Systems Analysis and Improvement to Optimize the Prevention of Mother-to-Child Transmission in Central Mozambique

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A dissertation
submitted in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

University of Washington
2013

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Program Authorized to Offer Degree:
School of Nursing

University of Washington

Abstract

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Background: Despite significant increases in global health investment and the availability of low-cost, efficacious interventions designed to reduce mother to child HIV transmission in low and middle income countries with high HIV burden such as Mozambique, the translation of these scientific advances into effective delivery strategies has been slow, uneven and incomplete. As a result, pediatric HIV infection remains largely uncontrolled.

Methods: We reviewed models and theories of change from a range of disciplines, including management sciences, nursing, medicine, engineering and sociology, that endeavor to explain the natural process of diffusion of innovation both at individual and group levels. Considering our hypothesis that health outcomes can be improved by identifying and reducing systems inefficiencies and improving program effectiveness in complex, multi-step health services – such as prevention of mother-to-child HIV transmission (pMTCT) – we subsequently reviewed novel analytic techniques to assess workflow that have been applied to health care settings and applied them to the model.

Results: A conceptual framework combining literature on systems analysis, quality improvement, and change theory with analytic techniques from industry, was developed as a foundation for the development of a systems analysis and improvement approach for application to pMTCT services in central Mozambique. The main practical elements of this framework include district and facility-level health managers' use of routine data to identify and rank health systems factors and service delivery approaches associated with high and low performance of pMTCT services, the subsequent application of a cascade systems analysis tool and process mapping by facility-level health care teams to understand their current systems and identify the most appropriate areas for intervention for service improvement, and an associated performance improvement approach to apply in service delivery facilities.

Conclusion: Enhancing the implementation of pMTCT interventions through appropriate systems analysis and improvement approaches can potentially reduce attrition along the pMTCT care cascade, leading to dramatic improvements in infant and maternal outcomes. This conceptual model is novel as it practically engages both district and health facility managers in the process of understanding their system, identifying bottlenecks, as well as generating and testing solutions across complex stepwise health care interventions such as pMTCT.

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CHAPTER 1.
Systems Analysis and Improvement to Optimize Prevention of Mother-to-Child HIV Transmission Services in Central Mozambique: A Conceptual Framework to Achieve Change

Introduction

It is well established that high functioning health care organizations are learning organizations that are willing and capable of change to meet the dynamic needs of the communities they serve (Institute of Medicine, 2012; Smith, Halvorson, & Kaplan, 2012; Ugurluoglu, Ugurluoglu Aldogan, & Dilmac, 2012). Over the last 10 years, the introduction of health services for HIV-infected individuals in resource constrained settings, such as Mozambique, have challenged public health systems that were traditionally designed to provide services for acutely ill individuals. HIV prevention, care and treatment services, including those targeting the prevention of mother-to-child transmission of HIV (pMTCT), have required substantial changes in staffing, service organization and supply chain management in order to meet the demands of more chronically ill populations (Beaglehole et al., 2008; Samb et al., 2010). As learning organizations, these health care systems require adaptation in order to respond to the changing needs of their population.

Models and theories of change help explain the processes of diffusion and dissemination of innovation both at the individual and group levels, and are described across fields including nursing, management sciences, medicine, engineering and sociology (Citrome, 2011; Cockerill & Barnsley, 1997; Dearing, 2009; Geibert, 2006; Montanari & Saberi, 2010; Rogers, 1995; Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). Change is discussed across classical theories, models of change, mid-range theories, social psychological theories, and organizational theories, in order to guide improvements in health services. Overlapping constructs are present across these theories (Aboud & Singla, 2012; Bandura, 1986; Briscoe & Aboud, 2012; Coates, Richter, & Caceres, 2008; Engle et al., 2007; Rahman, Malik, Sikander, Roberts, & Creed, 2008; Smith & Katikireddi, 2013). Effective application of these models and theories of change for 'cascade type' services, such as pMTCT, has been constrained by insufficient guidance and examples for their practical orientation across real world health service delivery settings, especially in resource-limited settings such as Mozambique. Theories and models of change that are appropriate for use in real world health settings are needed, in particular those that can be applied to cascade-type health services such as pMTCT.

PMTCT Cascade

In Mozambique, as in many resource limited settings with high HIV prevalence, pMTCT is delivered by maternal child health nurses, in a sequence of events related to the stage of pregnancy and post-delivery. The sequential pMTCT 'cascade' typically includes attendance at antenatal care (ANC), HIV counseling, HIV testing, the provision of prophylactic antiretroviral medicines (ARVs), safe delivery, safe infant feeding, infant follow-up including HIV testing and care and treatment initiation, and family planning (Ferguson et al., 2012; Padian et al., 2011). Attention to women's linkages into long-term HIV care and treatment services, including assessment for combination antiretroviral therapy (cART) and cART initiation, may also be priorities in pMTCT cascade analyses. Using the cascade, it is possible to quantify attrition along the pathway between women testing positive for HIV in ANC settings and accessing long term HIV care and treatment for both herself and her baby (Micek et al., 2009; Youngleson et al., 2010).

There is a growing recognition that the most critical priority for improving the effectiveness of pMTCT services is to increase the number of women successfully passing through the multiple, sequential steps in the pMTCT cascade (Barker, 2008), which logically argues for approaches that focus on optimizing existing pMTCT delivery systems and related HIV care services to lead to increased access to efficacious interventions. A number of novel analytical techniques to assess work flow in health care settings have the potential to improve health outcomes by identifying and reducing system inefficiencies, and improving program effectiveness, in complex, multi-step health services such as pMTCT. These tools and techniques, including cascade analysis, process mapping, and continuous quality improvement, have been adapted from industrial and systems engineering and manufacturing improvement approaches that have been effective in leading to dramatic and rapid increases in program efficiency through simple, low cost, iterative adaptations in the design of service delivery (Weinberg et al., 2001; Womak, Byrne, Flume, Kaplan, & Toussaint, 2005).

Efforts to expand pMTCT in Mozambique since its initial introduction in 2002 have led to gains in the number of facilities offering pMTCT services, reaching 86% of all clinics with ANC services nationwide (World Health Organization, 2011). Despite this expansion, gaps along the pMTCT care cascade limit its effectiveness. As of 2011, Mozambique reported low coverage of HIV counseling and testing (87% of estimated HIV-infected women), maternal access to ARV prophylaxis and cART for eligible women (51% of identified, eligible HIV-infected pregnant women), as well as limited infant access to ARV prophylaxis (42% of infants born to identified HIV-infected pregnant women in Mozambique) (UNAIDS, 2012b; World Health Organization, 2011). Infant feeding practices, low post-partum use of modern family planning methods, weak linkages with HIV care, and suboptimal integration with other effective ANC services further impede pMTCT effectiveness. As a result, pediatric HIV infection continues to be high, with estimated mother-to-child HIV transmission occurring in 28% of babies born to HIV-infected women in Mozambique (UNAIDS, 2012b).

In the context of a comparative study to evaluate a systems analysis intervention for pMTCT, we developed a conceptual model to guide nurse managers in the improvement of their pMTCT service provision. Through the model's application to the pMTCT cascade, we provide a practical tool, with a strong theoretical foundation, that can be readily adopted by nurse managers, public health practitioners, and applied researchers to improve complex health systems in the context of HIV prevention and care for chronic conditions.

Three sources—theories of change, evidence from practice, and in-depth understanding of one's audience, should inform the development of strategies, interventions and programs to promote effective and appropriate change within healthcare organizations. In their design, programs frequently do not consult comprehensive theories of change that have been developed to explain change at the individual, interpersonal, organizational and community levels. Furthermore, programs rarely rely on a combination of theory, evidence and insights about their audience to identify what and how to implement change, but instead use a logical framework to linearly connect desired outcomes to inputs and resources. However, problems, desired outcomes and resource needs are not necessarily arranged in a linear fashion, and behavior does not always logically follow from activities, and activities do not always logically follow from resources.[14] By examining in greater detail theories and models of change, and incorporating analytical tools from engineering and other applied fields, we propose a fully developed practical model that is informed by the three critical sources of theory, practical evidence and in-depth contextual knowledge.

Methods

To inform the development of our theoretical model for pMTCT systems analysis and improvement, we reviewed a range of theoretical models and theories of change that attempt to explain the process of diffusion and dissemination of innovation both at the individual and group levels. These models crossed multiple disciplines, including nursing, management sciences, medicine, engineering, and sociology, and were identified initially through a search on pub med engine for mention of Avedis Donabedian's *model for quality improvement* in health care settings. Based on other related theories and models of change introduced through these published manuscripts, we identified over 15 additional theories and models of change, and subsequently included the five most applicable in the development of our conceptual model. Under the assumption that health outcomes can be improved by identifying and reducing system inefficiencies that are barriers to program effectiveness in complex, multi-step health services such as pMTCT, we also reviewed novel analytic techniques from industry that have been applied to assess workflow in health care settings. The results from this review of techniques were compared and contrasted based on a criteria including adequacy for use in low and middle income country (LMIC) settings, appropriateness for stepped procedures such as pMTCT, and the research team's experience applying these techniques in similar healthcare settings. A new conceptual model was developed using the results of this review, and incorporating perspectives of the study team with substantial experience scaling-up pMTCT and other services in Mozambique.

Ethical Considerations

Ethical approval was obtained from the Mozambican Ministry of Health's National Committee on Bioethics for Health (#00002657), and was determined to be not constitute human subjects research requiring human subjects review by the Human Subjects Division at the University of Washington, Seattle, WA, USA

Results and Discussion

Theory

In this section, we review the five identified applicable theories and models of change that have been used in the development of our conceptual model, including the strengths and weaknesses of each theory and model in the context of pMTCT service delivery in LMIC contexts.

Diffusion of Innovation Theory

Classical theories of change describe the diffusion of innovation. One of the most well-known of these classical theories of change is Everett Rogers' *diffusion of innovation theory* (Rogers, 1995). Rogers' work highlights the innovation-decision process, which describes how potential adopter's perceptions of the innovation influence the change, or diffusion, of the innovation as well as the relationship between different adopter types and level and speed of diffusion. The innovation-decision process consists of five stages that potential adopters pass through as they decide whether or not to adopt an innovation. These stages include: *knowledge* (becoming aware of the innovation), *persuasion* (developing positive attitudes toward the innovation), *decision* (making a decision to adopt the innovation), *implementation* (using the innovation) and *confirmation* (continuing to use the innovation, adapting the innovation or abandoning it). Rogers makes the case that innovations are more quickly accepted if they are compatible with current values, beliefs and ways of doing things; are seen to be relatively advantageous when compared to current practices; are easy to use/do; are observed by others in use; and can be easily tried out before being officially adopted. Another important contribution of Rogers is his classification of adopters into types according to their rate of adoption of change. These types include innovators (the fastest to adopt), early adopters, early majority, late majority, and laggards. Rogers' classical theory helps identify possible determinants of change but does not give any indication of how to speed up change or slow it down in cases when the proposed change is not desirable. It does help identify possible motivating factors both at the individual and environmental levels that may influence the decision to change.

The most applicable element of Roger's *diffusion of innovation theory* to the introduction of a systems analysis and improvement approach for pMTCT services in central Mozambique is in the characterization of innovators into categories from early to late adopters. This categorization is useful as it highlights the utility of collecting health facility-level data on the dynamism of nurse managers (as key stakeholders) and health care teams as a predictor of health facility adoption of change. However, this theory neglects to highlight how health care teams work through the stages of change acceptance, and instead targets individual patients or health providers. The linear and finite organization of this model also does not allow for iterative changes to be made over time by the health care team, which is the reality of how change is adopted and adapted over time in real world settings. Furthermore, classical theories and models are limited in their applied utility, as they provide little instruction on procedures for identifying and using change determinants.

Rules for Dissemination

Planned models of change, such as Don Berwick's *rules for dissemination*, provide a set of logically interrelated concepts that systematically explain the means through which change occurs (Berwick, 2003). The term 'dissemination' in this model differs from the earlier concept of diffusion, as it represents the intentional and targeted distribution of information and intervention materials to a specific public health or clinical practice audience with the intent to spread knowledge and the associated evidence-based interventions (Glasgow et al., 2012). Like more traditional models of change, Berwick's model demonstrates how varied forces in the environment will react in certain change situations. Models of change differ from classical theories of change in their applicability, primarily by recognizing the possibility to engineer changes to the environment that affect the speed and spread of the dissemination of the innovation. Berwick's rules are derived largely from Rogers' (Rogers, 1995) work that target three clusters of influence, including: (a) perceptions of the innovation, (b) characteristics of the people who adopt the innovations (and those who do not), and (c) contextual factors (including communication, incentives, leadership and management). The *rules for dissemination* reiterate elements of Rogers' *diffusion of innovation theory* including that individuals within organizations are more likely to adapt to change if they perceive its value for themselves, if the change is compatible with their values and worldview, and if it is relatively easy to understand and use.

When applying this model to the introduction of a systems analysis and improvement approach for pMTCT services, it highlights the importance of creating health worker buy-in and deep understanding of the tool. Ownership is reinforced by the interventions that will be identified, developed and refined by the health care team. Building joint understanding and following through with team-defined action is crucial to ensure the appropriateness of the proposed solutions and movement towards continuous quality improvement. Berwick concludes by describing seven rules for effective implementers of change: (a) find sound innovations, (b) find and support innovators, (c) invest in early adopters, (d) make early adopter activity observable, (e) trust and enable reinvention, (f) create slack for change, and (g) lead by example. Although Berwick's model provides a useful framework to plan implementation activities, it does not articulate how nurse managers should systematically prioritize interventions for application and assessment at health facilities.

Theory of Planned Behavior

Social psychological theories have been applied in health care settings to explain why health workers adopt change. Icek Ajzen's *theory of planned behavior* posits that the strength of an individual's motivation to adopt a behavior and the amount of control they perceive to have over it are proximal determinants to engaging in the behavior (Ajzen, 1991). Ajzen refers to the strength of an individual's motivation to adopt a behavior as *intention*, which is influenced by the individual's attitudes and view of the behavior (including what others think of the behavior and how much the individual seeks approval from others). Ajzen proposes that behavior change is brought about by interventions that change these beliefs.

When applied to the introduction of a systems analysis and improvement approach for pMTCT in Mozambique, the *theory of planned behavior* highlights the importance of project ownership, sharing information on successes and challenges across implementing facilities, and active engagement and support of nurse managers and other leaders to influence nurses' adoption of interventions. Addressing these determinants of health worker adoption within the conceptual framework is critical for the successful introduction of this systems analysis and improvement approach.

Organizational Theories

As the introduction of a systems analysis and improvement approach in pMTCT settings in Mozambique proposes change across the organizational unit of the health facility, the most applicable models to inform the development of an appropriate conceptual model have been adapted from organizational theory, specifically Donabedian's *model of quality improvement* and the Associates in Process Improvement's *model for improvement,* which has been disseminated widely by the Institute for Healthcare Improvement (IHI) (Donabedian, 1966; Langley, 2009).

Organizational Theory 1: Model for Quality Improvement

Donabedian's *model for quality improvement* consists of a three component structure (structure, process, and outcomes), where each component has a direct influence on the next. Structure includes the attributes of the setting in which the provider delivers care (material resources, human resources, and organizational structure). Process consists of what is done to the patient in the giving and receiving of care while the outcomes include the patient's health status as a consequence of contact with the health care system. For example, if the health facility is an unpleasant place to be, health worker performance will suffer, patient attendance will be low, and those patients who do come will receive substandard treatment. Thus, the outcomes indicate the combined effects of structure and process, and structure and process are presumed to be readily measurable. Monitoring outcomes is to monitor performances that are conditioned on structure and process.

This model assumes that only structure and process can be manipulated. The *model for quality improvement* also represents a logical starting point for examining quality improvement at the organizational level, however its applicability to pMTCT is limited by its linearity as often structural changes do not result in process changes, and likewise process changes can have little or no effect on outcomes. The Donabedian model can be viewed as a precursor to the logical framework model used to guide development program planning by donor agencies in LMICs, whereby problems are viewed in relation to the desired program goals or outcomes (Innovation Network, 2007). The starting point here is the structure that allows for subsequent processes, which in turn influence outcomes. The notable gap in this model is that in real world settings, outcomes (or change) do not necessarily flow from processes, and likewise, processes do not necessarily logically flow from structure, especially in complex health service environments such as pMTCT services in central Mozambique. Despite this limiting factor, the general sequence of structure, process, and outcomes has informed much of quality improvement and change theory at the organizational level, including the Model for Improvement.

Organizational Theory 2: Model for Improvement

The *model for improvement* is a framework to guide improvement work. This model differs from other organizational models in that it is not meant to replace existing change models that organizations may employ, but rather it aims to accelerate existing improvement efforts. The model consists of two parts. First, asking three fundamental questions (in no certain order), including: What are we trying to accomplish (setting aims)? How will we know if a change is an improvement (establishing measures)? And what changes can we make that will result in improvement (selecting changes to test)? The second part involves Plan-Do-Study-Act (PDSA) cycles to test and implement changes in real work settings, and determine if the change is an improvement. By planning, testing, and observing the results, and acting on what is learned from an introduced change, the PDSA methodology employs the scientific method used for action-oriented learning.

This theory recognizes that not all change is improvement, but all improvement is change, and that fundamentally real improvement occurs when systems are changed (not when changes are made within systems). The three fundamental questions that initiate the process of this model require that specific aims are established, and that measures are selected to reflect improvements in patient needs rather than the organizational needs. Indicators are set to gauge whether new innovations should be kept, adapted or disregarded, or whether aims need to be amended, but not to select, restrict or punish. Leaders are effective when they look for change to consistently improve the work environment, and not rest comfortably in the status quo.

The *model for improvement* takes into account organizational processes, but does not systematically incorporate the use of routine data across the health services cascade to identify bottlenecks and prioritize solution-oriented interventions, which is a critical step to improve pMTCT service delivery.

Adapted Workflow Tools

The development of an appropriate conceptual model to guide implementation of change requires a foundation in theory, the application of evidence, and the insights of on-the-ground knowledge. In order to ensure the integration of these elements into our conceptual model, we have adapted and incorporated workflow tools originating from industrial and systems engineering that are increasingly being applied to health care in high and LMIC settings. By systematically linking workflow tools to steps in a comprehensive systems analysis and improvement approach, we join the theoretical with the practical, providing health care teams with tools to collectively examine their work environment and apply incremental improvements to affect organizational change.

Cascade Analysis

Previously, cascade analysis has been employed to identify bottlenecks in the stepwise flow of cART-eligible patients into care and treatment. Micek and colleagues developed a simple Excel®- based to tool that relies on routinely collected health information system data to examine the flow of patients through five steps in the HIV care cascade: (a) test for HIV, (b) enroll for care at the local HIV care clinic, (c) undergo CD4 testing, (d) initiate cART (if eligible), and (e) adhere to cART (Micek et al., 2009). This tool allows for the identification of the incremental number of people lost at each point in the HIV care cascade, and has a maximizing function to identify the additional number of people who could complete the entire cascade if each step was improved (assuming that the other steps of the care cascade remained constant). An adaptation of this tool for pMTCT is proposed to allow district and health facility nurse managers to identify and locate inefficiencies across their pMTCT service delivery cascade while determining where to intervene in the work flow to lead to the largest improvement.

Process Flow Mapping

A common element of systems analysis and institutional improvement approaches is to collaboratively describe and understand the existing system as part of identifying problems and risks, and then generate solutions. Process flow mapping is one method that engages nurse managers and other frontline health workers as they describe the discrete, sequential steps in their multi-step health service delivery strategies. The results of this analysis then serves as a basis for identifying contextually-appropriate systems innovations to improve system functioning (Colligan, Anderson, Potts, & Berman, 2010). Figure 1.1 is an example of a pMTCT process flow map created with health workers from one health facility in central Mozambique. It is often assumed that care provision is standardized across health facilities but in reality, process flow mapping demonstrates that care provision is frequently context specific, unique, and influenced by the specific configuration of health workers, infrastructure, and organizational culture at each facility. Even within health facilities, different health workers will describe different flow patterns, and, thus, when this activity is carried out in a collaborative manner, it allows for discussions focused on decreasing variability and improving efficiency and quality for patients.

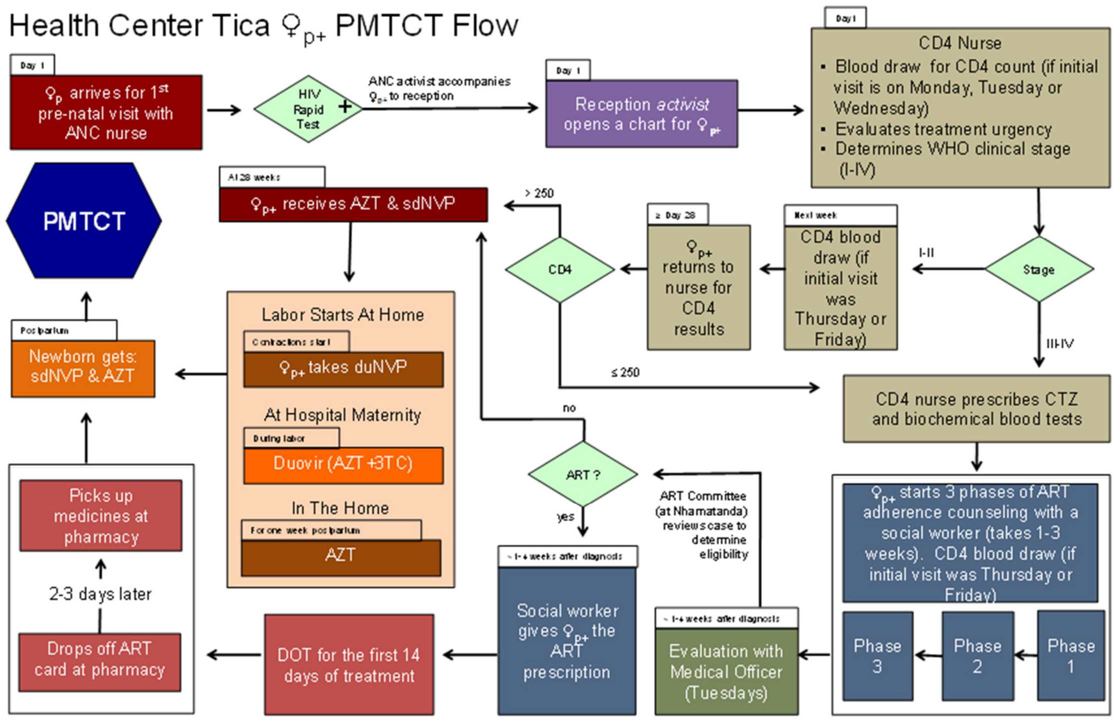

Figure 1.1. pMTCT Process Flow Map

A hallmark of systems analysis and improvement approaches is encouraging the collaborative participation of nurse managers and frontline health workers (usually nurses but also physicians, medical officers, pharmacists and laboratory workers) in the analysis of their system, as well as defining, implementing and evaluating improvement strategies using simple, locally accessible, and relevant data. Previous research, including from resource limited settings, has found that engaging local health staff along with nurse managers in health systems analysis and identification of adaptations for systems improvement leads to subsequent improvement strategies that are more appropriate, effective, and sustainable (Webster et al., 2012). Through building a shared understanding of how work is actually carried out, process mapping helps to build shared organizational values and goals, which has been found, along with the involvement of senior management champions, to be associated with improved health service delivery and patient-level outcomes at the facility level (Curry et al., 2011; Nelson, Batalden, & Godfrey, 2007). In our conceptual model, process flow mapping complements cascade analysis by allowing health care teams to go beyond prioritizing where in the pMTCT cascade to intervene, and to collectively identify specific target areas for workflow innovation.

The Systems Analysis and Improvement Approach (SAIA)

The conceptual model developed for application to improve pMTCT service delivery, the *Systems Analysis and Improvement Approach* (SAIA, Figure 1.2), is adapted from both Donabedian's *model of quality improvement* and the Associates in Process Improvement's *model for improvement*, and is influenced by Roger's *diffusion theory*, Berwick's *rules for dissemination*, and Ajzen's *theory of planned behavior*. This model borrows the three steps of Donabedian's model, and adds an additional action step, to have four iterative steps to assess and improve workflow.

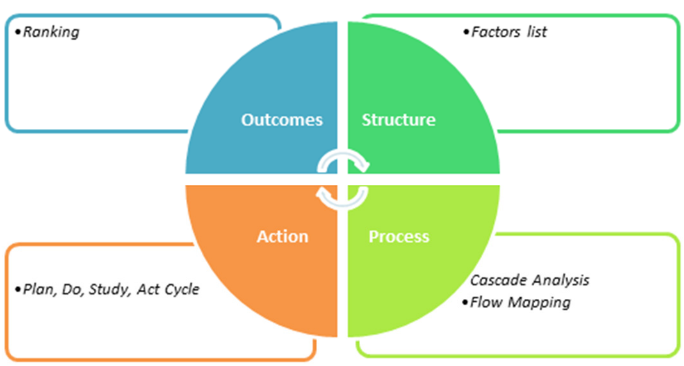

Figure 1.2. Systems Analysis and Improvement Approach (SAIA)

In the initial step ("outcomes"), district managers use routine data on progression through the pMTCT cascade to rank health facility performance across a district or sub-district level. By using routinely reported health information systems, facility nurse managers are able to rapidly combine and use available data to generate a composite indicator to rank health facilities across the designated geographic area. Furthermore, the SAIA generates a summary performance score that combines completion data from multiple steps of the pMTCT cascade (such as the proportion of women in antenatal care counseled and tested for HIV, proportion of HIV-infected women receiving CD4 test results in a timely manner, and proportion of eligible HIV-infected mothers receiving either prophylactic ARVs or cART), which reflects system performance across the broad pMTCT continuum. After ranking, health facilities are categorized into high, middle and low performing groups based on tertiles in the performance distribution.

Post ranking, additional information related to specific health facility functioning is collected in the next step ("structure"). The composition of the factors list can vary based on the needs of the health care team and their position in the health system (either district or facility level). A model of a factor's list used in Mozambique is in the Appendix. Domains covered may include human resource availability and allocation, leadership and management approach, infrastructure, service organization, availability of medications and other supplies, data quality, etc. This information may also be complemented with in-depth qualitative interviews to tease out additional information that may facilitate or impede pMTCT service performance.

The third step ("process") translates the data collected at the district or sub-district level for use by the health facility team. With performance data in hand, facility nurse managers and staff use the cascade analysis tool to identify the highest priority area of intervention in the pMTCT cascade intervention (such as ANC, maternity, post-partum services, and linkages to ongoing clinical care). Subsequently, the health care team creates a patient-level flow map of existing pMTCT services to describe patient flow in their facility. In the final step ("action"), which borrows from the *model for improvement,* a PDSA cycle is carried out by the health care team to brainstorm, prioritize, and test solutions, allowing information to generate change across the pMTCT cascade and across levels of management (between district and health facilities).

The SAIA model is distinct from the previously discussed organizational models in two notable ways. First, it targets both district and health facility health workers by engaging district managers in the initial identification of high and low performing health facilities, and subsequently in the collection of other related factors that may influence performance. The entire healthcare team at the facility level is also engaged through the inclusion of both nurse managers and frontline health workers in the process mapping and PDSA activities. Second, the SAIA model requires health care personnel to work as a team to use the cascade analysis tool and process flow mapping to jointly describe the current service delivery model and identify workflow bottlenecks and priorities, and then implement and assess solutions. By encouraging a team-based approach, the SAIA model foments motivation and ownership over model implementation by both nurse managers and frontline nurses and other health workers.

This systems view and improvement approach borrows state-of-the-art methodologies from industrial and systems engineering to holistically describe complex, real-world systems, and improve their functioning. The model's approach is designed to be simple in application in order to engage frontline health workers and facility managers to collaboratively lead service improvements by identifying bottlenecks and solutions that are within their scope of control. Because the model steps are appropriate and manageable for the targeted beneficiaries, the likelihood that the analysis and improvement approach, including workflow innovations, will be adopted by facility nurse managers is increased. Furthermore, because system engineering techniques, including cascade analysis and process flow mapping, have the potential to improve linkages within and between services and reduce bottlenecks that result in increased patient attrition, the application of a stepwise analysis and improvement approach is especially appropriate for pMTCT services that require both progression through a number of linked steps within ANC for preventing mother to child HIV transmission, as well as successful linkage with non-ANC delivered services for continued HIV care for mother and baby. To date, the most successful adaptations of engineering and manufacturing methods to health care have been made for services that are cascade in nature and repetitive, which holds well for pMTCT service delivery (Institute for Healthcare Improvement, 2005).

Conclusions

It is increasingly recognized that traditional randomized control trials designed to demonstrate intervention efficacy are not a panacea for improving the implementation and sustainability of health programs (Glasgow et al., 2012). Alternative research approaches that have better external validity and contextual relevance, and which provide results more quickly, easily and at a lower cost, are needed to develop appropriate solutions for both scaling up and sustaining effective health programs in LMIC settings. The SAIA model provides a practical, scalable, and sustainable framework for nurse managers and their teams to follow in order to rapidly identify and test what works in real-world settings.

CHAPTER 2.
What Does High and Low Have To Do With It? Exploring Performance Classification as a Means of Identifying Health System Factors Associated with Effective Prevention of Mother-to-Child Transmission of HIV Delivery in Central Mozambique

Introduction

Sub-Saharan Africa bears a disproportionate HIV burden, with nearly 70% of the global total, 92% of pregnant women infected globally, and 90% of all incident HIV cases in children (UNAIDS, 2013). Efforts to implement and take to scale highly efficacious, low-cost interventions to prevent mother-to-child HIV transmission (pMTCT) have been a cornerstone of reproductive health services in high-burden HIV settings for over a decade, leading to substantial increases in access and utilization of preventive services, with the objective of elimination of paediatric HIV infection. However, pMTCT services in sub-Saharan Africa remain sub-optimal, with an estimated 53% of HIV-infected pregnant women accessing pMTCT services in 2010 (Hardon et al., 2012; Msellati, 2009). Parallel to efforts to expand pMTCT, efforts have focused on implementing more efficacious pMTCT prophylaxis regimens, which together have reduced HIV transmission to newborns (Goga et al., 2012; Moodley, Parboosing, & Moodley, 2013).

To translate more efficacious regimens to effective pMTCT services, heterogeneous clinic-level facilitators and barriers that impact access and utilization must be addressed. By identifying modifiable health system factors associated with high and low-performing pMTCT systems, best practices can be disseminated and implemented to maximize the number of women and children reached with effective pMTCT services. Likewise, identified factors associated with poorer performance can be addressed across facilities to reduce their replication.

PMTCT is a highly complex package of healthcare interventions that spans multiple stages of women's reproductive and children's developmental lifespan, and health services specific to these stages. To maximize the benefit to mothers and children, pMTCT is delivered in a timed sequence, or 'cascade' that includes: attendance at antenatal care (ANC), HIV counselling and testing, provision of prophylactic antiretrovirals (ARVs), safe delivery, safe infant feeding, infant follow-up including HIV testing, family planning, and linkages to long-term HIV care and treatment (Ferguson et al., 2012). Comprised of a sequence of linked events, the pMTCT cascade provides a useful framework for organizing pMTCT services and quantifying attrition along the pathway from identifying HIV-infected women, preventing HIV transmission to children, and ensuring long-term access to HIV care and treatment. Improving pMTCT effectiveness requires increasing the number of women and their children who successfully pass through the multiple, sequential steps in the pMTCT cascade; therefore identifying replicable approaches to optimize the cascade is a critical priority (Barker, 2008).

Methodologies to Classify and Learn from Differential Performance

Identifying high and low-performing health facilities, and the drivers of performance, may highlight best practices associated with effective pMTCT service delivery in resource limited settings for replication in other pMTCT systems. Two methodologies developed by systems management and behavioural sciences that utilize performance classification and exploit performance differentials to improve health system functioning and individual-level health behaviours include Lot Quality Assurance Sampling and Positive Deviance.

Lot Quality Assurance Sampling (LQAS)

Categorizing high and low-performing systems to improve decision-making has been used in industry and the health sector to improve quality of services and goods (Hedt-Gauthier et al., 2012; Robertson & Valadez, 2006). One common method is LQAS, which was developed for quality control in industrial production. LQAS includes inspection of a small representative sample of a production lot, and if the number of defective goods in the sample exceeds a predetermined allowable number, the lot is rejected; otherwise the lot is classified as having acceptable quality (Dodge, 1959).

LQAS has been applied to the health sector to conduct rapid assessments of service coverage, the accuracy of health records, logistics and supply chain performance, training programs, and the quality of facility management (Deitchler, Valadez, Egge, Fernandez, & Hennigan, 2007; Oladele et al., 2012; Olives, Valadez, Brooker, & Pagano, 2012; Robertson & Valadez, 2006). Based on high or low performance classification, managers can focus their support on geographic areas or facilities with sub-optimal performance, which can provide insights into the relationship between improvement strategies and their effectiveness. Beyond identifying failing production systems, LQAS does not provide guidance on which components of the production system are failing. As a result, LQAS has limited utility for complex interventions like pMTCT, which may require tailored interventions depending on which pMTCT cascade step is under-performing.

Positive Deviance

Positive deviance focuses on high performers to understand and amplify their traits, practices and characteristics across a broader population (Positive Deviance Initiative, 2013). By identifying successful individuals and families with uncommon, beneficial practices (positive deviants) – and modelling these practices for others – positive deviance intends to build on internal solutions that are potentially more culturally appropriate and sustainable (Long et al., 2013). Positive deviance has been applied to multiple interventions in the areas of nutrition, hygiene, obesity prevention, health service utilization, breastfeeding adherence, and HIV/AIDS prevention (Bisits Bullen, 2011; Friedman, Mateu-Gelabert, Sandoval, Hagan, & Des Jarlais, 2008; Gabbay et al., 2013; Klaiman, O'Connell, & Stoto, 2013; Kraschnewski, Sciamanna, Pollak, Stuckey, & Sherwood, 2013; Marra et al., 2011; Masanja et al., 2012; Stuckey et al., 2011). By contrasting high and low-performing individuals, positive deviance provides a framework for understanding and improving outcomes in low-performing entities.

Despite their assessment of high and low performance, LQAS and positive deviance do not articulate a standardized approach for performance classification, which is challenging for pMTCT cascades that span multiple services in the antenatal, partum, and post-partum periods. The objective of this study is to develop and explore a performance classification approach as a first step towards identifying modifiable health system factors associated with pMTCT performance. By describing this approach, we provide a novel model for pMTCT performance assessment that relies on routinely collected and reported data, and which can be used to identify modifiable factors associated with pMTCT performance to inform program improvement efforts.

Methods

Study Design

Activities were conducted as part of a multi-methods, cross-sectional study designed to identify modifiable and non-modifiable health systems factors associated with pMTCT service performance. The results presented here contributed to the parent study which will be conducted in three sub-Saharan countries by developing the health facility performance ranking approach as a first step for identifying systems-level factors associated with high and low-performing clinics.

Study Setting

Thirty public sector health facilities with pMTCT services in three districts along the Beira corridor (the main transport route connecting the port city of Beira with Zimbabwe) in

Sofala province, central Mozambique, were included in the study. Sofala has an estimated population of 1,800,000, of which 850,000 live in the study districts (National Institute of Statistics, 2007). Sofala province has an estimated adult HIV prevalence of 15.5% (Mozambican National Institute of Statistics, 2010), which has been consistently higher among women routinely tested for HIV in ANC (17.8%) (Instituto Nacional de Saude, 2009).

Since its introduction in 2002, pMTCT expansion has increased to reach 100% of all public sector clinics with ANC services in the three study districts (and 86% of all facilities nationally) (World Health Organization, 2011). Despite high availability of pMTCT and high ANC attendance (approximately 95%), gaps along the pMTCT cascade limit its effectiveness, and paediatric HIV infection continues to be high, with an estimated 28% of children born to HIV-infected women acquiring HIV (UNAIDS, 2012b).

Study facilities included all public sector health facilities that met the inclusion criteria of 1) location in Beira city, Dondo or Nhamatanda districts; 2) provision of pMTCT at ANC in the last 6 months; and 3) consent to participate in the study. All but two facilities were included in the study, which were excluded because they were unwilling to participate or had limited physical access due to flooding.

Data Sources

Facility-level data for pMTCT performance ranking were sourced from provincial program reports covering the period from January through December, 2012. Data were based on monthly health facility data, which in parallel is entered into the national health information system at the district level. Monthly facility-level data were assessed for availability by the study team to identify missing reports, and irregular or missing data were cross-checked with facility-level registries to ensure accuracy. Missing data were recovered for all measures except CD4 testing data, which were inconsistently available at the facility-level.

Data on health facility characteristics were collected using a survey developed for study purposes from November, 2012 through January, 2013 (Annex I). Descriptive, facility-level variables were identified through review of published literature on pMTCT and quality improvement, and the final list of facility characteristics was developed in consultation with provincial program managers and technical advisors. The data collection form was developed in Portuguese, and piloted in one facility before study assistants visited all 30 health facilities to collect information from facility managers and front line health workers. Data from each facility were double entered by study personnel to ensure their accuracy.

Variable Definition

Performance Ranking

Three performance measures were *a priori* selected based on their presence in routine reporting systems and importance for successful pMTCT, including 1) the proportion of pregnant women in ANC tested for HIV at their first visit; 2) the proportion of pregnant women with a positive HIV test at first ANC visit who had a CD4 test in pregnancy; and 3) the proportion of women with a positive HIV test in the first ANC visit accessing effective prophylaxis or combination antiretroviral therapy (cART) in pregnancy (Table 1). HIV testing in first ANC visit was selected (*versus* testing at any time during pregnancy) because testing in first ANC is standard per Ministry of Health (MOH) guidelines, and because an effective pMTCT package should initiate as early in pregnancy as possible (MISAU, 2012). Single dose nevirapine was not included as an effective pMTCT prophylaxis in the third measure because of its relative ineffectiveness in preventing HIV transmission (Ghanotakis, Miller, & Spensley, 2012).

The twelve months of pMTCT cascade data were used to develop summary performance scores for each facility (n=30). Facilities were ranked into three performance categories (high/middle/low) based on tertiles in the distribution of performance outcomes. In order to assess the value of comparing high *versus* low-performing facilities in identifying modifiable health facility characteristics associated with pMTCT performance, we recoded facilities into two additional performance groups – one joining middle and high performers (to compare with low performers), and a second joining middle and low performers (to compare with high performers).

Modifiable and Non-Modifiable Facility Characteristics

Facility type was classified into three levels – quaternary/tertiary hospitals, secondary hospitals, and primary health centres. Catchment population sizes were provided by provincial and district authorities. Geographic location was defined as urban/peri-urban/rural based on their location in Beira or Dondo municipalities (urban), in the outlying neighbourhoods of Beira (peri-urban), or outside of Beira or Dondo municipalities (rural). Year of pMTCT initiation was provided by facility leadership. Staffing was defined as the number of health workers of cadres most relevant to pMTCT service delivery (physician, non-physician clinician, maternal and child health nurse, general nurse, midwife, custodian, social worker, and activist). Distance to a laboratory with CD4 capacity was estimated using driving distances between health facilities provided by provincial authorities.

Measures to describe pMTCT organization included integration with laboratory services (number of days per week with CD4 blood draws, availability of on-site laboratory capacity for CD4 and other laboratory monitoring), pharmacy services (medicines distributed via pharmacy or ANC/maternity), and outpatient care (adult and paediatric patient referral and tracking for continuity). Measures of community linkages included the presence of a mothers' support group, whether community activists carried out patient tracking, and whether health workers performed regular community outreach. General management practices were measured by the frequency of staff meetings. A list of essential medicines, supplies and materials related to pMTCT service provision was included in the factors list to assess the availability of key items over the preceding three months, as well as the length of stock outages, and was confirmed using stock registries.

PMTCT service utilization was captured through four patient volume measures over the six-months before data collection, including the number of ANC consults, the number of postpartum consults, the number of institutional births, and the number of modern family planning methods distributed.

Statistical Analysis

To refine the ranking procedures we first explored whether the rank performance order for the 30 study facilities changed according to performance measurement (including each of the three outcome measures alone, a composite indicator multiplying indicators one and three for each facility (HIV testing and effective prophylaxis or cART), and a composite indicator multiplying indicators one, two and three for each facility (adding CD4 testing to the previous indicator). Visual assessment focused on the consistency of rank order across high, medium and low categories depending on ranking strategy, using the composite indicator of HIV testing and effective prophylaxis or cART as the benchmark, with top 10 performing sites highlighted in green, the middle 10 in white, and the bottom 10 in red.

Assessment of the impact of ranking process on facility-level characteristics associated with facility performance was carried out for three of the five ranking approaches, excluding

CD4 testing data which were found to be less available and reliable. Unadjusted Chi-square tests for independence were performed to estimate the association between performance and health facility characteristics. For continuous variables, logistic regression for performance outcomes was used to quantify the magnitude and statistical significance of any associations with performance.

After describing factors associated with high *versus* low-performing pMTCT clinics, we assessed how the inclusion of the ten middle-performing clinics affected the list of factors significantly associated with differential pMTCT performance. For this analysis we developed ordinal logistic regression models including continuous clinic characteristics found to be significant in the bivariate analyses, and examined the magnitude of the associations between 3-level (low, middle, high) compared to 2-level (low, high, excluding the 10 middle-performing clinics). Next we aggregated low and middle-performing facilities to compare their characteristics to high-performing facilities, and then aggregated middle and high-performing facilities to compare their characteristics with low-performing clinics. This analysis ranked facilities using indicators one and three (HIV testing at first ANC and receipt of effective prophylaxis or cART), as these measures were most available and measured multiple, essential steps for successful pMTCT.

Data analysis was performed using Stata v11.2 (College Station, TX).

Ethical Approval

Study procedures were approved by the Ethics Committee of the Mozambique Ministry of Health, and was determined to be non-research by the University of Washington Institutional Review Board.

Results

The majority of health facilities were public sector, small to mid-sized primary health centres clustered in rural areas along the Beira corridor, with an average catchment population of approximately 28,000 inhabitants (Table 2.1).

Table 2.1. Characteristics of Study Clinics

	N	(%)
Clinic location		
Rural	18	(60)
Urban	5	(17)
Peri-urban	7	(23)
Clinic type		
Quaternary/tertiary	1	(3)
Secondary	1	(3)
Primary	28	(93)
Public/private		
Public	27	(90)
Private	0	(0)
Mixed	3	(10)
NGO support		
None	17	(57)
One	5	(17)
Multiple	8	(26)
Year of pMTCT initiation		
Before 2005	5	(17)
Between 2006-2008	21	(70)
After 2008	4	(13)
Other characteristics	Mean	Median
Distance to reference laboratory (km)	22	16
Catchment population (people)	27,774	19,644
No. 1st ANC visits in the last 6 months	674	468
No. institutional births in the last 6 months	482	257
No. post-partum visits in the last 6 months	418	189

Key: NGO: Non-governmental organization; pMTCT: prevention of mother-to-child-transmission; ANC: antenatal care

Two hospitals were in the sample, including one quaternary-level referral hospital and one rural hospital. Over half of facilities reported receiving no NGO support, and almost 70% began pMTCT services between 2006 and 2008, during the push to fully extend pMTCT services to all health facilities with MCH services nationwide. The mean distance between health facilities and their CD4 reference laboratory was 22 km (13.1 miles).

Effect of Performance Measures on Ranking

Visual assessment of the effect of performance measures on ranking found a consistency among lower performing clinics, with more variability in rank order among higher performing facilities (Table 2.2).

Table 2.2. Effect of PMTCT Measurement Strategy on Performance Ranking:

(dark grey=high performance, white=middle performance, spotted grey=low performance using dual HIV testing & ART-PPO mother ranking schema)

	HIV testing,			HIV testing, CD4			ART/PPO Mother			CD4 testing			HIV testing	
RANK	CLINIC	SCORE	RANK	CLINIC	SCORE	RANK	CLINIC	SCORE	RANK	CLINIC	SCORE	RANK	CLINIC	SCORE
1	A	0.917	1	J	0.382	1	A	0.947	1	J	0.611	1	S	1.000
2	B	0.885	2	H	0.321	2	B	0.923	2	H	0.442	2	AA	1.000
3	C	0.812	3	N	0.201	3	C	0.870	3	N	0.396	3	M	1.000
4	D	0.738	4	A	0.183	4	I	0.796	4	K	0.310	4	H	1.000
5	E	0.729	5	K	0.173	5	E	0.788	5	A	0.200	5	R	1.000
6	F	0.727	6	L	0.091	6	D	0.788	6	L	0.165	6	DD	1.000
7	G	0.727	7	I	0.090	7	F	0.782	7	I	0.124	7	G	1.000
8	H	0.726	8	E	0.070	8	G	0.727	8	E	0.096	8	J	0.998
9	I	0.724	9	T	0.033	9	H	0.726	9	T	0.078	9	K	0.984
10	J	0.626	10	M	0.029	10	L	0.647	10	M	0.056	10	W	0.975
11	K	0.558	11	D	0.025	11	J	0.628	11	Z	0.043	11	A	0.969
12	L	0.551	12	P	0.012	12	K	0.567	12	D	0.034	12	T	0.963
13	M	0.521	13	Z	0.011	13	N	0.561	13	P	0.024	13	B	0.958
14	N	0.506	14	Y	0.002	14	O	0.547	14	Y	0.007	14	CC	0.955
15	O	0.496	15	F	0.000	15	Q	0.545	15	F	0.000	15	X	0.946
16	P	0.478	16	S	0.000	16	P	0.540	16	S	0.000	16	D	0.936
17	Q	0.456	17	AA	0.000	17	U	0.524	17	AA	0.000	17	C	0.934
18	R	0.453	18	B	0.000	18	M	0.521	18	B	0.000	18	F	0.930
19	S	0.429	19	BB	0.000	19	R	0.453	19	BB	0.000	19	E	0.925
20	T	0.420	20	R	0.000	20	T	0.436	20	R	0.000	20	I	0.910
21	U	0.396	21	W	0.000	21	S	0.429	21	W	0.000	21	V	0.907
22	V	0.359	22	V	0.000	22	V	0.396	22	V	0.000	22	O	0.905
23	W	0.358	23	O	0.000	23	W	0.367	23	O	0.000	23	N	0.903
24	X	0.291	24	Q	0.000	24	X	0.308	24	Q	0.000	24	Y	0.895
25	Y	0.272	25	U	0.000	25	Y	0.304	25	U	0.000	25	BB	0.893
26	Z	0.243	26	X	0.000	26	Z	0.275	26	X	0.000	26	P	0.885
27	AA	0.229	27	CC	0.000	27	AA	0.229	27	CC	0.000	27	Z	0.883
28	BB	0.085	28	DD	0.000	28	BB	0.095	28	DD	0.000	28	L	0.850
29	CC	0.000	29	C	0.000	29	CC	0.000	29	C	0.000	29	Q	0.837
30	DD	0.000	30	G	0.000	30	DD	0.000	30	G	0.000	30	U	0.756

Of the three indicators representing a single step of the pMTCT cascade, receipt of ARV prophylaxis or cART for women identified as HIV-infected at first ANC visit was the most consistent in rank order compared with the composite indicator. The single indicator with the most divergence from the composite measure was HIV testing at first ANC visit, which was high at all pMTCT clinics (over 95% for half of the study clinics), and provided insufficient variability for characterizing high and low-performing pMTCT clinics. The single indicator of CD4 testing and composite indicator which included CD4 testing were insufficient as measures as half of the sites did not report results.

Impact of Ranking Approach on Characteristics Associated with Performance

Ranking strategy substantially impacted clinic characteristics associated with pMTCT performance (Table 2.3).

Using the two variable performance ranking approaches (HIV test at first ANC visit and ARV prophylaxis or cART for mother), five factors were found to be significantly associated with higher pMTCT performance, including larger catchment area, higher number of institutional deliveries, availability of PIMA point-of-care CD4 capacity onsite, higher numbers of MCH nurses, and higher number of MDs and non-physician clinicians (NPCs). Longer lag time from PCR blood draw to receipt of results at facility was associated with poor pMTCT performance, but shorter lag times were not associated with high-performing pMTCT clinics. Factors not associated with performance included clinic location, availability of NGO support, presence of a women's support group, active community-level patient tracking systems, and stock-outs of essential testing supplies and medicines.

Using maternal receipt of ARV prophylaxis or cART as the single indicator for performance ranking, the presence of a support group for HIV-infected was also found to be significantly associated with higher performance; the remaining factors remained unchanged.

Using HIV test at first ANC visit as the single indicator for performance ranking dramatically altered the factors associated with pMTCT performance, with only stock-outs of AZT in ANC remaining associated with high pMTCT performance. All other indicators that were positively or negatively associated with pMTCT performance were no longer significant in this analysis.

Table 2.3. Clinic Characteristics Associated with High pMTCT Performance by Ranking Approach

Ranking Measure	+ Association	(p value)	- Association	(p value)	No association	(p value)
(1) HIV test at first ANC visit & PPO-ART for mother	Catchment size	(p=0.01)*	Wait time between PCR blood draw & receipt of results at facility	(p=0.04)*	Clinic location (rural, urban, peri-urban)	(p=0.29)
	No. MCH nurses	(p<0.01)*			NGO support	(p=0.17)
	No. MDs & NPCs	(p<0.02)*			Active tracing LTFU	(p=0.52)
	PIMA CD4 analyses at facility	(p<0.04)			HIV+ mothers support group at facility	(p=0.19)
	No. of deliveries in prior 6 months	(p<0.01)*			Community linkages	(p=0.43)
					Schedule of receiving requisitions & delivering consumables	(p=0.36)
					ANC stock outs of:	
					AZT	(p=0.79)
					HIV rapid test	(p=0.59)
					Pharmacy stock outs of:	
					HIV rapid test	(p=0.79)
(2) PPO-ART for mother	Catchment size	(p<0.01)*	Wait time between PCR blood draw and receipt of results at facility	(p<0.05)*	Clinic location (rural, urban, peri-urban)	(p=0.37)
	No. of MCH nurses	(p<0.01)*			NGO support	(p=0.16)
	No. of MDs & NPCs	(p=0.03)*			Active tracing LTFU	(p=0.52)
	PIMA CD4 analyses at facility	(p=0.04)			Community linkages	(p=0.66)
	No. of deliveries in prior 6 months	(p<0.01)*			Schedule of receiving requisitions & delivering consumables	(p=0.57)
	HIV+ mothers support group at facility	(p<0.01)			ANC stock outs of:	
					AZT	(p=0.79)
					HIV rapid test	(p=0.59)
					Pharmacy stock outs of:	
					HIV rapid test	(p=0.38)
(3) HIV test at first ANC visit	ANC stock outs of: AZT	(p=0.04)	None	NA	Clinic location (rural, urban, peri-urban)	(p=0.42)
					NGO support	(p=0.55)
					Active tracing LTFU	(p=0.52)
					Community linkages	(p=0.66)
					Schedule of receiving requisitions & delivering consumables	(p=0.16)
					ANC stock outs of:	
					HIV rapid test	(p=0.59)
					Pharmacy stock outs of:	
					HIV rapid test	(p=0.79)
					Catchment size	(p=0.83)*
					No. of MCH nurses	(p=0.25)*
					No. of MDs & NPCs	(p=0.61)*
					PIMA CD4 analyses at facility	(p=0.33)
					No. of deliveries in prior 6 months	(p=0.80)*
					HIV+ mothers support group at facility	(p=0.55)
					Wait time between PCR blood draw and receipt of results at facility	(p=0.37)*

All p-values are from chi-squared tests unless noted with *(unadjusted logistic regression).
Key: PPO (Prophylaxis), ART (Antiretroviral Therapy), ANC (Antenatal Care), MCH (Maternal Child Health), MD (Medical Doctors), NPC (Non Physician Clinicians), PIMA CD4 (Point of Care rapid CD4), NGO (Non-Governmental Organization), LTFU (Lost to Follow Up), AZT (Zidovudine).

Impact of Middle-Performers on the Association of Clinic Factors and pMTCT performance

Removing the ten middle-performing clinics and comparing the magnitude of associations with three-level performance did not dramatically alter the results (Table 2.4).

Table 2.4. Associations of Continuous Clinic Characteristics with Performance, Using Different Performance Outcomes

Variable	3-level performance*		2-level performance (mid-performers omitted)		2-level performance (low/middle vs. high)		2-level performance (low vs. middle/high)	
	Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value
Catchment area (per 10,000 inhabitants)	1.92 (1.09-3.38)	0.02	3.57 (1.84-6.91)	0.0002	1.47 (0.92-2.33)	0.10	4.74 (1.46-15.36)	0.01
Wait time (days) between PCR blood draw & receipt of result at clinic	0.95 (0.90-1.00)	0.04	0.10 (0.01-1.41)	0.09	0.96 (0.90-1.02)	0.15	0.91 (0.83-1.00)	0.05
Number of MCH nurses	1.12 (1.03-1.22)	0.009	1.26 (1.08-1.47)	0.003	1.08 (0.90-1.02)	0.06	1.21 (1.05-1.41)	0.01
Number of MDs & NPCs	2.21 (1.12-4.39)	0.02	5.16 (1.22-21.86)	0.03	2.00 (0.99, 4.01)	0.05	5.37 (1.31-21.99)	0.02

PCR=Polymerase Chain Reaction, MCH=Maternal Child Health, *NPCs = Non-Physician Clinicians

*p-values of continuous variables calculated using unadjusted ordinal logistic regression with robust standard errors

With the exception of lag time between PCR blood draw and receipt of results at the pMTCT clinic, all additional explanatory factors remained significantly associated with performance.

Aggregating the middle-performing clinics with the high or low-performing groups slightly impacted the characteristics significantly associated with pMTCT performance. Most notably, catchment area size was less strongly associated with performance when middle-performing clinics were aggregated with the low-performing group, though the strength and direction of the association was similar to the analysis omitting middle-performing clinics. Decreased wait time between PCR blood draw and receipt of result at clinic was more significant when the middle-performing facilities were aggregated with the high-performing group compared with the analysis omitting middle-performing facilities. For both the number of MCH nurses and number of MDs/NPCs, there was no meaningful difference in direction and strength of association when the middle-performing clinics were included in the analysis.

Discussion

In this article we explore an approach to classify pMTCT performance based on routinely collected health systems data, coupled with additional data collection on modifiable and non-modifiable health systems factors, to identify best practices for pMTCT. We found that using two measures to classify pMTCT performance was preferable to one, though one measure (effective PPO or cART in pregnancy) provided sufficient performance variability to detect associations with health system factors. Classifying high and low performance provided consistent results across ranking measures, though granularity was improved by including middle performers in either the high or low-performing groups. In this analysis, human resource availability (especially MCH nurses), catchment size and utilization were positively associated with effectively pMTCT service delivery. Delay PCR results was negatively associated with pMTCT service delivery. Notably, measures of community linkages were not associated with pMTCT service delivery across the ranking approaches.

This study was limited by its relatively small sample of 30 facilities from one geographic location in one country, limiting the generalizability of the findings. Nonetheless, the methodology of using high and low performance shows promise, providing a framework that can be evaluated in other settings for HIV and non-HIV related services, and can be used to verify and add to the initial list of modifiable and non-modifiable factors associated with pMTCT performance.

The principal strength of this study is its reliance on routine health information system data coupled with simple data collection that is feasible during routine supervision. By using health facilities as the unit of analysis (rather than individual patient attributes, knowledge or behaviours), this study delves into broader determinants of effective pMTCT services that are under the control of health system managers, and can be modified to lead to broad improvements in service effectiveness. Furthermore, the simple analysis approach is geared towards district MCH managers to improve data use for pMTCT service redesign and enhancement, relying on strategies that are effective in their service delivery context.

In this study, increased human resources were significantly associated with pMTCT performance, which is consistent with literature that has highlighted the importance of human resources for better health systems outputs and measures of population health impact (Anand & Barnighausen, 2004; Muldoon et al., 2011). This relationship is logical given severe personnel constraints, and in the context of improving pMTCT service quality, underscores the need for more efficient allocation of limited human resources and significant investments to produce and retain human resources. Thus any intervention to improve pMTCT delivery must address human resource constraints, either directly, or more likely, indirectly through the introduction of systems analysis and improvement approaches to increase the efficiency of delivery. The lack of associations between pMTCT performance and community and social support may be the result of the sample size, or the substantial importance of other factors like personnel availability.

The inability of individual measures (especially HIV testing in pregnancy) to capture a 'high-performing' facility was likely due to insufficient variability in this measure across study facilities. Further research into the variability of pMTCT cascade measures in other settings is warranted to guide application of the ranking approach.

The use of routine health information system data to classify health facility pMTCT performance represents an opportunity and a challenge in low resource, high burden settings such as Mozambique. Using existing data sources reinforces routine information systems and can lead to investment by health workers in assessing and improving service delivery, though incomplete or inconsistent data can result in inconsistent rankings (such as CD4 data, which incidentally will become a less important gateway-to-care measure in decisions about patient care as Option B+ is introduced).

Conclusions

This study supports using fewer, targeted performance measures for systems analysis. As reporting requirements increase to meet the expectations of funders, less time is available to use data for program improvements by district and frontline health managers. Targeting high and low performance is one practical approach to rapidly use routine pMTCT cascade data to achieve a systems perspective of pMTCT functioning at the health facility level, and to exploit differences across facilities to identify best practices across health facilities to inform system improvement efforts.

CHAPTER 3.
The Prevention of Mother-to-Child Transmission of HIV Cascade Analysis Tool (PCAT): Supporting Health Managers to Improve Facility-Level Service Delivery

Introduction

Over 90% of HIV-infected pregnant women and children live in sub-Saharan Africa (UNAIDS, 2012a). Prevention of mother-to-child transmission (pMTCT) using antiretroviral prophylaxis is a proven efficacious intervention, and can reduce HIV transmission to less than 2% of deliveries (Lindegren et al., 1999; McKenna & Hu, 2007; Siegfried, van der Merwe, Brocklehurst, & Sint, 2011). In practice however, gaps along the pMTCT care cascade diminish pMTCT effectiveness in resource-limited settings.

The pMTCT cascade represents a complex system of sequential, interdependent steps that pregnant HIV-infected women pass through in order to receive appropriate care and treatment for themselves and their newborns. The sequential pMTCT 'cascade' typically includes antenatal care (ANC) attendance, HIV counseling and testing, prophylactic antiretroviral medicines (ARVs), safe delivery, safe infant feeding, infant follow-up including HIV testing, and family planning (Ferguson et al., 2012; Padian et al., 2011). PMTCT cascade analysis may also include women's linkages into long-term HIV care and treatment services, including assessment for combination antiretroviral therapy (cART) and cART initiation. It is argued that a comprehensive systems view enables decision-making among managers and frontline health workers, including identifying bottlenecks, and defining and implementing appropriate solutions to improve their system (Committee on Engineering and the Health Care System, 2005).

Mozambique's pMTCT cascade performance is similar to many resource-limited settings with a high HIV burden. HIV testing in antenatal care is high (estimated at 87% among ANC attendees), while maternal access to antiretroviral (ARV) prophylaxis and combination ART (cART) for eligible women and newborns remains low (51% and 42%, respectively) (UNAIDS, 2012b; World Health Organization, 2011). Infant feeding practices, low post-partum use of modern family planning methods, weak linkages with HIV care, and sub-optimal integration with other effective ANC services further impede pMTCT effectiveness. As a result, pediatric HIV infection remains high, with HIV transmission occurring in an estimated 28% of babies born to HIV-infected women in Mozambique (UNAIDS, 2012b).

Quality improvement (QI) has been highlighted as an approach to bridge the gap between evidence-based knowledge and its application to improve health outcomes (Berwick, 1989, 2003). QI has been broadly applied in high resource health systems, with limited but growing experience in resource-limited settings, including maternal and child health services such as pMTCT (Smits, Leatherman, & Berwick, 2002), in the areas of data quality (Mphatswe et al., 2012; Youngleson et al., 2010), continuous monitoring and performance improvement (Doherty, Chopra, Nsibande, & Mngoma, 2009; Youngleson et al., 2010), strengthening community/health facility linkages, and strengthening the coordination of non-governmental organizations (NGOs) (Mate, Ngubane, & Barker, 2013). Experience with QI for pMTCT has relied on time and resource intensive peer-to-peer exchange, training, and expert mentoring to successfully highlight delivery bottlenecks, identify workflow modifications to address these bottlenecks, and evaluate the impact of these innovations (Barker, Mphatswe, & Rollins, 2011; Doherty et al., 2009; Wendt, 2013; Youngleson et al., 2010). Other studies have used quantitative analysis to assess the flow of patients through HIV services to highlight where to intervene for improvement efforts, though the complexity of the analysis procedures limits their use by clinic-level health workers (Micek et al., 2009). Strategies to support heath authorities to independently conduct QI for pMTCT – including assessing where to intervene along the pMTCT cascade – are also needed to expand QI efforts and improve service effectiveness and program ownership.

Use of routine health management information systems (HMIS) for decision-making has been difficult in resource-limited settings, including for pMTCT (Barron et al., 2013; Mate, Bennett, Mphatswe, Barker, & Rollins, 2009; Young, Mahomed, Horth, Shiraishi, & Jani, 2013), partially due to lack of investment in HMIS quality (Mphatswe et al., 2012). Efforts to improve the quality of routine HMIS and stimulate its use by health system managers include periodic data audits (Gimbel et al., 2011; Hoek, 2013; Mate et al., 2009; Mphatswe et al., 2012), the collection of fewer, streamlined indicators (Shaw, 2005), and developing tools tailored to the needs and competencies of health facility managers and frontline health workers to foster their active engagement with their data.

The objective of this paper is to introduce the process for developing a rapid, simple approach to support health facility managers to use routine HMIS data to assess facility performance across the pMTCT cascade as a first step in identifying where in the pMTCT cascade to intervene to maximize improvements in overall pMTCT delivery.

Methods

Scope and Purpose

The overall objective of the pMTCT cascade analysis tool (PCAT) is to provide frontline MCH health managers at the health facility level with the means to rapidly, independently and quantitatively track patient flows through the pMTCT cascade, and readily identify priority areas for clinic-level improvement interventions.

Setting

The PCAT was developed, adapted and piloted over a 6-month period in Beira city, the capital of Sofala Province, central Mozambique (Figure 3.1). Beira is a large port city (population 470,000) (Instituto Nacional de Estatistica, 2007), and high HIV burden (estimated at 17.8%) (Instituto Nacional de Saude, 2009). In the Mozambique health system, maternal and child health (MCH) nurses are responsible for the management and delivery of pMTCT services across the pregnancy, birth and post-partum periods.

Figure 3.1. Sofala Province, Mozambique.

Cascade Tool Development

Over a four-week period beginning in January, 2013, a group of 5 experienced MCH program managers and researchers met weekly to adapt an HIV care cascade tool for the pMTCT cascade (Micek et al., 2009). This original tool included quantifying loss to follow-up across the multiple, linked steps in the HIV care cascade, including (a) HIV testing, (b) enrollment at an ART clinic for HIV-infected adults, (c) CD4 testing post enrollment, (d) ART initiation among eligible individuals, and (e) adhering to ART post ART initiation. This support tool also includes a maximizing function to guide improvement interventions by quantifying the step that – if fully improved – would lead to the largest number of patients to successfully pass through the entire HIV care cascade.

In developing the PCAT, initial priorities included (a) introduction of the steps specific to the pMTCT cascade; (b) adaptation of the interface for data entry by frontline health managers using a broadly available program such as Excel®; (c) ensuring the tool uses only data available through the routine HMIS ; (d) an output design that clearly indicates which individual improvement step would lead to the largest overall efficiency gains across the pMTCT cascade; and (e) creation of versions in English, French and Portuguese (Table 3.1).

Table 3.1. Top Identified Adaptation Priorities

1	PMTCT-specific cascade steps
2	Adaptation of interface for frontline health worker data entry
3	Prioritize use of routine HMIS data
4	Simplified output to ease with health worker translation into practice
5	Multi-language option

Process mapping techniques were used to chart PMTCT cascade steps in five facilities, including ANC attendance, HIV testing and counseling, provision of prophylactic ARVs, safe delivery, safe infant feeding, infant follow-up including HIV testing, and family planning, in order to obtain site-specific knowledge of service delivery (Ferguson et al., 2012; Padian et al., 2011). Attention to women's linkages into long-term HIV care and treatment services, including eligibility assessment for cART and cART initiation, were also considered as part of the pMTCT cascade.

After pMTCT cascade mapping, discussions focused on refining the objectives of the PCAT, identifying users and beneficiaries, and reaching consensus on which steps of the pMTCT cascade should be included based on data availability, data quality, and their importance for achieving effective pMTCT service delivery.

Initial versions of the PCAT (designed in Excel®) were shared and discussed with 27 additional pMTCT managers and frontline nurses, including at the provincial (4), district (5 people from 3 districts), and facility levels (18 people from 10 health facilities). Gathering feedback on the PCAT included a series of 1-2 hour meetings where the tool was presented and discussed based on the understandability, usability, and appropriateness of the tool. Over the following six months the PCAT was redesigned based on continued stakeholder feedback, and pilot tested in five health facilities with pMTCT services before its introduction. The iterative development process is described in Table 3.2.

Table 3.2. PCAT Tool Development Timeline

Activity	Month 1	2	3	4	5	6
Initial planning meetings-researchers/program managers	X					
Tool adaptation & development		X				
Feedback meetings with program managers & frontline health workers		X				
Tool revisions			X			
Feedback meetings with program managers & frontline health workers			X			
Tool revision				X		
Feedback with program managers & frontline health workers					X	
Tool introduction						X

Results

The first version of the PCAT was described by pMTCT managers as overly complex, requiring multiple data manipulations across multiple spreadsheets. Unlocked cells led to inadvertent formula tampering. CD4 testing was eliminated as a cascade step because the introduction of new pMTCT norms no longer required based cART or prophylactic ART eligibility based on CD4 (Direccao Nacional de Saude Publica, 2012). Managers also stated their preference for a tool that they could manipulate without support from external entities.

The PCAT evolved in a number of notable ways (Figure 3.2). A total of seven cascade steps were included to cover two connected parts of the cascade (pregnancy through post-delivery, and delivery through infant follow-up). Prevalence calculations were included as sub-headings under relevant steps. Cells that did not require data inputs were locked and wording simplified. Font color, size and other design changes were made to improve PCAT user-friendliness.

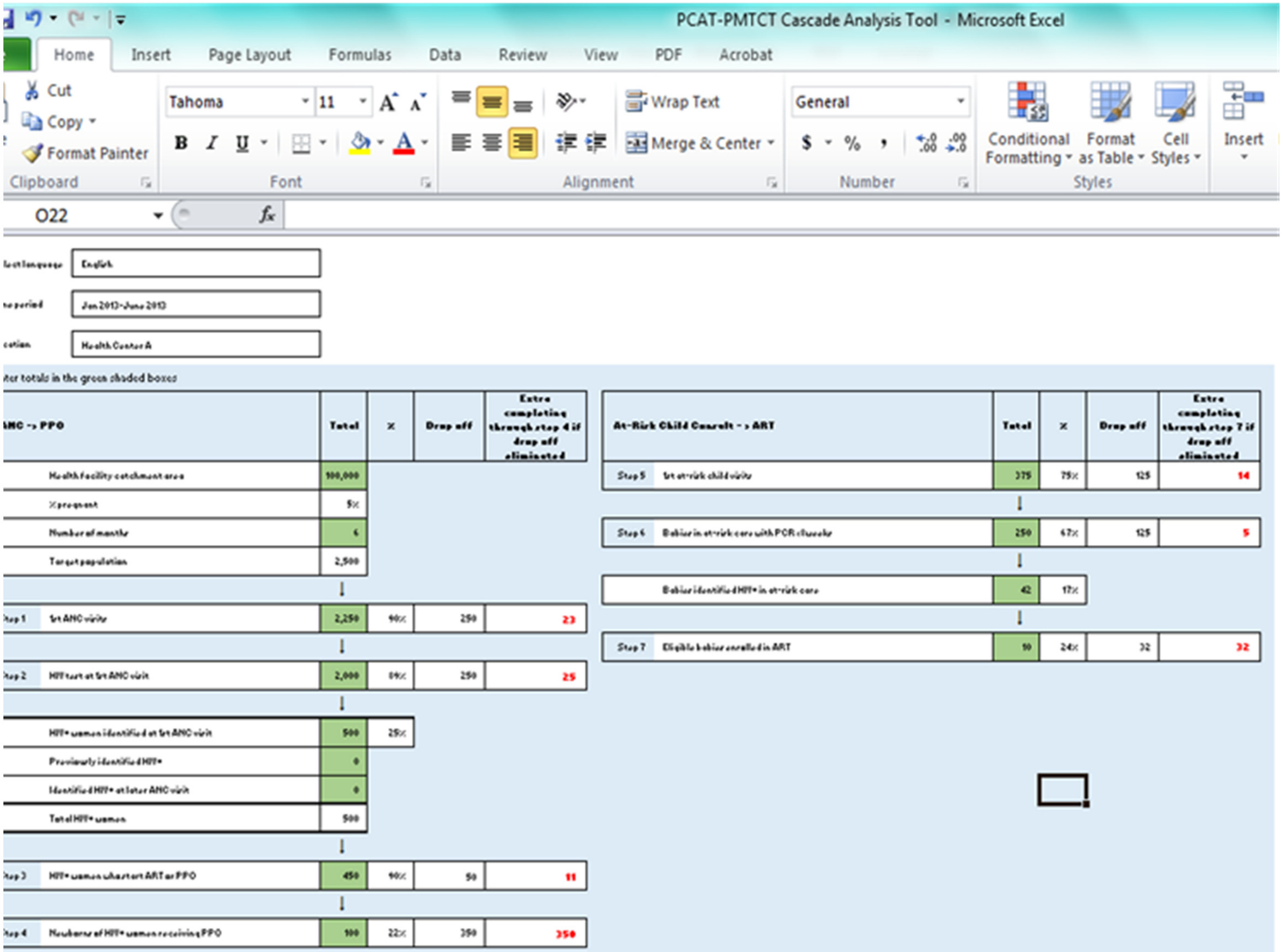

Figure 3.2. PMTCT Cascade Analysis Tool (Screen shot)

Stepwise drop offs and maximization functions were included at the key steps along the cascade. Maximization functions were included for two different endpoints; for steps 1-4, step 4 (the number of newborns receiving ARV prophylaxis at the maternity) was the endpoint, while for steps 5-7, step 7 (the number of eligible babies who initiate ART) was the endpoint. While the drop off function allows the health worker to rapidly assess how many patients are lost at each step, the maximization function describes how many additional people will be served if only one step is improved to 100% capacity while others stay the same.

After the second and third rounds of feedback meetings, the PCAT was further simplified. The subsequent version was developed to streamline commands, add custom functions, and simplify the interface. Stakeholders universally preferred the revised PCAT visually and functionally, and found the tool to be easy-to-understand and useful. The final version of the tool for use and adaptation is located in Annex 1.

A hypothetical example of the PCAT (Figure 3.2), based on a facility catchment population of 100,000, an estimated 5% of which are pregnant annually, and covering a six month period. If the health facility reported 2,250 first ANC visits, then the tool will estimate that 90% of the target catchment population is served (a drop-off of 250 women), and that if this step were to be maximized to 100% (from 90%) then an additional 23 newborns of HIV infected mothers would receive prophylaxis at the maternity (step 4). This reporting of coverage, drop off and maximization is continued for each step along the cascade.

PCAT Content

The PCAT allows frontline health managers to rapidly quantify their pMTCT cascade, and enables managers to quickly and easily identify which step has the largest impact on progression through the cascade (tool available at: http://www.healthallianceinternational.org/publications/presentations/).

Pregnancy through post-delivery: The first section of the PCAT begins at first ANC visit and extends to the administration of prophylactic ARVs for the newborn at the maternity. The initial four steps include (a) number/proportion of 1st ANC visits (of those births expected); (b) number/proportion of HIV tests administered at the 1st ANC visit; (c) number/proportion of women identified with HIV in the first ANC visit who initiate cART or prophylaxis (PPO); and the (d) number/proportion of newborns of HIV-infected mothers who receive prophylaxis at birth or shortly thereafter.

Post-delivery through ART initiation in children: The second cascade section begins post-delivery with the first at-risk newborn consult through the administration of cART for eligible HIV-infected infants. The three steps of this section of the cascade include (e) number/proportion of first at-risk child visits among HIV-exposed newborns; (f) number/proportion of enrolled children with PCR tests completed prior to 8 weeks of life; and (g) number/proportion of eligible children initiating cART.

Step 1. Number of 1st ANC visits. Data on the number of first ANC visits from registries or facility reports is divided by the target population to estimate the proportion of pregnant women accessing ANC. The drop off (or added number gained if this step were to be maximized) is calculated by subtracting the number of first ANC visits from the estimated target population.

Step 2. Number of HIV tests at 1st ANC visit. Data on the number of women receiving HIV testing in first ANC is entered to estimate the proportion of pregnant women tested for HIV, with the number to be gained if this step were improved calculated by subtracting the number receiving an HIV test from the number of first ANC visits. HIV testing data are located in ANC registries and in facility reports. HIV testing in subsequent ANC visits are not included in this calculation, as its objective is to model actual performance compared with a fully functioning system. Although women are often tested for HIV later in ANC, they would ideally be tested at first visit to have time for comprehensive pMTCT services prior to delivery. Therefore, the maximizing function for this step assesses the number of additional women who would be tested in first ANC visit should this step be improved.

After entering the number of women tested for HIV, the tool requires entering the number of HIV-infected women identified, and automatically calculates HIV prevalence. Additional fields allow for entering the number of women identified with HIV in prior pregnancies and subsequent ANC visits to provide an accurate denominator for further steps in the pMTCT cascade.

Step 3. HIV+ women who start PPO or cART. The total number of pregnant women initiating cART or PPO over the relevant time period is entered, and the proportion of HIV+ women receiving an effective PPO or cART during ANC is automatically calculated. If this step were improved, the number of additional women receiving PPO or cART is calculated by subtracting the number receiving PPO or cART from the number of HIV-infected women attending ANC. Required data are available in ANC registries and monthly facility reports.

Step 4. Newborns of HIV+ women receiving PPO. The number of newborns of HIV-infected mothers who receive PPO at the maternity directly after birth is entered and the proportion of newborns of HIV+ mothers receiving PPO at the maternity is automatically calculated. The number of additional HIV-exposed newborns who would receive PPO if this step were maximized is calculated by subtracting the number receiving PPO from the total number of HIV-infected women in antenatal care. Required data are available in maternity registries and monthly facility reports.

Step 5. 1st at-risk child visits. The number of HIV-exposed children who enroll at at-risk child care is entered to estimate the proportion of children born to women identified with HIV in pregnancy who enter HIV care. The number of additional HIV-exposed newborns who would enroll in HIV care if this step were improved is estimated by subtracting successfully enrolled children from the overall number of children born to HIV-infected women identified in ANC. These data are available in the at-risk child consult registry which informs the monthly facility level report and is subsequently entered into the electronic HMIS.

Step 6. Babies in at-risk care who PCR <8 weeks. The number of children enrolled in at-risk care who receive a PCR diagnosis by 8 weeks of life is entered to calculate the proportion of enrollees with an early HIV diagnosis, and estimate drop off in children who receive a HIV diagnosis according to recommendations if this step were improved. Data on PCR diagnosis is captured via clinic registries and monthly health facility level reports. Subsequently, the number of HIV-infected newborns identified through PCR testing within 8 weeks of life is entered to calculate the proportion of HIV-infection in tested infants, and provide a denominator for the last cascade step.

Step 7. Eligible babies enrolled in cART. The number of children initiating cART is used to estimate the proportion of eligible children initiating cART, and the added number who would initiate cART if this step were improved. These data are sourced from clinic registries and monthly health facility reports.

Study procedures were approved by the Ethics Committee of the Mozambique Ministry of Health, and was determined to be non-research by the University of Washington Institutional Review Board.

Discussion

This paper describes the process of developing a systems analysis tool for pMTCT services (PCAT). The PCAT is intended to be a decision-making support tool for front line health workers and district managers by providing a comprehensive understanding of their systems' performance, covering the ANC, delivery, and post-partum phases for mothers and their newborn children. After iterative testing, the PCAT has been streamlined to capture key steps of the pMTCT cascade, and be user-friendly for stakeholders in resource-constrained environments to be used as adjunctive support for quality improvement in pMTCT.

A primary strength of the PCAT is that it was designed for use in settings with limited resources and high HIV burden. By relying on routinely-collected data (or data available through clinic registries), the PCAT can be readily populated to provide a rapid guide on where to intervene in the pMTCT cascade to maximize the number of women and children receiving successful pMTCT. The PCAT is open-source, available in English, French and Portuguese, and is highly flexible to meet the needs and context where it is intended to be applied. The PCAT can use data from any time period (such as one month, six-months or one year of data), or aggregate the level of the health system (facility, district or province) depending on the needs of the user.

Lessons Learned through PCAT Development

The PCAT development process and resulting tool provides a number of lessons learned that influence its use for quality improvement efforts.

Maximizing Function

Numerous papers have documented the use of cascade drop off, specifically identifying the number of eligible patients not receiving services by cascade step. However the addition of the maximizing function provides health facility managers with information on how many additional people will be served if only one step is improved to 100% capacity while others stay the same. This information can be extremely helpful in identifying where in the pMTCT cascade interventions to intervene. Although not a panacea, the PCAT can be a powerful tool for health facility managers who are most able to make a difference in their workplace service flow.

Data quality

Because it will influence service delivery modifications, the PCAT requires data of acceptable quality, which can be a challenge in resource-constrained health systems facing high HIV burden. For example, over or underestimates of utilization may result from inaccurate catchment population estimates. By engaging frontline health workers and managers in PCAT implementation, the process is designed to focus attention on areas of potential poor data quality (such as unrealistic numbers), with the intention of improving data quality.

Making Choices

To encourage PCAT use, the tool was pared down to a minimum number of steps within the PMTCT cascade. Because the PCAT is designed to guide interventions in pMTCT within ANC, maternity, and at-risk child visits, these phases were included in the PCAT. Critical areas such as family planning, linkages to long term ART for mom and baby, and community linkages were not included. These are areas of great importance, which merit further study and adaptation but were not in the scope of this paper.

In addition, CD4 testing was not included in this cascade for two reasons. With the advent of Option B+, which places all HIV-infected mothers on ART regardless of CD4 levels, this measure is no longer a critical step in the pMTCT cascade. In addition, a transition of partner support resulted in extremely limited data availability for this measure. As a result, over half of the sites reported no available data, which made beta testing extremely difficult.

Shopping Around

In large, urban areas with multiple health facilities, we found that it is common for pregnant and post-partum women to seek services at multiple facilities depending on factors such as proximity, desire for anonymity, perceived service quality, and availability of specialized services. Thus, a woman may attend one facility for ANC, another for birth and still another for at-risk care for newborns. As a result, in urban areas the PCAT may under or over-estimate service utilization across the pMTCT cascade at the facility level. However, discussion based on the PCAT can lead to an appreciation of these dynamics by facility staff, and based on iterative application of the PCAT with quality improvement activities, the PCAT data may become more accurate as retention improves at individual facilities over time.

Shifting pMTCT Strategies and Forms

The PCAT development process coincided with the introduction of Option B+, which changes strategy to initiate lifelong cART for pregnant women after HIV diagnosis. This change has simplified the PCAT by eliminating CD4 as an entry barrier for cART or PPO. Furthermore, new forms were introduced during PCAT development, including MCH ‘passports’ that include longitudinal patient data for mothers and children, new clinic registries and monthly reporting formats. In some instances these modifications were designed to address needs for patient-level care indicators and donor requirements rather than systems strengthening efforts. An example of this is the selection of the number of CD4 tests under 350 cells/mm^3 rather than the total number of CD4 tests carried out, which is an essential indicator for assessing pMTCT system functioning prior to the introduction of Option B+. The PCAT is sufficiently flexible to address changes in clinical protocols and changes in reporting format.

Our experience suggests that it is feasible and appropriate to adapt this cascade analysis tool for pMTCT services at the health facility level as a starting point for discussions of where to implement improvement strategies. The resulting PCAT does not stand alone, but requires engagement with frontline health workers and managers to fill out, interpret and apply the tool, and then follow up with QI activities. Further research on how to encourage adoption, interpretation, and sustainability of the PCAT by frontline health workers and managers is needed. However, the PCAT is available for application and further refinement, and provides a platform to improve the use of data for decision-making as an interim step towards improving service delivery and patient health outcomes.

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Appendix.
QUESTIONNAIRE ON MODIFIABLE AND NON-MODIFIABLE HEALTH SYSTEM FACTORS RELATED TO PMTCT

CATEGORIES FOR VERIFICATION								**SOURCE ***
1		Province/District and HF Code						I
2		Date		____/____/_________ (DD/MM/YYY)				V
3		Health facility characteristics (CIRCLE ONE)	a	Rural (0)/ Urban (1) / Peri-Urban (2)				V
			b	Teaching/Referral Hospitals (0)/ Provincial Hospitals (1)/ District/Rural Hospital (2)/ Urban Health Center (3)/ Rural Health Center (4)/ Health Post (5)				I
			c	Public (0)/ Private (1)/Faith-based/NGO (2)				I
			d	NGO support: None (0)/ One (1)/ Multiple (2)				I
4		Year of pMTCT initiation		_____/_____/______ (DD/MM/YYYY)				I/HIS
5		Population served by health facility (catchment area)						I
6		Distance to the reference area laboratory (km)--for CD4						I
7		How many 1st ANC visits in the last 6 months?						HIS
8		How many institutional deiveries in the last 6 months?						HIS
9		How many **total** post-partum care visits in the last 6 months? (including 48 hours to 10 week check-ups)						Maternity & postnatal registries
10		How many modern family planning methods were delivered in the last 6 months?		**Types**	**Number delivered in 2012**			
				Pill cycles				R
				Injectibles				R
				Implants				R
				IUD				R
Human Resources								
11		Number of nurses working in MCH services in this facility						
12		Number of health workers by level and training area working in pMTCT (ANC, maternity, post-partum care, outpatient care)		**Category**	**Number**	**List primary sector**	**Works in more than 1 sector?**	
			a	MD/Non-physician clinician				HR DIST
			b	Superior level nurse				HR DIST
			c	Mid-level nurse				HR DIST
			d	Basic-level nurse				HR DIST
			e	Midwife				HR DIST
			f	Social worker				HR DIST
			g	Other				HR DIST
			h	Other				HR DIST
			i	Other				HR DIST
			j	Custodial staff				HR DIST

13		How many nurses/midwives joined your facility in the last year? (include both new cadres and replacements)				I
14		Are there community health workers/volunteers who carry out active tracing for women and children lost to follow-up?	**Yes**	**No**		I
15		If yes, describe the number and function of these community health workers/activists	Themes covered	Adherence		I
				Child nutrition		I
				Dual protection		
				Other		I
16		Are there support groups for HIV infected women in your facility?	**Yes**	**No**		I
System for distributing HIV testing supplies (gloves, lancets, capillary tubes, Determine test strips						
17		In the Pharmacy, at what interval do you receive requisitions from the MCH sectors of your health facility? (verify in the requisition book) - CIRCLE ONE OPTION	Weekly (0), bi-weekly (1), monthly (2), quarterly (3), without schedule (4)			I
18		In the Pharmacy, at what interval do you deliver the consumables to the MCH sectors of your health facility? (verify in the received materials forms)-CIRCLE ONE OPTION	Weekly (0), bi-weekly (1), monthly (2), quarterly (3),without schedule (4)			I
19		In the PHARMACY, have you had stock ruptures in the last 3 months? If yes, how many days? (verify in the registries if there are data gaps)		**Yes**	**No**	**Nº de dias**	
			Gloves				I/V/R
			Lancets				I/V/R
			Capillary tubes				I/V/R
			Determine				I/V/R
20		In ANC, have you had stock ruptures in the last 3 months? If yes, how many days? (verify in the registries if there are data gaps)	Gloves				I/V/R
			Lancets				I/V/R
			Capillary tubes				I/V/R
			Determine				I/V/R
System for distributing registries and forms (MCH registries, ANC forms)						
21		In ANC, what is the periodicity for requisitioning registries and forms, including ANC, Maternity, Post natal, pre ART and ART registries? (verify in the requisition forms)- CIRCLE ONE OPTION	Weekly (0), bi-weekly (1), monthly (2), quarterly (3), without schedule (4)				I/V/R
22		In the ANC, what is the periodicity for receiving these materials, including ANC, Maternity, Post natal, pre ART and ART registries? (verify in the received materials forms)-CIRCLE ONE OPTION	Weekly (0), bi-weekly (1), monthly (2), quarterly (3), without schedule (4)				I/V/R
23		In ANC, Maternity, Post Partum care, and At-Risk care, have there been stock outages of registry books during the last 3 months? (Verify the registry books for data gaps)	**Yes**		**No**		I/V/R
24		In ANC, have there been stock outages of daily or monthly reporting forms during the last 3 months?					I/V
25		Verify if there are ANC forms/MCH booklets available					I/V
Distribution system for medicines (NVP, 3TC, AZT, cART)						
26		At the pharmacy what is the periodicity for receiving medicine requisitions from the MCH sectors? (Verify in the requisition books)-CIRCLE ONE OPTION	Weekly (0), bi-weekly (1), monthly (2), quarterly (3), without schedule (4)				I/V/R
27		At the pharmacy, what is the periodicity of sending on these medicines to the MCH	Weekly (0), bi-weekly (1), monthly (2), quarterly (3), without schedule (4)				I/V/R

		services? (Verify in the received materials forms) -CIRCLE ONE OPTION					
28		At ANC have there been stock outs of pMTCT medicines? (Verify in the registry book for data gaps)		**Yes**	**No**		
			NVP				I/V/R
			3TC				
			AZT				I/V/R
			cART				I/V/R
29		In ANC, how many days have there been of stock rupture of pMTCT medicines over the past 3 months? (Verify in the registry books)	NVP				I/V/R
			3TC				
			AZT				I/V/R
			cART				I/V/R
Health Information System							
30		Compare data registries for different MCH components (daily and monthly registries: ANC, maternity, post-partum care, family planning, at risk child visits? Compare for concordance in the past 30 days (last available completed month)	**Daily Registry**		**Monthly Report**		
		ANC # 1st ANC visits					I/V
		Maternity # institutional births					I/V
		Postpartum # post partum visits					I/V
		Family Planning # modern family planning methods distributed					I/V
		At-risk child visit # at risk child visits					I/V
31		Is there an improvised registry in place?					I/V
32		If yes, what purpose does it serve (what data does it capture)?					I
Service Management							
33		Are there monthlyfacility level management meetings?					I/V
34		Are there regular linkages with the community through outreach service provision, campaigns, education sessions, or community meetings? (at least quarterly)?					I
35		Verify meeting notes from previous management meetings and/or participate in a meeting. **Themes discussed**		**Yes**	**No**	**Duration of discussion (minutes)**	
			Analysis of supply levels				I/V
			Requisitions made				I/V
			Data review				I/V
			Other				I/V
Service Organization							
36		Are there linkages between the sectors that carry out pMTCT activities (ANC, Maternity, Post-partum care, Family Planning, At-risk child chare) and other sectors (sharing of codes of HIV-infected pregnant women)?		**Yes**	**No**	**# Of days**	
	Outpatient care						I
	a	Are mothers referred systematically to outpatient services after delivery?					
	b	Are babies systematically referred after PCR or rapid test diagnosis in at-risk care?					
	Laboratory						I
	c	Are CBCs done at this facility?					I/V
	d	Are Biochemistry panels done at this facility?					I/V
	e	Are CD4 analysess done at this facility?					I/V
	f	Are PIMA CD4 analyses done at this facility?					I/V

	g	Are blood draws done for HIV-infected women the same day they are identified?				I/V
	h	Is there a functioning refrigerator at this health facility?				
	i	Is there a functioning air conditioner at the health facility?				
	j	How many days a week are blood draws done for CD4 analysis?				I
	k	How many days over the past 3 months was there **no transport** for CBC or Biochemistry panels?				I
	l	How many days over the past 3 months was there **no transport** for CD4 samples?				I
	Pharmacy					
	m	Is pMTCT prophylaxis distributed in ANC/at the maternity?				I/V
	n	Is ART distributed at the pharmacy?				I/V
					Sector name	
37		What is the flow of HIV+ pregnant women at this health facility to receive the following services? Please list where these services are carried out (ANC, Mat, Pos-Partum, At-risk child consult)	Counseling			I
			HIV testing			I
			Patient chart initiation			I
			CD4 blood draw			I
			Clinical staging			I
			cART initiation			I
			Family planning			I
			Infant HIV diagnosis			I
38		**Service OBSERVATION** (Observe at least 10 consults to calcualte the mean duration of each consult in minutes)--Please sit outside the office and annote time. DO NOT sit inside the consult room.	Average time of 1st ANC visit			V
			Average time of at-risk child visit			V
			Average time of post-partum care visit			V
			Wait time between PCR blood draw and receipt of results at the facility			V

*KEY: V:visit/direct observation, I: interview with health facility/reproductive health service manager, HR DIST: Human resources at the district level, R: registers, HIS: routine health information system,cART: combination antiretroviral therapy