker. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina.

INTRODUCTION

This report provides guidance on developing an electronic solution to track patients across the prevention of mother-to-child transmission (PMTCT) continuum of care to increase retention and improve linkages and referrals across services. We examine how the DHIS2 Tracker software can be used for this purpose and discuss general advantages and limitations of this technology. This guidance is customized to address the complexities related to the PMTCT continuum of care, but the approaches for planning, designing, and configuring a patient tracker in DHIS2 are applicable to any health program.

The report discusses issues that must be considered prior to developing an electronic PMTCT Tracker program, such as questions around data security, governance and management of the program, the amount and types of data to collect, and overall system design. We then provide detailed guidance on how to configure the DHIS2 Tracker software to address the most common challenges associated with tracking mother-infant pairs across the PMTCT continuum of care. We propose an approach for designing and setting up a PMTCT Tracker that will allow the program to:

- Link mother and infant records to allow for careful monitoring of HIV-exposed infants
- Track patients across facilities by allowing scheduled visits to be marked as completed at any facility where the mother chooses to receive care
- Facilitate referrals by allowing facilities to schedule visits at other locations
- Generate alerts and notifications when appointments are missed
- Generate reports at the facility and district levels that list individuals who are overdue for scheduled appointments
- Use built-in analytics and dashboards for creating standard PMTCT indicators using longitudinal data from individual patients

The primary purpose of the PMTCT Tracker is to prevent loss to follow-up along the continuum. Some principals surrounding the development of this tracker are:

- Keep information and data to a minimum, and collect only what is needed to track progression of the mother-infant pair along the continuum of care.
- The PMTCT Tracker is not intended to replace an electronic medical record that tracks all services received along the way.
- Data security and confidentiality are of critical importance and must be considered at all stages of the PMTCT Tracker design and development process.

This document is organized as follows. The Background Section describes why an electronic PMTCT Tracker is desirable and why we propose the DHIS2 Tracker software program for this purpose. The Assessing the Environment Section highlights some key information that needs to be compiled and considered prior to designing an electronic PMTCT Tracker in a given country. The Planning for Tracker Development Section discusses key decisions from a programmatic perspective that must be made as the electronic PMTCT

Tracker is designed. This section is primarily intended for program managers and monitoring and evaluation (M&E) officers. The System Design and Configuration Section describes the overall structure of the DHIS2 Tracker and provides detailed guidance on how to configure a PMTCT Tracker in DHIS2. This section also discusses technological options and issues that must be considered in the configuration process. The Training Guidance section provides guidance on how to train data collectors and other users of the PMTCT Tracker. This section is for anyone planning the rollout of the Tracker and those directly involved with training and supervising the implementation of the Tracker. Appendix A provides details on how to achieve a specific configuration for a PMTCT Tracker that was designed to meet specific global objectives, namely monitoring adherence to the PMTCT continuum of care, flagging missed appointments, tracking patients across facilities, and linking child and mother records for improved follow-up of exposed infants. This guidance reflects lessons learned from the PMTCT Tracker that was developed and pilot tested in Zimbabwe.[4]

In countries where electronic medical records (EMRs) already exist, establishing a DHIS2 Tracker may not be necessary. A patient tracking system can be programmed within the EMR software to generate alerts for missed appointments and potentially link mother and infant records for closer follow-up of HIV exposed infants. In such cases, guidance in this document will still be relevant, particularly in terms of selecting the steps to track. The configuration will be different, but issues around selection of data elements to track will be relevant.

[4] Schmale, A., Moonze, L., Scott, F., Johnson, S., & de la Torre, C., (2018). Testing a Client Tracker for the Prevention of Mother-to-Child Transmission of HIV in Zimbabwe: Findings and Lessons Learned. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina.

BACKGROUND

Since the 2011 launch of the *Global Plan Towards the Elimination of New HIV Infections Among Children by 2015 and Keeping Mothers Alive,* considerable improvements have been made in reducing mother-to-child transmission of HIV (Joint United Nations Programme on HIV/AIDS [UNAIDS], 2015). Most high-burden countries have made great strides in strengthening their PMTCT programs, achieving almost universal testing of pregnant women; coverage of antiretroviral (ARV) medications among HIV-positive pregnant women is near 80 percent (UNAIDS, 2016). As a result, the rate of infection among HIV-exposed infants has dropped significantly. Nevertheless, UNAIDS estimates that 110,000 children continue to be infected annually in the 21 Global Plan countries[5] alone because many women and their HIV-exposed infants do not complete the full continuum of care required to prevent mother-to-child transmission of HIV (UNAIDS, 2016). PMTCT requires adherence to a strict treatment regimen that includes testing for HIV, obtaining test results, initiating treatment and prophylaxis,[6] and finally adhering to an ARV regimen. After birth, infants must also initiate a continuum of care to adhere to ARVs, undergo HIV testing, and continue to be monitored until breastfeeding ceases (Chi, Stringer, & Moodley, 2013).

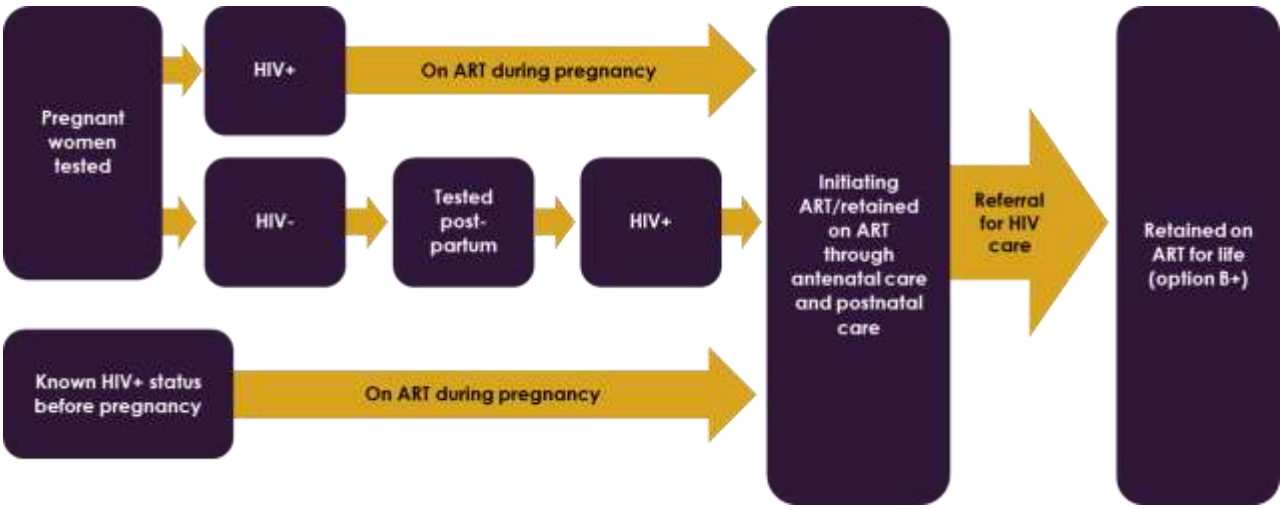
> "These activities involve testing and counseling for HIV, early attendance (from 14 weeks of pregnancy) for antenatal care (ANC) to optimize antiretroviral (ARV) prophylaxis for prevention of mother-to-child transmission (PMTCT), adherence to the drugs, CD4 count testing, and, in breastfeeding populations, retention in the PMTCT program until breastfeeding cessation, which may be for up to 24 months." (President's Plan for AIDS Relief [PEPFAR], United States Agency for International Development [USAID], & HIV Core, 2015)

To break the epidemic, retention to the PMTCT continuum of care needs to happen on a large scale:

> "Achieving and maintaining low transmission rates requires universal coverage across the prevention of mother-to-child transmission cascade, including high antenatal attendance, high HIV testing and counselling rates, antiretroviral therapy coverage over 90%, systems that support lifelong adherence to antiretroviral therapy and retention for mothers in the postpartum period, and active provider-initiated prevention of HIV infection among pregnant and breastfeeding women." (UNAIDS, 2016)

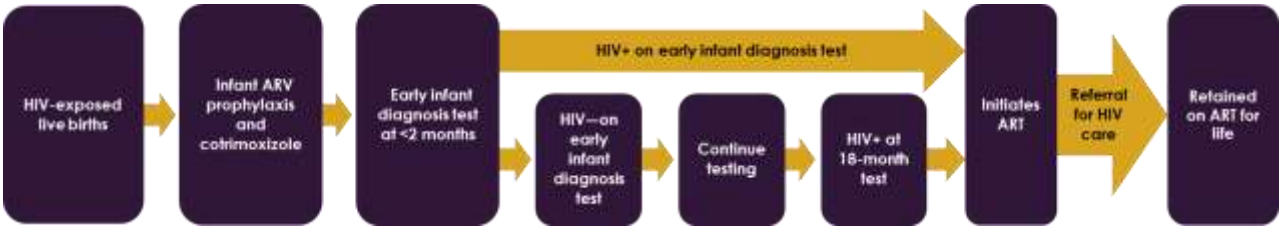
[5] These are the 21countries that accounted for 90 percent of pregnant women living with HIV.
[6] In countries not following Option B+, an additional step includes screening for ART eligibility.

Figure 1. PMTCT continuum of care for mothers



Source: Adapted from World Health Organization (WHO). (2015). *Consolidated strategic information guidelines for HIV in the health sector.* Geneva, Switzerland: WHO.

Figure 2. PMTCT continuum of care for HIV-exposed infants



Source: Adapted from World Health Organization (WHO). (2015). *Consolidated strategic information guidelines for HIV in the health sector.* Geneva, Switzerland: WHO.

Attrition at any point along the PMTCT continuum of care increases the risk of infection to the child. It is therefore important to have mechanisms in place to track the mother-infant pair across the multiple services, ensuring that they keep appointments and meet key benchmarks (such as testing the infant within two months of birth). The rapid identification and re-engagement of women who have missed appointments is critical.

Challenges with Tracking PMTCT Patients

There are important challenges related to tracking patients across the PMTCT continuum of care, and the paper-based tools commonly used in sub-Saharan Africa are not adequate to respond to these challenges (Inter-agency Task Team on the Prevention and Treatment of HIV Infection in Pregnant Women, Mothers and Children, 2015). This section presents some of the reasons why tracking PMTCT patients is difficult.

The services received by PMTCT patients are typically recorded in a number of distinct registers.

PMTCT data are captured on different registers that include antenatal care (ANC) registers, PMTCT registers, labor and delivery registers, postnatal care (PNC) registers, pharmacy and laboratory registers for women, and

child welfare clinic and early infant diagnosis registers for HIV-exposed infants. Determining whether a woman is retained in care across the continuum requires tracing her across all these registers (PEPFAR, USAID, & HIV Core, 2015). The process of manually checking registers across facilities to find the same individual and confirm service provision is cumbersome, labor intensive, and impractical, especially in high-volume facilities. It is often difficult to determine with certainty whether women with the same or similar names appearing on different registers are in fact the same, especially in countries where many individuals have the same surnames. Even with the use of unique identifier codes (UICs), tracing a woman across registers to determine whether she is receiving all the services needed is difficult (PEPFAR, USAID, & HIV Core, 2015). As a result, identification and re-engagement is not often done when women miss appointments or fail to meet key milestones, leading to unnecessarily high levels of loss to follow-up.

Patients receive PMTCT services at different sites.

If tracking women across registers in a given facility is challenging, doing so across facilities is even more difficult without an electronic system used in conjunction with UICs (PEPFAR, USAID, & HIV Core, 2015; Gourlay, et. al, 2015). Movement of PMTCT patients across facilities is common, however, and may occur because the full continuum of PMTCT services is not available at the originating facility or because the woman is referred for more specialized care (e.g., for delivery complications) (World Health Organization [WHO], 2015b). Women may also elect to receive care at a new facility to be near family for the delivery and postnatal period, to receive what they perceive is a better quality of care, or to receive HIV-related services more anonymously. In such cases, tracking the woman is difficult. The originating facility has no way of knowing whether the woman is adhering to care elsewhere or whether she is lost to follow-up (Gourlay, et al., 2015; PEPFAR, USAID, & HIV Core, 2015). Even if the facility that holds the new records could be identified, mechanisms do not exist for linking records from different facilities.

In some cases, women may be formally referred to another facility to receive a specific service. Tracking women who are referred should be easier, but referral systems are often dysfunctional in sub-Saharan Africa and lack documentation and systematic processes for referral follow-up. It is therefore common for women to be lost to follow-up during the referral process.

Tracking women after delivery is particularly challenging.

After delivery, it is common for women to be lost to follow-up (Phillips, et al., 2015; Watson-Jones, et al., 2012). Women may not seek care for themselves after delivery and stop attending clinics. The postpartum period may involve the referral of women to another facility or service provider for PNC or the transfer to a care and treatment facility for lifelong antiretroviral therapy (ART), but many women disengage from care at this phase due to poor referral and linkage systems (Phillips, et al., 2015; Keehan & Karfakis, 2014; WHO, 2015b; Watson-Jones, et al., 2012). Monitoring systems to track the mother-infant pair after delivery are lacking, and data tend to be poor or nonexistent (UNAIDS, 2016). As a result, more than half of infections in infants occur during the breastfeeding period (UNAIDS, 2016).

The PMTCT continuum of care involves tracking two individuals and linking the mother and infant records.

If the child's record is not linked to the mother's PMTCT record, it is difficult for the clinics to know which children have been exposed to HIV and are in need of specialized PMTCT services. If the parents do not voluntarily reveal this information to the child's wellness providers, the child will be lost to follow-up. Furthermore, after delivery, both mothers and infants need to follow a treatment regimen for PMTCT. Linking mother and child records is needed to monitor both individuals and understand the continued risk of exposure for the child. This has proven to be difficult, particularly when the services are not provided through the same provider or at the same facility (UNAIDS, 2016).

Advantages of Electronic Tracking Systems

New technologies provide an opportunity to overcome these challenges and more effectively track the progression of patients across the continuum of care, regardless of where services are received. Programs with active follow-up of patients have less loss to follow-up (PEPFAR, USAID, & HIV Core, 2015; Sibanda, et al., 2013). Tracking individual women longitudinally has been shown to improve retention in care along the entire continuum of care (Keehan & Karfakis, 2014). Using electronic databases that house individual-level records offers many advantages:

- They can track patients across facilities if the database is centrally located and accessible to all facilities (PEPFAR, USAID, & HIV Core, 2015).
- By generating alerts and notifications of upcoming or missed appointments, electronic tracking systems can improve retention in care (Keehan & Karfakis, 2014; Mushamiri, et al., 2015).
- They can facilitate the rapid return of test results to providers and patients, leading to more timely treatment (Finocchario-Kessler, et al., 2014).
- They can help differentiate between patients who require follow-up and patients who have transferred to another facility or have died (WHO, 2015b).
- They can facilitate communication between providers and community health workers to retain mothers in care (Finocchario-Kessler, et al., 2014; Mushamiri et al., 2015).
- They can lead to early diagnosis and early initiation of ART for infants (Finocchario-Kessler, et al., 2014).

From an M&E perspective, electronic patient tracking systems have the advantage of generating individual longitudinal data that can improve reporting of key HIV and PMTCT indicators. Advantages of these data include the following:

- The individual data can easily be aggregated to construct key PMTCT cascade indicators. In the case of the DHIS2 Tracker, these analyses can be configured and performed in the same program and exported to other systems such as the national health management information system (HMIS).
- Individual longitudinal data can improve the accuracy of cascade indicators. Current practice often requires constructing these indicators based on the number of individuals seeking certain services in a given time period (e.g., numbers tested for HIV, numbers enrolled in care and treatment). These groups may contain different individuals due to population movement or to delays in care-seeking

behavior. Sometimes constructing cascade indicators requires more complex analyses to identify the population that should serve as the denominator.

- These data also increase accuracy by reducing double-counting of patients through better tracking of individuals across services and sites (WHO, 2015b). Double-counting can occur when patients seek care at more than one facility or when they repeatedly test for HIV.
- Individual longitudinal data are also helpful in estimating the timing of progression across the cascade, where lags exist, and how significant they are.
- Data can be aligned to provide information about the country program, to better meet PMTCT program goals.
- The data generated can help identify facilities or districts that are underperforming.

What is DHIS2?

DHIS2 is a computer software package that has been developed to support all aspects of a HMIS, including the following:

- Collecting data from multiple sites
- Storing data, categorizing data, and managing data quality
- Analyzing data and displaying them in reports, charts, and maps
- Sharing data with other systems or organizations

DHIS2 is "free and open-source" software, which means that it can be used free of charge by anyone and that the source code (programming code) has been made public and shared with any other interested programmers.

One of the strengths of DHIS2 is that it is configurable through a user-friendly interface, which means that programming code is not required to build a system in DHIS2, so a new system can be set up relatively quickly and easily. Anyone who has received specialist training in DHIS2 and who has a good understanding of data (e.g., an M&E staff member) can configure a DHIS2 system.

DHIS2 is supported by a large community that includes software development teams (led by the University of Oslo), many Ministries of Health, Health Information Systems Program branches in various countries, local and international nongovernmental organizations, consultancy firms, and, many individuals. Because of its wide user base and large community of support, DHIS2 has emerged as a popular HMIS system in developing countries and has been chosen as an official system not only by WHO, PEPFAR, and many Ministries of Health, but also by a number of large international nongovernmental organizations (WHO, 2015b).

DHIS2 is under constant development, with new features and releases being added every four months. This document references DHIS2 versions 2.30 to 2.32, which are the versions of DHIS2 officially supported at the time of publication. The latest version of DHIS2 is available at https://www.dhis2.org/overview; to see a

list of features that have been added or changed in the current version and each previous version, click on the version number.

The DHIS2 Tracker Program

DHIS2 was originally designed to collect aggregate or summary data (e.g., the total number of pregnant women taking HIV tests, the total number testing positive, the total number receiving ART in a given time period). This enabled analysis of services delivered but provided no information on individual patients.

More recently, DHIS2 added a Tracker data collection model, which enables the tracking of an entity (e.g., a patient) over time.[7] The DHIS2 Tracker allows a patient to be registered and data on services and visits to be added to the record, building a history of the patient's care. The Tracker enables electronic booking of future appointments and automatic detection and notification (using Short Message Service [SMS], e-mail, dashboards, etc.) of missed appointments or services (DHIS2 Documentation Team & University of Oslo, 2019). Facilities that are connected to the Internet can share patient records and add information that other clinics facilities can see and edit. They can use the booking system to refer patients to each other and to notify the originating clinic that services were rendered.

Why choose the DHIS2 Tracker

- The DHIS2 is commonly used for HMIS in developing countries by people at all levels of the health system are familiar with it.
- Most countries have experts that can configure and program the technology.
- It is open-source software available free of charge.
- It has many built-in features that allow it to operate as a PMTCT Tracker with some configuration but without the need for added development.
- It facilitates data use through the use of dashboards and strong data visualization options.

The DHIS2 Tracker is designed to be simpler than an EMR, so it does not have some of the key EMR features, particularly around user access and data security. Whereas an EMR is designed to be the primary tool used by clinic staff as they work with patients, the DHIS2 Tracker is designed to collect a more limited set of data and to be used alongside other paper records, adding a tracking and communication functionality to the existing core clinical records, rather than replacing them. The DHIS2 Tracker can also serve an interim tool to track PMTCT patients across the continuum of care while an EMR is established.

The following two sections describe the process of assessing your needs and your program context. It is important to carefully consider whether the DHIS2 Tracker will meet your needs. The data security and confidentiality features in DHIS2 are continually evolving and should be carefully considered when initiating the design of a PMTCT Tracking system, given how sensitive these data are. If you find that you need your system to do more than basic tracking of patients and referrals over time, and your organization has the more extensive skills and resources required, then you may want to consider rolling out a full EMR and using it to track patients instead of establishing a tracker through DHIS2.

[7] https://www.dhis2.org/overview

ASSESSING THE ENVIRONMENT

Before establishing an electronic PMTCT Tracker, it is necessary to understand the context in which the tracker will operate and the factors that will affect the design and rollout of the program. This section covers a list of areas that need to be assessed before designing the PMTCT Tracker.

Current Tools and Reporting System for the PMTCT Program

Before designing the PMTCT Tracker, you must examine all the registers and tools currently in use at PMTCT facilities for recording services provided to PMTCT patients. To help determine whether these registers and tools can be used to feed information to the electronic tracker, or whether new or supplemental tools need to be developed, you must document the following:

- Are the registers and data collection tools standardized across all facilities?
- What data elements are included in these tools? Do they meet the data needs of the Tracker?
- Who completes the registers and tools?
- Is it feasible to trace a single woman across all the registers and tools?
- Are UICs used for PMTCT patients across all services? Or are separate codes used for different services (e.g., for ART and ANC)? Who assigns the codes?
- Is an EMR system in place that captures data about PMTCT services?
- To what extent are the data collected meeting the information and reporting needs at the facility, district, and national levels?
- Are the tools being used to track patients lost to follow-up? Are they adequate for this purpose?
- Are the tools being used to trace patients who are referred to other sites? Are they adequate for this purpose?
- What difficulties and bottlenecks are facilities experiencing when tracking PMTCT patients?

The tools to be reviewed include electronic tools in use to monitor HIV and AIDS programs in the country. For example, some countries may have electronic tracking systems for ART patients or HIV testing databases. In such cases, you should consider the appropriateness and feasibility of integrating these systems with the PMTCT Tracker. If the country uses a paper-based system, it is important to assess whether the registers and tools are readily available and consistently used to document PMTCT services, and that standardized definitions are used for all data elements. If the paper-based system is not functioning as intended, it is important to understand why to avoid similar challenges when transitioning to an electronic system.

If an EMR system is in place, it may be possible to create a patient tracking system in that software instead of establishing a DHIS2 tracker for this purpose. If an independent patient tracker is preferable, the possibility of exporting data from the EMR into a DHIS2 tracker should be assessed.

In addition to assessing the tools, you must map out how the PMTCT data are reported, who compiles the PMTCT data at the facility and district levels, where data entry in electronic format takes place, and how frequently data entry occurs. This will help determine whether the same data flow and data management pathways can be used for the PMTCT Tracker or whether new procedures and staffing are needed for data compilation and entry of individual patient data.

PMTCT Treatment Protocols and Organization of Service Delivery

Countries and even facilities within countries may organize their services differently, with differing levels of service integration (WHO, 2015b). In some settings, ARVs may be available directly from the ANC providers, and in others patients may need to obtain ARVs from a separate pharmacy or care and treatment center. Understanding how patients move across services and when they must change providers or sites to receive services is important when designing the configuration for the PMTCT Tracker. For example, if services are not fully integrated, you will need to decide whether to track ARV pickups or ANC visits to monitor mothers' compliance with the PMTCT protocol. The location and turnaround time for early infant diagnosis testing should also be considered because it affects how test results are entered into the Tracker. For example, early infant diagnosis results can be entered by the facility ordering the test or directly by the laboratory.

In addition, you must refer to national PMTCT guidelines to align the PMTCT Tracker to the country-specific protocols for the testing and treatment of HIV-positive pregnant women and their infants. Examples of issues to consider related to the PMTCT treatment protocols include the following:

- Schedule of infant testing
- Level of integration of ANC and ART
- Frequency of ARV pickups
- Whether referrals are needed for continued ART after delivery
- Where data are recorded
- Communication and data flow alignment between different services, such as ANC, ART, PMTCT, laboratories, and referral hospitals

Capacity to Manage an Electronic PMTCT Tracker

The success of an electronic PMTCT Tracker will depend on the capacity at the facility and district levels to implement the related tasks, including the following: collect data in a timely fashion, use computers for data entry, ensure data quality, provide supervision, train employees, maintain confidentiality and data security, and use the data as intended (Health Metrics Network, 2006). It is important to examine the workloads of staff involved in the collection and reporting of PMTCT data (e.g., clinical staff, HMIS staff) to determine whether current staffing levels can accommodate the increased responsibilities associated with rolling out an electronic PMTCT Tracker. Some gaps in capacity can be easily addressed through trainings, but others, such as staffing shortages, may require a greater commitment and long-term planning.

Computer skills will be important in rolling out an electronic PMTCT Tracker, so familiarity with computers and with DHIS2 software in particular should be assessed. If the country already uses DHIS2 for its HMIS, this will facilitate the implementation of a PMTCT Tracker because the technical skills needed to configure and use this software will be more advanced.

Data Policies Governing Health Data

Countries and ministries often have policies that govern how health data can be used, stored, and shared. These policies may include eHealth policies, electronic health record policies, and policies that govern the national HMIS. You must familiarize yourself with these policies before beginning to design a PMTCT Tracker to understand any restrictions that may apply. These policies may affect where the database can be hosted, the types of information that can be collected, who can access the data, and the types of data security measures that need to be put in place to protect patients' personal information. If relevant policies do not exist, or are not specific enough, consider whether new ones are needed.

Stakeholders

Many stakeholders are involved with strengthening or delivering PMTCT services and ensuring that proper M&E mechanisms are in place. It is important to identify the stakeholders because their input and buy-in are necessary for the successful implementation of an electronic PMTCT Tracker. Stakeholders can include the following groups:

- The Ministry of Health, including representatives from the National AIDS Control Program and the HMIS
- Clinical providers who provide services and fill out the registers and forms at the facility
- HMIS point persons at the facility and district levels who are responsible for compiling and reporting PMTCT data
- Individuals at the facility and district levels who are in charge of identifying and tracking PMTCT patients lost to follow-up
- Health management teams at the regional, district, and facility levels that will use the data generated by the PMTCT Tracker
- Implementing partners working to strengthen PMTCT programs
- Donors who support PMCTC programs

Existing Infrastructure

DHIS2 is a web-based program and requires reliable infrastructure at the national and subnational levels. Issues such as Internet connectivity, reliability of the electric grid, and availability of servers will affect how the electronic PMTCT Tracker can function. Options may exist to bypass blackouts or poor Internet connectivity, but the overall design of the system, including where data are entered, who can access the data, and at what level reports can be generated, will depend on the overall infrastructure environment and the resources available to improve it. To ensure timely data entry and client tracking, a PMTCT Tracker should be operational at the facility level, and therefore infrastructure required at PMTCT facilities should be

considered. Before initiating the design of a PMTCT Tracker, you should assess the infrastructure, identify gaps, and determine whether and when these gaps can be resolved.

If the country already uses DHIS2 for its HMIS, this will help understand the challenges of setting up a web-based system in that specific environment. We also recommend that patient-based trackers such as the PMTCT Tracker should be configured in a separate instance and not configured in any other DHIS2 instance (such as that used for HMIS) for data security and confidentiality reasons. In such circumstances, the ability to run two separate instances of DHIS2 should be examined.

PLANNING FOR TRACKER DEVELOPMENT

This section is designed to guide PMTCT program managers through the key steps and decisions they must take regarding the PMTCT Tracker, which involve the purpose, inputs, organization, and management of the tracker. Other stakeholders involved in the decision-making process should also familiarize themselves with these steps.

Establish a Governance and Leadership System for the Development of the PMTCT Tracker

When establishing a national electronic tool, it is highly recommended that you establish a governance structure to oversee the development process, coordinate stakeholders, facilitate decision making, advocate for resources, provide accountability for the security of patient data, and mandate the implementation and use of the tool. It is helpful to establish a governing council with key stakeholders, such as the National AIDS Control Program and HMIS officers, to help inform decisions at each step of the development and implementation process. In addition to the responsibilities listed above, the governing council should ensure that the PMTCT Tracker adheres to national health data policies, or in the absence of such policies can help develop them. It should also ensure that clearly defined procedures and processes are defined for data management, access, use, and security (TechTarget, n.d.).

Define the Scope and Purpose of the PMTCT Tracker

Before developing the PMTCT Tracker, you must clearly define the objectives and scope of the Tracker, along with the programmatic gaps and information needs it will address. This should be done in consultation with key stakeholders who will use the PMTCT Tracker, including Ministry of Health staff at the district and facility levels. You will need to gather requirements for the PMTCT Tracker and prioritize them. You will likely identify many issues that the Tracker can help resolve and information needs it can meet. However, we recommend starting with the most pressing issues. Overloading the PMTCT Tracker with data will create undue burden on the facility staff who will collect and enter the data and will lead to poor quality data.

Illustrative objectives of the PMTCT Tracker

- To link the records of mother-infant pairs
- To track PMTCT patients along the continuum of care
- To monitor referrals of patients across facilities
- To document receipt of key services or diagnostic results
- To compile individual-level data for construction of PMTCT indicators

The overall scope of the PMTCT Tracker will also depend on the resources available and the existing technology infrastructure. For example, tracking patients across facilities requires a central database to which facilities connect through the Internet. Tracking patients within a single facility can be done on a locally installed Tracker that does not require an Internet connection.

Note that a patient tracker is not intended to function as an EMR. An EMR provides detailed information about the test results, diagnoses, treatment prescribed, and services rendered for a given patient. A tracking system contains less detail and is intended solely to monitor that the patient is adhering to an appointment schedule, and that key milestones of the PMTCT continuum of care are achieved. If you require more

detailed information regarding patient case management, consider implementing an EMR system instead. Many EMR systems have analytic capabilities that allow them to additionally function as a patient tracker.

Protect Patients and Ensure Confidentiality

Electronic data collection can lead to many unforeseen risks and outcomes and greatly increase the chances of breaching confidentiality. Electronic data can potentially be accessed and seen by a large number of people, and they can be improperly downloaded and shared. It is important to consider all potential risks when developing an electronic tracker, particularly one that collects data on vulnerable population such as HIV-infected women and their children (Waugaman, 2016). Confidentiality breaches could severely harm patients due to stigma and result in legal implications for the program (WHO, 2015b).

Establish a separate DHIS2 instance for your PMTCT Tracker

Many countries have DHIS2 programs already in use for their HMIS. It is possible to create a PMTCT program in an existing DHIS2 instance, but we recommend against this. In an integrated system, there is a larger risk for a breach of confidentiality because users of one program may inadvertently gain access to the data in the PMTCT Tracker. To protect patient confidentiality, it is best to create a separate and independent instance for the PMTCT Tracker. Data from this system can be aggregated and de-identified and shared with other systems as needed.

Systems need to be in place to protect the confidentiality of data that are collected and shared. Health information systems need to ensure the equity and confidentiality of patients and enforce this across all users and persons accessing the data. Table 1 describes some measures that can be taken to protect data security and patient confidentiality at an individual and organizational level. However, do not rely exclusively on this list. When designing a PMTCT Tracker, patient confidentiality and data security need to be considered at every step and with every decision that is made, including decisions regarding which data to collect, who is involved in data entry, where the data are stored.

Table 1. Actions for protecting confidentiality

• Avoid using names or any other identifiable data when possible • Understand risks to individuals and train others in this regard • Create and use a system for UICs • Control who can see the data and where they are sent • Place data entry computers in locations where screens cannot be seen • Have all Tracker users sign confidentiality agreements • Set up clear protocols for protecting data and train users on them • Monitor database activity, including who downloads data	• Define clear user roles and limit access to data based on roles • Create clear hierarchy levels to assign restrictions • Clean any shared or aggregated data of identifiers • Conduct security risk assessments for organizational data • Develop privacy and security protocols for different technologies used • Designate resources for security risks and assessments • Know the privacy and security policies and capabilities of the technology used

Define Data Elements to be Collected

The data you want to collect will depend on the objectives and scope of your PMTCT Tracker. Although you could potentially collect detailed information on every service received at every visit, this is not recommended. Careful consideration needs to be given to the amount and type of data collected. When making these decisions, the following issues should be considered.

Determine the purpose of your Tracker. If you are using it to track progression of patients across the continuum of care, you do not need details on every service received along the way. You only need to document that patients are showing up for key appointments (e.g., mothers are picking up their ARVs on schedule and children are tested on schedule). If you want to use the PMTCT Tracker to monitor patient transfers across specific services, then data on only those specific transfers or referrals need to be collected. If you are using the PMTCT Tracker primarily to link mother-infant pairs to monitor HIV-exposed children, then only limited information about the mother's HIV status and delivery may be required. If you intend to use the data for creating specific PMTCT cascade indicators, consider the minimum amount of data needed to do so. The PMTCT Tracker should not be used instead of an EMR. If you need detailed information on PMTCT services received, choose a different software program. Collect only what is needed to match your purpose.

Minimize the burden of data collection and entry on lower levels of the health system. Collecting large amounts of data creates an unreasonable burden on facility and district-level staff and will likely lead to backlogs in data entry and poor-quality data. Data entry backlogs will defeat the purpose of creating a Tracker that requires timely data to identify patients who have missed an appointment or referral. You should aim for all data to be entered either live or within 48 hours of a patient visit, so that the missed appointment alerts and notification systems function as intended.

Decide how the data will be used. For each data element you want to include, have a clear plan for how those data will be used. Will the data be used to create indicators? Or to inform programmatic decisions? Who will use the data and at what level of the health system? Every data element should have a clear purpose. Avoid including data simply because they seem important.

Determine the types of reports to be generated. DHIS2 has a strong analytic component that generates reports based on individual or aggregate data. It will be helpful to decide what types of reports you want the PMTCT Tracker to generate and to be clear on the indicators and level of disaggregation desired. This also informs the data you need to collect.

Weigh the desire to collect data against the risk to the patients. Limiting the amount of data collected is an additional safeguard for patient confidentiality because it limits the amount of information that can be exposed. Restricting personal identifying information is important. Opt for using unique IDs instead.

Determine the Tools That Will be Used to Collect the Data

During the environmental assessment you will have examined the registers and tools currently used for recording PMTCT services. Now you need to evaluate those tools against the objectives you have defined for the PMTCT Tracker and the data elements you would like to include. You will need to determine whether you can populate your Tracker using the data from the available registers or whether revised or supplemental tools need to be rolled out.

Paper-based tools are needed to collect the data that you will eventually enter in the Tracker. We do not recommend moving to a paperless system because uncontrollable factors such as electric outages can disrupt use and lead to lost or incomplete data.

Data needed for a PMTCT Tracker generally come from the following registers:

- ANC Register
- ART Register or PMTCT Register (whichever captures ART information during and after pregnancy)
- Labor and Delivery Register
- Child Care or Pediatric Register

You will need to verify that these registers allow you to identify individual patients receiving services and that they include unique identifiers, used consistently across all services, to facilitate tracking patients across registers. Ensure that proper documentation of all visits is kept at the facility.

Other tools that may be useful for capturing data needed for a PMTCT Tracker include the following:

- Patient cards, kept at the facility, can simplify tracking the services obtained by a given individual and facilitate data entry tasks by avoiding the need to search for information across multiple registers.
- A daily log of patients who visit the clinic can help quickly identify which patient records need to be updated in the Tracker that day.
- A referral register (or referral slips) can help identify which patients were referred to another facility, so that this information can be recorded in the PMTCT Tracker program.
- A means to document when the next appointment is expected for a patient, if appointments are not planned on a regular (e.g., monthly) schedule is important so that appointment completion can be tracked.
- A filing and record-keeping system will help organize data that have been entered and those that need to be entered.

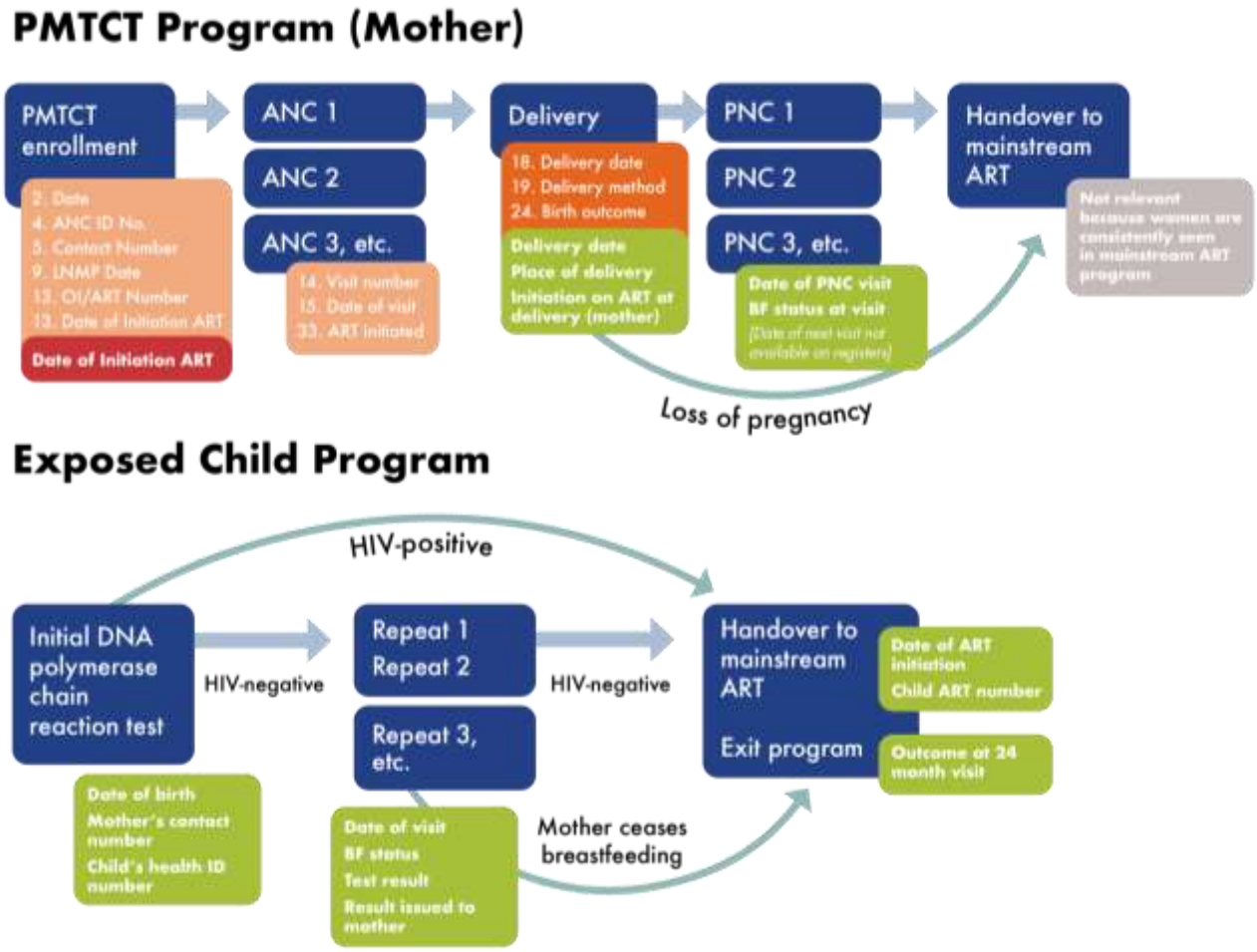
It is also important to consider what information is needed to register each PMTCT patient in your Tracker and ensure that you have a means for collecting that information. For example, you will need the patient's unique ID. You may want to capture contact information (in case follow-up is needed for missed appointments). We also recommend capturing the date of last menstrual period (LMP) so that you can estimate the patient's delivery date and enable alerts to initiate tracking the newborn child at that time.

When deciding whether to use new or existing tools, consider the following:

- The cost associated with changing the PMTCT tools, including printing and training costs
- Whether new tools will affect the HMIS reporting system
- Whether it is feasible to use existing tools in conjunction with supplemental tools to collect additional data instead of revising the existing tools

Figure 3 provides an example of data elements needed for the proposed PMTCT Tracker and how these were mapped to existing registers in Zimbabwe where the Tracker was piloted.

Figure 3. Mapping the PMTCT Tracker data elements to the clinical registers



Peach=ANC register, orange=labor and delivery register, green=HIV-exposed infant register, red=Opportunities Infection/ART patient booklet Numbers correspond to column numbers in registers. Not all registers had numbered columns.

Design the Data Collection and Management Process

Key decisions for the PMTCT Tracker are where and at what level of the system data entry will take place, who will be responsible, what technology they will use, and who will have access to the data. We address each of these questions below.

Decide where data entry will occur. When possible, data entry should happen at the facility level. The primary tools (patient cards or registers) are located at the facility and therefore can be directly accessed during data entry. Data entry at the facility also avoids delays associated with having to transfer paper copies to the district. The main barriers to data entry at the facility are lack of computer equipment, connectivity, and overburdened staff who may not have time for the additional data entry responsibilities. These issues must be addressed by the program when designing the system. Are resources available for equipping all the facilities? Can additional data clerks be hired to facilitate data entry? It is also important to ensure that data are captured in a private location or office to protect the confidentiality of the PMTCT patients.

Another possibility is to import data from an EMR system such as OpenMRS. Typically, EMR systems have analytic capabilities that would allow for internal tracking of patients. If it is deemed preferable for patient tracking to occur in a DHIS2 platform (e.g., to facilitate tracking across both EMR and non-EMR sites), then integration with an EMR should be considered to reduce the need for additional data entry. More information on integration across DHIS2 and OpenMRS is available online.[8]

Determine who will enter the data. Although best practice is for existing staff to take on data entry responsibilities, integrating the PMTCT Tracker into their mainstream work, this should be carefully assessed to ensure that it is sustainable. In high-volume facilities, a data entry clerk may be needed. Staff or data entry clerks should perform data entry daily or two to three times weekly, depending on the volume of patients. If you use a data entry clerk, it is important to cross-train replacement staff, so that tasks can be covered during leave and periods of heavy data entry.

When rolling out the PMTCT Tracker, you will need to decide whether to enter all retrospective data for existing PMTCT patients into the Tracker (i.e., information on services received prior to the Tracker rollout). Doing so will allow you to begin tracking all current patients across the continuum of care. However, this back-entry of data can require considerable time and resources, especially in high-volume facilities. It will likely require a dedicated team of data entry clerks to compile and enter these data. An alternative is to start registering only new PMTCT clients after the PMTCT Tracker is functional. We do not recommend entering only partial data for current clients (i.e., omitting services received prior to Tracker rollout) because it can lead to missing data for the calculation of some key indicators generated by the Tracker.

Identify the technology that will be used for data entry. Limiting factors for data entry at the facility level are unreliable electricity and Internet connectivity. DHIS2 can accommodate various types of data entry programs, including web-based and mobile data entry (described in the System Design and Configuration section and Appendices B and C). Depending on the infrastructure, equipment, and staff capacity, you should choose what makes the most sense in your context.

Determine who will have access to the data. Controlling access to the data helps maintain the confidentiality of patients and data integrity. Limiting access to identifiable data also limits the chances for breaches in confidentiality. You can control access by clearly defining user roles. Only grant access to personal data to those who require them and in cases in which access is justified by their role in service delivery or M&E. Establish clear supervision and support protocols. Consider who will need to access reports and whether they need individual or aggregate data. Additional

[8] The OpenMRS website provides information on integration with DHIS2: https://wiki.openmrs.org/display/projects/OpenMRS-DHIS2+Integration+Module+-+User+Guide

information on the types of reports that can be generated is provided in the System Design and Configuration Section.

Share Information and Data

During the PMTCT Tracker design process, it is important to consider what data or reports must be shared with external organizations or government bodies. This will usually involve sharing aggregate or summary data generated by combining the individual patient records in your PMTCT Tracker. Due to the sensitivity of these data, the individual PMTCT patient records themselves should not be shared. DHIS2 has built-in data manipulation options that facilitate the generation of reports. To share summary data, you will need to develop either indicators and reports or SQL views[9] that calculate these summary figures before they are shared. SQL views will require more technical skills than generating indicators and reports. These reports can be downloaded or shared electronically. DHIS2 has excellent data sharing capabilities, with a wide range of options and formats (the options are discussed in greater detail in the Data Sharing Section).

The requirements for these reports should be carefully laid out and documented, including the following:

- The partner or organization that will be receiving the data
- How frequently data will be shared
- The suggested DHIS2 option for sharing data (e.g., through CSV or the application programming interface [API])
- A specification explaining the data format that the other organization or system requires
- A description of security precautions that need to be followed (e.g., password-protecting or encrypting files before sending).

There may also be requirements for your PMTCT Tracker to accept data shared by other systems or organizations. Two common reasons for importing data from other organizations into your PMTCT Tracker are described below:

Maintaining the reference data in your DHIS2 system (for example, keeping a list of districts or health facilities updated). We discuss this situation in greater detail in the Configuring Your Organizational Hierarchy section.

Enabling core patient data (such as patient registrations or clinic visits) to be captured in other systems and merged into your PMTCT Tracker. This decision can be more problematic and should be carefully weighed. The primary purpose of the PMTCT Tracker is to ensure that each patient can be carefully tracked over time, with the disparate services they receive all recorded in single record. The risk with external data capture is that these external systems will create a second, duplicate record for a given patient if they do not have direct access to the PMTCT Tracker's patient list. Third-party data collection tools should only be considered if they can reference the patient list held in the Tracker. The data security implications need to be considered as well.

[9] SQL or Structured Query Language is a programming language often used to manipulate and manage data.

Uniquely Identify Patients

The biggest challenge facing any attempt to track patients over time and across facilities is correctly identifying individual patients, whether mothers or infants, when they access services. If patients are not identified correctly, then one of two things can happen:

- An existing patient is not found in the system, and a duplicate record is created. This can lead to gaps in the patient's primary record, and the patient can falsely appear as lost to follow-up when in fact she or he has been retained in care.
- A new patient is accidentally matched to a different existing patient's record; this is a particular problem where popular or common names mean that many patients in an area share an identical name, and other attributes need to be used to distinguish patients.

The consequences of accidentally creating duplicate records for a patient are not as serious as adding patient data to the wrong record. The former error will appear as lost to follow-up and will hopefully be investigated; the latter could result in more significant outcomes, such as the patient being removed from tracking or referred to the wrong service. For this reason, patient searching and matching should be geared to err in favor of not making a match unless it is absolutely clear that the correct patient record has been found. Training staff is critically important to ensure that they understand the importance of accurate matching and undertake careful searches before entering data or creating new patient records.

One of the most effective tools for correctly identifying patients over time and across facilities is a UIC. You will need to implement an effective UIC before you can begin tracking PMTCT patients electronically (Appendix D contains guidance for creating a UIC). Using the UIC alone, however, introduces two risks:

- The UIC is mistyped, and the wrong patient record is retrieved.
- The patient loses her paperwork with the UIC and cannot be found in the system.

Some systems developed using DHIS2's Tracker feature have resolved this issue by also including identifiable information, such as patient name, sex, and age or date of birth, enabling a search to be done even if the UID is missing. The sensitivity of PMTCT data means that you should carefully consider any decision to include patient-identifiable data in your PMTCT Tracker. Although this will improve the accuracy of matching patients to their Tracker records, the security configuration we recommend means that any staff member is able to search *all* patients registered in the Tracker (not just those in their own facility), so including additional information introduces confidentiality risks that need to be carefully managed.

To reduce the risk of mistyped UICs, one option would be to request clinical information from the patient that can then be used to confirm that the correct record has been retrieved. For example, after retrieving her record based on the UIC, staff could ask the patient to confirm her LMP or delivery date, which are recorded during patient registration in the system, and then check this against the date already recorded in the Tracker.

If you would like to include patient names and other identifiable information but do not want all staff to have access to this information, another option might be to set up a separate registration screen (i.e., a separate DHIS2 program) that is used to register patient names, generate UICs, and perform name searches. Access to this program could then be restricted to a small number of staff (e.g., clinic managers), and all other screens

in the PMTCT Tracker would use UICs only. If a patient attends without her UIC, the manager could use the registration screen to search using patient name and other identifiers and pass the relevant UIC to other staff who can then use it to find the patient in the main PMTCT Tracker.

SYSTEM DESIGN AND CONFIGURATION

This section will provide DHIS2 technical staff with advice and recommendations on how to design and configure a PMTCT Tracker. Program staff should ensure that, in addition to the guidance in this section, technical staff are provided with details of the assessment they have undertaken and the decisions they have already made based on the Planning for Tracker Development section.

This section provides a **general guide** to designing and setting up a PMTCT Tracker in DHIS2 that addresses the most common problems associated with tracking PMTCT patients across the continuum of care. We explain a range of available options to be considered as you design a PMTCT Tracker tailored to your local needs and circumstances, and we provide general recommendations on best practices for key aspects of your configuration.

To help technical staff better understand the general guidance presented in this chapter, we have also presented in Appendix A a concrete example of a configuration solution based on these recommendations. This sample configuration meets many key objectives of a PMTCT Tracker, including monitoring adherence to the PMTCT continuum of care, flagging missed appointments, tracking patients across facilities, and linking child and mother records for improved follow-up of exposed infants. The proposed configuration is only one of many possible configurations that could be produced using this guidance, but it provides technical staff with concrete, practical technical notes on *how* to implement the recommendations in this guidance.

The technical staff who will be designing and configuring your PMTCT Tracker in DHIS2 need a good understanding of DHIS2 and the Tracker component. For example, they might have the following experience:

- Completed these DHIS2 Level 1 courses: DHIS2 Fundamentals Academy and DHIS2 Tracker Academy (see https://www.DHIS2.org/academy
- Previously set up a simple Tracker program in DHIS2 (ideally using DHIS2 version 2.29 or later), or have easy access to support from someone who has done so

Technical staff should also be familiar with the DHIS2 documentation, which can be found at www.DHIS2.org/documentation. The two most important documents are as follows:

- The **Implementer Guide**, which explains how to install and set up a DHIS2 server
- The **User Guide**, which explains how to configure and use the DHIS2 software

This section will cover five key aspects of the design and configuration of a PMTCT Tracker:

- **Confidentiality and security:** Arrangements to ensure that all other aspects of system design incorporate best practice security and protect confidential patient data
- **DHIS2 setup and configuration:** The way that the DHIS2 Tracker software should be set up and configured, including system settings and design of the PMTCT Tracker program
- **Reporting and analytics:** Design of the indicators, reports, and dashboards
- **Data sharing, interoperability, and integration:** How data are shared with other systems
- **Infrastructure:** The arrangement of servers, Internet connectivity, and patient devices that will be used by DHIS2

Managing Confidentiality and Security

Before embarking on the technical design of a PMTCT Tracker in DHIS2, technical staff should also carefully read the section titled Protect Patients and Ensure Confidentiality and discuss with program staff the measures that will be put in place to protect the confidentiality of PMTCT data and ensure strong system security. Throughout the design of the PMTCT Tracker, you should follow the principles of "minimum data" and "least privilege," which involve collecting only the minimum confidential data required (resist requests for "nice-to-have" data to be included) and giving users the minimum access needed to carry out their role (Waugaman, 2016).

Conducting Risk Assessments

Confidentiality and security should be considered at every step of the system design process, from both a technical and a human perspective. Once the system design process has been completed and implemented, it is strongly recommended that you **carry out a final confidentiality and security risk assessment** with the full team involved in the project to think through and identify any potential confidentiality or security risks (Waugaman, 2016).

You will never be able to remove all technical risks, but if they are clearly identified, you can put non-technical processes in place to avoid them or reduce their impact. For example, the ability of DHIS2 to export data to CSV or Excel poses a confidentiality risk, because confidential data can then be saved in a file that has no password protection. This risk cannot be removed at a technical level because users who have access to certain parts of the analytics will always be able to download and export those data, but having identified this as a technical risk, you can put other measures in place to reduce it, such as ensuring that all users with assigned roles that include individual analytics modules (particularly Pivot Tables and Event Reports) receive training on the confidentiality risks, sign a confidentiality agreement, and understand that they should not download or export reports that contain data that could identify patients.

Maintaining Security Records

The technical team that will be maintaining the PMTCT Tracker should keep records on confidentiality and security. This simple set of records does not need to be complicated or comprehensive and is needed to ensure that all risks and security measures are documented in one place so they can be easily reviewed and any gaps quickly identified. At a minimum, the records should include the following:

- A risk register (a list of any risks that are identified, with measures taken to avoid them or reduce their impact) that is updated with the results of each risk assessment[10]
- A register of all PMTCT Tracker users and confirmation that they have signed a confidentiality agreement before being given access
- An information-sharing register that records the export or sharing of any data with other organizations and the measures taken to protect those data

[10] For an overview of the technical aspects of IT risk management principles and practice, see https://en.wikipedia.org/wiki/IT_risk_management.

Conducting Security Audits

DHIS2 provides a range of tools to help audit security. You should ensure that all technical staff maintaining the PMTCT Tracker are familiar with the following features and that these regular checks and audits are undertaken:

- The Audit History feature, which shows a full history of user changes to a patient's record, should be used to investigate any discrepancies or suspicious changes to patient records. This feature can be accessed in the patient's dashboard by clicking on the "head and shoulders" logo next to "Profile."
- Searches should be done through the User Management screen to identify staff who have left and dormant users so that their accounts can be shut down.
- Regular reviews should be done of bugs reported through the DHIS2 Community (join at https://community.dhis2.org), and any known security bugs should be carefully tracked using the DHIS2 bug tracking website (join at https://jira.DHIS2.org).

DHIS2 System Setup and Configuration

Comparing Configuration and Customization

Configuration is the process of setting up a DHIS2 information system using the user-friendly interface. Configuration does not require additional programming; you can use a wide range of components and features that are already built into DHIS2 and tailor them to create a system that meets your own requirements. **Customization** is the process of adapting or extending DHIS2 itself. Customization requires programming or software development work, which must be done by specialist software developers or other IT experts.

When undertaking the initial **assessment** stage of a PMTCT Tracker project (see the Assessing the Environment section), program staff will often identify desirable features or core requirements that are not yet available in DHIS2 Tracker. Because DHIS2 is an open-source software package, it is tempting to consider customizing DHIS2 to meet your needs, but unless you have extensive experience with customizations, we recommend against this.

Reasons to avoid customization of the DHIS2 Tracker include the following:

- These options introduce the need to maintain and support your customizations, which in turn requires either having in-house programmers or establishing an ongoing relationship or contract with a supplier for this support and maintenance.
- Despite the introduction of API versioning, the DHIS2 API is not always stable, so there is a risk that customizations based on the API will break when new versions of DHIS2 are released; this means that customizations can significantly increase the burden of testing and tweaking your PMTCT Tracker whenever a new version of DHIS2 is released.
- Customization of the source code for DHIS2 itself means that you effectively "fork" or create your own version of the software, and as a result you will lose access to the frequent updates and support that the DHIS2 developers and community provide.

Unless you have significant resources and specialist software development skills in your team, we strongly recommend that you do not undertake any customization of DHIS2 as part of the PMTCT Tracker. If your project is well-resourced, you could instead consider funding or contributing to the development of relevant features within the core DHIS2 application and apps, rather than creating your own customizations; this will take longer than doing your own customizations, but any changes will then will benefit the DHIS2 community as a whole and can in turn be maintained and supported by that community.

Configuring Your Organizational Hierarchy

The health system **organizational hierarchy** in DHIS2 represents how health facilities are nested in a hierarchy of administrative units that typically include wards, districts, and regions or provinces. A specific facility or district is an **organizational unit** in the hierarchy. In DHIS2, the organizational hierarchy plays a critical role in granting access to data and in generating reports and analytics. Therefore, it is important to put considerable thought and care into the design of this hierarchy. The organizational hierarchy is often your first step in the DHIS2 system setup process, and the decisions you make here will also shape the design of the data elements, programs and program stages, and even your security setup. For a PMTCT Tracker, it typically makes sense to use the same organizational hierarchy that is found in the national HMIS.[11]

If the country has an interoperable Facility Registry, then this should always be used as the basis for the PMTCT Tracker's organizational unit hierarchy. "Interoperability" means that the Facility Register can automatically exchange data with other systems using agreed-on standards, so that when facilities are added or updated, those changes will also be automatically pushed to your PMTCT Tracker's DHIS2 instance. (For a more detailed explanation of what an interoperable Facility Registry is, see https://ohie.org/facility-registry/.)

It is best to use existing organizational hierarchies.

A single, common organizational hierarchy across all systems in a country (including other DHIS2 instances) will be much easier to maintain and will facilitate sharing and analyzing data across separate DHIS2 instances.

If the country uses DHIS2 for its HMIS, but does not have an interoperable Facility Registry, then the existing organizational hierarchy that has been configured for the HMIS DHIS2 instance can still be easily used. The DHIS2 import and export features make it fairly easy to implement a single organizational hierarchy across multiple instances: choose one DHIS2 instance as the master (in this case the HMIS instance), export the organizational hierarchy as XML or JSON configuration files, and import it into the PMTCT Tracker. You will need to set up a process to re-do this import routinely (e.g., monthly) to ensure that you have the most up to date list of facilities.[12] After you have created the hierarchy, you should only permit changes (i.e., adding new facilities, editing facility details) to the master DHIS2 instance; all other DHIS2 instances, including your PMTCT Tracker, should be updated ***only*** by importing the XML or JSON export files from the master instance. The reason for this is that DHIS2 creates a unique ID for every new facility you create, so even though you might be able to manually create what looks like the same organization

[11] We assume here that you are following best practices in placing your PMTCT Tracker in a separate DHIS2 instance—please see the Configuring User Access and Security section for further details.
[12] DHIS2 2.24 introduced a new automated "metadata synchronization" feature, which removes the need for manual exports and imports; however, it is not currently possible to synchronize organizational units only—this feature will synchronize all metadata, or none.

unit in two different instances, in reality they will have different unique IDs, which creates future compatibility issues.

Note that you will also need to set up a process for handling new facilities that are imported into your PMTCT Tracker, such as assigning your programs to any new organization units after they are imported. You will also need to set up a process to update permissions when new organizational units are loaded, such as assigning existing users to a new facility that has been added.

If there is no interoperable Facility Register or HMIS DHIS2 instance, you will need to create an organizational hierarchy from scratch. In such a case, refer to Appendix E for additional guidance on how to do this.

Understanding Programs and Program Stages

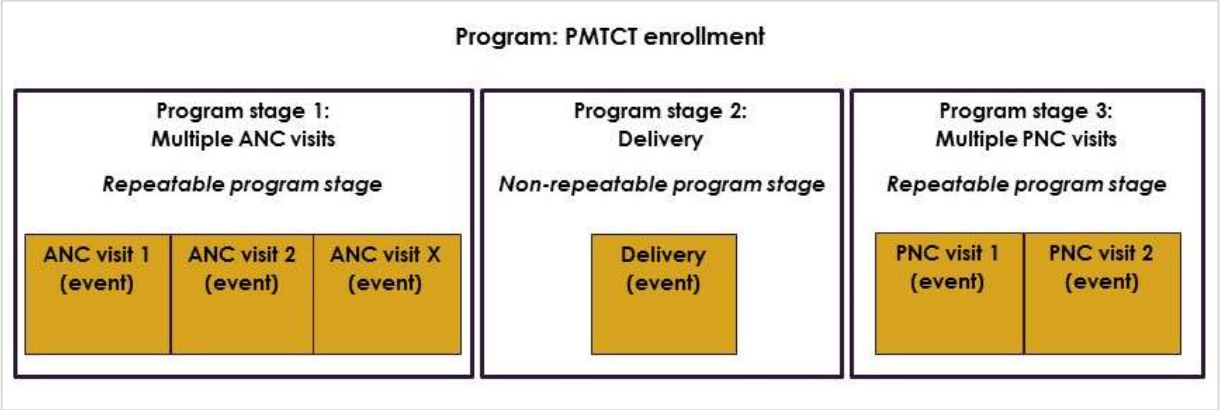
The DHIS2 Tracker is extremely powerful and feature-rich, but it is also complex and has many restrictions and limitations on how the data can be used and reported. Developing a PMTCT Tracker needs careful thought and planning before any actual configuration work can begin.

Programs and program stages are the building blocks of your PMTCT Tracker. For our purposes, we use the following definitions.

- A **program** is a structured episode of care for a given individual with predetermined steps that happen sequentially until the program is completed (e.g., the continuum of care from enrollment in PMTCT to diagnosis to being referred to lifelong ART at a care and treatment center).
- The program is divided into **program stages** that correspond to distinct steps or types of visits (e.g., program stages for PMTCT can include ANC, delivery, PNC and handover to ART).
- In a program stage, each actual contact or visit is called an **event.** A program stage can be set to allow a single event or visit, or it can be configured to allow a flexible number of repeated events or visits. For PMTCT, program stages such as *delivery* and *handover to ART* contain a single event that must be documented. *ANC* and *PNC* program stages may each include a series of repeated visits or events that can be recorded.

A typical program structure might look like that illustrated in Figure 4.

Figure 4. Illustration of the relationship of program, program stages, and events in the DHIS2 Tracker



Understanding Dates in the Tracker

A number of different dates need to be configured when setting up a PMTCT Tracker, and it is worth carefully reviewing these before you create your programs and program stages. The terminology for dates is not always consistent in the DHIS2 documentation, and dates are one of the most common areas of confusion encountered when configuring a DHIS2 Tracker. This section provides an overview of the different dates used by the Tracker along with specific guidance on how to configure them for the PMTCT Tracker.

A **program** has two dates associated with it; both are important, because DHIS2 uses them to restrict data entry and to calculate due dates and notifications:

- **Enrollment date:** Although you can set this to be whatever date you choose (the label is configurable), it is usually the date in which the patient enrolled in the program of care.
- **Incident date:** This is a key date in the patient's pathway that you typically choose as the base date from which visit schedules and notifications are calculated. (There is also a setting that lets you use the enrollment date instead for these schedules and notifications.)

Note that both of these dates need to be entered when you enroll a patient into the program, and if they are used to generate bookings for future appointments (which is the case for a PMTCT Tracker), then these dates cannot be changed once the patient is enrolled. So for our purposes, both enrollment date and incident date can be used only for aspects of a program of care that are ***already known at the time of enrollment*** (e.g., "actual delivery date" would be appropriate as an incident date for a postnatal program of care but not for a PMTCT program of care, because it is not known at the time of enrollment in PMTCT).

The **program stage** does not have any dates associated with it.

Each **event** has two dates associated with it:

- **Due date:** This is the future date ("booking") on which an event should ideally occur; it can be automatically prompted by DHIS2 (by setting the program stage's "Scheduled days from start" or its

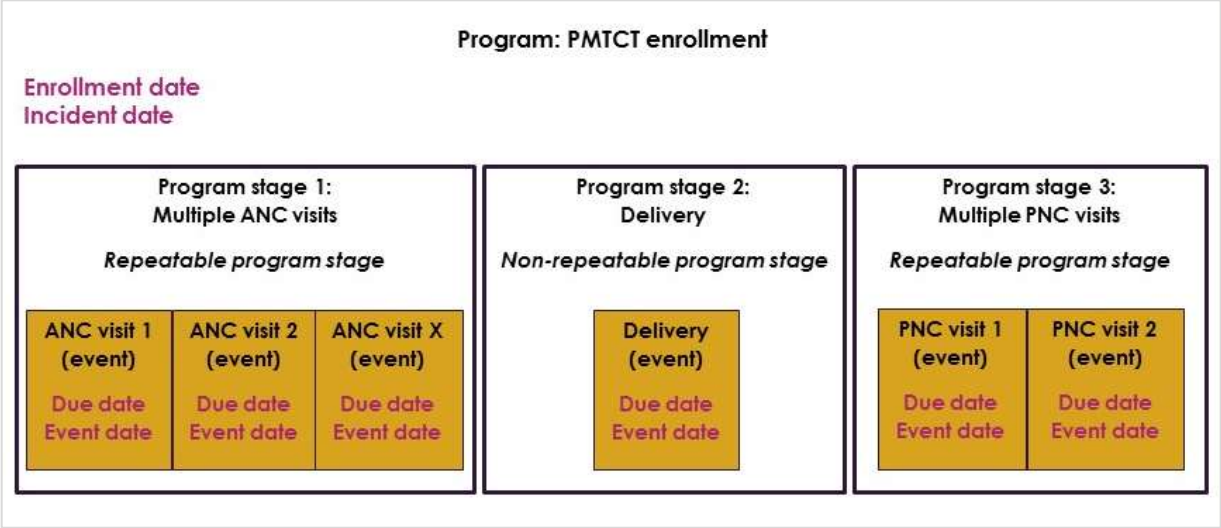
"Standard interval days"), or it can be set by staff when they use the calendar icon in the patient dashboard to schedule a future booking.

- **Event date:** This is the date entered by staff (or sometimes automatically generated) to show when the event actually occurred. (In different parts of DHIS2, this is also referred to as "Execution date" or the event's "Report date.")

If you schedule an event to happen in the future, then this upcoming event (booking) will have a due date, but it will not have an event date yet. After you convert the scheduled event or booking to an actual (completed) event or visit, an event date is also recorded for it. If you create an event or visit directly, without first scheduling it, then only the event date is important (the due date will still be populated with a default value, but it will be ignored by DHIS2).

Figure 5 refers to Figure 4 to illustrate the various dates used by the Tracker.

Figure 5. Use of dates within programs, program stages, and events in DHIS2 Tracker



Configuration of Entities and Relationships

Each Tracker program in DHIS2 is based around a single "entity," which in our case is individual patients. Although you will need to set up different programs for mother and child, you have the option of either creating a single entity (e.g., "person") that includes them both (in other words, a single list of persons that includes both mothers and children), or of creating separate entities for "mother" and "child." There are advantages and disadvantages to both of these options. Using separate entities can act as a data quality constraint (e.g., users can never accidentally create a relationship between two mothers when intending to create a mother-child relationship). Additionally, if you are creating other DHIS2 Trackers that may cover both mothers and children (e.g., an ART Tracker), then it will be more efficient to have a single "person" or "patient" entity that you can use across all of your Trackers.

Regardless of which option you choose, you will need to set up a new "mother-to-child" relationship type, with entries for "mother" and "child" that can be used by staff to link the records for each individual mother

and child in the Tracker. It is important that in this relationship type, you specify not only the tracked entity, but also the specific program—this will help ensure that when users register a newborn child from the mother's record, they also enroll the child in the correct program.

Configuring Programs and Program Stages

The overall structure of the proposed PMTCT Tracker focuses on managing transitions of care at five key points:

- Initiation of treatment (or treatment status at enrollment, if already on treatment)
- Transition of mother from ANC to delivery, which can often occur at a different location
- Transition of mother from delivery to PNC to ensure that PNC occurs
- Transition of child from delivery to the Exposed Child program of care to link the mother and infant records and ensure that testing is done
- Transition of both mother and child from the PMTCT pathway to mainstream ART

The key objective is to ensure that patients are not lost to follow-up during any of these transitions and that they receive key interventions at each stage.

Programs and program stages are very flexible within DHIS2. There are no restrictions on how you set them up, and there are many different ways you could translate the transitions above into a collection of programs and program stages. For example:

- You could make each step of the process a separate program (one for ANC visits, one for delivery, one for PNC visits, and one for ART).
- You could make the entire PMTCT continuum of care for the mother a single program, with various program stages for ANC visits, delivery, PNC visits, and ART (and similarly, create a single program for the child's section of the PMTCT pathway).

Each of these options (and the range of options in between) has different features and limitations, so you need to carefully consider the advantages and disadvantages of each when configuring your PMTCT Tracker. The main considerations are as follows:

- Users set the enrollment date and incident date for a program when enrolling a patient; if you are scheduling bookings based on these dates, users cannot change them after a patient has been enrolled. This means that combining pathways with different starting points (e.g., ANC and ART) in a single program can be problematic—you will probably only be able to automatically schedule bookings for the earlier pathway, and users will need to manually book dates for the other one (making the system more complex to use).
- Recent versions of DHIS2 enable you to restrict users to specific program stages within a program, so it is no longer necessary to split a pathway of care into separate programs for security reasons.
- Patients can easily move between facilities during the course of a program, so there is no need to create separate programs for stages of care that may be delivered away from the enrolling clinic, such as delivery or ART handover. If you set permissions correctly, any facility can open a booking, add the relevant information in services provided, and mark the visit as having been completed.

- Booking prompts, automation (program rules), and notifications work within a single program only—you cannot construct program rules or notifications that run across two or more programs.
- Program indicators (for use in the analytics) can draw on data from a single program only—you cannot construct program indicators across multiple programs (although you can reference their totals in a standard indicator).

Given these considerations, we suggest keeping the number of programs as small as possible to facilitate collaboration by different teams on a single pathway of care and to minimize the complexity of your configuration (e.g., the limitation that indicators, rules, and notifications cannot cross programs). A suggested structure is therefore as follows:

- For the mother's pathway of care, we suggest configuring a single program that tracks pregnant women identified as HIV-positive through ANC, delivery, PNC, and handover to mainstream ART. These stages of care follow sequentially. Combining them into a single program allows you to automate the future scheduling of each stage after the previous stage is complete, and it also allows you to easily produce reports and alerts for lost patients at any stage of the pathway. The one limitation to this configuration is that because the actual delivery date cannot be known at the point of enrollment in PMTCT, the correct date for first PNC visit cannot be automatically generated—users will need to manually reschedule this date when booking the first PNC visit after the mother has delivered.[13]
- The child's pathway of care requires a separate program from the mother, because it is attached to a different patient (the child) and because in the case of multiple births, more than one exposed child episode can result from a single PMTCT episode. Based on the considerations outlined above, we suggest also using a single program to track the child through his or her entire PMTCT pathway: initial HIV testing after birth, repeat testing while still breastfeeding, and handover to ART if a positive test is recorded at any point.

Using the mother-to-child relationship discussed above, these two programs will be linked in the Tracker to ensure that the HIV-exposed infant is properly tracked and that information is available regarding the preventive services used by the mother.

An underlying assumption in this design is that ART services will have a patient monitoring system and that the role of the PMTCT Tracker is to ensure that PMTCT patients are tracked and monitored until they have been securely handed over to mainstream ART. If this is not the case, and you would like to use the same DHIS2 Tracker to manage ART on an ongoing basis, then we suggest adding a separate ART program that provides ongoing ART tracking. (In this case, we would also suggest using a single "person" or "patient" entity for both mother and child, so that they can both be enrolled into this ART tracker program.)

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[13] The alternative would be to configure PNC as a separate program, which would enable you to set "actual delivery date" as the incident date and base all PNC bookings on this date; however, DHIS2 cannot automate the transition from one program to another, so the risk is that users might forget to enroll the mother in this second program after delivery, and she would no longer be tracked by the system.

Note that these program configurations are *suggestions* rather than firm recommendations. The flexibility of DHIS2 means that you can implement a wide variety of potential configurations, and these suggestions are intended solely as a starting point for your own program and program stage designs. You will need to adapt or tailor them to accommodate your particular project's needs and to reflect other DHIS2 system design decisions you may have made.[14]

Configuration of Program Rules

DHIS2 program rules are designed to guide the workflow of your PMTCT Tracker and to enforce data quality by preventing erroneous data entry by staff. The different types of program rule you will need to configure are as follows:

- **Program rules to automate and enforce the sequencing of the PMTCT pathway:** These use the "hide program stage" action to ensure that the user can only select program stages (visit types) when they are appropriate—for example, hiding the PNC program stage until the delivery program stage has been completed, and then hiding the ANC program stage. "Hide field" program rules can also ensure that critical steps are not duplicated (e.g., hiding the "DNA PCR test" data element after a "yes" has been recorded). A collection of these program rules should be used to automate the flow of visits and key transitions involved in the PMTCT and Exposed Child programs of care.
- **Program rules to remind and prompt staff about key actions:** These use the "Warning on complete" action to provide instructions to users at key points of the patient journey that cannot be automated in DHIS2 (e.g., a reminder after the mother's delivery to register and enroll the child in its own Exposed Child program). These can also be used to remind users of the options available to them (e.g., after delivery, either adding a PNC booking at this clinic or adding a referral to another clinic).
- **Program rules to check the integrity of data capture:** These can range from a simple comparison of two items (e.g., a warning if the user selects "initiated on ART" but forgets to capture an "ART initiation date") to complex rules that cover the whole pathway (e.g., blocking "initiated on ART" if a check of all past visits shows that this has already been selected during a previous visit). It is important to configure these wherever there is the possibility of inconsistent data entry.

Note that if program rules apply to multiple programs (e.g., a program rule to validate a patient attribute in both the PMTCT and Exposed Child programs), a copy of the rule will need to be created for each of these programs, because program rules apply only to the program in which they were created.

Another limitation is that program rules in DHIS2 are not currently triggered during enrollment, so any program rules configured for patient attributes will only be triggered *after* the patient has been enrolled and the first program stage is being recorded.

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[14] At the time of publication of this guidance, some Tracker features are not fully implemented in the Android version of the DHIS2 Capture app, so the program and program stage structure we suggest in this section cannot currently be used with Android. The DHIS2 Capture Android app is under active development, however, so we recommend reviewing the latest version of the app during the system design stage to determine whether your own Tracker can be used with Android.

A full set of examples of the program rules outlined above are provided in the sample configuration in Appendix A.

Suggested Configuration of Attributes and Data Elements

DHIS2 allows you to configure any number of fields to capture during registration of entities/patients (these fields are called tracked entity **attributes**) or during events/visits (these fields are called **data elements**).

Data elements are attached to one or more program stages, enabling staff to capture these data for the visit.

Attributes in your PMTCT Tracker can either be attached to the patient (this field will then show in *every* tracker program in which the patient is enrolled) or can be attached to a specific tracker program (the field will then appear only for that program). We recommend that cross-cutting fields such as ID numbers be attached to the patient, and that fields specific to PMTCT care (e.g., "Date of initiation into ART") be attached to the tracker program.

It is strongly recommended that in your PMTCT Tracker, you only collect the minimum data needed for tracking and reporting purposes. The following items are recommended as a minimum:

Patient attributes (captured during registration or at key transition points):

- Attached to the "Mother" tracked entity type
    - ANC ID number
    - ART patient number
- Specific to the PMTCT program
    - Date of initiation into lifelong ART (completed when initiation occurs)
    - Mother's contact number
- Attached to the "Child" tracked entity type
    - Child health ID number
    - ART patient number
- Specific to the Exposed Child program
    - Child's date of initiation into lifelong ART (completed when initiation occurs)
    - Mother's ANC ID number
    - Mother's contact number (if the same attribute is used for both mother and child, then this can be automatically inherited during the child's registration)

Data elements (captured during visits):

- Mother
    - The visit type for ANC and PNC visits (e.g., "First ANC visit (0–15 weeks)")
    - Whether the mother has been initiated into lifelong ART during the visit

- Child
    - The outcome of any DNA PCR tests
- Both mother and child
    - Breastfeeding status (type of feeding or whether breastfeeding has ceased)
    - The outcome of handover to mainstream ART (successful or not)

We recommend that you create most of these data elements as integers, with options containing a text description and an integer as the code (e.g., "Yes" is displayed but the code "1" is recorded). This gives you more flexibility with program indicators, which have a wider range of options for analyzing integers than for analyzing text.

In addition to these minimum data, you will likely want to capture additional data for operational and reporting purposes, such as to monitor whether particular screenings or interventions have been completed. We strongly recommend that you strictly limit any additional data collection to reduce the data entry burden at the facility and district levels. If in doubt, we recommend that you "start small" when rolling out your PMTCT Tracker; after it has been operational for a few months, you can re-assess the viability of collecting additional data items.

Suggested Notifications

DHIS2 has a very useful notifications feature, which enables you to send reminders and notifications to either staff or patients. DHIS2 is always able to send notifications to system users through its internal messaging system; if you set up the appropriate server options and connectivity infrastructure, DHIS2 can also send notifications to users and patients (tracked entities) through e-mail or mobile text message (SMS).

Studies show that reminders of upcoming appointments sent by text message significantly improve treatment adherence (Finitsis, Pellowski, & Johnson, 2014), and it is highly recommended that you take advantage of the notifications feature to support the transition of patients through the PMTCT continuum of care and thus reduce loss to follow-up.

General **reminders of all upcoming appointments** will involve sending a high volume of SMS reminders (one for every patient visit), so it is recommended that you configure these only if your program is well-resourced. Sending SMS **reminders only to patients who have missed appointments**—a much smaller cohort—is much more cost-effective, so it is highly recommended that resources be identified to send reminder messages for all missed ANC and PNC appointments, all deliveries that are more than two weeks past the expected due date, and all missed child DNA PCR tests. Notifications can be a powerful tool for reducing loss to follow-up rates in the PMTCT continuum of care, so we strongly recommend that you review your own specific PMTCT Tracker design and adjust or expand this list of notifications where appropriate.

A few more points to consider:

- For all missed appointment notifications, we suggest that reminders be sent at least a few days after the appointment date, to account for delays in data entry, because in some circumstances (e.g., if power has been down at the clinic), it may take a few days for a patient's visit to be captured in the PMTCT Tracker.

- In the text of each message, you can mention the name of the clinic, but for confidentiality reasons, it is extremely important that messages only refer generically to an "antenatal clinic" and make no mention of any HIV-specific aspects of care.
- Wherever possible, you should translate messages into the patient's household language.

Reporting and Analytics

Although the development of reporting and analytics cannot begin until most other aspects of a DHIS2 system have been configured (e.g., user access, data elements, programs, program stages), the *design* of reporting and analytics should be one of the first steps undertaken in system design. The goal of an information system is usable and actionable information, and best practice is therefore to begin by defining the required reports and analysis and then work backward to ensure that the right organizational units, data elements, and program structure are put in place to enable these reports and analyses.

As part of the planning for Tracker development, program staff should have clearly identified their information needs and drawn up outlines or mockups of the core reports that they require from the PMTCT Tracker.

The development of reports and dashboards in DHIS2 is fairly straightforward and well documented. This section focuses on how best to develop the **indicators** and **program indicators** that will be required for reporting purposes. Both types of indicator are formulas that you construct and can then add to any report, chart, or map; when the report, chart, or map is run, the indicator considers the time periods and organization units that have been selected and automatically calculates the appropriate measure. Because we are using longitudinal data to track patients over multiple visits, construction of these indicators can be complex, and this section provides advice on how to do this. The examples given are based on the program and program stage structure outlined previously.

Your PMTCT staff are likely to require the following types of reports:

- Operational reports, which assist staff in tracking individual patients and managing their care
- M&E reports, which enable staff to assess the overall performance of the program

Operational Reports

Although a wide range of operational reports (reports that assist staff in their day-to-day work) could be created from a PMTCT Tracker, we will focus on those that have the most impact on service delivery: tracking reports, which identify patients who have missed a step in their care and are in danger of becoming lost to follow-up.

The simplest and most effective tool for tracking patients in DHIS2 is the Tracker Capture app's **Overdue Events feature** (accessed via the Tracker Capture Reports module). This tool is quick and easy to use (the user simply selects a program to see a list of all missed appointments and deliveries), and it also provides one-click access to the individual patient dashboard of each overdue patient in the list. Note that all overdue reports will be shown against the organization unit that books the event, so it is important for external clinics (e.g., a hospital doing a delivery) to refer all bookings back to the original clinic. Only when the external clinic

refers bookings back to the original clinic will users be able to see those patients in the missed appointment reports.

As a result of how we have suggested constructing programs and program stages, the following tracking reports can be generated by using the Tracker Capture app's Overdue Events feature:

- Women whose enrollment visits have not been fully completed
- Women who have missed a scheduled ANC appointment
- Women who are more than two weeks past their delivery due date but for whom delivery details have not been reported or captured
- Women who have missed a scheduled PNC appointment
- Infants who are more than eight weeks old but have not received their first DNA PCR test
- Infants who have tested negative but missed their follow-up DNA PCR test (e.g., at six months)
- Mothers and infants who have been referred to mainstream ART and whose transfer has not yet been acknowledged by the receiving clinic

M&E Reports

One of the most powerful benefits of implementing a PMTCT Tracker is the automation of many M&E reports. Because PMTCT M&E involves longitudinal data, that is, tracking single patients across multiple events over time, monitoring PMTCT using traditional paper-based records is complex and often prone to errors (e.g., patients who test more than once may be inadvertently double-counted). A PMTCT Tracker can not only remove the burden of manually counting records, it can also help resolve these data quality issues by maintaining a single patient record across time and across multiple clinics, which in turn enables accurate counting of *enrolled patients* rather than visits or tests.

DHIS2 also automatically handles aggregation—you can drill down to see the contributions of a single clinic to the overall statistics or aggregate up to regional or national levels to see overall performance. This can be particularly useful where patient pathways cross different clinics; for example, if patients are usually tested in an ANC clinic but are often initiated in an ART clinic. DHIS2 will not only show these separate clinic figures, but will also automatically aggregate them to produce the overall performance for this patient cohort across all facilities.

Techniques for Developing PMTCT indicators

It is important to note that in line with PEPFAR definitions and M&E reporting periods, standard PMTCT indicators are not based on tracking individual patients over time (like operational reports), but are instead based on ***activity within a given period.*** For example, for PMTCT_EID, the number of infants who received their first virologic test *in the quarter* is divided by the total number of pregnant women enrolling positive/testing positive *in the quarter;* the numerator and denominator here will be based on different cohorts (most infants receiving virologic tests in *this* quarter will have been born to mothers who tested positive/enrolled in *previous* quarters), and this may generate results greater than 100 percent.

There are a number of techniques that can help make developing indicators for PMTCT much easier:

- Each program indicator can either measure events (Analytics type "Event," where the number of events is counted) or measure enrollments (Analytics type "Enrolment," where each enrollment is counted only once, regardless of how many events are involved). The second option can be useful for counting the number of patients enrolled, rather than the number of visits.
- If you want to count only specific responses or events, rather than writing complicated formulas with conditional statements, you can use filters to exclude all events except the ones in which you are interested in and then use a simple "event_count" or "enrollment_count" as your formula. (When DHIS2 processes program indicators, it will first exclude events based on the filter, and then use only the events that remain to calculate the rest of the program indicator.)
- With PEPFAR PMTCT indicators, it is extremely important to ensure that there is no double-counting (e.g., accidentally recording the same mother as both "Already on ART" and "Initiated on ART this visit," or counting a child twice if he or she receives two tests). Techniques for doing this include using program rules to hide a question (e.g., hide "DNA PCR test" after it has been recorded as "yes").
- In some cases, you may need to check whether any "yes" response has *ever* been recorded in a series of yes/no questions, such as whether the patient was initiated on ART during any ANC or PNC visit. DHIS2 is not actually able to easily do this—a program indicator can only return the *latest* response to a question; it cannot search among multiple responses. A technique for getting around this limitation is to configure a yes-only question. In other words, the user either selects "yes" (a value) or does not select any response (no value is captured); the program indicator can then test for whether a *latest* value exists (in which case there were one or more "yes" responses), or there is no latest value (in which case "yes" has never been selected in any visit).
- Most PMTCT indicators are too complex to be captured in a single DHIS2 program indicator, but you can construct different components of the PMTCT indicator into separate DHIS2 program indicators, and then combine all of these into a single DHIS2 indicator (with the numerator and denominator each containing different program indicators).

Examples of how to use these techniques are provided in the sample configuration in Appendix A.

Configuring User Access and Security

Due to the sensitive nature of PMTCT patient data, your PMTCT Tracker should ideally be set up in a DHIS2 instance reserved for confidential patient trackers, without any other data sets or programs. If this is feasible, the security model can be greatly simplified: there will be no need to carefully partition users and administrators of other data sets and programs, and the risk of administrators or technical staff accidentally exposing the PMTCT Program to staff who should not have access is greatly reduced.

This section describes users and their roles and how to configure their access to the system to ensure security.

Administrators

Administrator rights (the "ALL" authority in DHIS2) override all other permission settings, providing access to every part of a DHIS2 instance. Elements such as private dashboards are not by default visible to administrators, but administrators can access all dashboard content. Because of the sensitivity of PMTCT patient data, only DHIS2 administrators with direct responsibility for maintaining the PMTCT Tracker instance of DHIS2 should be given administrator rights. Other technical staff should not be given these rights "just in case"—rights can be created for them when specific pieces of work are required and then removed again afterward.

User Creation

New users can be created in DHIS2 either through e-mail invitation or direct setup; e-mail invitation is more secure because accounts cannot be accessed until they have been activated. Wherever possible, it is important to ensure that all users of the PMTCT instance are invited through an official work e-mail address and not a personal e-mail address (e.g., Hotmail, Gmail); this reduces the likelihood of former staff being able to regain access after leaving the organization and ensures that administrator accounts can be recovered if an unforeseen event means that the administrator is no longer available.

Understanding User Access

User access in DHIS2 is based around three concepts: user roles, user groups, and organizational units.

User roles are used to control permissions to access the built-in **apps and functionality** in DHIS2 (e.g., DHIS2 apps, ability to create or delete objects)**.** For example, user roles will determine whether users can see the Tracker Capture module and whether they can register and update entities/patients.

User groups are used to control the **sharing** of individual items of **content** that have been configured in DHIS2 (e.g., programs, data elements, reports). For example, user groups determine access to each program and program stage, as well as whether users have read-only or read-and-write access. After individual items of content have been shared with a user group, users who are added to that group gain access to that content.

Organizational units are used to restrict a user's access to **data** in all but specifically selected facilities or areas. There are three aspects to organizational unit access—data capture, data output (reports/analytics), and search—and each user can be assigned different groups of organizational units for each of these three aspects.

The intersection of user roles, user groups, and organizational units determines a user's overall permissions, with DHIS2 always applying the most restricted level of access of these three. For example, users will only be able to explore a particular pivot table report ("favorite") if:

- One of their user roles provides access to the pivot table module.
  and
- They are a member of a user group that has been given permissions ("sharing") to view that specific pivot table (or the pivot table has "public" sharing).

and

- They have been assigned "data output" permissions for all organizational units in the report.

If any of these is missing, users will not be able to access the pivot table report.

Configuring User Roles and User Groups

The configuration of DHIS2 user roles, user groups, and each user's assigned organizational units should follow the principle of least privilege, whereby users are given the minimum access and permissions they need to carry out their work. The design of user rights should therefore be based on real-world staffing structures and roles, reflecting the tasks that staff undertake in their day-to-day jobs.

Creating a single DHIS2 role for each real-world staff role can be somewhat inflexible, and it is good practice to further break down roles into specific tasks and responsibilities, which act as building blocks for user access; this flexibility helps ensure that each user is given only the specific collection of permissions they need to carry out their job.

In recent versions of DHIS2, it is possible not only to restrict access to the PMTCT Tracker as a whole, but also to restrict access to specific program stages. This is useful for situations in which patients move between clinics and may attend different facilities for aspects of their care (for example, ANC visits at their local primary care clinic and delivery at the district hospital); each of these facilities can be restricted to viewing only the program stages for the services that they provide, enhancing confidentiality and reducing data entry errors.

In terms of the PMTCT Tracker, one limitation we face in constructing user roles and user groups and in assigning organizational units is that it is not possible to restrict user access to either just the web version or just the Android version of Tracker Capture—adding or removing Tracker Capture permissions from a user role will add or remove access to both versions.

Configuring Organizational Unit Assignments

Because your PMTCT Tracker will contain very sensitive data, you need to take particular care when assigning users to organizational units to ensure that staff can only see the data relating to their own areas of responsibility. For user access purposes, the following principles should be followed when assigning users the three different types of organizational unit access.

Search Organizational Units

All data capture and supervision users should be assigned the top-level organizational unit for the entire country hierarchy. This is necessary because we want users to be able to search for any patient, regardless of where she was registered.

Data Capture Organizational Units

Staff who are involved with multiple clinics (such as supervisors) can be assigned to any specific point in the organizational hierarchy, covering the area or group of facilities that they supervise. In line with the settings recommended above, they should only have permissions to view data, not edit them.

Each data capture user should be assigned to one organizational unit for data capture (i.e., the facility in which they work). If users work across multiple facilities, they should be individually assigned to each of these facilities and to no others. For security and confidentiality reasons, it is extremely important that staff have data capture or editing permissions for only the facilities in which they work.

Note: Organizational units is an area in which the web and Android versions of the Tracker Capture app work quite differently. In the web version, permissions for "data capture" cascade down to include all levels below—so giving a user "data capture" permissions to a district will simultaneously give the user permissions to all facilities in the district. If you are using the Android version, however, you will need to assign staff "data capture" rights to each individual organizational unit (i.e., clicking on multiple facilities, such as clicking on the district above, will have no effect). If you are using both web and Android versions, it is probably wise to simplify security by always using the Android approach (assign each individual an organizational unit), because this works in both web and Android.

Data Output Organizational Units (Reports/Analytics)

All data capture and supervision users should be assigned full permissions to the entire country hierarchy/tree. This is necessary because we want facilities to be able to share patient bookings and visit records with each other, and users can only view these if they have been assigned "data output" permissions for the organizational unit where the visits occurred. The "data output" permissions allow users to view data only—they cannot edit the data unless they also have "data capture" permissions for the same organizational units.

Users who only have access to reports, without any data capture permissions, can be assigned data output organizational units that are appropriate to the reports they should be able to see (e.g., a specific region or the whole country).

Preventing Edits to Historical Data

DHIS2 includes a data-locking feature, which enables you to prevent edits to events or visits a certain number of days after data entry has been completed (use the "Completed events expiry days" setting). You can also

lock data entry for a certain number of days after the end of each period (e.g., select a "monthly" or "weekly" period and "expiry days" = 3 to specify that all data entry for the month/week must be completed within three days of the end of that period).

This feature is useful in preventing staff from going back to edit older data, but it should be used with caution. If delays (e.g., power cuts) mean that data entry needs to be done after this cutoff, then frustrated users might end up simply registering visits on the wrong date to get around the lock. If this happens, you might need to give staff more time or support for data entry or adjust the cutoff to a more realistic time period.

Data Sharing

Your project may be required to share data with external organizations or government bodies. This could be as simple as monthly uploads to another system, or as complex as live interoperability between DHIS2 and another system (i.e., both systems update each other in real time).

As part of the planning for the Tracker development stage, program staff should have identified these data sharing requirements and provided you with the following:

- The partner or organization that will be sending or receiving the data and the technical contact person
- How frequently data need to be shared
- The suggested DHIS2 option for sharing data (see text box)
- If sharing your PMTCT Tracker data with others: a specification explaining the format that the other person or system requires and setting out a definition of each data item
- If receiving data shared from others: a specification with a description or definition of each data item in the data being shared
- Any security precautions that need to be followed (e.g., password-protecting or encrypting files before sending)

DHIS2 data sharing options

DHIS2 includes a wide range of options for sharing data:

CSV imports and exports: This is the simplest way of sharing data and is used by many systems besides DHIS2. Because it is plain text, it would need additional encryption if used for individual patient data. Each system uses different CSV layouts, so you may need to manipulate the file if you want to load it into another system.

XML or JSON imports and exports: These are mainly used to share reference data between different DHIS2 instances. XML and JSON formats are more complex than CSV, but they are also more sophisticated, with detail such as data types and security permissions.

SMS: DHIS2's automated SMS functionality is a useful way of sharing small amounts of simple data, such as sending data about a referral, or collecting the results of a lab test. It is more suited to sharing data with people than with other systems. It is not as robust as using the DHIS2 API, and SMS messages are not encrypted.

API: DHIS2 has a sophisticated API that lets your PMTCT Tracker automatically talk to another system over the Internet without the need for manual imports or exports. You can easily encrypt this traffic using the https protocol. However, API integration is more complex to set up and maintain than simple imports and exports, so it should only be undertaken if you have the necessary funding and technical staff.

Health Information Exchange: A health information exchange is a framework/ platform that enables multiple systems in a country or sector to all share data with each other.

Reference Data

It is good practice to import or automatically synchronize key items of reference data, rather than to manually re-enter them into DHIS2, so this is likely to be an important area where data sharing is required. In particular, imported data may include official lists of regions and districts, or data from a master facility list.

You may also want to set up sharing of organizational unit metadata with another DHIS2 instance via XML exports and imports—please see the discussion about this in the section titled 'Configuring your Organizational Hierarchy'.

Incorporating Core Patient Data and Activity Captured on Other Systems

In the Planning for Tracker Development section, we warned against allowing core PMTCT data capture—patient registration, data entry for visits—to be done on other systems and then shared with the Tracker unless these other systems are tightly integrated with DHIS2's patient listing (tracked entity instances). The key reason for this is the complexity of the DHIS2 Tracker's longitudinal data model: even if a consistent UIC is used for patients across the different systems, allowing the collection and import of data based solely on this UIC rarely provides sufficient protection against errors or duplicate registrations. During data collection, there should ideally be a live checking of UICs against the PMTCT Tracker (e.g., through an API call or offline synched patient listings) to ensure that the UIC being captured exists in DHIS2.

Interoperability with Data for Accountability, Transparency, and Impact

A common need for data sharing is with Data for Accountability, Transparency, and Impact (DATIM), a DHIS 2 system that consolidates reports from all PEPFAR grantees globally. Although PEPFAR currently restricts direct uploads to DATIM, PEPFAR Country Programs may be able to offer options for electronic reporting to both PEPFAR Implementing Partners that provide core PEPFAR reports, and to Ministries of Health that provide PEPFAR-MoH alignment data. More information about PEPFAR's electronic data reporting methods can be found on the DATIM support page: https://datim.zendesk.com/hc/en-us/articles/115002334246-DATIM-Data-Import-and-Exchange-Resources. If you are interested in exploring these options further, you can contact the Strategic Information Advisor for your national PEPFAR team.

Infrastructure

Both DHIS2 and the PMTCT Tracker we configure within it are software; as such, they need a supporting environment of computer hardware and connectivity (called "infrastructure") in order to run.

The following infrastructure are required for the PMTCT Tracker:

- A powerful computer (server) capable of running DHIS2
  or
  An online DHIS2 hosting service
- Devices such as computers, tablets, or phones (clients) that staff use to connect to the server for data capture and reporting
- Connectivity (e.g., Internet) in facilities and the field

The requirements for each of these is described in detail as follows.

Servers and DHIS2 Instances

Throughout this section, **server** means the computer or machine and operating system on which DHIS2 is installed, and **instance** means each DHIS2 web server plus the database that is running on that server. Although you usually install DHIS2 only once on a server, it is possible to install multiple copies or instances of DHIS2 on a single server, each with its own web server, and each appearing to the outside world as a separate DHIS2 website.

Use a separate instance for the PMTCT Tracker.

Whether you are maintaining servers yourself or using hosting, for security reasons we recommend that a **separate DHIS2 instance be set up for patient-based tracker programs like the PMTCT Tracker,** rather than incorporating them alongside other programs or data sets in a shared DHIS2 instance. This is because the PMTCT Tracker contains highly sensitive data about each PMTCT patient and their HIV status, and therefore it requires even stricter security than normal DHIS2 instances. Multiple data sets and programs mean a more complex permissions configuration (often involving multiple administrators), which in turn increases the chances of a permissions mistake that exposes PMTCT data to the wrong user. For this reason, a separate instance, with a simpler security model and as few administrators as possible, is recommended, particularly if you choose to include patient-identifiable data in your configuration.

Use a centralized or decentralized server.

There are two ways in which DHIS2 can be set up:

- A **centralized server/instance model,** with a single national or global DHIS2 server and every region and facility connecting patient devices to this single server. This setup is simpler to maintain, but it relies on Internet connectivity being available at least some of the time. Even with a single server, users can enter data while offline for short periods of time.
- A **decentralized server/instance model,** with each region (or each major facility) having its own DHIS2 server and data then being regularly shared between these servers through the Internet or a USB stick. This is a more complex setup, which requires IT support at each site, but it enables local data entry even when the Internet is down for long periods of time.

We strongly recommend the **use of a single, centralized server** for PMTCT tracking. There are a number of reasons for this:

- PMTCT is usually delivered by a wide range of small facilities, particularly the ANC given to women during pregnancy. It is highly unlikely that these smaller facilities will have the IT support required to maintain servers and keep DHIS2 configurations up-to-date.
- Unlike aggregate data, tracker data can be shared across different facilities; for example, one facility can create a tracker record for a mother, and other facilities will then update it with further visits. Data sharing between separate servers is therefore much more problematic for tracker data than for aggregate data.

- Because DHIS2 is designed to work offline for short periods of time (data are cached in the web browser or Android app), even slow or interrupted Internet connectivity does not require separate servers or instances to be set up at each site.

Decide whether to own your servers or use a professional hosting service.

As with all DHIS2 systems, if you are using a centralized server model, a decision will need to be made about whether to set up DHIS2 servers yourself or whether to use a hosting service.[15]

The advantages of hosting are that your DHIS2 server and instance are set up by experts, incorporating best practice security, and that all maintenance is done for you (e.g., DHIS2 updates, system backups, security patches). The disadvantages of hosting are that it involves ongoing charges, which are often more difficult for a program to fund than one-off investments, and that it can be more expensive in the longer term.

Given the security considerations of working with patient-level HIV-related data, we recommend that you consider setting up and maintaining servers and DHIS2 instances for the PMTCT Tracker yourself if the following apply:

- Local laws require you to do so (e.g., patient data are not allowed to leave the country, and no hosting is available in your country).
- You are already maintaining DHIS2 instances and have a successful track record of installing, securing, and maintaining them.

Otherwise, it is safer to start with hosting, particularly if you decide to include patient-identifiable information in your Tracker. The hosting service will have the expertise to maintain tighter security against hackers and other security threats. If unsure of your long-term plans, you can take a monthly hosting contract, which leaves open the option of moving to your own servers at a later date.

Use separate production, development, test, and training instances

It is best practice to have separate production ("live"), development, test, and training DHIS2 instances. For cost reasons, it may be acceptable to combine any of the latter three, but it is extremely important that the production instance not be used for testing or training. This ensures that live data cannot be accidentally altered during testing or training, and makes it impossible for staff doing testing development or training to see confidential data. With DHIS2 aggregate data collection systems, everything is sometimes done in a single instance by setting up separate test and training organizational units; however, given the sensitivity of the data it contains, this is not an appropriate solution for the PMTCT Tracker.

Maintaining separate development, test, or training instances can be complex. You either need to set up DHIS2's metadata synchronization feature to ensure that the configuration is identical on both instances, or you need to regularly make a backup or copy of your production server, while taking great care to ensure that all patient data (entities and events) are then immediately removed (this will require SQL scripting). If you are

[15] A hosting service is a company that uses its own servers to provide you with ready-to-configure online DHIS2 instances. See https://www.DHIS2.org/hosting.

using a hosting service, they should be able to assist with this. For security reasons, however, maintaining separate instances is a "must do"—it is not acceptable to have confidential PMTCT patient data on development, test, or training instances.

Ensure that all servers incorporate best practice security.

It is important that a high level of server security is implemented on the production server. This is not as important for test, or development servers, but if they are not secured to the same degree, then different admin passwords and encryption keys should be used, and production backups should never be restored to them.

The DHIS2 Implementation Guide outlines a number of different options for installing DHIS2. Due to the sensitivity of PMTCT data, it is recommended that in all cases, the most secure options are implemented:

- SSL/https, to ensure all data transmissions over the Internet are encrypted
- nginx/reverse proxy, to provide another security layer between the web server and the Internet
- No server-side caching, to avoid malicious manipulation of URLs

The following measures should also be put in place (these are not covered by the DHIS2 documentation):

- Encryption of the database. Postgres, the database used by DHIS2, does not offer full-database encryption (known as TDE), so you will need to encrypt the hard disk on which the database sits, using either full-disk or file system encryption.
- If using hosting, your DHIS2 instances are likely to already be on encrypted drives (you should confirm this with your supplier).

DHIS2 also offers the ability to encrypt the content of specific fields (attributes), so that they can only be seen through the user interface, not in the database. Field-based encryption prevents the data from being used in analytics or search algorithms, so encrypting these specific fields would mean that they could not be used to search for a patient, but they could still be used to *confirm* a patient's identity after they have first been matched using an ID.

Note that some of these measures—particularly encryption and turning off server-side caching—can slow down your server, so you may want to consider this when choosing the specifications of your server hardware.

Ensure that routine backups and disaster recovery plans are in place.

As with all systems, it is extremely important that you make regular backups of both your whole server and your DHIS2 database (the DHIS2 Implementation Guide explains how to do a database backup), and store these backups at a physical location that is different from where the server is stored. As part of this process, you should regularly (e.g., once a month) test the process of restoring a backup to ensure that it works as expected. Restoring a production backup to your test/training server is an ideal way of doing this, but make sure that you take the server offline before doing so, and clear out any patient data before putting it back online again.

Disaster recovery planning involves preparing for a scenario where you may need to do more than just restore a backup; for example, if you lose your whole server room, or if your hosting supplier ceases trading, which would both involve re-creating a significant portion of your infrastructure. When drawing up disaster recovery plans, the cost of the measure should be weighed against the costs of downtime. If you can afford to fall behind in data entry for a few days, then it does not make sense to spend a lot of money creating a backup server room offsite, and your disaster recovery plans might simply consist of documentation on how to set up a temporary server and restore a backup to it.

Given the sensitivity of PMTCT data, it is important that any backups and disaster recovery measures are just as secure as the data in the production DHIS2 instance. One common security mistake is to put a DHIS2 instance on a server with an encrypted hard drive, but then store database backups on an unencrypted disk—backups must be encrypted to the same standard as the DHIS2 instance itself.

Devices and Connectivity in Facilities and the Field

Choices about both the **devices to use for data capture** and the **type of Internet connectivity** to use go hand-in-hand, and it is therefore suggested that you consider both devices and connectivity as a single, combined decision. The choices you make will also be shaped by the options you choose for data capture.

Data Capture Options

DHIS2 offers two core options for Tracker data capture:

- Online web Tracker Capture (via browser), using Internet connectivity
- The DHIS2 Capture Android app, using Internet connectivity

DHIS2 also offers other supplementary options for data capture, such as SMS, as well as a range of third-party Android data capture apps, such as MoTech, CommCare, and DataWinners, which can collect and manage data offline and synch them back to DHIS2 at a later date. These are beyond the scope of this document and need to be considered in light of the risks around offline data entry, but they may be worth exploring if the DHIS2 Android apps do not fully meet your needs.

The Tracker design that we have suggested uses a wide range of DHIS2 features, and in line with this, we assume that your users will be using the web-based Tracker Capture app or a future release of the Android Tracker Capture app (after all required features are fully functional).

Device and Connectivity Options

Your choice of data capture shapes the options available to you for patient devices and Internet connectivity.

The available options for devices are generally:

- Basic mobile phone
- Android smartphone
- Android tablet
- Laptop/netbook

- Personal computer

These options are explored in detail in Appendix B, but for the purposes of our PMTCT Tracker, we recommend the web version of Tracker Capture on a laptop, personal computer, or Android tablet plus keyboard for users based in facilities. For mobile users, we recommend an Android tablet with the web version (or if a new release has the appropriate features, the Android app) for Tracker Capture.

The available options for Internet connectivity include:

- Mobile Internet
- Dial-up Internet (landline)
- Fixed-line broadband Internet

These options are explored in detail in Appendix C, but for the purposes of PMTCT Tracker data capture and reporting, we recommend the use of either **landline broadband** to the clinic (plus Wi-Fi to connect individual users) or a good **mobile Internet** connection. For mobile Internet, your users will need to be in an area with 4G, 3G, or Edge coverage. **3G** and **4G** mobile Internet are fast enough for both web and Android DHIS2 use; 4G is fast enough to link more than one device at a time, so it can be used to connect a whole clinic. **Edge** is more widely available in most countries and is suitable for Android data collection. Depending on its reliability (and the patience of your users), Edge can also be used with the DHIS2 web interface, although the initial loading of Tracker Capture might take a little time. Older **GPRS** or **2G** mobile Internet is too slow for regular web use.

Additional Technical Notes

During our interviews with technical staff experienced in configuring DHIS2 Trackers, the following points were noted:

- Because DHIS2 itself is under constant development, bugs are regularly identified in the software, and it is important to keep track of both these software bugs and any configuration issues that staff encounter. The latest versions of DHIS2 include an internal support messaging system, enabling staff to use DHIS2 to report any bugs or configuration issues they come across, and we recommend that your team uses this (or another system) to track all issues and ensure that they are resolved as quickly as possible.
- DHIS2 has a lot of issues associated with caching, where the web browser retains (and displays) old configuration elements. It is important to train users to use the Browser Cache Cleaner app after every configuration change or if they encounter particular bugs.[16]
- Although DHIS2 officially supports all major browsers, including Chrome, Firefox, and Internet Explorer, far less testing is done on Firefox or Internet Explorer, and it is therefore recommended that you deploy Chrome for your users.

[16] For example, if you change the data elements and layout in the PMTCT Tracker, users may still continue to see the old layout in their data entry screens until they have applied the Browser Cache Cleaner.

TRAINING GUIDANCE

This section provides training guidance for facility staff or other cadres who will be entering data into the PMTCT Tracker. This guidance, along with the PMTCT Tracker User Manual, should be used to facilitate the training.

Other general guidance to consider before beginning training includes the following:

- Map the data flow and registers prior to the training so that they are specific to the actual data flow and registers used in country and at the facility.
- Use copies of actual registers during the training so that participants become familiar with information collected at the facility.
- Ensure that each trainee has a working laptop that can support the DHIS2 program that is comparable to the tools they will be using in the facility.
- Conduct facility assessments prior to training to have a good understanding of the patient flow in the facilities and the tools used.
- Ensure that all facilities that will be included in the PMTCT Tracker have all the equipment needed to run the Tracker program (e.g., laptop, Wi-Fi connectivity).
- Deliver the training as the PMTCT Tracker goes live, so that the training is fresh in trainees' minds as they begin to use the Tracker.

Training Objectives

The training should focus on three key roles for the tracker: data capture, supervision, and dashboards and weekly report reviews. (See Appendix F for a suggested agenda.)

To use the PMTCT Tracker, users must be able to:

- Understand core PMTCT Tracker and confidentiality concepts
- Log into the PMTCT Tracker, navigate the system, and maintain their user account
- Capture and review PMTCT patient data
- Actively track and follow up on PMTCT patients
- View PMTCT dashboards and other reports
- Create PMTCT reports, maps, and dashboards if performing the role of report review and analysis

The Training Team

The training team will need varying skills and experience to cover all key roles and objectives of the training. It is important that they collaborate and draw on real-life experience to prepare trainees for their new roles. The training team members should have the following:

- Experience in delivering formal training
- Strong skills in configuring and using the PMTCT Tracker

- Experience in the provision of PMTCT services and data flow
- M&E skills and experience
- Experience troubleshooting common IT and Internet issues
- A good understanding of national PMTCT protocols and practices

If a single trainer embodies all these skills and experiences, he or she may perform the training; however, it is more likely that at least two trainers will be needed to facilitate the training:

- A trainer with an M&E background and strong DHIS2 skills
- A trainer with experience in the provision of PMTCT services

User Manual

A User Manual has been developed that will take trainees step by step through the PMTCT Tracker, as it has currently been developed. This is an important guide to have available as you train data collectors and other Tracker users, because the User Manual will be their main resource for guidance during data collection. It is important that this manual is adapted to fit the Tracker developed for the country and updated to reflect the DHIS2 version used. It may also require further updates during or after training as trainers and trainees come across new situations or issues that were not initially anticipated when the manual was adapted. The User Manual is available at https://www.measureevaluation.org/resources/publications/ms-19-178.

Materials for Training

Each trainee will need a number of materials to be fully trained on how to use the PMTCT Tracker. Electronic equipment (e.g., laptop, cell phone) should mirror the equipment they will have in the facility for data collection. Trainees will need the following:

- Laptop
- Cellphone
- Adequate stationary (pens, notebook, sticky notes, etc.)
- Backup battery for laptop and phone
- Chargers for laptop and phone
- Wi-Fi dongle (if applicable)
- Copy of the User Manual
- Copy of registers used at the facility for PMTCT patients

Who to Train

The following guidance discusses who would be best to train in an ideal situation and may not be feasible for all programs. Different countries have different requirements on who should be trained, such as existing clinic staff or data collectors who are hired for the program. If using separate data entry staff, it is important to train those who are familiar with facility settings and understand facility workflow, because the goal is to integrate PMTCT data collection for the PMTCT Tracker into the day-to-day work of the clinic. It is also important that data entry staff speak local languages, have experience handling confidential patient data, and are familiar with using computers.

There are four key roles on which users will need to be trained. Not all users will need to perform every role, but there can be overlap in some areas if needed. The key roles are:

- **Data capture staff** will be based in each facility. These could be service providers, data clerks, support staff, or dedicated data capture staff, depending on what is feasible for the facility. These users can view all patient records and can only capture data for visits to their own facility. They will also be able to view PMTCT dashboards and reports for their facility and at the country level.
- **Supervisors** will oversee the PMTCT teams in multiple facilities. These users will be able to view all the patient records but will not be able to edit them. They will need to relay any edits back to data capture staff, who are the only ones able to make corrections (this is to ensure accuracy, accountability, and ownership for corrections). They will also be able to view PMTCT dashboards and reports.
- **Report writers/analysts** will develop PMTCT dashboards and reports in DHIS2 and are usually M&E or HMIS staff. These users cannot view or alter patient records, but they can create and edit tables, charts, maps, and dashboards that other users can view. They are also able to view patient data through the DHIS2 analytical tools.
- **Report viewers** will only have access to view the top-level dashboards and reports that have been shared with them by report writers/analysts.

A table of training objectives and competencies for each user role can be found in Appendix G.

The training encompasses three different stages:

- **Classroom-based training** will familiarize trainees with the objectives of the PMTCT programs and corresponding data that will be collected, and the PMTCT Tracker.
- **Facility-based training** will allow trainees to practice data entry in a facility setting and address any challenges before the Tracker goes live.
- **Supervision** of data collection will ensure that data collectors are correctly collecting data, entering them into the PMTCT Tracker, and addressing any issues or challenges with the use of the Tracker.

Classroom-Based Training

The main objective of the classroom-based training is to introduce the trainees to the PMTCT Tracker by reviewing PMTCT data flow in facilities, data collection and entry for HIV-positive mothers and their children, and the PMTCT Tracker. Classroom-based training should also focus on understanding the data collection process, gaining familiarity with facility registries, and using dummy data for practice. (A download link for a set of dummy data to accompany the User Manual can be found at https://www.measureevaluation.org/resources/pmtct-tracker/).

Classroom training should include general data collection concepts, such as:

- Preparation for data entry:
    - Charged laptops and cell phones

    - Adequate stationary
    - Appropriate attire for the facility environment
    - Needed software installed on laptops
- Data quality standards:
    - Data collection
    - Following up on missing or unclear data
- Confidentiality concerns for people living with HIV:
    - Patient confidentiality
    - Data storage

After the general data collection element of the training has been completed, the training can then focus on the PMTCT Tracker. This part of the training should cover the following:

- Reviewing the background and objectives of the PMTCT Tracker
- Establishing a common understanding of terminology
- Discussing and mapping the data flow and potential gaps or bottlenecks
- Determining whether an intermediary tool will need to be used for data collection, especially if data will be collected retroactively (further guidance on an intermediary tool can be found in the report Testing a Client Tracker for Prevention of Mother-to-Child transmission of HIV in Zimbabwe)
- Reviewing each section of the User Manual and projecting the trainer's screen (if possible) to walk through the data entry process for the tracker.
- Discussing each section of the User Manual in detail, identifying any further changes or revisions
- Identifying common challenges and gaps that could begin when implementation starts, such as limited access to registers, commonly missing data, or multiple data sources
- Delineating information that is required for the Tracker and determining possible approaches to finding data sources or using other data points to determine what is missing

After the trainees have been adequately introduced to data entry for the Tracker, it is important to give them ample time to try data entry on their own. While still in the classroom setting, provide a set of dummy data, which includes common errors (i.e., incorrect data, missing data, sloppy handwriting), so trainees can practice data entry. For this section of training, it is helpful to:

- Set up a practice instance of the PMTCT Tracker that participants can use, so that data will not feed into the actual live instance.
- Allow trainees to work at their own pace to identify those who are more adept at using the Tracker and those who could use more support, and then adjust teams and resources accordingly.
- Allow trainees to work through issues on their own, referring to the User Manual and taking note of updates needed to the manual to better fit the setting.

- Take note of any common issues with the local implementation of the PMTCT Tracker, so that they can be fixed before moving onto facility data collection.
- Work with the DHIS2 programmer to help make any adjustments to the live PMTCT Tracker so that the Tracker will better fit the facility setting.

After this practical session is completed, you should work with participants to create feedback and troubleshooting systems. At the beginning of implementation, there will likely be configuration bugs or issues that will need to be addressed. Topics to discuss during this session include the following:

- Creating a forum to resolve issues, which can be done using a communication app such as WhatsApp
- Determining the best procedure for contacting the developers who have configured the local PMTCT Tracker, should their support be needed
- Setting up a monitoring system with supervisors to review data entry for any errors and a feedback system so that clinic staff can correct any data
- Discussing backup plans if the Internet or power is not available at the facility or Wi-Fi or Internet is not accessible
- Creating a procedure for properly capturing referrals so that they are integrated into data collection and so that any issues with referrals are addressed

Facility-Based Training

Facility-based training should take place immediately after the classroom-based training, if possible, so that the information is still fresh in the trainees' minds. Facility-based training should also occur as the PMTCT Tracker goes live in the facility, which allows information to be further reinforced and for feedback to be provided to programmers, trainers, and supervisors, so that any necessary updates or adaptations can be made. The same trainers who facilitated the classroom-based training can conduct the facility-based training; alternatively, area supervisors or peers who have been successfully using the PMTCT Tracker in their own facilities can conduct the training.

At the facility, we recommend beginning by physically mapping out the data by going to each location where data are stored and collected and talking to those who collect the data at each location. This will help trainees understand where data travels to and from in the facility and understand challenges, gaps, or bottlenecks they may encounter while doing data collection. This also helps trainees, trainers, and supervisors understand the facility schedule to identify a time that is best to do data collection for the PMTCT Tracker.

Some general guidance to follow when visiting the facility includes the following:

- Training processes should be sensitive to facility staff and patients and work around their schedule to avoid disrupting normal facility schedules and data flow.
- Staff undertaking data collection should understand that they are dealing with very sensitive data and that patient confidentiality must always be respected. This includes:

- Adequately storing all data (i.e., with passwords on computers and locked in a room at facilities for paper-based materials)
- Keeping patient records securely at the facility
- Ensuring that notes do not contain identifiable information or that records with such information are destroyed

After the data team has mapped out the facility's data flow and introduced the training process to those who they will interact with at the clinic, they can begin to gather data to enter into the Tracker. It is important to allow adequate time for training on data collection and entry. After the team is accustomed to data collection, the process will be less time consuming as they figure out their own systems and procedures for data collection and entry.

Some general guidance for data collection and entry during training includes the following:

- It is important to determine what times of the day are best to undertake data collection, taking into consideration staff availability and access to registers.
- For facility-based practice, use a dummy or practice version of the PMTCT Tracker so that the practice data are not integrated with the data in the live Tracker.
- Identify all possible information sources and backup sources in case the primary sources are incomplete or if they cannot be accessed at a certain time.
- Identify and discuss anomalies in registers and patient books (e.g., identifying duplicates, following up on questionable data), so that the entire training group is aware of an issue and knows how to handle it.
- Create follow-up procedures with other facility staff so that trainees know with whom to discuss missing or unclear data.
- Create feedback loops for communicating with supervisory staff, especially if there are bugs in the PMTCT Tracker or if updates need to be made, so that changes can be made quickly and data entry is not delayed.
- If retrospective data will be collected, consider training additional data collectors because this can be time consuming and may require extra help, especially if there are large amounts of missing data and inconsistent data flow at the clinic.
- If back-dated data will be captured in the PMTCT Tracker, many of these records may be missing or incomplete, so staff may have to triangulate multiple sources of data to properly populate these historical data.
- Discuss possible unique identifiers for patients if they are not using them in the facility or if they are missing in the register or patient book.

Supervision Requirements

It is important that follow-up supervision takes place to ensure data quality and that data collectors are adhering to their training during data collection and entry. The duration of post-training supervision can vary,

but supervisory visits should be continued for as long as needed to ensure that data collectors are adhering to standards and to assist with any challenges that they may encounter.

Two types of supervision should follow the training:

- Remote review of data
    - Supervisors review data entered in the PMTCT Tracker for any errors, anomalies, or inconsistencies.
    - Supervisors check data against the expected numbers to be entered for timeliness and completeness of data.
    - Supervisors check for outliers and follow up with any questions so that errors can be addressed and fixed.
    - If an intermediary tool is used, supervisors can compare numbers between the intermediary tool and the PMTCT Tracker.
- Onsite supervision visits
    - On a regular schedule (e.g., weekly), a supervisor will visit the data collection facility to ensure that data collectors are adhering to training guidelines.
    - Supervisors can also compare data in the computer with paper-based tools.
    - Supervisors can help data collectors address any challenges they are facing at the facility for data collection and entry.
    - Supervisors can review and discuss Tracker reports with data collectors and facility staff.
    - As data collectors have fewer problems, these supervisory visits can be decreased as needed.

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APPENDIX A. SAMPLE PMTCT TRACKER CONFIGURATION

This appendix presents a sample PMTCT Tracker configuration, based on the recommendations and suggestions outlined in this guidance document. This sample configuration is included for demonstration purposes only, because it is only one of many possible configurations that could be produced using this guidance, but it provides technical staff with concrete, practical technical notes on *how* to implement the recommendations in the guidance document. A configuration file for this sample PMTCT Tracker (which can be imported into your own DHIS2 instance), can be downloaded at https://www.measureevaluation.org/resources/pmtct-tracker/.

Sample Configuration of Tracked Entity Types

For the sample PMTCT Tracker, we have chosen the first of the two options outlined in the guidance, creating separate entity types for mother and child. This enables us to attach specific attributes to each tracked entity type, which will appear in every tracker program in which they are enrolled: "ANC ID number" and "ART patient number" for the mother, and "Child Health ID" for the child.

The relationship between these two tracked entity types is configured as follows:

- Set the "From constraint" to tracked entity type: mother.
- Set the "To constraint" to tracked entity type: child, and also select the "Exposed child program" so that this appears as the default when you register a new child from the mother's record.
- If you are using the latest version of DHIS2, check the "bidirectional" box, and enter the initiating name (what is seen from the mother's record) as "Children" and the receiving name (what is seen from the children's record) as "Mother."

Sample Configuration of Programs and Program Stages

In the guidance, we have suggested configuring the PMTCT Tracker as two DHIS2 programs, linked by the mother-to-child relationship configured above. Specifics on how we have configured these programs and their respective program stages in the sample PMTCT Tracker are provided below.

PMTCT Program

This program tracks pregnant women identified as HIV-positive along a linear path through antenatal care (ANC), delivery, postnatal care (PNC), and final handover to mainstream antiretroviral therapy (ART). We have created this program with the last menstrual period (LMP) date as the incident date, "Date enrolled in PMTCT" as the enrollment date, and "Mother" as the entity.

In terms of options, we ensure that the "Show incident date" box is selected and do not allow future dates for either enrollment or incident. The "Only enroll once" box is *not* selected because a woman can have multiple pregnancies and PMTCT episodes. We have set "Display front page list" to "No" for confidentiality reasons. We have not selected the "Ignore overdue events" box; although women can enroll in PMTCT at any point in their pathway, we want to make sure that we retrospectively record key dates such as enrollment visit and delivery date.

The sample PMTCT Tracker includes the following program stages:

- **PMTCT enrollment visit:** This non-repeatable visit is automatically created when users enroll a pregnant woman in the PMTCT program (the "Open data entry form after enrollment" box option is selected and "Enrollment date" is used as the report date). This captures whether the enrollment visit is (a) the visit in which the patient first tests positive, or (b) the first ANC visit for a woman who is already known to be positive; if it is the latter, we use a program rule to prompt the user to complete the patient's "Date of initiation into lifelong ART." The "Ask user to create new event when stage is complete" box is also selected, so that when this enrollment visit is completed, staff are prompted to book the next ANC visit.
- **ANC visit:** Because women in PMTCT programs usually keep a more frequent schedule of visits than normal ANC patients, and they can join at any point during their pregnancy, a relatively simple setup has been used for the remaining ANC visits: automatically-prompted and repeatable "ANC visit" events, with a data element used to record the type of ANC visit—for example, "First visit (0–15 weeks)." "Generate events based on enrollment date" has been selected and both the "Scheduled days from start" and the "Standard interval days" have been set at 30, so that ANC visits are scheduled at regular intervals (in this example, every 30 days) after the initial enrollment visit. The "Ask user to create new event when stage is complete" box has been selected, so that upon completion of the current ANC visit, staff are prompted to schedule the next upcoming ANC visit (this scheduled event provides the basis for patient notifications and overdue appointment reports).
- **Delivery:** This is a non-repeatable program stage, and here it has been configured to be auto-generated 294 days after the LMP date ("Generate events based on enrollment date" has *not* been selected, because we are using this LMP date instead). This means that upon enrollment, a delivery event will be automatically scheduled for the end of the 42-week window, and reminders and overdue reports will be automatically generated if this date passes without notification of the delivery. The "Ask user to create new event when stage is complete" box has been selected, but staff will need to manually reschedule the default date for the first PNC visit[17].
- **PNC:** This is a repeatable program stage with a data element used to record the type of PNC visit. This program stage is *not* auto-generated on enrollment, and although it is automatically created when the delivery event is completed (with a "Scheduled days from start" that is the same as the Delivery program stage [i.e., 294]), a program rule prompts staff to manually change the date of this booking, because this default date is unlikely to be correct (the default has been set much earlier than likely, so that if staff forget to manually change this date, the patient will appear on their Overdue Events reports). This stage is repeatable, with "Ask user to create new event when stage is complete" selected and interval days set according to the PMTCT protocol (in our sample PMTCT Tracker, we have configured it for every 30 days).

[17] The alternative would be to configure PNC as a separate program, which would enable you to set "actual delivery date" as the incident date and base all PNC bookings on this date; however, DHIS2 cannot automate the transition from one program to another, so the risk is that users might forget to enroll the mother in this second program after delivery, and she would no longer be tracked by the system.

- **Mother referral to ART:** This is a non-repeatable event scheduled by PMTCT staff to manage the handover to mainstream ART. This event should be completed by the receiving ART clinic after the mother is seen in a mainstream care and treatment clinic. Because this handover can occur at any time, "Scheduled days from start" is set to 0.

  This is the final event/visit in the pathway, so we have also selected the "Ask user to complete program when stage is complete" box to ensure that staff are prompted to close out the entire PMTCT program after this handover is completed (i.e., tracking will cease).

Exposed Child Program

When a pregnant woman in the PMTCT program is recorded as having delivered, a program rule prompts the user to create a child record in the Exposed Child program. In our sample PMTCT Tracker, this program dynamically adjusts to direct children through one of two paths: if HIV-positive, a referral to mainstream ART; if HIV-negative, a repeated cycle of testing until they test positive or stop breastfeeding. This program has been created with "Date of birth" as the enrollment date and "Child" as the entity. The incident date is not used—we have ensured that "Show incident date" is *not* selected, and for clarity set this label to "Not used"—and all program stages have "Generate events based on enrollment date" selected.

In terms of options, the "Only enroll once" box is selected, because children can enroll in this program only at birth, the "Display front page list" is set to "No" for confidentiality reasons, and we do not allow future dates for either enrollment or incident.

This program includes the following program stages:

- **Initial DNA PCR test:** To track whether the child receives a DNA polymerase chain reaction (PCR) test within the guidelines (in our case, within eight weeks of birth), an initial auto-generated and non-repeatable "Initial DNA PCR test" event is scheduled on this latest recommended date for the test. This then triggers overdue appointment reports and notifications if the test is not completed by this date.[18]

  The "Ask user to create new event when stage is complete" box is selected, so that after the initial test has been done, staff are prompted to arrange the next event or visit—in the case of a negative test, this will be a follow-up test, and in the case of a positive test, this will be a referral to mainstream ART. A program rule is used to automate which of these is scheduled (see the section 'Sample Program Rules and Inline Indicators' below).

- **Follow-up DNA PCR test:** If the initial test is negative and the child is breastfeeding, then this repeatable event will be scheduled by staff after the initial visit. The "Scheduled days from start" and the "Standard interval days" parameters are configured according to your guidelines for how often these follow-up tests should be done—in this sample PMTCT Tracker, we have assumed that repeat testing should be done at a maximum of six months later, so both of these are set to 182 days. (We

[18] Note that in some countries, testing is now done *both* at birth *and* within six to eight weeks of birth; in this case, you will need to replace this single "initial test" program stage with two separate program stages: an "at birth test" and a "6–8 week test."

have also set up an alert in the mother's PMTCT program, so if she reports that she has ceased breastfeeding, staff are prompted to manually rebook an earlier follow-up test for the child.)

We have selected the "Display generate event box after completed" box to ensure that staff are prompted to make a new booking after each visit is complete. As with the initial visit, this will be *either* another follow-up test *or* a referral to mainstream ART.

- **Child referral to ART:** If any of the tests above are positive, then this non-repeatable event is scheduled by the child health clinic to manage the handover to mainstream ART. This event should be completed by the receiving care and treatment clinic after the child is in mainstream ART. This handover can occur at any time, so "Scheduled days from start" is set to 0.

  This is the final event or visit in the pathway, so the "Ask user to complete program when stage is complete" box is selected to ensure that staff are prompted to close the entire Exposed Child program after this handover is completed (i.e., tracking will cease).

Sample Configuration of Attributes and Data Elements

The following is the set of key attributes (data attached to patients) and data elements (data attached to events or visits) that we have configured for the sample PMTCT Tracker. In line with the guidance, we have kept this to the minimum required for tracking purposes, to keep the data entry burden on staff as low as possible.

Attributes

- Attached to tracked entity type "Mother"
  - "ANC ID number" (mandatory). This is unique to prevent duplicate records from being created. (If no existing number is used, DHIS2 can also be set up to generate this automatically.)
  - "ART patient number" (not mandatory). Where available, this can be used as a second ID to help identify the mother.
- Specific to the PMTCT program
  - "Date of initiation into lifelong ART" (not mandatory). Recording this date as an attribute instead of a data element is useful for reporting purposes and makes it possible to access this information across multiple enrollments (e.g., this date is available if the mother is enrolled in PMTCT again for a subsequent pregnancy).
  - "Mother's contact number." The value type is set as "Phone number" so that if SMS notifications are set up, this phone number can be used to send SMS notifications to the mother. This attribute is shared with the child and set as "Inherited" (see below).
- Attached to tracked entity type "Child"
  - "Child Health ID number" (mandatory), for use in the Exposed Child program. This is unique to prevent duplicate records from being created.
  - "ART patient number" (not mandatory). This should be recorded if handover to ART occurs, to help track the child during this transition.

- Specific to the Exposed Child program
    - "Child's date of initiation into lifelong ART," for use in the PMTCT program and Exposed Child program. Recording this date as a patient attribute is useful for reporting purposes and makes it possible to access this information across multiple enrollments (e.g., this date is available if the mother is enrolled in PMTCT again for a subsequent pregnancy).
    - "Mother's ANC ID number" (mandatory), for use in the Exposed Child program. This is *not* unique because a mother's ID may be used for more than one child. This enables users to easily find both a mother and her children by searching for the mother's ANC ID number.
    - "Mother's contact number." Because this attribute is shared with the mother and selected as "Inherited," the mother's mobile number is automatically added to the child's record when it is created, meaning that the mother then receives any missed appointment notifications for the child.

Data Elements

- "ANC visit type" and "PNC visit type" are required to enable a single, repeatable program stage to cover all ANC or PNC visits. Drop-down options include the different types of ANC and PNC visits (e.g., "First visit (0–15 weeks)"), as well as an option for "Other" to be used for visits that are not part of the formal ANC and PNC schedules (e.g., visits solely for antiretroviral refills).
- "Initiated on lifelong ART this visit" is included at every step in the PMTCT program's ANC and PNC stages. This is used to record when a patient first starts lifelong ART, so program rules (see 'Sample Program Rules and Inline Indicators' below) will hide it for patients already on ART or if it has been selected during a previous visit. This is an integer, with a custom option set containing a single "Yes" (value is 1) option—if the patient was not initiated on ART, the user leaves this question blank. This is necessary because program rules can only test for the latest value of a data element, whereas we need to be able to see whether *any* positive value has been recorded to prevent a patient from accidentally being initiated twice.
- "Outcome of DNA PCR test," required for the Exposed Child program. This is required for reporting and enables program rules to check whether further testing or an ART referral should be scheduled. This only has the options "Positive" or "Negative." Options do not include "Not administered" or "Inconclusive" because this event should not be completed until a clear test result has been received for the child.
- "Breastfeeding status," required for the Exposed Child program. This enables program rules to check whether further testing visits are required.
- "Outcome of handover to mainstream ART," required for both programs. This includes the two options "Successful (patient on lifelong ART)" and "Unsuccessful (patient refused treatment or died before treatment started)."

Sample Program Rules and Inline Indicators

The following program rules have been configured in the sample PMTCT Tracker to reinforce the training that staff receive on using the PMTCT Tracker and to enforce and support good patient workflow:

PMTCT Program

- A set of "hide program stage" program rules manage the automation of the PMTCT program:
    - A rule that hides the PNC program stage until a delivery has been recorded
    - A rule that hides the ANC program stage once a delivery has been recorded
    - A rule that hides the Handover to ART stage until the mother has ceased breastfeeding or has miscarried
- An "error preventing complete" program rule prevents the user from selecting "Already on ART at enrollment" = "Yes" without also filling out the patient's "Date of initiation into lifelong ART" attribute.
- A "hide field" program rule hides the "Initiated on lifelong ART this visit?" question throughout the program if the user records that the patient was already on ART at enrollment.
- Two "error preventing complete" program rules prevent the user from selecting "Initiated on lifelong ART this visit" = "Yes" if it has already been selected in a previous visit or if the "Date of initiation into lifelong ART" attribute has not been set to the same day.
- A "warning" program rule, which, if the delivery event has been updated with anything except "Loss of pregnancy," prompts staff to use the "Add child" link to enroll the child in the Exposed Child program, and to book a postnatal appointment for the mother at the appropriate facility. (Staff should be trained to do this, but the prompt will help ensure that they do it.) This prompt also reminds staff to delete any future ANC bookings that were open at the time of delivery.
- If there is a "Loss of pregnancy or stillbirth," a "warning" program rule prompts staff to close the PMTCT program and initiate handover of the woman to mainstream ART. This prompt also reminds them to delete any future ANC bookings that were scheduled.
- If the mother ceases breastfeeding, a "warning" program rule in the PMTCT program prompts staff to move the mother to the ART handover program stage and to switch to the Exposed Child program and schedule a final DNA PCR test for the child.

Exposed Child Program

- A pair of "hide program stage" program rules manage the automation of the Exposed Child program:
    - A rule hides the follow-up test program stage if a child tests positive or the test result is not yet recorded. This also prevents new bookings or visits from being added until the current visit has been updated.
    - A rule hides the handover to ART program stage if a child tests negative. This also prevents new bookings or visits from being added until the current visit has been updated.

- A "warning" rule prompts the user to cancel further bookings and close the entire Exposed Child program if a child stops breastfeeding.

The following **program indicators** have been placed on the patient dashboard of the sample PMTCT Tracker to provide staff with a quick and easy reference to the expected delivery date:

- An indicator that calculates the "Estimated delivery date" using the *d2:addDays* function
- Two indicators that show the patient's ART initiation status: "Already on ART at enrollment" (true or false) and "Initiated on ART during this pregnancy episode" (true or false)

Sample Notifications

The following notifications have been included as examples of how notifications can support patient adherence and reduce loss to follow-up:

Remind patient of upcoming ANC and PNC appointments: This is an Antenatal and Postnatal program stage notification that is triggered one day before the scheduled (booked) date, with attribute "Contact number (mother)" as the recipient. It includes the name of the clinic in the SMS, but for confidentiality reasons, the text refers only to an antenatal appointment and does not mention PMTCT.

Remind patient of missed ANC or PNC appointments: This is an Antenatal and Postnatal program stage notification that is triggered seven days after the scheduled (booked) date, with attribute "Contact number (mother)" as the recipient. (Although the configuration indicates "seven days after scheduled date," this message will only be sent if a visit is not recorded for this appointment.)

Remind patient three weeks after delivery due date if delivery details have not yet been recorded: This is a Delivery program stage notification that is triggered seven days after the scheduled date (which in this sample configuration has already been set at two weeks after the due date), with attribute "Contact number (mother)" as the recipient. This is most likely to be triggered if the patient has delivered elsewhere, and that facility may simply have not yet updated the PMTCT Tracker, so the message reflects this possibility: "We have not yet received details of the birth of your child—please bring all papers you have been given to [clinic name], where we can also provide postnatal care."

Remind mother if an infant's initial or follow-up DNA PCR test has been missed: This notification is set up for the Initial DNA PCR and Follow-up DNA PCR program stages, and is triggered seven days after the scheduled date, with attribute "Mobile number (mother)" as the recipient. For confidentiality reasons, it avoids any mention of the DNA PCR test and says only that a postnatal appointment has been missed and that the mother needs to urgently bring [child name] to [clinic name]. Because this is such a critical test, in this sample PMTCT Tracker we have configured a second reminder 14 days after the scheduled date, bearing in mind that the second notification will be sent only if the patient does not attend an appointment before that date.

Sample Indicators

To demonstrate the techniques that can be used to undertake this sort of longitudinal analysis, we have included the following two key PMTCT indicators in our sample configuration:

- Percentage of HIV-positive women who receive ART to reduce the risk of transmission during pregnancy and delivery (President's Emergency Plan for AIDS Relief [PEPFAR] indicator PMTCT_ART)
- Percentage of infants born to HIV-positive mothers who had an HIV virologic test within 12 months of birth (PEPFAR indicator PMTCT_EID)

It is important to note that in line with PEPFAR definitions and monitoring and evaluation reporting periods, these indicators are not based on tracking individual patients over time (like operational reports), but instead they are based on ***activity within a given period*** (see the guidance for further details).

Percentage of HIV-positive women who receive ARTs to reduce the risk of transmission during pregnancy and delivery (PMTCT_ART)

This requires the following combination of program indicators and indicators:

"Already on ART" program indicator: This is a count events indicator based on the PMTCT Enrollment program stage, which takes the count of enrollments for events where (filter) the data element "Already on ART at enrollment" is "Yes" (i.e., =1). We have put program rules in place to ensure that a user cannot select "Yes" to both "Already on ART" and "Initiated on ART this visit," so this accurately counts the number of patients already on ART when enrolled in PMTCT.

"Initiated on ART" program indicator: This is a count events indicator based on the PMTCT enrollment visit, ANC visit, and PNC stages of the PMTCT program, which takes the count of events where (filter) any "Initiated on lifelong ART this visit" data element is "Yes" (i.e., 1). We have put program rules in place to ensure that this "Yes" can be recorded only once during a patient's enrollment and that it cannot be selected if that patient was already on ART when they enrolled; this ensures that patients cannot be double-counted.

Total PMTCT enrollments program indicator: On the assumption that *all* women who test positive in ANC are enrolled in the PMTCT Tracker, this counts the total number of PMTCT enrollments (analytics type "enrollment," expression is the enrollment_count), giving the total number of known-positive women (= PMTCT_STAT_POS).

Percentage of HIV+ women receiving ART indicator: Finally, we have constructed an overall indicator that combines these three program indicators to provide the total percentage of HIV-positive women receiving ART (PMTCT_ART):

$$\frac{\text{("Initiated on ART" + "Already on ART")}}{\text{"Total PMTCT enrollments"}}$$

Percentage of infants born to HIV-positive mothers who had an HIV virologic test within 12 months of birth (PMTCT_EID)

This requires the following combination of program indicators and indicators:

"Virologic test within 2 months" program indicator: This is a count events indicator based on the initial DNA PCR test program stage (this indicator measures the first test only, not retesting) of the Exposed Child program. It takes the count of enrollments for events where (filter) there is a result recorded for "Outcome of DNA PCR test" and the event occurred within two months of birth (it uses the function "months between" enrollment date and event date).

"Virologic test within 3–12 months" program indicator: This repeats the indicator above, but with the filter capturing only "Initial DNA PCR test" events that occurred within 3–12 months of birth.

"Total PMTCT enrollments" program indicator (=PMTCT_STAT_POS), as defined above.

Percentage of infants born to HIV+ mothers with virologic test within 12 months: Finally, we have constructed an overall indicator that combines these three program indicators to give the total percentage of HIV-positive women whose children receive a virologic test within 12 months of birth:

$$\frac{(\text{"Virologic test within 2 months"} + \text{"Virologic test at 3–12 months"})}{\text{"Total PMTCT enrollments"}}$$

User Roles

Reflecting the recommendations made in the guidance, the roles that have been included in the sample PMTCT Tracker represent a set of "building blocks" that can be used to flexibly provide users with the access they require. It is suggested that you also use these roles as the minimum for user access for your own PMTCT Tracker; you may want to expand on these roles and introduce further distinctions, but to preserve the principle of least privilege, we recommend that you do not reduce or merge these minimum roles.

There are two core user roles:

PMTCT data capture: This role is the core role used by facility staff (usually data clerks, or perhaps also providers). It has access to the Tracker Capture app, all necessary authorities to add, edit, and delete patients (tracked entities) and enrollments, and the *Search Tracked Entity Instance in all organizational units* authority to enable searches for entities and patients registered at other facilities. This role has not been given any reporting authorities.

PMTCT supervision: This role is for staff overseeing or supervising multiple facilities. It has access to the Tracker Capture app, but it has not been given authorities to add or update tracked entity instances or enrollments. This enables scrutiny but ensures that data capture staff retain full responsibility for the data. This role does not have any reporting authorities.

Given the sensitivity of PMTCT data, it is recommended that access to reports is governed by separate user roles that are explicitly assigned to each user based on their needs. The following user roles have been configured for report access in our sample PMTCT Tracker, and users need to be given at least one of them:

PMTCT summary reports: This role is granted only the Dashboard app (no other analytics apps) and access to event analytics, meaning that these users are able to access only the pre-built summary reports made

available to them in dashboards (they cannot click through to other analytics apps). This role is useful for staff who need to view prepared reports and do not undertake data entry.

PMTCT confidential reports: This role is granted access to event analytics and all analytics apps, which means that users are able to drill down from the dashboard to explore confidential data or to view favorites that are shared with them; however, they do not have any authorities to ***create*** tables, charts, maps, or dashboards, so they cannot easily share confidential information with others.

PMTCT report writer/analyst: This role is designed to be used only by selected analysts and has all authorities required to explore confidential data and to create and share tables, charts, maps, and dashboards, as well supporting elements such as indicators, legends, and map layers.

Recommended PMTCT User Groups

Reflecting the recommendations made in the guidance, the following user groups have been configured in the sample PMTCT Tracker:

- A user group to match the PMTCT supervision roles. This has read-only access to both the PMTCT and Exposed Child programs.
- Three user groups to accompany the Data Capture role: one each for "All" (read-write access to all program stages in both the PMTCT and Exposed Child programs), "Delivery" (read-write access to only the Delivery program stage of the PMTCT program), and "ART" (read-write access to only the ART Handover program stages of both programs). This enables users to be given access to either the whole sample PMTCT Tracker, or to just the Delivery or ART Handover program stages.
- A "summary reports" user role. Only non-confidential reports should be assigned to this user group, making it easy to restrict access to dashboards and favorites containing confidential patient data.
- A "confidential reports" user role. All dashboards and favorites should be assigned to this user group, but it should only be granted to users who have been authorized to see confidential patient data.

When granting access to program stages, it is important that you grant "can view metadata" access to *every* program stage for *every* user group. This will not let them see data (data access can be restricted by "view only" or "no access"), but it will let the user's login know that these program stages exist, even if they are hidden. If this is not done, things like program rules can result in errors if they include the missing program stages.

APPENDIX B. DEVICE OPTIONS

This appendix provides a detailed explanation of the full range of devices that can be used to capture DHIS2 data. The following options are available:

- Basic mobile phone
- Android smartphone
- Android tablet
- Laptop/netbook
- Personal computer (PC)

Smartphone

Normal smartphones can use the Android Tracker app, but usability is reduced due to their small screen size—even a seven-inch tablet will provide staff with a better view of patient data than a smartphone. This disadvantage is offset, however, by the fact that Internet-enabled phones are often cheaper than Internet-enabled tablets and can serve the dual purpose of both phone and data capture tool (and if staff have already been issued smartphones, then it makes sense to leverage this existing infrastructure).

Smartphones also potentially require less training than tablets or computers because many staff will already be familiar with them. Allowing staff to use their own phones can, however, create security risks. The DHIS2 Android Tracker Capture app stores confidential patient data locally on the phone, so you should ideally install mobile device management (see below), but this locks down the phone to some extent, so staff are often resistant to having it installed.

Tablet

An Android tablet with built-in mobile Internet (SIM card) is a strong contender for use with DHIS2. A high-specification tablet (e.g., quad-core processor and 2GB memory) provides the flexibility of being able to use both the web-based and the Android versions of DHIS2 apps.

Another major advantage of tablets is that they work well in environments where power is poor. They have a long battery life, and low power consumption means that they can charge off solar power or car sockets.

The cost of a high-specification tablet should be about half that of a laptop or PC. For bigger facilities with a wireless LAN, cheaper tablets with only wireless connectivity (no SIM card) can also be used, which reduces both purchase costs and running costs (i.e., devices share a single Internet connection). However, this requires good information technology support at the facility to ensure high availability of the wireless network. The web version of DHIS2 may also run a little slowly on low-specification tablets.

Laptop/Netbook

Laptops are less portable and more expensive than tablets, but they are also more powerful, which can sometimes be important for web dashboards and analytics or for doing large amounts of web-based data capture. The larger screen size of a laptop can also be useful for viewing dashboards. Laptops usually have better quality screens, with better outdoor visibility, but this is unlikely to be important for prevention of

mother-to-child transmission of HIV, which is mostly facility-based. Stronger processors and larger screens also mean that laptops need access to a main power supply; unlike PCs, however, laptops can go for a number of hours without power, which can be useful in situations where the main power supply fluctuates for short periods of time.

The key trade-off between a netbook and a laptop is lower processing power and fewer features in return for a lower price and longer battery life. Battery life alone can make netbooks a more attractive option than laptops, and because the processing power of netbooks has increased in recent years, most of them should be able to easily handle the web-based version of DHIS2 Tracker Capture and analytics.

Personal Computer

PCs are cheaper than laptops and tend to have a longer lifespan. Unlike laptops, individual components on a PC can be easily replaced. The main drawbacks of PCs are their reliance on steady power (although adding an interruptible power supply can help compensate for this) and their size and weight, which can make them difficult to integrate into existing clinic and facility setups. Both PCs and laptops—particularly PCs—tend to require more information technology support than Android devices. Given these considerations, PCs are a useful option for office-based work and heavy amounts of data capture, but otherwise laptops or tablets are probably a better option for developing country environments.

Keyboards

One important consideration is whether a physical keyboard will be required. Most Android devices only have on-screen virtual keyboards. If the device is being used by staff for intermittent data capture—for example, a nurse who registers selected patients in DHIS2—then a physical keyboard may not be necessary. If a staff member does sustained periods of data capture that requires the capture of names and other text, then an external physical keyboard will be essential. Built-in laptop keyboards should be used for long periods of time because the screen should ideally be at head height. Staff using a device primarily for reporting purposes should not need a physical keyboard.

Device Security

Using web-based access to DHIS2 is fairly secure. Although the web browser will cache some aspects of DHIS2, the amounts of confidential patient data involved will be minimal, so if the device is stolen or breached, the confidentiality risk is also very small.

However, using the DHIS2 Android Tracker app (rather than the web-based Tracker module) presents much more of a security problem, because large numbers of patient records can be stored locally on each user's device; loss or breach of the device could potentially expose the full PMTCT records of large numbers of patients. Each Android device therefore needs to be encrypted, so that data cannot be accessed without the password. This is easy to do (it is a setting in Android) but difficult to enforce because staff can easily unencrypt their device without your knowledge or use a low-quality password such as "123." You should therefore ideally install a mobile device management solution on each Android device, which locks down the tablet or phone, ensures that it remains encrypted, and enforces the use of complex passwords.

APPENDIX C. CONNECTIVITY OPTIONS

This appendix provides a detailed explanation of the full range of connectivity options that are available for use with DHIS2. These options include the following:

- Short Message Service (SMS)
- Unstructured Supplementary Service Data (USSD)
- Mobile Internet
- Dial-up Internet (landline)
- Fixed-line broadband Internet

Note that for completeness, all options are discussed here, but not all of them are appropriate for use with the PMTCT Tracker. Our recommendations for or against each option are provided.

SMS

This involves sending data to and from DHIS2 via SMS messages. This connectivity usually involves the smallest up-front investment because staff can use almost any mobile phone (not just smartphones). However, it also has some significant disadvantages. Data entry is both slow and unstructured (i.e., there is no way of restricting the codes or data types that are entered, so staff can easily accidentally enter invalid data in the SMS that they send); this is a challenge that can probably be managed with simple aggregate data entry, but it becomes quite problematic with the more complex structure of Tracker data. For a given volume of data, SMS is usually more expensive than most other connectivity options because an SMS contains a tiny amount of data but involves a fixed per-SMS charge.

It is also worth noting that DHIS2's built-in SMS commands have strict validation restrictions (e.g., data must come from a phone number attached to a DHIS2 user), and any submissions held up this way have to be manually released, further complicating data entry. There are a range of third-party data collection tools (e.g., CommCare, FrontlineSMS, DataWinners, Mango) that offer SMS alongside other options and can then feed these data into DHIS2; however, they all share the same drawbacks listed above. Given this balance of strengths and weaknesses, we would tend to recommend against using SMS for Tracker data capture; it is, however, still a useful option for sending certain types of data to users and patients, particularly patient notifications and reminders.

USSD

This involves sending data to and from DHIS2 by entering codes (usually starting with *) on a mobile phone, pressing the 'call' button, and receiving a pop-up text in return. Like SMS, almost any mobile phone can send short codes, and most people are already familiar with using them (e.g., to request an airtime balance or change mobile network settings). Another advantage of USSD over SMS is that data can be carefully structured into a series of questions and restricted answers to ensure that responses are valid.

Although it is reliable and easy to use, USSD is very complex to set up for the following reasons:

- It is not built into DHIS2, and requires software customization.
- It must be configured separately by each mobile network and thus involves setting up contracts and technical liaison with all of the major phone companies in the country (a complicated undertaking).

If USSD data collection has already been successfully implemented, and you have the opportunity to piggy-back on this existing infrastructure, then its strengths mean that is worth considering as an option for PMTCT Tracker data capture. Otherwise, we recommend using the much simpler Internet connectivity options.

Mobile Internet

Sometimes also referred to as mobile broadband, this involves using a mobile phone network for Internet access, either by inserting a SIM card into the device itself or by plugging in a USB modem that holds the SIM card.

Mobile Internet has the advantage of being easy to deploy (you can distribute computers and devices with mobile Internet already installed, rather than having to visit sites to install it), and in the field it can be used flexibly, wherever there is coverage. But this flexibility comes at a slightly higher cost:

- Unless using 4G, a mobile Internet connection is not usually fast enough to link more than one device at a time, so if you are using multiple personal computers, laptops, or mobile devices at a site, a separate mobile Internet account is recommended for each device.
- Although with frequent use, mobile Internet is likely to be cheaper than using SMS, for a given volume of data it is usually more expensive than fixed-line broadband Internet and can have lower caps and ceilings on data use.

The speed of mobile Internet can vary, depending on the type of mobile network that is available in each area and whether the SIM or device itself can handle 3G or 4G.

- **3G** (which appears as "3G," "H," or "H+" on a phone) and **4G** ("4G" or "LTE") provide fast Internet, but they are still being rolled out in most low-income countries and are likely to be available in major urban areas only. If you have a strong mobile signal, 3G and 4G should be fast enough for both web and Android DHIS2 use.
- **EDGE** mobile Internet (sometimes also called 2.5G) appears as "E" on a phone. It can be somewhat slow when used for regular web-based data entry but provides sufficient bandwidth for the Android Tracker Capture app.
- **GPRS** or 2G, which appears as "G" on a phone, is the oldest and slowest mobile Internet technology, but has the advantage of being available in almost any area that has mobile phone coverage. It is too slow for web-based use of DHIS2. It can be used to *maintain* the Android Tracker Capture app, but some operations that require heavy data use—such as logging in for the first time (which downloads all organizational units and events for the user) or updating the app—will not be feasible on GPRS.

Dial-up Internet (landline)

This involves connecting a personal computer or laptop to the telephone line using a modem and using the telephone line to connect to an Internet supplier. This ties up the telephone line (often at the cost of a normal telephone call), so is generally used for short periods of time only, when Internet access is required. This is an old type of Internet access and is quite rare now, even in developing countries. It is both slow and unreliable, and is therefore not recommended as a connectivity option.

Landline Broadband Internet (plus network cables or wireless)

This involves getting broadband Internet installed at the facility or site, either through an existing telephone or television cable (which does not tie up the line) or by adding a dedicated Internet cable. Because all or part of the line is dedicated to this connection, it provides "always on" Internet connectivity. Usually, a computer is not directly connected to this broadband line—a local area network of either Ethernet cables or Wi-Fi points are installed throughout the building and attached to the broadband line so that multiple computers, laptops, and mobile devices can use this single Internet connection.

The main advantage of landline broadband is that where available, it is usually cheaper than mobile Internet access, particularly if you have multiple computers, laptops, and mobile devices or are using large amounts of data. However, it is not always as widely available as mobile Internet, particularly in rural areas, and is more logistically complex to deploy and maintain (particularly if installing together with a local area network).

APPENDIX D. CREATING UNIQUE IDENTIFIER CODES

One of the most effective tools for correctly identifying patients over time and across facilities is a unique identifier code (UIC). You will need to implement an effective UIC before you can begin tracking PMTCT patients electronically. A true UIC meets the following criteria:

It is globally unique. A globally unique identifier code is essential if patients are moving across facilities. Existing patient IDs may not be truly unique. For example, hospitals and clinics often issue patient numbers, but because each facility has its own numbering system, you may find that the same number has been issued to two different patients in two different facilities.

It does not change over time. Personal data such as mobile phone numbers are sometimes used as patient identifiers in low-resource environments. Although unique at a point in time, mobile phone numbers often change over time, and a mobile phone number can also be used by various members of a family; therefore they should not be used as part of a UIC.

In the context of PMTCT, another important consideration in creating a UIC is confidentiality. The UIC should not contain elements that could be used to identify a patient, such as date of birth or the first three letters of the surname.

There are four common methods for obtaining UICs for use in a program as follows.[19]

Use an existing national registration system. This could include a government ID card number or a national healthcare ID number. In developing country contexts, however, it is extremely rare to find government ID programs that are truly universal, and both poor patients and key affected populations often lack formal IDs (PEPFAR, USAID, & HIV Core, 2015). The other disadvantage is that because of their wide use, national IDs are often seen as being public information, and HIV-positive patients are therefore reluctant to share them.

Use an existing program-specific patient ID. This could include an ANC number or an ART patient number. If you decide to use this as the primary UIC, it is important to ensure that this is genuinely unique; for example, avoid using an ANC card number if patients who lose their card are issued a new card with a new number. Even if you do not use a program-specific ID as the primary UIC, capturing additional program-specific IDs in your PMTCT Tracker can be useful because this will enable staff to search for and identify a patient using any one of a number of different IDs.

Generate a new numeric PMTCT UIC for the patient. Recent versions of DHIS2 can generate a patient number that is unique across the system. If Android devices are used for data collection, DHIS2 issues each Android device its own list of available patient numbers, so that it is able to generate a unique patient number

[19] Biometrics, such as fingerprints, is another option, but is still a new and developing area of technology, and has not been integrated into DHIS2. There are also complexities around sourcing and maintaining scanning devices.

even when offline. This is a simple and useful option if patients' first contact in the PMTCT continuum of care will typically be with a staff member using the PMTCT Tracker.

Generate a constructed UIC for the patient. This involves generating a unique identifier code from information provided by the patient, such as combining letters from their name, surname, family members' names, district of birth, and date of birth. It is important that this UIC obscures the patient's identity (e.g., use the second and last letter of the surname, rather than the first three letters). This has the strong advantage of being reproducible at different times and places—if the patient visits two different clinics without her paperwork, this UIC can be accurately reconstructed on-the-spot—so it is a useful approach if Internet connectivity is poor, and patients can enter the PMTCT continuum of care using any of a number of different points. However, it is difficult to ensure that a UIC like this is unique across large populations, so a lot of thought needs to go into the components of a constructed UIC.

APPENDIX E. ADVICE ON SETTING UP AN ORGANIZATIONAL HIERARCHY FOR THE FIRST TIME

If you are constructing your own organizational unit hierarchy, rather than using an existing one, you should give yourself time to really think through the design and make sure that it is appropriate for both reporting and security purposes. Although it is possible to change some aspects of the hierarchy at a later date (particularly the higher levels that do not have data attached to them), it is a complex undertaking, with impacts on security, data collection, and reporting, so it is better to get the hierarchy right at the beginning of the project and to hold it stable once the system goes live (i.e., into production).

The DHIS2 Implementation Guide covers how to set up a DHIS2 organizational unit hierarchy, so we will not cover all aspects of it here. We will, however, present some general recommendations that are specific to the needs of a PMTCT Tracker.

The first question to consider is the level at which you require **data to be grouped and aggregated for reports.** There will probably be existing requirements for reports at the national, regional, and district levels; because the PMTCT Tracker has a very operational focus, it is also worth considering your staffing hierarchy and whether additional groupings might be useful here. For example, if there are two or more field offices in a region, then it might be useful to create a "field office" level under the "region" level so you can provide each office with its own reports. Each level that you create will be available as a grouping in reports and dashboards.

The next question to consider is how you want to **restrict access to operational data and reports.** Although you are able to easily restrict access to functions or programs using user roles and user groups, you gain a further level of security by restricting users to just the clinic or area for which they are responsible. This is a good reason to go beyond the district level and take your organizational unit hierarchy one step further, down to the individual facility level. This will allow staff in a clinic to be able to edit each other's visit records, but staff in other clinics in the same district will not be able to. Note that they can still share a single patient's overall record, they just cannot edit each other's visits in that record.

Only create organizational unit levels **in which the child (sub) grouping is wholly contained in the parent**—do not create levels in which the child grouping runs across multiple parent levels. For example, "facility" is an appropriate child of "district" because each facility can sit in one district only; however, "clinic type" is *not*, because a clinic type like "hospital" will have to be repeated under multiple parents. For cross-cutting groupings like this, an organizational unit group should be used instead of an organizational unit level.

Think carefully about how you will **maintain each level** in the organizational unit hierarchy because this is where many DHIS2 systems experience problems over time. External listings (e.g., a gazetted list of government districts with unique codes) are much easier to keep updated than listings that need to be updated with information provided by field staff (e.g., a list of villages included in a program) because establishing a system for rapid and responsive updates from field staff can be difficult.[20] For this reason, we

[20] If required, "village" can be included as an attribute in the Tracker; this will not be available in reports and analytics, but it can be exported for analysis elsewhere.

also recommend making facilities (service delivery) or districts (community outreach) the lowest point in your organizational unit hierarchy and not going down as far as individual staff members or service providers. The individual staff member or service provider level would enable to you put tighter security in place (providers could be prevented from editing each other's activity), but the frequent movement of staff would make this difficult to maintain as an organizational unit level.

APPENDIX F. SUGGESTED TRAINING AGENDA

Day	Time	Content
Classroom-based training		
Day 1 [DATE]	AM session	Objectives of PMTCT Tracker Data Quality Standards Confidentiality Introduction to DHIS2 Tracker
	PM session	Sections from User Manual: 1. Introduction to Manual 2. PMTCT Tracker Concepts 3. Access and Navigate the PMTCT Tracker
Day 2 [DATE]	AM session	Sections from User Manual: 4. Data Capture and Review: General Principles 5. Data Capture and Review: Mother's PMTCT Program
	PM session	Sections from User Manual: 6. Data Capture and Review: Exposed Child Program
Day 3 [DATE]	AM session	Sections from User Manual: 7. How to Make and Accept Referrals 8. Actively Track and Follow up on PMTCT Patients
	PM session	Sections from User Manual: 9. PMTCT Dashboards Begin practice with Dummy Data
Day 4 [DATE]	AM session	Dummy Data Practice
	PM session	Dummy Data Practice
Facility-based training		
Day 5 [DATE]	AM session	Map PMTCT Data Flow at Facility Identify All Data Sources Make/Take Note of Adaptations Needed in Tracker Program
	PM session	Practice Data Entry (on Practice Tracker Site or Intermediary Tool) from Facility Data Sources
Day 6 [DATE]	AM session	Practice Data Entry (on Practice Tracker Site or Intermediary Tool) from Facility Data Sources
	PM session	Live Data Entry with Supervision
Day 7 [DATE]	AM session	Live Data Entry with Supervision
	PM session	Live Data Entry with Supervision
Follow-up supervision Weeks 2–6 [up to Week 10]		

APPENDIX G: KEY ROLES AND TRAINING OBJECTIVES

Training objective	User role/group			
	Data capture	Supervision	Report writing/ analysis	Report viewing
1. Understands core PMTCT Tracker and confidentiality concepts	✓	✓	✓	
2. Can log into the PMTCT Tracker, navigate the system, and maintain user account	✓	✓	✓	
3. Can capture and review PMTCT patient data	✓	✓		
4. Can actively track and follow up on PMTCT patients	✓	✓		
5. Can view PMTCT dashboards and other reports	✓	✓	✓	✓
6. Can create PMTCT reports, maps, and dashboards			✓	

Training objective Competency area	**Competency**
1. Understands core PMTCT Tracker and confidentiality concepts	
Core PMTCT Tracker concepts	Understands all national and organizational policies and protocols relating to PMTCT
	Understands best-practice PMTCT protocols and workflows (Option B+)
	Understands flow of PMTCT data (both paper and electronic) from facilities to other levels and back again
	Understands what DHIS2 is, how it fits into a national HMIS, and that the PMTCT Tracker is a module within DHIS2
	Understands benefits of using PMTCT Tracker
	Understands concept of server, Internet, and client (and online vs. offline)
	Understands frontline ownership of data and responsibility for data quality
	Uses the User Manual and Flash Card
Confidentiality and data protection	Understands the organization's confidentiality and data protection policy (particularly restrictions on person-identifiable data)
	Understands the organization's security policy (particularly regarding user accounts and passwords)
	Understands the concept of "minimum access" and how the organization's data are restricted by user
	Understands computer security (users must never share accounts or passwords with anyone, etc.)
2. Can log into the PMTCT Tracker, navigate the system, and maintain user account	
Logs into and navigates DHIS2	Opens web browser and navigates to the PMTCT Tracker via URL or shortcut
	Logs into and out of the PMTCT Tracker, and confirms which user is logged in

Training objective Competency area	**Competency**
	Understands how access is restricted by role (user roles and user groups) and facility (organization unit)
	Understands the difference between data capture, supervisor, and report writer/analyst roles
	Views available DHIS2 modules and navigates between them
	Runs Browser Cache Cleaner (and understands loss of offline data)
Manages DHIS2 user account	Views user profile and updates it (especially job title and phone number) when necessary
3. Can capture and review PMTCT patient data	
Understands Tracker data capture concepts	Understands concept of tracking a patient over time (all enrollments and visits linked to patient)
	Understands how patient, enrollment, and visit are shown in the layout of the patient dashboard
	Understands the difference between scheduled bookings, open visits, and completed visits
	Understands the concept of an enrollment date and event dates, and how these are grouped into periods in the analytics
	Understands that enrollment is owned by a particular facility, and temporary vs. permanent referrals
Creates and updates PMTCT Tracker records	Opens the Tracker Capture module, selects facility/area, and selects program
	Searches for and opens an existing patient's PMTCT record
	Registers a new patient in the PMTCT program
	PMTCT program—schedules and captures ANC visits
	PMTCT program—captures delivery or end of pregnancy, and registers all children in the Exposed Child program
	PMTCT program—schedules and captures PNC visits
	PMTCT program—schedules and captures mother's handover to mainstream ART
	Exposed Child program—schedules and captures DNA PCR tests
	Exposed Child program—schedules and captures child's handover to mainstream ART
	Exposed Child program—closes enrolments for HIV-negative children
	Understands the concept of validation rules and that warnings or blocks may pop up
	Understands how data are saved (color coding) and online and offline working (including risks/issues)
	Understands how to delete a patient (and the consequences)
	Is able to view audit trail for edits to data

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This publication was produced with the support of the United States Agency for International Development (USAID) under the terms of MEASURE Evaluation cooperative agreement AID-OAA-L-14-00004. MEASURE Evaluation is implemented by the Carolina Population Center, University of North Carolina at Chapel Hill in partnership with ICF International; John Snow, Inc.; Management Sciences for Health; Palladium; and Tulane University. Views expressed are not necessarily those of USAID or the United States government.
MS-18-127 Revised September 2019

ISBN: 978-1-64232-200-2

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