# THE IMPACT EVALUATION OF A PBF PILOT IN CENTRAL AFRICAN REPUBLIC

## Research Protocol

November 6th, 2012

# Background

**Central African Republic (CAR) is a very poor country that has recently emerged from over a decade of armed conflict**. CAR is a land-locked country with an estimated population of 4.3 million (2009), and an average per capita GDP of approximately US$350 (2009)[i]. The overall poverty headcount ratio is 62 percent and over three-fifths of the population subsists on less than US $1.25 per day[ii]. CAR has also suffered from more than a decade of conflict and political instability. Unsurprisingly, the conflict has had important adverse consequences for economic growth and welfare. Illustrating the point, CAR was ranked 179$^{th}$ out of 182 countries in the Human Development Index in 2009.

**CAR has made little progress in improving health status- maternal and child health remains extremely poor, particularly in rural areas**. CAR is not on track to achieving the health MDGs[iii] (See figures 1 and 2 below). About 176 of every 1,000 babies born die before age five, while about 106 of every 1,000 infants born die before their first birthdays[iv]. As a result of political and social unrest in the last decade, the maternal mortality ratio increased to 1355 in 2003. The available data – which may not be very reliable – suggest that it may have decreased sharply to 540 in 2006. Yet, the target of 171 deaths per 100,000 in 2015 will not be achieved. The Total Fertility Rate also remains high at 4.8 births per woman as of 2008[v]. Rural areas are considerably worse-off in terms of health than urban areas. To illustrate, the Under Five Mortality Rate (U5MR) is 126 per 1,000 in urban areas compared to 199 per 1,000 in rural areas. Similarly, the Infant Mortality Rate (IMR) is 119 per 1,000 in rural areas compared to 79 per 1,000 in urban areas[vi].

**Utilization of critical maternal, child and reproductive health services remains very low and is especially low in rural areas.** Only 53% of deliveries are attended by a skilled attendant in CAR. At 36% of deliveries, this figure is even lower for rural areas[vii]. A mere 32% of all 12-23 month olds in CAR are fully immunized. The prevalence of malaria is very high and is an important cause of morbidity and mortality: over 13% of under-fives had malaria in the four weeks preceding a recent household survey[viii]. Despite this, only a third of under-fives in the country sleep under any bednet (treated or non-treated) and only 57% of under-fives with fever were treated with an appropriate anti-malarial. In rural areas bednet use is even lower at 22% while only 47% of rural under-fives with fever are treated with an anti-malarial. Modern contraceptive use is a mere 8.6% in the country as a whole[ix].

**Available data on services delivered per health worker indicate that service volumes are quite low relative to the human resources available.** Averages of 4 outpatient consultations are delivered each day per health worker with curative care responsibilities. The corresponding figure for maternal health services is a little over 4. Furthermore, in both cases there are considerable differences between regions. The analysis suggests that service utilization is quite limited relative to the clinical human resources available, and that considerable room for improvement exists both across the board and in health regions such as Région Sanitaire (RS) 3 where a health worker sees 2 outpatients each day on average. This analysis cannot shed any light on potential demand-side barriers that may be constraining service utilization. However, the available data on quality suggest that limited utilization may also reflect quality shortcomings and that creating a good quality supply of health services that can meet current levels of latent demand for health services may be an essential first step[x].

***Table 1 : Evolution of key health indicators in CAR***

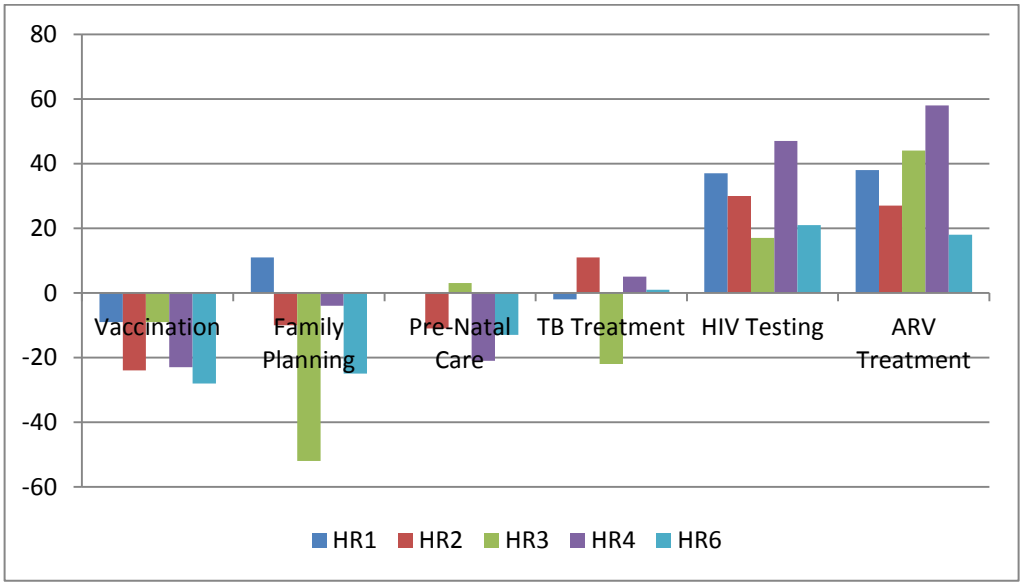
| Indicators | 1995 | 2000 | 2006 | 2010 |
|---|---|---|---|---|
| HIV/AIDS Prevalence 15-49 years (%) | - | 6.4 | 6.3 | 4.9 |
| At least 1 antenatal visit (%) | 67.0 | 62,05 | 69.0 | 68.3 |
| Births attended by skilled personnel (%) | 50 | 42 | 53.4 | 53.8 |
| Contraceptive Prevalence (%) (modern methods) | 3.0 | 6.9 | 8.6 | - |
| Children 12-23 months old fully immunized % | 36.6 | 19.2 | 32 | - |
| Measles vaccine coverage (%) | 52.4 | 33.5 | 62 | 49.8 |

Source: DHS (1994/95), MICS-2 (2000), MICS-3 (2006), and MICS-4 (2011).

**Available data suggests that physical and financial access and quality are important problems in the CAR health system.** A national household survey[xi] found that 26% of respondents reported needing health services in the four weeks preceding the survey. Of these, however, only 13% used any health services. Among those who used health services, over half (53.6%) reported being dissatisfied. High cost (57.2%), long wait times (27.0%), drug stockouts (27.2%), the long distance to health facilities (18.8%) and the perceived ineffectiveness of treatment (21.4%) were all cited as causes of dissatisfaction. Overall, 35% of respondents reported having to travel over an hour to reach a health facility. When disaggregated by residence, only 9% of urban residents reported travelling for over an hour while nearly half (48%) of rural residents reported travel times exceeding one hour indicating that physical access to care may be especially limited in rural areas.

**Service availability for non-HIV services has fallen in all the regions between 2006 and 2011, but RS 3 and 6 show the biggest declines.** With the exception of post natal care, the proportion of health facilities offering non-HIV related MCH services has dropped for most regions between 2006 and 2011. For example, in Région Sanitaire 6, only one third of health facilities had functional delivery (34%) and cold chain equipment (35%). Less than 57% of health facilities offer *any* immunization services− this needs to be expanded considerably if the currently high rates of under-five mortality are to decline. Furthermore, only 44% of health facilities offer any FP services and only 26% of facilities offer TB treatment. Half or less than half of all health facilities had vaccines, oral contraceptives or vitamin A pills in stock on the day of the survey. Région Sanitaire 1, however, has been able to maintain its non-HIV services to a greater extent than the other regions. HIV-related services have not been affected by this trend[xii].

**Chart : Percentage point change in facilities offering key services between 2006 and 2011 by Région Sanitaire**




**Shortcomings in CAR's health information system do not allow for proper monitoring and evaluation of health sector performance.** Only 43% of health facilities overall had the necessary data collection tools (forms or registers) required for reporting to the routine reporting system (Health Management Information System or HMIS). Hospitals are far more likely to have tools (64%) than Centres de Santé (56%) or Postes de Santé (34%). Overall 66% of health facilities transmitted the trimester report for the most recently completed month. There exists no mechanism for data verification at the various levels of the health system, while the compiling and processing of data remains purely administrative.

**Clinical health workers' knowledge on how to manage complicated maternal and child health cases; is quite low.** In a recent facility-based study, midwives and auxiliary midwives were questioned on maternal care while nurses and nursing assistants were questioned on malaria and diarrhea. All staff were questioned on immunization. The score on how to appropriately treat child malaria or diarrhea cases was less than 50/100. While the staff dedicated to maternal care were mostly able to cite proper treatment protocol on ANC and deliveries, while they were less able (less than 40/100) to cite steps on how to behave in front of more complicated maternal cases (Woman bleeding during/after delivery).

Given the context of CAR's poorly functioning health sector, appropriately designed Performance Based Financing (PBF) can potentially help to address many of the abovementioned challenges by:

1. Improving the alignment between resource allocation and maternal and child health needs by purchasing priority service delivery indicators at higher rates;
2. Allowing facilities to retain PBF funds for use at the operational level, and giving facilities management autonomy on how to use these funds;

3. Creating incentives for health facility managers and health workers to expand coverage of important public health services and improve their quality by linking facility payments to service delivery and quality indicators, and offering health workers bonuses that are linked to facility performance;
4. Improving governance through better verification and oversight of performance and introducing incentives for good performance.

There are promising indications from a number of countries in Sub Saharan Africa that suggest that PBF may be a useful approach to address the types of challenges evident in CAR. The Rwandan experience with PBF has attracted considerable interest and has had promising results in terms of increasing the proportion of staff in public sector facilities, increasing financing to the prefecture level and improving the coverage of key maternal and child health services[xiii]. Neighboring Burundi has also – albeit more recently – implemented a PBF program that is similar to the one planned in Cameroon. Some promising preliminary results are available from Burundi. Since PBF has been implemented, facilities in Burundi are more likely to have the full complement of skilled staff (an increase from 37% in 2006 to 71% in 2010) and coverage of important health services such as skilled birth attendance has increased from 57% in 2006 to 82% in 2010 while contraceptive prevalence − often slower to change − has increased from 9% to 16%[xiv].

Over time, PBF has been implemented in a growing number of countries. Many studies have shown a positive association between PBF and health service coverage, and some with improvements in quality. An impact evaluation in Rwanda where prefectures were randomly assigned to treatment (PBF) and comparison (input financing with matched financial resources) groups found large and statistically significant positive impacts on institutional deliveries and preventive care visits from young children and also on the quality of prenatal care[xv]. However, a lack of controls and the presence of confounders in most studies that have been published on PBF initiatives[xvi] means that the *impact* of PBF initiatives on service coverage, quality and health outcomes remains open to question. Moreover, few studies have examined the factors that influence the impact of PBF− an area of considerable operational significance since PBF often involves a package of constituent interventions: linking payment and results, independent verification of results, managerial autonomy to facilities and enhanced systematic supervision of facilities[xvii].

## Prior experience with PBF in Central African Republic

**Several PBF-oriented programs have recently been introduced successfully in CAR. Several PBF-oriented programs have recently been introduced successfully in CAR.** An EU-financed PBF pilot "Amélioration des Soins de Santé de Base dans les Régions Sanitaires 1 et 6" (ending in 2012) is currently being implemented in 4 of 16 districts (prefectures) in CAR and covers a total population of 1.01 million inhabitants. Cordaid (an international NGO with extensive PBF experience) has been contracted as the PPA since 2009. Within the context of this project, performance-based contracting in the education sector was also piloted in several primary schools. The mid-term evaluation of the project highlighted the critical role of a steering committee in both overseeing the project implementation from the central level as well as ensuring that lessons learned from the pilot were shared with other health sector partners interested in promoting PBF in CAR. Experience from the pilot project also identified that in CAR, paying for performance did not lower the overall cost borne by clients, despite the increase in utilization and quality of services. As a result, the mid-term evaluation also recommended that the reduction of the cost of services to clients should be included as a specific indicator of PBF.

**Outside of the EU-financed project, since 2008 Cordaid has implemented PBF in an additional health prefecture in Region 2, while several other NGOs (Aide Médicale Internationale, or AMI; the International Rescue Committee; etc.) have also introduced forms of performance-based bonuses to increase accountability and the quality of services of health centers**. AMI has put a particular focus on reducing financial barriers to care. The level of bonus payments a contracted health facility is awarded is linked to how much service fees and the cost of drugs are reduced. An external evaluation of the Cordaid project in Region 2 provided several key lessons on PBF in CAR: (i) increased utilization was achieved through both improving the quality of care and reducing service fees and the price of medicine; (ii) gains in community mobilization and ownership were attained through contracting local organizations to conduct counter-verification activities; (iii) the health information system was strengthened through improvements in the routine reporting system and submission of monthly facility reports; and (iv) increased involvement of the local health management committee (Comité de Gestion, CoGes) was an important factor in contributing to good governance and accountability at the facility level. It was also noted that the poor health information system did not allow for the development of a strategic vision for PBF by the prefecture level health authorities. As a result, ownership of the PBF initiative at the regional and prefecture levels remained limited. Ensuring that local health authorities are able to define local health priorities is an essential element to successfully implementing PBF.

## Proposed PBF pilot in Central Africa Republic

The proposed pilot will learn from prior experience with PBF in CAR. The pilot will implement PBF in public, Faith Based Organization (FBO) and not-for-profit non-governmental organization (NGO) facilities across 7 prefectures in the 2nd, 3rd, 4th and 6th regions of CAR covering a total population of approximately 2.5 million[1] (see Table 2 below). International NGOs with the best PBF technical proposals will be hired to design PBF programs in each of these four regions in consultation with the Ministry of Health, Population, and the Fight against HIV/AIDS. However, drawing on the experience of Central African Republic, Burundi and Rwanda, the PBF implemented will likely have the following key features:

- Performance contracts will be signed between a Performance Purchasing Agency (PPA) and public and non-profit private sector health facilities in each region. These performance contracts will govern results-based payments to facilities, and performance bonuses from facilities to their health workers.
- The pricing for each output to be purchased from health facilities will take into account both public health priorities and the need to incentivize the delivery of high quality services. The outputs to be purchased from health facilities will include service output indicators for priority MCH services adjusted for patient satisfaction/ perceived quality and facility-level indicators of quality. These

[1] The four regions for the PBF pilot were identified in consultation with the Government of Central African Republic as the Health System Support Project (HSSP) was being developed in September 2011. The opportunity for building an impact evaluation into the pilot was identified during the early stages of the project's development. The four regions selected were chosen due to the poor service delivery and health status outcomes observed in area. Region 1 was excluded due to its proximity to Bangui and relatively satisfactory health outcomes, while Region 5 was excluded due to security concerns. Region 7 is Bangui the capital and thus not a rural setting. Thus, the selected regions do not necessarily provide a representative sample of CAR.

outputs will be verified by one or more third parties (typically the PPA). The final list of services to be purchased will be decided when the Ministry of Health begins the process of negotiating PPA contracts.

- Facilities will have the management autonomy to use PBF payments based on priorities identified in their business plans, including to offer health worker performance or retention bonuses or to purchase inputs. Facilities will have the management autonomy to decide the level of performance bonuses to their health workers within limits defined by the contracts between the PPA and health facilities. Facilities will also have the management autonomy to hire and fire staff hired with PBF revenues.
- Facilities will have the autonomy to procure medicines from government-approved distributors and retail outlets, and will not be obliged to procure their medicines from any single source.
- Facilities will have to adhere to defined guidelines on the use of PBF revenue.

The details of PBF design will be finalized at a later stage. However, it is important to point out that PBF will be designed such that it is as uniform as possible across regions. The services to be purchased will be uniform as will unit prices for outputs to be purchased with a similar equity adjustment formula to adjust for remoteness or other disadvantage. PPA NGO overheads will be negotiated to similar levels so that the amounts allocated for PBF implementation are similar across regions. Monitoring and supervision processes and frequency will also be the same across regions. Finally, the frequency of payments will also be uniform across regions.

***Table 2: Health facilities and population estimates within the PBF pilot and Impact Evaluation zone***

| | Region | Prefecture | Population (2011) | # Health facilities | | | Total |
|---|---|---|---|---|---|---|---|
| | | | | Hospital | Health Center | Health Post | |
| 1 | 2 | Mambéré Kadéi | 424,833 | 2 | 20 | 12 | 34 |
| 2 | 2 | Sangha Mbaéré | 117,709 | 1 | 11 | 14 | 26 |
| 3 | 3 | Ouham | 429,987 | 1 | 18 | 33 | 52 |
| 4 | 3 | Ouham-Pendé | 501,359 | 2 | 11 | 13 | 26 |
| 5 | 4 | Ouaka | 322,251 | 1 | 22 | 32 | 55 |
| 6 | 4 | Kémo | 137,910 | 1 | 10 | 19 | 30 |
| 7 | 4 | Nana Grébizi | 137,206 | 1 | 5 | 22 | 28 |
| | | **Sub-total** | **2,071,255** | **9** | **97** | **145** | **251** |
| 8 | 6 | Mbomou* | 191,002 | 0 | 21 | 26 | 47 |
| 9 | 6 | Basse-Kotto* | 290,155 | 1 | 15 | 28 | 44 |
| | | **Total** | **2,552,412** | **10** | **133** | **199** | **342** |

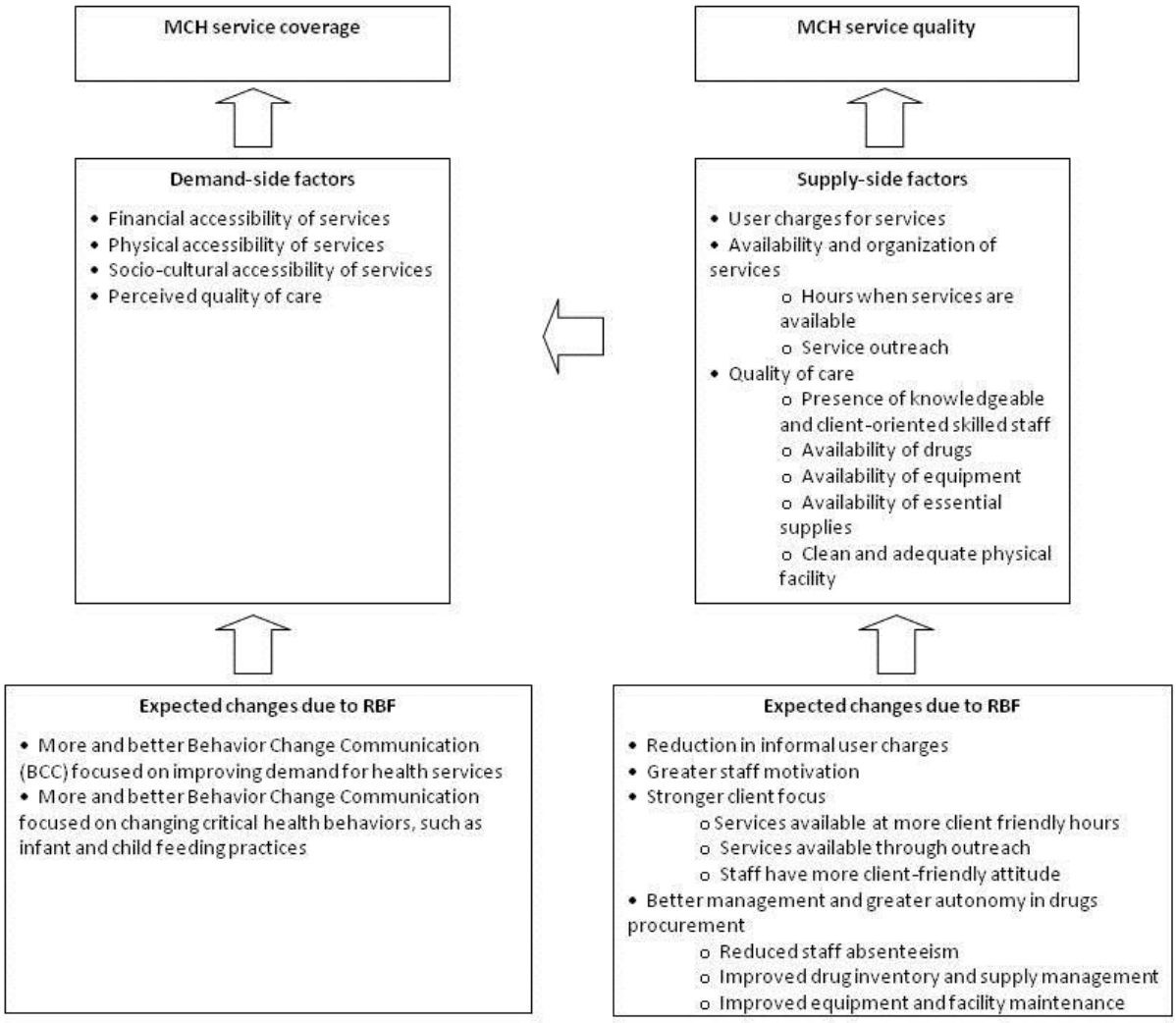
* Note- Mbomou and Basse-Kotto prefectures will be included in the implementation of PBF in CAR, but will be excluded from the Impact Evaluation sample as PBF has already been introduced in these prefectures. Health facility and household baseline surveys will also be conducted, but their data will be excluded from IE estimates.

# Research Questions and Policy Relevance

**How will RBF improve these targeted outcomes?**

Figure 1 describes the hypothesized manner in which PBF will trigger changes that can improve MCH service coverage. The PBF interventions envisaged will be focused primarily on the supply side. We expect PBF to improve MCH service coverage and quality primarily by incentivizing facility managers and health workers:

**Figure 1: How does PBF affect MCH service coverage and quality**




1. Purchasing priority quality-adjusted service outputs can incentivize facility managers and health workers to expand the delivery of priority and high quality MCH service outputs in a client-focused manner and to increase demand for health services
2. Independent monitoring can also encourage managers to manage for results while managerial autonomy and supervisory support can enable them to respond to these incentives
3. Performance bonuses to health workers can incentivize health workers to adopt a client-friendly attitude, reduce absenteeism and reduce informal charges to patients

We expect that this will, in turn, result in important changes at the health facility level such as:

1. Lower user charges
2. More accessible health services
3. Better facility functioning and improved quality of care, and
4. An increased focus on generating demand for health services

Better technical quality of care is one of the intended outcomes. In addition, we expect that the facility-level changes that are triggered by PBF can influence care-seeking and health behaviors and ultimately lead to improved MCH service coverage. Lower user charges can improve financial access to health services, more client friendly hours can improve physical access to health services, while demand generation activities and improved technical quality of care can lower socio-cultural barriers to service use and encourage greater service uptake.

**Research questions**

As PBF has never been systematically evaluated in Central African Republic on any meaningful scale, our larger policy objectives are to: (a) identify the impact of PBF on maternal and child health (MCH) service coverage and quality, (b) identify key factors responsible for this impact, and (c) assess cost-effectiveness of PBF as a strategy to improve coverage and quality. In doing so, we expect that the results from the impact evaluation will be useful to designing national PBF policy in CAR and will also contribute to the larger body of knowledge on PBF.

The impact evaluation will focus on the following primary research questions:

1. Does the PBF program increase the coverage of MCH services?
2. Does the PBF program increase the quality of MCH services delivered?
3. Does varying the level of PBF payments for MCH services delivered lead to variations in MCH service coverage and quality outcomes? Or can similar results be achieved at lower cost?
4. What is the optimal fee schedule (level of PBF payments) for improving MCH service coverage and quality?

Resource allocation and purchasing procedures have important implications for cost, access, quality, and consumer satisfaction. Efficiency gains (both technical and allocative) from purchasing arrangements provide better value for the money and therefore provide a means of obtaining additional "financing" for the health system. Moreover, the efficiency of a system has important financial implications for long-term fiscal sustainability and for governments to find the "fiscal space" in highly constrained budget settings for large increases in public spending.

The effects of a payment scheme on health-sector performance are heavily influenced by how rates are set. High rates can lead to higher costs, incomes, and profits. Low rates can discourage supply or undermine quality. In this sense, the impact evaluation will measure the effect of various levels of PBF payments on MCH service coverage and quality in order to estimate optimal payment levels for improving MCH outcomes.

In addition to the abovementioned primary research questions, the impact evaluation will also examine the following secondary research questions that relate to intermediate outcomes in the hypothesized causal pathway describing the relationship between PBF and improved MCH service coverage and quality (see Figure 1 for more details):

1. Does the PBF program lower informal charges for health services?
2. Does the PBF program lower formal user charges?
3. Does the PBF program increase funds available at the facility level (as management autonomy may lead to more efficient use of resources)?
4. Does the PBF program improve physical and social accessibility of health services? Accessibility of health services will be examined in terms of the convenience of facility opening hours, availability of services through outreach, client perceptions of convenience of accessing health services and client perceptions of health providers' attitudes towards clients
5. Does the PBF program lower staff absenteeism?
6. Does the PBF program increase demand generation activities by health facilities?

**What are the targeted outcomes that will be measured by the impact evaluation?**

The main targeted outcomes that the impact evaluation will measure fall into two main groups: (a) maternal and child health service coverage indicators and (b) quality of care indicators. Tables 3 and 4 below describe these indicators in more detail. In addition to the technical quality of care indicators described in Table 4, the impact evaluation will also measure client perceived quality with a scale developed for the Central African context.

For the purposes of PBF implementation, the service coverage indicators will be expressed as outputs (rather than coverage indicators with population denominators) and collected routinely by health facilities. These data will then be verified by the PPA or a third party entity designated by the PPA to carry out this function. Quality indicators will be monitored by a PPA or other third party for each facility using a supervision checklist. These routinely collected data will not be used for the purposes of the impact evaluation.

In addition to the abovementioned routine data collection associated with PBF implementation, the impact evaluation will collect data on service coverage and health behaviors using household surveys, while facility surveys will be implemented for the quality indicators.

***Table 3: Impact Evaluation MCH service coverage indicators***

| | **Indicator** | **Coverage/ Expenditure** |
|---|---|---|
| 1 | Proportion of children under 1 year who are fully immunized** | 30% |
| 2 | Contraceptive Prevalence Rate (modern methods)** | 15% |
| 3 | Unmet need for Family Planning* | 23% |
| 4 | Children under 3 years who have received Vitamin A* | 60% |
| 5 | Skilled birth attendance** | 54% |
| 6 | Women who have had 1 antenatal care visits in most recent pregnancy** | 68% |
| 7 | Women who have had 4 or more antenatal care visits in most recent pregnancy** | 31% |
| 8 | Children aged between 11 and 59 months who have participated in growth monitoring in the previous month | Not available |
| 9 | Women who received at least two tetanus toxoid vaccinations in most recent pregnancy* | 51% |
| 10 | Children aged under 6 months who are exclusively breastfed* | 23% |

*Source: MICS 2006
**Source: MICS 2011

***Table 4: Impact Evaluation facility-level quality indicators[a]***

| | **Indicator** |
|---|---|
| 1 | Proportion of full complement of clinical staff present on the day of survey |
| 2 | At least one female clinical staff present on the day of survey |
| 3 | Proportion of health facilities with water for hand washing, soap and clean towel in patient examination area |
| 4 | Proportion of health facilities with at least one clean and functioning latrine |
| 5 | Proportion of health facilities with basic EPI equipment |

| | Indicator |
|---|---|
| 6 | Proportion of health facilities with EPI vaccines in stock on the day of the survey |
| 7 | Proportion of health facilities with basic delivery equipment |
| 8 | Proportion of health facilities with basic ANC equipment |
| 7 | Proportion of health facilities with basic clinical equipment |
| 9 | Number of essential drugs available on the day of the survey |
| 10 | Average number of contraceptive methods in stock on the day of survey |
| 11 | Proportion of health facilities with bednets in stock on the day of the survey |
| 12 | Proportion of facilities with an up-to-date EPI register |
| 13 | Proportion of facilities with an up-to-date ANC and delivery register |
| 14 | Proportion of facilities with completed HMIS monthly report |
| 15 | Proportion of facilities that have a working waste disposal system (bin, pit or incinerator) in use and safety box for sharps |
| 16 | Proportion of facilities that can perform lab tests for malaria, TB, HIV and full blood count on the day of the survey |
| 17 | Proportion of facilities with working means of communication (radio, mobile phone, landline) |
| 18 | Proportion of facilities with a working vehicle to transport patients for referral |
| 19 | Proportion of health workers who report receiving their full salary on time |
| 20 | Average health worker clinical knowledge score[b] |
| 21 | Under-five examination quality score (based on IMCI protocols) |
| 22 | ANC examination quality score (based on national ANC protocols) |
| 23 | Average client satisfaction score |
| 24 | Proportion of health facilities that conduct outreach for key MCH services |
| 25 | Proportion of clients who report that facility opening hours are convenient |

[a]No data are available on these indicators

[b]Health worker knowledge will be measured using case vignettes, which are to be finalized. The vignettes will be focused on services to be purchased under PBF, tailored to the epidemiological profile of CAR and will keep in mind national protocols.

The impact evaluation will also measure indicators that could potentially mediate improvements in service coverage and quality (primary outcomes of interest). These include:

1. Informal charges and formal user charges
2. Funds available at the operational (i.e., facility) level
3. Factors that determine physical and social accessibility of health services, including facility opening hours, outreach for health services and staff behaviors
4. Staff absenteeism
5. Demand generation activities such as Behavior Change Communication by facility staff

In addition, the impact evaluation will also measure the following health status indicators through rapid blood tests and anthropometry:

- Prevalence of malaria among children aged under 5 and currently pregnant women (only at endline)
- Prevalence of anemia among children aged under 5 and non-pregnant women who have delivered a baby in the preceding 2 years (only at endline)
- Weight and height of children aged under 5 years, mothers of children less than two years of age, and pregnant women (both and baseline and endline)

These health status measures are not the primary target outcomes of the impact evaluation, however, and the study may not have adequate power to detect statistically significant changes over a two year time frame. These data are being collected in anticipation of further rounds of data collection after the two-year impact evaluation.

# Identification Strategy

The study will be a blocked-by-region cluster-randomized trial (CRT), having a pre-post with comparison design. We will rely primarily on experimental control to answer the main research questions for this study. Individual health facilities in each region will be randomized to one of the 3 study groups. Individual public and private not-for-profit Health Centers [Centres de Santé (CS)] and Health Posts [Poste de Santé (PS)] who meet pre-established criteria[2] in 7 prefectures[3] from the 3 pilot regions will be randomly assigned to each study group to create a factorial study design. This process of random allocation seeks to ensure that the two study groups are comparable in terms of observed and unobserved characteristics that could affect treatment outcomes so that average differences in outcome can be causally attributed.

All prefecture hospitals in these 7 prefectures will be included in the full PBF (i.e., treatment) arm. This is because prefecture hospitals play a critical role in supervising and acting as source of referral services for all facilities in the prefecture. Prefecture hospitals will supervise and support treatment and comparison group Health Centers and Health Posts differently based on the group they are assigned to. Household and facility-based surveys will be implemented in prefecture hospitals and households associated exclusively with their catchment areas[4] in the 7 pilot prefectures to gain insights into the role that prefecture hospitals are playing in the 3 study groups. However, these data will not be used for making inferences about the impact of PBF.

**Blocking at the regional level**

The difference between a regular cluster-randomized trial (CRT) and a blocked CRT lies in the way in which the treatment units—the health facilities in this case—are randomly allocated into treatment and control conditions. In a regular CRT, health facilities would be randomly assigned into treatment and control conditions independent of the region (or prefecture) they belong to. In this blocked-by-region CRT, each region will have its own randomization scheme. In other words, there will be 3 random allocation processes, one for each region being included in the evaluation (i.e., 3 blocks).

The tradeoffs involved in adopting a blocked versus an unblocked design are discussed widely in the experimental design literature. Blocking is generally considered an effective way to increase the face validity of a design and often also its statistical power. The boost in power will depend on several

[2] Not all health facilities (particularly Postes de Santé) provide the minimum package of services, nor are staffed with qualified health personnel, necessary for contracting with the PPAs. Only health facilities that meet criteria regarding service provision and health worker staffing will be included in the impact evaluation. These criteria will be formally established prior to the piloting of PBF and the impact evaluation.

[3] As previously indicated, 9 prefectures in Regions 2, 3, 4, and 6 will participate in the PBF pilot. However, 2 of these prefectures– Mbomou and Basse-Kotto in Region 6 – have already begun implementing PBF under the EU health sector project. The impact evaluation will therefore exclude these prefectures, although implementation of PBF in public and private not-for-profit facilities will be financed in these prefectures through the larger project.

[4] Some villages will not fall within the catchment areas of other CSs and PSs in the prefecture. Households in these villages will be excluded from the sample for the impact evaluation.

factors, including the number of blocks, the number of clusters per block, the number of observations per cluster, and the proportion of outcome variation lying between blocks. If there are large between-block differences in the main outcomes of interest, blocking will likely increase the power of the study.

**Study groups**

Table 5 below describes the 3 study groups formed by randomizing Health Centers and Health Posts. We hope to answer the main research questions identified by making comparisons between these groups.

For the purposes of our study, the **'full' PBF package** of interventions will include the following elements:

- Linking payment and results, including performance bonuses for health workers
- Independent monitoring of results
- Systematic supervision of health facilities defined as regular supervision by an external supervisor from the prefecture hospital team using a structured checklist and providing immediate feedback to facility staff on problems identified and potential solutions to improve service delivery. Systematic supervision will include monitoring whether the facility is complying with national user fee guidelines
- Managerial autonomy to facilities defined as autonomy over use of resources combined with the autonomy to hire and fire staff

**Group T1: Full PBF Package**

Facilities in group T1 will implement this full PBF package with health worker performance bonuses,

**Group C1: Full PBF Package but with PBF payment levels at 50% of Group T1 payment levels**

Facilities in group T1 will implement this full PBF package with health worker performance bonuses, but payment levels for targeted health services will be 50% lower than those found in Group T1. For example, if the unit price for a child fully vaccinated is $5.00 in Group T1, the unit price will be $2.50 in Group C1.

| Service | Number Provided | Unit Price (T1) | Unit Price (C1) | Total Earned (T1) | Total Earned (C1) |
|---|---|---|---|---|---|
| Child fully vaccinated | 100 | $5 | $2.5 | $500 | $250 |
| Skilled birth attendance | 20 | $10 | $5 | $200 | $100 |
| Curative care <5 years of age | 1,000 | $0.5 | $0.25 | $500 | $250 |
| **Total** | | | | **$1,200** | **$600** |
| Remoteness (Equity) Bonus | | +50% | | $1,800 | $900 |
| Quality correction | | 60% | | **$1,080** | **$540** |

Both T1 and C1 facility managers will have the autonomy to hire staff with their PBF revenues or budgetary supplement received, and also to fire these staff if necessary. T1 and C1 facility managers will also have the autonomy over how to use these revenues.

**Group C2: Status quo**

C2 facilities will be the 'business as usual' facilities and will not receive any additional resources, inputs or supervision. C2 facility managers will not have the autonomy to hire/ fire staff or financial autonomy.

District-level supervisors responsible for supervising T1 and C1 facilities will use the same tools and receive the same supplementary payments for visits to facilities in these two groups. Quality scores will be linked to facility payments in both T1 and C1 facilities. C2 facilities will be the 'business as usual' facilities and will not receive any additional resources or inputs. C2 facility managers will not have the autonomy to hire/ fire staff or financial autonomy. National user fee caps, and facility user fee rates, will be published on a signboard placed in all study group health facilities. The IE team will also include monitoring of adherence to national guidelines as part of the monitoring and supervision intervention in T1 and C1 facilities. As the status quo group, the C2 facilities will not receive this additional monitoring & supervision.

All public sector prefecture hospitals in these 7 prefectures will all be included in the full PBF (T1) group, and will not be included in the sample for estimation of impact. They will, however, all be included in the survey.

The interventions in T1 and C1 and C2 groups will be implemented for a period of 2 years. A baseline study will be completed before implementation begins. An endline study will be conducted after the interventions have been implemented for 2 years.

***Table 5: Study groups***

| | |
|---|---|
| **T1:** PBF with health worker performance bonuses at 100% PBF payment levels | **C1:** PBF with health worker performance bonuses at 50% PBF payment levels |
| **C3:** Status quo | |

The impact evaluation team is aware that individuals living in the catchment area of a facility assigned to a given study group (e.g. C1) may visit a health facility assigned to a different group (e.g. T1). The low density of health facilities in the predominantly rural study prefectures lowers these risks. Nonetheless, where this occurs it could bias our estimates of impact. The impact evaluation will therefore seek to (a) minimize, and (b) measure contamination and account for how this may have affected the estimates of impact. To minimize contamination, facility-based catchment area mapping to define realistic catchment areas for health facilities was conducted, in collaboration with the Ministry of Health, in November 2011. This mapping has helped to define 'true' catchment areas by taking into account physical features (like terrain or water bodies) and roads that influence travel time and thereby potentially affect health facility choice. Households will then be sampled from these catchment areas (see data section for more detail). GIS mapping for the defined catchment areas will occur during data collection for the baseline survey. During data collection, the survey team will ensure that the health facility actually used for each service of interest is accurately recorded so that any contamination can be measured. Each survey team will increase the likelihood of accurate identification of the health facilities used by obtaining and using local names for health facilities in a given area and potentially showing respondents photographs of local health facilities when attributing service use to a health facility during the household survey.

In addition, we will use statistical methods (such as regression analysis) to examine the relationship between PBF and:

1. Key expected changes in the hypothesized causal pathway, including:
    a. Funds available at the operational (i.e., facility) level
    b. Informal charges for health services and formal user charges for health services
    c. Degree of client orientation, including facility opening hours, outreach for health services and client perceptions of staff behaviors
    d. Facility management, including reduced absenteeism, availability of drugs and functioning equipment
    e. Demand generation activities such as Behavior Change Communication by facility staff
2. The cost-effectiveness of PBF, i.e., how much of an improvement in coverage and quality does each $ of PBF buy? We will examine this issue by comparing incremental costs and results in the PBF treatment arm to the corresponding costs and results in each comparison arm. We will examine costs in terms of: (a) Total (public and private) costs; (b) Public costs; (c) Out-of-Pocket costs to households
3. Health worker retention
4. Coverage of key services that are not purchased as part of the PBF pilot
5. The extent to which PBF resources are benefitting the poor by conducting a benefit incidence analysis for PBF resources.

Finally, the study will also include a qualitative component at endline to probe deeper for explanations or explore specific issues that are relevant to PBF. The issues of interest to the qualitative component will be identified after PBF implementation has begun. Candidate topics include:

- How do top performing and low performing PBF facilities (in terms of results achieved) differ from each other? What factors enabled the success of top performers? What factors contributed to poor performance of low performing facilities? What is the role that management plays in high and low performing facilities?
- How do key stakeholders (health workers, facility managers, regional administrators, national policy makers and clients) perceive PBF? What are the key perceived benefits and disadvantages of RBF?

# Data

The evaluation will rely on two main sources of data to answer the impact evaluation research questions identified:

1. Household surveys: A household survey will be implemented at baseline (i.e., before implementation of PBF begins), and at endline (i.e., after PBF has been implemented for two years).
2. Facility-based surveys: A facility-based survey will be implemented at baseline and at endline.

The impact evaluation will use the HRITF survey instruments as a starting point and tailor them to the needs of this research and to the Central African context. Table 5 below summarizes the data sources for the impact evaluation.

The same facilities included in the baseline facility sample will also be visited at endline. Households surveyed at baseline will also be visited at endline, and will be included in the endline sample if they continue to meet eligibility criteria. Additional households may be sampled at endline if necessary to meet sample size requirements.

**Household surveys**

A household survey will be conducted in each of the 7 prefectures to be included in the impact evaluation. To select the households to be surveyed, a catchment area will first be established for each of the 97 Health Centers and 145 Health Posts. No more than 20 households will be randomly selected for survey in the catchment area of each selected health facility. Only households with at least one pregnancy or birth in the 2 years preceding the survey are eligible for inclusion.

Since this is a cluster-randomized trial, the sample size estimation must take into account design effects. In total, there are approximately 242 clusters defined by Health Centers and Health Posts (i.e., each facility constitutes a cluster) and we have at least 80 health facilities in each of the three study groups. This tally does not include the 9 prefecture hospitals which are not to be randomly assigned.

The parameters are therefore the following:

- number of clusters (i.e. EA) = 242
- number of observations by cluster = 16
- Total number of observations= 3872
- Design effect assumed= 2
- alpha = 0.05

Assuming a baseline prevalence/ coverage of 54%, the minimum effect size we can detect with 80% power and an alpha of 0.05 is 0.06. Please refer to annex-1 for more details.

The instrument will be administered to women in sampled households who have delivered a baby within the two years preceding the survey. The main themes covered in the household survey include:

- Health behaviors for MCH services
- Health seeking behaviors, barriers to use and health service use
- Household health expenditures
- General perceptions of health service quality

In addition, the survey teams will weigh and measure the height of all children aged under 5 years, mothers of children less than 2 years, and pregnant women who are present in the household during the survey team's visit.

**Facility-based survey**

A facility survey will be conducted in all the Health Centers, Health Posts and Prefecture Hospitals in the 7 prefectures included in the impact evaluation. A more streamlined survey will be conducted at Health Posts than the complete survey that will be conducted at Health Centers and Hospitals. All facility team visits will be unannounced. The facility-based survey includes multiple components. The sample of health workers, patient-provider observations and client exit interviews will be selected to enable findings from these three components to be linked.

***Facility assessment module***

The facility assessment module seeks to collect data on key aspects of facility functioning and structural aspects of quality of care. The respondent for this module will be the individual in charge of the health facility at the time when the survey team visits the health facility. The main themes to be covered by the facility assessment include:

- Facility staffing, including the staffing complement of the facility, staff on duty at the time of the survey team's visit and staff present at the time of the survey team's visit
- Facility infrastructure and equipment
- Availability of drugs, consumables and supplies at the health facility
- Supervision
- Record keeping and reporting to the Health Management Information System
- Facility management
- Official user charges at the facility
- Revenues obtained at the health facility, and how revenues have been used

In addition, a sample of essential drugs (list to be determined) will be taken at endline for laboratory testing. The purpose of doing so is to check if there is a difference in the quality of drugs between PBF (treatment) and non-PBF facilities as PBF facilities will have the autonomy to procure drugs themselves from a variety of sources. At the moment the majority of Health Centers procure drugs exclusively from the l'Unité de Cession de médicaments (UCM). Policy makers are concerned that permitting facilities to procure their drugs from other sources could result in the procurement of counterfeit or sub-standard drugs, and this component of the facility-based survey would provide some evidence on this issue.

The full Facility Assessment module will be conducted at all Health Centers and Hospitals. For Health Posts, a more simplified questionnaire that evaluates basic facility functioning will be used.

***Health worker interview module***

A stratified random sample of clinical and lay health workers with maternal and child health service delivery responsibilities at sampled health facilities will be interviewed as part of this module. The main themes to be covered by this module include:

- Role and responsibilities of the interviewed health worker
- Compensation, including delays in salary payments
- Staff satisfaction and motivation
- Technical knowledge on Maternal and Child Health. The latter will be assessed through the use of vignettes. The vignettes will be focused on services to be purchased under PBF, tailored to the epidemiological profile of CAR and will keep in mind national protocols. The vignettes will be finalized at a later stage.

A stratified random sample of 4 health workers will be taken at each of the 106 Health Centers and Hospitals resulting in a total number of 424 health worker interview observations in these facilities. Eligible health workers include doctors, nurses, midwife/auxiliary midwife, and any other health worker providing maternal and newborn care. In facilities with less than 5 health workers on their staff roster (all Health Posts and many Health Centers have 1-2 health workers), all eligible health workers will be

interviewed. Thus, an additional 145 health worker interviews will be conducted in Health Posts, for a total of 569 health worker interviews.

The full Health Worker module will be conducted at all Health Centers and Hospitals. For Health Posts, a more simplified questionnaire will be used.

***Observations of patient-provider interaction module***

While the health worker interview module collects information on what health workers know, the purpose of this module is to gather information on what health workers actually *do* with their patients. A member of the survey team will therefore observe consultations with a systematic random sample of patients under five presenting with a new condition (i.e., not for follow-up visits or routine) and new ANC clients. The observer will use a structured format to note whether key desired actions are carried out. In the case of patients under five, the instruments will be focused on whether IMCI protocols are followed. For ANC clients the instruments will examine whether key desired actions (including counseling) are carried out. As Health Centers do not offer ANC services on all days of the week – typically these are offered 2 days each week – we propose to implement the ANC observations module in a sub-sample of facilities. We expect that 2 facilities out of every 5 surveyed will offer ANC services on the day of the survey team's visits. We anticipate therefore that the patient provider ANC observation module will be implemented in approximately 42 facilities. Under-five patient provider observations will likely be feasible at all Health Centers and Hospitals visited. 5 under-5 and 5 ANC observations will be undertaken at each facility where these modules are implemented. We therefore anticipate a total of 210 ANC observations and 530 under-five observations. All health workers selected for patient-provider observations will be included in the health worker interview sample.

The patient-provider direct observation module will only be conducted at Health Centers and Hospitals.

***Patient exit interviews***

A systematic random sample of 10 patients visiting the facility (5 patients aged under-five and 5 patients aged over 5) for curative care with a new complaint will be interviewed to assess the patient's perception of quality of care and satisfaction at all Health Centers surveyed. If the patient is a child, the child's caregiver will be interviewed. The 5 under-fives included in the patient exit sample will be the same 5 children whose consultation with a provider was observed. In addition to this, exit interviews will be conducted with all ANC clients whose consultation with a provider was observed. In total we expect 1060 exit surveys with patients who visited the health facility for curative care consultations and 210 exit surveys with ANC clients.

Patient exit interviews will only be conducted at Health Centers and Hospitals.

***Table 5: Data sources for impact evaluation***

| Data | Who | Level | Type | Source | Survey Instrument | Frequency | Description of Data |
|---|---|---|---|---|---|---|---|
| Household survey | Currently pregnant women; Women who have had a child in the 2 | Household | Quantitative | Primary | Adapted HRITF Household Survey Instrument | Twice: Baseline & endline | Health service use, health care seeking behaviors and barriers to use for MCH services, health |

| Data | Who | Level | Type | Source | Survey Instrument | Frequency | Description of Data |
|---|---|---|---|---|---|---|---|
| | years preceding the survey n=3,872 | | | | | | expenditures, perceptions of health service quality |
| Household survey | Currently pregnant women, non-pregnant women who have had a child in the 2 years preceding the survey, children under five | Household survey | Anthropometry & biomarkers | Primary | Not applicable | Anthropometry: Baseline & Endline<br><br>Rapid blood tests: Endline | Rapid diagnostic tests for malaria & anemia; Height and weight measurements |
| Facility assessment | Facility in-charge<br><br>n=251 | Facility | Quantitative | Primary | Adapted HRITF health facility questionnaire | Twice: Baseline & Endline | Facility staffing, infrastructure, drugs supply, equipment, supervision, HMIS reporting and management, user charges, facility revenue |
| Facility assessment-Drugs sample for lab testing | Not applicable<br><br>n=251 facilities | Facility | Laboratory testing | Primary | Not applicable | Once: Endline | Quality of selected drugs |
| Health worker interviews | Health care workers<br><br>n=569 | Facility | Quantitative | Primary | Adapted HRITF Health Facility Questionnaire | Twice: Baseline & Endline | Staff work load, compensation, motivation, satisfaction and knowledge |
| Patient-provider observation (Under-five & ANC) | First time ANC clients n=210<br><br>New under-5 patients for curative care n=530 | Facility | Quantitative | Primary | Adapted HRITF Health Facility Questionnaire | Twice: Baseline & Endline | Treatment and counseling provided to patients. |
| Patient exit interviews | First time ANC clients n=210<br><br>New under-5 | Facility | Quantitative | Primary | Adapted HRITF Health Facility Questionnaire | Twice: Baseline & Endline | Patient's (or caretaker's) perception of quality of care and satisfaction |

| Data | Who | Level | Type | Source | Survey Instrument | Frequency | Description of Data |
|---|---|---|---|---|---|---|---|
| | patients for curative care n=530<br><br>New over-5 patients for curative care n=530 | | | | | | |
| Incremental costs of implementing PBF or comparison group interventions | Not applicable | Performance Purchasing Agency | Quantitative | Secondary | Administrative records and reporting | Periodic reporting as PBF commences | Costs incurred in implementing PBF or comparison group interventions |

* Note- Mbomou and Basse-Kotto prefectures (in Region 6) will be included in the implementation of PBF in CAR, but will be excluded from the Impact Evaluation sample as PBF has already been introduced in these prefectures. Health facility and household baseline surveys will also be conducted in these prefectures, but their data will be excluded from IE estimates. Thus sample size estimates included in the table to not include health facilities and households from Mbomou and Basse-Kotto.

## Ethical review and clearance

There is no Institutional Review Board in Central African Republic. Thus, ethical clearance will be acquired from an IRB based in the United States. In the past, the HRITF team has worked satisfactorily with the Western Institutional Review Board. The IE team will look into WIRB as an option.

## Timeline

Table 6 below sets out the time line for the impact evaluation by fiscal year. The baseline survey will be initiated and completed before PBF implementation begins. Survey data collection will be conducted in May-July 2012. We anticipate that the PBF implementation will begin in July-August 2012, and endline data collection will be implemented after two years in March-May 2014. Prior to beginning PBF implementation health facilities (CSs and PSs) will be randomized to the study groups in a public ceremony (PBF Pilot Initiation Workshop). Since all health facilities will be sampled in the baseline random assignment to treatment or comparison groups does not need to be conducted before the baseline. Dissemination workshops are planned to disseminate both baseline and endline findings. In addition, impact evaluation findings will be disseminated to a wider international audience by publishing the final evaluation report as a working paper.

The timelines presented below were discussed and agreed with the Ministry of Health in CAR during an impact evaluation workshop that will be held in Bangui in December 2011.

***Table 6: Timeline***

| | FY 2012 | | | | FY 2013 | | | | FY 2014 | | | | FY 2015 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Phase** | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Program Design | | | | | | | | | | | | | | | | |

| | FY 2012 | | | | FY 2013 | | | | FY 2014 | | | | FY 2015 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Phase** | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Impact Evaluation Design | | | | | | | | | | | | | | | | |
| Evaluation Preparation | | | | | | | | | | | | | | | | |
| Baseline Data Collection | | | | | | | | | | | | | | | | |
| PBF Pilot Initiation Workshop | | | | | | | | | | | | | | | | |
| Initiation of PBF pilot | | | | | | | | | | | | | | | | |
| Exposure to PBF Treatment | | | | | | | | | | | | | | | | |
| Baseline Data Documentation and Storage | | | | | | | | | | | | | | | | |
| Baseline Analysis and Report | | | | | | | | | | | | | | | | |
| Baseline Dissemination Workshop | | | | | | | | | | | | | | | | |
| Midterm documentation | | | | | | | | | | | | | | | | |
| Evaluation Preparation | | | | | | | | | | | | | | | | |
| Endline Data Collection | | | | | | | | | | | | | | | | |
| Endline Data Documentation and Storage | | | | | | | | | | | | | | | | |
| Impact Analysis and Report | | | | | | | | | | | | | | | | |
| Endline Dissemination Workshop | | | | | | | | | | | | | | | | |

## Research team

The research team includes the following individuals:

- Damien de Walque, Senior Economist in DECHD. Damien de Walque will be the Principal Investigator for the impact evaluation.
- Gaston Sorgho, Sector Lead Specialist Human Development in AFTHE. Gaston Sorgho is TTL for the impact evaluation and for the larger Health Systems Support and Investment Project within which this pilot is nested.
- Hadia Samaha, Senior Operations Officer, AFTHE. Hadia Samaha is co-TTL for the impact evaluation and for the larger Health Systems Support and Investment Project.
- Paul Jacob Robyn, Public Health Specialist, AFTHE. Paul Robyn will be the technical coordinator for the impact evaluation
- Andres Martinez, University of Michigan. Andres Martinez will assist the research team with power calculations, sampling and other statistical aspects
- A national team in charge of overseeing implementation of the impact evaluation will be established. The team will consist of representatives from the Ministry of Health, Population and the fight against HIV/AIDS and partner development institutions (WHO, UNFPA, UNICEF in particular). Team members will take part in the Impact Evaluation workshop in Bangkok, Thailand in October 2012. A focal point within this team will coordinate relations with other actors within the Ministry of Health, notably actors at the central, regional and district levels involved in the Impact Evaluation.

In addition, strategic oversight for the impact evaluation will be provided by Benjamin Loevinsohn, Lead Public Health Specialist, AFTHE.

The Ministry of Health, Population and the fight against HIV/AIDS will conduct the household and health facility surveys in collaboration with locally-recruited consultants. The Ministry will work under the guidance of the World Bank impact evaluation team.

# Annex- 1: Power calculations

This impact evaluation seeks to identify the effects of PBF on MCH service coverage and quality and compare these effects to two other combinations of interventions. The study therefore has three groups:

<table>
<tr><td>T1: PBF with health worker performance bonuses at 100% PBF payment levels<br><br>80 facilities*<br><br>1290 households (16 households per facility catchment area)</td><td>C1: PBF with health worker performance bonuses at 50% PBF payment levels<br><br>80 facilities*<br><br>1290 households (16 households per facility catchment area)</td></tr>
<tr><td colspan="2">C2: Status quo<br><br>80 facilities*<br><br>1290 households (16 households per facility catchment area)</td></tr>
</table>

*Eligible Health Centers are functional public sector and NGO & FBO Centres de Santé and Postes de Santé; Eligible households are households with at least one pregnancy or birth in the two years preceding the survey. Since there are 97 eligible Health Centers and 145 eligible Health Posts, each study group will include *at least* 24 Health Centers, 36 Health Posts and *at least* 1290 households. The total household sample size will be approximately 4,800.

***All*** eligible health facilities in the pilot prefecture will be included in the sample for the baseline and endline surveys. The main target outcomes for the impact evaluation include Maternal and Child Health service coverage indicators. Since the coverage levels for different services vary, the power calculations were based on those for Skilled Birth Attendance (SBA) since these are likely to yield the most conservative sample size requirements. The CAR MICS 2010 estimated the SBA rate at 54%.

Since this is a blocked cluster-randomized trial with randomization blocks at the Regional level, the sample size estimation must take into account design effects and blocking effects. In total, there are 242 clusters defined by Health Centers and Health Posts (i.e., each health facility constitutes a cluster) and we have at least 80 health facilities in each of the three study groups. There are also approximately 80 health facilities per block. This tally does <u>not</u> include the 9 prefecture hospitals which are not to be randomly assigned.

This analysis is for Skilled Birth Attendance (SBA) as the main outcome of interest, defined as a binary indicator at the household level (present or not). The calculations are for the pair-wise comparison T1 vs. C2. In theory, the power for the pair-wise comparisons T1 vs. C1 and C1 vs. C2 will both be lower. It is assumed that, in each region, the 80 or so clusters are allocated in a balanced way into the three treatment conditions, so there will be about 27 clusters in each treatment condition (T1, C1 and C2) in each of the three regions. The underlying model used is discussed in the Optimal Design software documentation.

The statistical power to detect a treatment effect depends on:

- The Type I error (α=0.05).
- The number of households per cluster (*n*=16)
- The total number of clusters being included in the pair-wise comparison in each block (*J*=54)
- The number of blocks (*K*=3)
- The expected treatment effect (not in standard deviation units)
- The distribution of prevalence rates among the control clusters (or all clusters before the intervention). Prevalence rates are determined by the probability of success in the control group ($\varphi_c$) and the variability around that probability of success (quantified using a plausible interval). A "success" is defined here as observing the outcome under study.
- The expected distribution of prevalence rates among the treated clusters.

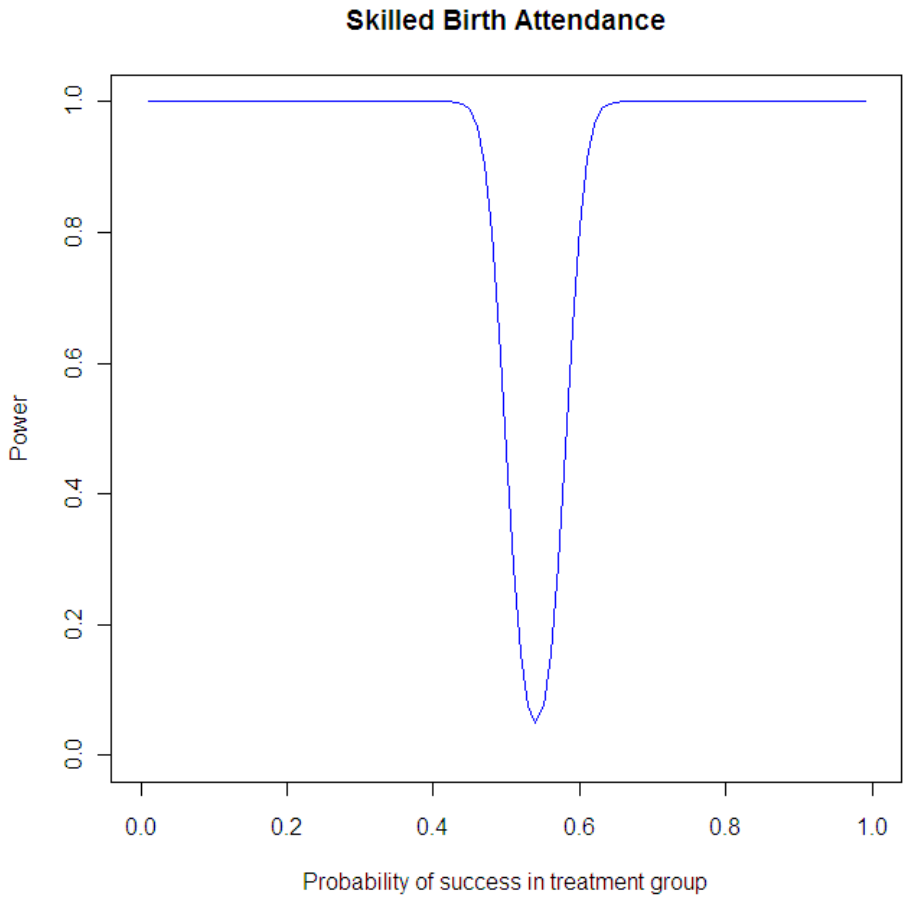
Note the standardized treatment effect (effect size), the intra-class correlation (ICC) and the design effect are concepts that do not really apply in this case since the within-cluster variation depends on the prevalence rate. Therefore, there is not constant standardized treatment effect or intra-class correlation. Instead, the expected treatment effect is measured here as the change in the probability of success in the treatment group ($\varphi_e$) relative to the probability of success in the control group ($\varphi_c$).

To be concrete, take the Skilled Birth Attendance (SBA) prevalence rate, estimated at 54%. Suppose the interval (0.44, 0.64) contains 95% of the plausible values for the probability of success $\varphi_c$ in the health facilities before the intervention. The plausible interval need not be centered at $\varphi_c$. However, given the balanced nature of the design and to avoid further complications, assume for now such centering.

Under these assumptions, the power to detect a treatment effect will naturally depend on how different from 0.54 the "average" prevalence rate is expected to be among the health facilities in the treatment group. The relationship between the probability of success in the treatment group and the power to detect a treatment effect is shown in Figure 1. Note how the power increases rapidly as the expected probability of success among the treated health facilities departs from 0.54.

Note power depends heavily on the amount of variation in prevalence rates between health facilities. These results indicate the study would have about 0.81 power to detect a change of 6 percentage points in the probability of observing a SBA as long as 95% of the health facilities have prevalence rates that fall in the (0.44, 0.64) range. More variability in the prevalence rates would however translate into less power. For example, if 95% of the health facilities have prevalence rates that fall in the (0.34, 0.74) range, the power to detect a change of 6 percentage points in the probability of observing a SBA would fall to about 0.64. On the other hand, if 95% of the health facilities have prevalence rates that fall in the (0.50, 0.58) range, the power to detect a change of 6 percentage points in the probability of observing a SBA would increase to about 0.86.

**Figure 1: Probability of success in the treatment group vs. power to detect treatment effect in a blocked CRT with binary outcome.**




Assumptions include:

- 0.05 Type I error.
- 16 households per cluster
- 27 clusters per treatment condition
- Balanced allocation
- 1 pair-wise comparison
- 3 blocks
- Average prevalence rate in the control group: 54%
- 95% plausible interval for the probability of success in the control group: (0.44, 0.64)
- 95% plausible interval for the probability of success in the treatment group is of the same size as that of the control group.

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[xvi] See, for instance Cambodia (Soeters et al. 2003), Haiti (Eicher et al. 2001), Afghanistan (Arur et al. 2010; Palmer et al, 2009), and Eldridge et al., 2009.
[xvii] In fact, some authors would argue that it is inappropriate to view RBF primarily as a provider payment mechanism, and that RBF should be viewed as a larger health systems reform paradigm. See for instance, Meessen, B., Soucat, A. & Sekabaraga, C. 2010. 'Performance-based financing: just a donor fad or a catalyst towards comprehensive health-care reform?' *Bulletin of the World Health Organization*. November 2010