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Missed Opportunities for Early Access to Care of HIV-Infected Infants in Burkina Faso

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Introduction

Despite the efficacy of Prevention of Mother-To-Child- HIV Transmission (PMTCT), Human Immunodeficiency Virus (HIV) pediatric infection still occurs in Africa because of the lack of operational access to this intervention. Without any intervention, mortality of HIV infected children can reach up to 35% before the first birthday and up to 52% before the second birthday [1,2], and the untreated survivors would need substantial care [3]. However, early antiretroviral treatment routinely started before 12 weeks of age significantly increases infant survival by 76%, reduces morbidity and enhances immunological benefits [4,5,6,7]. The 2010 World Health Organization (WHO) revised guidelines recommend early antiretroviral treatment in all HIV infected children less than two years of age, regardless of their immune status [8]. These guidelines also recommend a routine Early Infant Diagnosis (EID) from six-weeks of age of all HIV-exposed infants. EID requires sophisticated technology before 18 months of age because of the persistence of maternal antibodies in infants [9]. In addition, the uptake at each step in the EID cascade...
Highlights that even with the highest reported level of uptake, nearly half of HIV-infected infants may not successfully complete the cumulative cascade [10]. In sub-Saharan Africa, HIV-exposed infants continue to suffer from insufficient access to EID and antiretroviral therapy. In 2010, a survey was conducted in Burkina Faso, Ghana and Côte d'Ivoire, to identify the major challenges regarding HIV prophylaxis for children in West Africa [11]. The results of this survey indicated that only a small proportion of HIV-exposed newborns received antiretroviral prophylaxis. Scaling-up management of early pediatric HIV infection remains challenging in West African countries in 2011. But there is a need to increase the PMTCT coverage and to trace the children born in the setting of the PMTCT programs [12]. It is crucial to identify the barriers at the national level. Burkina Faso is a West-African developing country where HIV prevalence was about 1.0% in 2010 [13]. HIV EID in children born to HIV-infected mothers is organized in cascade from the district health care facilities, towards district hospital laboratories, to the university hospital laboratories. There are few data on the full PMTCT cascade coverage and postnatal services in regard to infants born to HIV-infected mothers. Problems are related to resource management, and lack of assessment of sites.

We described the access to pediatric HIV diagnosis and care in Ouagadougou, the capital of Burkina Faso. We also assessed the health care facilities regarding the conformance of staff and infrastructures with WHO standards for the care of HIV infected infants in Ouagadougou in 2010–2011.

Methods

Access to HIV care for infants in Burkina Faso

Burkina Faso is administratively divided into 13 regions, 45 provinces and 351 rural and urban municipalities. In 2011, the public health system was organized around four types of hospitals: district, confessional, regional, and university hospitals. Besides the public health facilities, Burkina Faso had also a large number of private health care facilities and traditional healers [14].

The “big” Ouagadougou equated the Center region with a population of 2 136 582 inhabitants in 2011, of whom 39.7% were children less than 15 years of age [14]. The Center region was the most populous and urbanized of the 13 administrative regions of Burkina Faso, with a land area of 2 869 square kilometers [15]. We identified in this region two university hospitals, five district hospitals, one confessional hospital, eight hospitals without surgical units, and 81 primary health care facilities [16]. According to the 2010 health and demographic survey, the HIV prevalence in Ouagadougou was estimated at 2.1% [95% CI: 1.5–2.7] in 2010 [13].

PMTCT services are integrated in the national health system. All pregnant women who come for antenatal care in a health care facility are expected to be counseled for HIV testing. In case of consent, HIV screening is performed on-site using rapid HIV antibody tests, with a simultaneous HIV result delivery. The pregnant women who attend antenatal consultation with a documented positive result are also tested for the sake control, unless that they are already treated with antiretroviral drugs. In any case, there were included in the PMTCT cascade.

In Burkina Faso, the option A of PMTCT was still recommended in 2011 and HIV-infected pregnant women were eligible to antiretroviral treatment on the basis of CD4 count. Pregnant women with more than 350 cells/mm³ CD4 count were prescribed zidovudine at 28 weeks gestation in antepartum. In intrapartum, at onset of labor, a single dose of nevirapine and the first dose of zidovudine/lamivudine were given. In postpartum, a daily zidovudine/lamivudine was given for seven days. Whenever the pregnant women’s CD4 count was inferior or equal to 350 cells/mm³ a triple antiretroviral therapy was started as soon as diagnosed, and continued for life. Infants received a daily nevirapine dose from birth up to one week after the complete cessation of breastfeeding. When mothers were not breastfeeding or were on antiretroviral drugs, infants were given a daily nevirapine dose up to six weeks of age. Infant breastfeeding was the most recommended feeding option.

After delivery, HIV-infected mothers and their children were advised to go to the nearest health care facility for a postnatal visit and an EID performed since six weeks of age. This EID was based on a first deoxyribonucleic acid polymerase chain reaction (DNA PCR) test on a Dried Blood Spot (DBS) and was scheduled once a month. The DBS were sent for processing by the corresponding district hospital to one of the three laboratories in Ouagadougou region (the university hospital Yalgado Ouédraogo, the university hospital Charles de Gaulle, and the Saint Camille hospital). All HIV tests results were sent back to the health care facilities via the corresponding district hospitals. In case of a first positive DBS result, a second DNA PCR test is performed on a blood sample to confirm HIV infection [17].

Context and study design

The study was conducted in the implementation phase of the MONOD ANRS 12206 clinical trial (ClinicalTrials.gov registry n’NCT01127204), which was approved by the national ethics committee and the Burkina Faso Ministry of Health. The study was conducted in the capital of the country (Ouagadougou). Health professionals who were interviewed and parents of children who were enrolled for treatment provided a clear written consent. The ethics committee approved the consent procedure. The informed consent was waived for the use of aggregate register data.

The ANRS 12206 MONOD trial is a randomized controlled trial whose aim is to assess a simplified once daily antiretroviral treatment in virologically suppressed HIV infected children initially treated with a triple therapy containing lopinavir/ritonavir before the age of two [Appendix S1].

We undertook a cross-sectional survey from January 2011 to January 2012, to evaluate the performance of PMTCT cascade, and the conformance of infrastructures and staff in health care facilities with pediatric HIV services in Ouagadougou.

Study site and population

We included all the health care facilities providing PMTCT services, infant HIV diagnosis and antiretroviral treatments in Ouagadougou. We first used their 2011 aggregate data to document the PMTCT cascade. Then, in each health care facility, we interviewed all the heads of the various services: health districts, health care facilities, PMTCT services, laboratories, pharmacies, pediatric services, statistics and epidemiology surveillance division, and human resource services.

Data collection

We used 2010 and 2011 Ministry of Health statistical yearbook, as the reference figures [14,16]. We designed a semi-structured questionnaire with three sections according to the staff targeted: pediatric, laboratory and pharmacy services. Two medical epidemiologists, one midwife and one sociologist carried out the desk review and interviewed the selected health professionals. The questionnaire reviewed variables related to PMTCT statistics (cascade of HIV care from antenatal services to EID of HIV-exposed children at six weeks of age and antiretroviral treatment care for HIV-infected children), infrastructures, laboratory...
We checked the space available in pediatric consultation ward, laboratory, and pharmacy rooms. This criteria was classified as conform if the available space was superior or equal to that required by the WHO standards. We also checked other qualitative criteria such as the availability of power supply, infection control and the respect of privacy and confidentiality by health professionals. The conformance was good if all the criteria were met. For laboratory tests, we assessed the capacity for performing the required tests in hospitals, without neither shortages of laboratory reagents nor failure of medical devices. Finally, the conformance was good if antiretroviral drugs and drugs for opportunistic infection treatment and prophylaxis were available to treat HIV infected children with a regimen recommended by the national guidelines.

Statistical analysis

The prevalence of HIV infected pregnant women was calculated by dividing the number of HIV infected pregnant women by the total number of pregnant women screened for HIV infection. The 95% confidence intervals were determined according to the following formula: 

$$P - Z_{1 - \frac{1}{2}} \sqrt{\frac{P(1-P)}{n}} \leq \frac{1}{2n}$$

$$P + Z_{1 - \frac{1}{2}} \sqrt{\frac{P(1-P)}{n}} \geq \frac{1}{2n}$$

where $p$ = prevalence, $n$ = sample size. We described the coverage of pediatric HIV services and the flow from HIV-exposed children to access to ART, of HIV-infected children. The cascade of care was compiled on Microsoft Excel software using proportions. All the proportions of the PMTCT cascade were calculated by dividing the total number of favorable cases by the number of eligible cases with their 95% confidence intervals according to the formula previously mentioned.

Results

From the 103 health care facilities providing PMTCT services in Ouagadougou in 2011, 127 health professionals were interviewed: 7 (5.5%) pediatricians, 5 (3.9%) general practitioners, 10 (7.9%) pharmacists, 5 (3.9%) nurse-epidemiologists, 75 (59.1%) nurses, 7 (5.5%) midwives, 9 (7.1%) pharmacist assistants, 5 (3.9%) laboratory technicians, 2 (1.6%) biologists, and 2 (1.6%) human resource managers.

Staffing in pediatric HIV health services

In 2010, there was no HIV treatment for HIV-infected children in primary health care facilities in Ouagadougou. All pediatric HIV care was provided by the six district hospitals, and two university hospitals. In these hospitals, a total of 225 health professionals were directly involved in pediatric HIV infection care, and among them 40% worked in the two university hospitals (Table 1). Overall, 10.7% were pediatricians, 4.4% general practitioners, 19.1% nurses, 5.8% counselors, 8.9% pharmacists, and 29.8% laboratory technicians. Six of the eight hospitals had at least one pediatrician.

In 2010, the total population of children less than 15 years old in the whole region was estimated at 811 115 [16]. With an HIV prevalence of 0.26% in children less than 15 years old [11], we estimated the number of HIV infected children less than 15 to be about 2 109 (811 115 x 0.26%) in Ouagadougou. With 24 pediatricians in this area (10.7% of the overall staff dedicated to pediatric HIV care), one pediatrician was responsible for 33 797 (811 115/24) children less than 15 years age of whom 88 (2 109/24) were HIV infected.
When evaluating the conformance of health staff requirements of the WHO standards in the health district hospitals [19], the staff is overall insufficient: general practitioners are less than 1/10 000, and pharmacists are less than 1/20 000 in all the five health districts of Ouagadougou. We had more than 1/4000 nurses in four health districts. Overall, both physician and pharmacist staff were scarce.

PMTCT cascade

In 2011, out of the 76 935 expected pregnancies in the Center region, 67 592 attended at least one antenatal consultation (87.8%). Among the pregnant women attending antenatal consultation, 58 036 accepted to be HIV-tested (85.9%) and the HIV prevalence was 1.8% (95% CI: 1.7%–1.9%). Furthermore, 441 out of the 1 064 HIV-infected pregnant women (41.4%) benefitted from a PMTCT intervention (option A). Then, only 313 (29.4%) HIV-exposed infants (0–18 months) had an HIV virologic test on a DBS, and 306 (97.8%) among these infants tested received their results, usually within a month, but sometimes within a four-month period. Still among the infants tested, 40 children were initially identified as HIV-infected, and 33 (82.5%) out the infants tested, were referred to the MONOD study sites before the age of two for an HIV test confirmation using a deoxyribonucleic acid polymerase chain reaction (DNA PCR). With three children identified as false positive (9%) and 30 (91%) confirmed to be HIV-infected, the HIV prevalence was estimated to be 9.6% (95% CI: 6.3%–12.9%). Finally, 27 children (90.0%) were enrolled in the MONOD ANRS 12206 trial and treated with a triple lopinavir/ritonavir based therapy (Table 2). Their median age at diagnosis was 13 months [IQR: 7–19].

Seven children (17.5%) were not referred for HIV care. One of them died before his laboratory result was released. The six remaining did not come back for their laboratory results and we were not able to contact them because of missing telephone numbers or addresses in the health care facility registers.

Among the six (18.2%) children who were referred to MONOD clinical sites, but were not enrolled in the trial to start an antiretroviral therapy, two died before being able to initiate treatment because of their advanced stage of HIV disease. One was lost to follow-up after his father refusal to consent for treatment, and three were finally controlled as HIV-negative and not eligible for antiretroviral treatment.

Infrastructures

The conformance of infrastructures was globally gauged “not conform” because of two criteria: safe waste management and fire safety. Indeed, none of the health care facilities had either segregate color-coded waste containers or fire extinguishers.

Essential laboratory tests and apparatus

The availability of essential laboratory tests was checked in health care facilities (Table 3). The lack of some of the laboratory tests was associated to either a failure/lack of the corresponding laboratory apparatus or a reagent shortage. The table 4 displays the reasons for the laboratory non conformance. In addition, lack of apparatus maintenance has been underlined in all the health care facilities.

Essential drugs

The availability of essential antiretroviral drugs was quite good in 2010, and the conformance was judged to be good in spite of few shortages which did not affect the treatment of HIV-infected patient according to national guidelines. A shortage of seven days
was observed for lopinavir/ritonavir, lamivudine and abacavir in Charles de Gaulle university hospital in 2010. In addition, Bogodogo district hospital noticed a shortage of 30 days for the combination lamivudine + nevirapine + stavudine (triomune junior). The drugs for opportunistic infections were available and conform to WHO standards, but they were not free of charge for HIV-infected patients in 2010, except anti-tuberculosis drugs and cotrimoxazole.

Discussion

This cross-sectional survey assessed for the first time the staff, the infrastructures and the PMTCT cascade from prenatal PMTCT up to pediatric HIV care in Ouagadougou. We documented that only 40% of HIV-infected women received a PMTCT intervention and less than a third of HIV-exposed children were tested during the postnatal period. Moreover, it provides a description of the health care system in this country, useful to understand some of the weaknesses of the system when it comes to the issue of EID in all HIV exposed children, and their access to antiretroviral therapy.

There are several drawbacks in our observations. Firstly, the incompleteness of the data collected may be the source of information bias in this study. Our study method was partially based on desk review, where we checked the statistics in the available registers. Unfortunately, we could not get all the information related to our objectives. For instance, it had not been possible to routinely determine the duration of laboratory reagent shortage. Secondly, we were not able to really link one-to-one the PMTCT with the postnatal data, and we assumed that each HIV-pregnant woman was supposed to give one alive pregnancy outcome, without taking into account multiple pregnancy outcomes or stillbirth. Furthermore, some of the infants tested in 2011, had their mothers attend their first antenatal consultation in the preceding years, and some of the pregnant women tracked in 2011 will give birth in 2012 as well, resulting in a kind of compensation allowing the PMTCT and EID coverage estimates. Consequently, we feel that these figures were accurate enough to understand the overall patient flow throughout the health care system services. Thirdly, the conformance of health care services was determined with respect to the WHO standards, ideally suitable for district hospitals [19]. These standards might not be suitable when applied to university hospitals, where a higher standard of care is expected. Lastly, in terms of representativeness, our results showed a similar proportion of antenatal consultations among pregnant women in Ouagadougou, compared to the rest of the country (88%) [14]. As a matter of fact, Ouagadougou had a greater number of private health facilities compared to the rest of the country [14], and their statistics were

Table 2. The PMTCT cascade until HIV pediatric care in Ouagadougou, 2011.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Number</th>
<th>Percentage (%)</th>
<th>Confidence Interval 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant women expected</td>
<td>76,935</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td>Pregnant women attending antenatal consultation</td>
<td>67,592</td>
<td>87.8 (100%)</td>
<td>[87.6–88.0]</td>
</tr>
<tr>
<td>Pregnant women having been counseled for HIV testing</td>
<td>60,156</td>
<td>89.0</td>
<td>[88.8–89.2]</td>
</tr>
<tr>
<td>Pregnant women having been HIV-tested</td>
<td>58,036</td>
<td>85.9 (100%)</td>
<td>[85.6–86.1]</td>
</tr>
<tr>
<td>HIV-infected pregnant women</td>
<td>1,064</td>
<td>1.8 (100%)</td>
<td>[1.7–1.9]</td>
</tr>
<tr>
<td>Pregnant women exposed to PMTCT intervention</td>
<td>441</td>
<td>41.4</td>
<td>[38.4–44.4]</td>
</tr>
<tr>
<td>HIV-exposed infants having been HIV-tested using DBS</td>
<td>313</td>
<td>29.4 (100%)</td>
<td>[26.6–32.2]</td>
</tr>
<tr>
<td>DBS tests results returned</td>
<td>306</td>
<td>97.8</td>
<td>[96.0–99.6]</td>
</tr>
<tr>
<td>Infants identified as HIV-infected on the first DBS test (100%)</td>
<td>40</td>
<td>12.8</td>
<td>[8.9–16.6]</td>
</tr>
<tr>
<td>HIV-infected infants referred to pediatric care</td>
<td>33</td>
<td>82.5</td>
<td>[71.9–95.5]</td>
</tr>
<tr>
<td>Infants confirmed as HIV-infected on the second test (DNA PCR on blood sample)</td>
<td>30</td>
<td>9.6 (100%)</td>
<td>[6.3–12.9]</td>
</tr>
<tr>
<td>HIV-infected infants initiated on antiretroviral therapy</td>
<td>27</td>
<td>90.0</td>
<td>[79.2–100.0]</td>
</tr>
</tbody>
</table>

100% is the reference number.
DNA PCR = deoxyribonucleic acid polymerase chain reaction.
DBS = dried blood spot.
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not included in our figures. As a result, the number of antenatal consultations was lower than that was really carried out in Ouagadougou. However, in our study, we considered all pregnant women who were on PMTCT antiretroviral protocol with the hypothesis that their children would be referred to the public system if they were found to be HIV-infected.

Our study helped to identify major challenges facing EID and antiretroviral treatment access for children in Burkina Faso. A survey conducted in Burkina Faso, Ghana and Côte d’Ivoire, from January 2010 to February 2011 had already reported the lack of access to child PMTCT prophylaxis [11]. Our results confirm that in the urban setting of Ouagadougou. The level of missed opportunities was so high that it was difficult to cover sufficiently with PMTCT intervention, the mother-infant couple, estimated at 59%, as well as to offer EID to all HIV-exposed children, reaching 71%. We also conclude that these missed opportunities should be greater at the national level considering the fact that the health

Table 3. Conformance of Ouagadougou hospitals according to WHO standards, in 2010.

<table>
<thead>
<tr>
<th>WHO criteria of conformance</th>
<th>District hospital</th>
<th>University hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 6</td>
<td>N = 2</td>
</tr>
<tr>
<td></td>
<td># conform/N</td>
<td># conform/N</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room space &gt;9 m²</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Power (electricity) available</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Tap water available</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Tuberculosis infection control (ventilated waiting rooms, cough control, good patient flow)</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>HIV infection control (injection safety, appropriate use and disposal of sharps, personal protective equipment for staff, post exposure prophylaxis available)</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Waste management (3 color-containers available)</td>
<td>0/6</td>
<td>0/2</td>
</tr>
<tr>
<td>Privacy of patient’s test protected</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Communication (land line available)</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Fire extinguisher available</td>
<td>0/6</td>
<td>0/2</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>Not conform</td>
<td>Not conform</td>
</tr>
<tr>
<td><strong>Laboratory test available</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid HIV antibody test</td>
<td>4/6</td>
<td>2/2</td>
</tr>
<tr>
<td>DBS</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>CD4 count</td>
<td>1/6</td>
<td>1/2</td>
</tr>
<tr>
<td>Hemoglobin determination</td>
<td>5/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Serum alanin aminotransferase</td>
<td>4/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Serum creatinin &amp; blood urea nitrogen</td>
<td>4/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Bilirubin determination</td>
<td>4/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>5/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Blood sugar</td>
<td>4/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Tuberculosis diagnostics</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Pregnancy test</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Urine dipstick for sugar and protein</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>Not conform</td>
<td>Not conform</td>
</tr>
<tr>
<td><strong>Drugs available</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antiretroviral drugs</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td>Opportunistic infection drugs</td>
<td>6/6</td>
<td>2/2</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>Conform</td>
<td>Conform</td>
</tr>
<tr>
<td><strong>Staff</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One general practitioner for 10 000</td>
<td>0/6</td>
<td>Not applicable*</td>
</tr>
<tr>
<td>One pharmacist for 20 000</td>
<td>0/6</td>
<td>Not applicable*</td>
</tr>
<tr>
<td>One nurse for 4 000</td>
<td>4/6</td>
<td>Not applicable*</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>Not conform</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

*The university hospitals are located in the center region, but patients are referred from the whole country.

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care system would be more complex and thus weaker at the rural level in comparison to the urban one.

Some factors could explain these missed opportunities and could be separately addressed. Firstly, the low awareness of HIV prevention and care services in the community could explain the non-attendance of EID services or the rejection of these services by families. In Burkina Faso, only 20.1% of the population attended the secondary school in 2008/2009 [21] and therefore we think that substantial efforts should be developed to make them aware of the benefit of PMTCT services. In addition, men should also be targeted in education, because they are likely to be reluctant to carrying out HIV screening, and they can greatly support their wives in using PMTCT services [22,23].

Secondly, we highlighted the lack of adequate quantitative and qualitative health care workers (HCW) to cover the needs. At the six-week postnatal visit for instance, due to the fact that nurses were not all trained to perform DBS, the DBS could only be performed once a day in a month. Mothers who would like have their infant HIV-tested could only return on this unique day, leading to a high attrition rate because of the inadequate offer of this simple service.

Thirdly, the inaccessibility to EID services is also related to the health system organization, as the current DBS sample circuit and transportation is too complicated and should be simplified. Indeed, the need to go through each district hospital while the final laboratory test is performed in each university laboratory hospital should be considered. It would be more efficient to perform the DBS directly in the health care facilities, to limit the lost to follow-up rate. In the neighboring country of Côte d’Ivoire, we had a similar problem of low coverage rate of EID, favored by the civil war, with only 24% of the HIV exposed children early diagnosed in 2010 [24]. In comparison, a study carried out in 2008, showed that DNA polymerase chain reaction testing in routine was 35.2% for children hospitalized in Malawi, but their age was not specified [25].

Similarly, the low PMTCT intervention coverage is related to problems in the health service organization. When a pregnant woman attends antenatal consultation in a health care facility, she is counseled and screened for HIV with a rapid HIV antibody test. In case of HIV infection, she is referred to the referent district hospital in order to carry out the other tests such as CD4 count, before visiting a doctor who would prescribe an option A antiretroviral treatment, mainly based on nevirapine. Then, she is later sent back in the former health care facility, to pursue her antenatal follow-up. Although not documented, we assume that some pregnant women could not reach the district hospitals, thus increasing the number of lost to follow-up. This could explain why a lot of pregnant women attend antenatal consultation but do not benefit from PMTCT intervention, when they are HIV-infected.

Fourthly, there are also laboratory related challenges, with the need to offer routine services while the HIV-prevalence is still low, leading to frequent laboratory reagent shortages. Thairu et al. also confirmed our results about maintenance and reagent stock management, in their study in Burkina Faso and Zimbabwe [26]. A frequently-cited barrier to expansion of EID programs is the cost of the required laboratory assays.

Thus, substantial sequential barriers explain the low PMTCT and EID complete cascade coverage, and the lack of personnel and infrastructure requirements. A review reported that even with the highest reported levels of uptake, nearly half of HIV-infected infants may not complete the cascade successfully [10].

Additionally, we raised the overall problem of the EID strategy performances. In settings with low HIV prevalence or well performing PMTCT program, vertical transmission rates may be as low as 2% at six weeks and the positive predictive value of a single test will be approximately 50%, meaning that only half of infants who are tested positive are truly infected [27,28]. For this reason, a confirmatory test is essential, especially in the context of a low HIV prevalence country such as Burkina Faso. Indeed, in our study, the high rate of false positive DBS (9%) highly affects the positive predictive value of the national HIV screening strategy. Acknowledging this, the test confirmation is a priority and laboratories should implement reliable quality control system and constantly work on maintaining high quality standards of EID.

Antiretroviral access for HIV-infected children looked good in our study when compared to the estimates of the Ethiopian study, where only 8.4% of positive babies had access to antiretroviral treatment [29]. But, it is important to point out the contribution of the Monod trial implementation in our results, which set up a network whose aim was to improve the coverage of pediatric antiretroviral therapy beyond the EID.

A shortage of some antiretroviral drugs was observed in two health care facilities for several days, as a result of delays in

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<th>Table 4. Reasons for Ouagadougou laboratory non conformance in 2010.</th>
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<td>Laboratory tests non available</td>
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<td>Rapid HIV antibody test</td>
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<td>CD4 count</td>
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<td>Hemoglobin determination</td>
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<td>Serum alanin aminotransferase</td>
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reporting. In effect, antiretroviral drugs are provided by the
Ministry of Health division for HIV/AIDS (Comité Ministériel de
Lutte contre le Sida), and they required periodic reports, before
delivery. Hence, a delay in providing a report will ultimately end
in a delay in drug supply.

Moreover, while all antiretroviral drugs were free of charge in
Burkina Faso in 2010, the opportunistic infection drugs are
charged to families. It has already been reported that having to
pay for HIV treatment and laboratory tests, increases the risk of
lost to follow-up [30].

When analyzing the conformance of health centers with respect
to the PMTCT cascade, we can point out that the infrastructure
requirements are almost met, and that the absence of fire
extinguishers and segregate color-codes waste containers, did not
affect antenatal consultation rate which is quite good in a
developing country setting such as this. However, the non
conformance to laboratory test requirements explained why we
observed an attrition of the cascade at the number of children
tested for HIV infection. The conformance of pharmacies was
found to be good and consequently two-third of HIV infected
children were treated. The missed opportunity for treatment was
related to communication and pregnant women HIV testing
circuit problem.

Globally, the causes of non conformance at the district and
university hospitals are almost similar because they are public
centers (except Saint Camille hospital), run by the Ministry of
Health. The causes could be a lack of resources, or a
mismanagement of the available resources.

The problem could be alleviated by improving the communi-
cation process between the peripheral health services and the
national procurement system. The community awareness should
also be improved and contextualized to the socio-cultural needs of
the region.

Moreover, training in a large scale on DBS practicing and in
HIV care among HCW would be useful and promote task shifting
activities [31,32,33]. Finally, characteristics of the health care
facilities could be determinant in improving the pediatric HIV
care in Africa as reported in the HEART project [34]:
characteristics associated with favorable children enrolment in
care are nutritional support, linkages with associations of people
living with HIV, access to EID and integration of PMTCT
services. Applying the South African strategies to improve
antiretroviral treatment in the province of KwaZulu-Natal could
be beneficial. In addition to training all the staff in contact with
mothers and children, they carried out campaigns aimed at
increasing HIV testing during immunization and clinics, routinely
testing of HIV in children with tuberculosis and malnutrition, and
systematically testing for HIV, all children admitted at hospital
[35]. However, in Burkina Faso, as the HIV prevalence is lower
than that of South Africa, it would be more efficient to start the
systematic HIV diagnosis by screening first the children with rapid
HIV antibody tests. Expanding these characteristics to improve
pediatric HIV treatment in Burkina Faso, warrants further
evaluation for improving the scaling up of pediatric HIV care.
Finally, as it was reported in South Africa, it is possible to improve
the identification of HIV-infected children and ensure a prompt
start on ART when needed with relatively simple measures,
limited staffing and budgets [35].

Despite an overall good access to prenatal services in
Douala Cameroon, there are still many missed opportunities
for both the prevention of mother-to-child transmission and the
early access to diagnosis and antiretroviral therapy for HIV-
infected children before two years of life. The government should
look forward to improving the awareness and education among
the population, training health care workers for HIV diagnosis and
care, facilitating the access to EID and making health care facilities
more attractive to families. In addition, the DBS circuit should be
simplified to avoid lost to follow-up. Early access to EID and to
antiretroviral therapy will require political willingness and
leadership to address these health system barriers in Burkina Faso.

Supporting Information
Appendix S1 The ANRS 12206 MONOD Collaboration
Study Group. (DOC)

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reagents/materials/analysis tools: CY M. Congo MB NM VL PV. Wrote
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PV ET MB LK CY IS DY FK M. Congo.

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