The Impact of Health Worker Absence on Health Outcomes: Evidence from Western Kenya

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October 2010

Abstract

Absenteeism of health workers in developing countries is widespread with some estimates indicating rates of provider absence of nearly 40% (Chaudhry et. al. 2006). This is the first paper to present evidence of the impact of health provider absence on health outcomes. Using longitudinal data from nearly 600 ante-natal care seekers at a rural ante-natal clinic in Western Kenya, we start by showing that women whose first clinic visit coincides with the nurse's attendance are nearly 60 percentage points more likely to test for HIV and 13 percentage points more likely to deliver in a hospital or health center. Since the benefits of PMTCT services depend on HIV status, we estimate the heterogeneous impact of absence based on women's self-reported expectations of being HIV-positive. We find that women with a high pre-test expectation of testing HIV-positive and whose first ANC visit coincides with nurse attendance are 25 percentage points more likely to deliver in a hospital or health center, 7.4 percentage points more likely to receive PMTCT medication, 9 percentage points less likely to breastfeed and 10 percentage points more likely to enroll in the free AIDS treatment program at the clinic than similar women whose first visit coincides with nurse absence. These results suggest that nurse attendance has large effects on the behavior of pregnant women that translate into large gains in child and maternal health.

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1 Introduction

Human capital is widely viewed as playing an essential role in the creation of wealth and economic growth, particularly in developing countries. Yet, provider absence in the health and education sectors – the core of human capital formation – appears to be a tremendous problem in precisely those regions that stand to gain the most from these sectors. Indeed a recent multi-country survey of education and health providers recorded very high rates of provider absence ranging from 20% for teachers to nearly 40% for public health workers (Chaudhry et. al. (2006)). While negative associations between income per capita and absence levels underscore the potential importance of this phenomenon, causal micro-evidence on this relationship is quite limited. Only a handful of studies have estimated the impacts of teacher absence on learning (Das et. al (2007); Duflo, Hanna and Ryan (2008); and indirectly, Kremer, Miguel and Thornton (2009)). This is the first paper to provide evidence on the impact of health provider absence on health outcomes.[1]

Of course, the impacts of health worker absence will fundamentally hinge on the marginal productivity of health professionals. In an environment where provider competence and effort are notoriously low, the impacts of absence could be quite minimal (Banerjee, Deaton, and Duflo (2004), Das, Hammer and Leonard (2008)). Even when service quality is high, health worker absence will have relatively modest impacts for conditions that are either self-limiting or relatively nonresponsive to treatment. Estimation of impacts of absence is further challenged by potential concerns about endogeneity – health workers choose to be absent and households choose health providers. Such concerns will be exacerbated if provider absence is in part driven by provider competence and other dimensions of service quality, especially for impact estimates that exploit cross-provider variation in absence.

This paper examines the impact of health worker absence on various health outcomes

[1]Bjorkman and Svensson (2009) find large health gains associated with a randomized intervention that improves service quality along several dimensions, including provider attendance. The impacts of provider absence alone cannot be separated from other program effects in their empirical framework.

and overcomes the various identification issues by using longitudinal data from a clinic in rural western Kenya. Firstly, we exploit across-time variation in the attendance of a health provider who is the only nurse (among several health workers, including other nurses) qualified to provide counseling for prevention-of-mother-to-child-transmission (PMTCT) of HIV to pregnant women coming to the antenatal care (ANC) clinic. HIV prevalence in the study area is very high, thereby raising the importance of the PMTCT services – HIV counseling and testing and the provision of medications to women who test HIV-positive. Secondly, we use a panel of nearly 600 women seeking ANC at the clinic. PMTCT counseling services are offered as part of the ANC package and are not offered elsewhere in the study catchment area. Thirdly, the absence rate of the PMTCT nurse is relatively low and unpredictable, minimizing concerns about selection by pregnant women in the study area. Finally, the context we study has very high ANC utilization rates, implying that our results travel well to similar contexts outside the study area.

Our empirical strategy is two-fold. We begin by showing that the PMTCT nurse's absence is uncorrelated with a wide range of observable characteristics of the pregnant women as well as visit date information. We then present reduced form estimates of the effects of the nurse's absence on a range of health outcomes. The lone PMTCT nurse at the ANC clinic was absent from work on approximately 9 percent of the days when the clinic was open during our study period. First time visitors to the clinic who arrived on a day when the PMTCT nurse was absent were nearly 60 percentage points less likely to receive PMTCT counseling and HIV testing services over the entire course of their pregnancy. This impact of nurse absence is large and robust to controlling for pre-test beliefs about HIV status and date characteristics of the first ANC clinic visit. Women whose first visit coincided with the PMTCT nurse's absence were also 13 percentage points less likely to deliver at a hospital or health center, where deliveries are safest.

Since the benefits of a hospital birth and breast-feeding depends on the HIV status of the pregnant woman, in the second part of our empirical strategy we use an interacted specification to estimate separate effects for women with high and low self-reported pre-test expectations of being HIV-positive. We verify the validity of this strategy by showing that the pre-test expectations predict the actual HIV status of women who were tested at the clinic. We find large and significant effects of PMTCT nurse attendance that are consistent with underlying HIV status. Women with a high pre-test expectation of being HIV-positive who had a nurse present during their first ANC visit were nearly 27 percentage points more likely to give birth in a health center or hospital than similar high risk women whose first visit coincided with nurse absence. More crucially for the long run health of children, high HIV-positive expectations women whose first visit coincided with the nurse attendance are 7.5 percentage points more likely to receive PMTCT medications and 9 percentage points less likely to breast-feed their child than similar high HIV-positive expectations women whose first visit coincided with nurse absence. In addition, high HIV-positive expectations women whose first visit coincides with the nurse's presence are nearly 10 percentage points more likely to enroll in the free AIDS treatment program than their high-risk counterparts whose first visit coincides with nurse absence.

Given the efficacy of PMTCT medications and the importance of breast-feeding on the transmission of HIV from mother-to-child, these impacts indicate that health worker absence in our setting has far-reaching implications for the health outcomes of women and their children. The absence of the PMTCT nurse in this context translates into 3.7 additional HIV infections per 10,000 live births. Applying our estimates to the average multi-country study absence rate and holding other features of the environment constant implies a four-fold increase in the rate of new infections.

The remainder of the paper is organized as follows. Section 2 provides background information on counseling and HIV testing services during antenatal care and describes the data, Section 3 presents the empirical strategy, Section 4 presents reduced form estimates of the effects of health worker absence, as well as the differential impacts by HIV status priors. Section 5 discusses our results and conclusions.

2 Background and Data

The data used in this study were collected by the authors between July 2005 and February 2007. The first wave of data was collected as an in-clinic survey between July 2005 and February 2006. The second wave was a household-based survey implemented between May 2006 and February 2007. The study enrolled a sample of pregnant women attending an antenatal clinic at a rural health center in western Kenya. The health center is located in Maseno Division, a region that has a population of over 60,000 individuals and lies within Kenya's Nyanza Province. The health center serves a predominantly rural population even though a number of patients from the peri-urban areas of Maseno division use the clinic. The ethnic composition of clinic users is predominantly Luo although about 10 percent of the sample are Luhya. HIV prevalence in Nyanza Province is the highest of all the provinces in Kenya. Data from the 2007 Kenya AIDS Indicator Survey (KAIS) indicate that 17.6% of adult women in the province are HIV-positive, compared to a national average of 8.7% (Amornkul PN, Vandenhoudt H, Nasokho P, Odhiambo F, Mwaengo D, et al. (2009).[2] The health center offers outpatient, inpatient and antenatal care services. It also includes an HIV care and treatment clinic that is managed by the US-Kenya academic medical partnership, USAID-Academic Model Providing Access to Healthcare (AMPATH). AMPATH provides PMTCT medication for pregnant women who are HIV-positive as well as highly active anti-retroviral therapy (HAART) for patients who have developed AIDS at no cost to the patient.

Typically, women make three to four visits to the antenatal clinic during their pregnancy. In addition to receiving routine antenatal care, women are generally offered counseling and HIV testing services (CTS) at the first visit. If they decline these services during the first visit or if a PMTCT nurse counselor is not present, the women can obtain counseling and HIV testing during subsequent visits. All women are eligible for a pre- and post HIV-test

[2] This is consistent with results from the 2003 Demographic and Health Survey (DHS) that 18.3 percent of adult women in Nyanza province were HIV-positive, compared to a national average of just under 7 percent (Central Bureau of Statistics, Kenya 2004).

counseling session. As part of the information provided to women in these sessions, women are encouraged to deliver at the health center or with a professional birth attendant. Women who test HIV-positive are counseled on ways to prevent transmission of the virus to their partner and unborn children. For PMTCT, the women are typically referred to AMPATH's HIV clinic, which is in the same health center. AMPATH provides a full course of HAART to these women during the period before and after delivery (as indicated above there is no charge for the treatment, and the administrative data from AMPATH allow us to establish whether the women in the study enroll in AMPATH).

Enrollment into the study was limited to women visiting the ANC clinic for the first time for the observed pregnancy between July 2005 and February 2006. During enrollment, a short intake questionnaire was administered *prior* to engaging with the staff at the ANC clinic (we refer to this as wave 1 of the study). Due to the space and time constraints at the clinic, the wave 1 questionnaire was kept fairly brief. This questionnaire obtained information on socioeconomic status, fertility preferences, HIV knowledge and subjective beliefs about a woman's own HIV status as well as her partner's. Data on the presence of the PMTCT nurse on any given day, whether the pregnant women consented to the HIV test, and the test result itself (with patient consent) were obtained from the administrative records of the antenatal clinic.[3] Since patients who did not receive CTS during the first visit could do so on subsequent visits to the ANC clinic, administrative records were used to routinely update the CTS status of enrolled women. During the first wave, we also obtained consent from the women to visit them at their homes after delivery.[4] Only a handful of first wave respondents did not consent to the home visit. 591 women who were interviewed at the clinic during wave 1 were located in wave 2, and sample attrition between waves was under

[3]The PMTCT nurse was defined as absent if on a given day when the ANC clinic was open there was no entry in the PMTCT logbook. We also kept a direct-observation record of PMTCT nurse absenteeism in order to make sure that days on which all ANC visitors refused the test are not coded as days of PMTCT nurse absence. Such a coincidence did not occur during our sample period.

[4]Using the expected date of delivery from the administrative records, household visits for the intake respondents were scheduled for approximately two months after delivery.

10 percent.[5] The second wave of the study was part of a large community-based study of maternal health. This wave of the study included a broader survey instrument that included a household roster, questions on education, health, consumption, marriage, sexual behavior, assets, income, and transfers. Interviews were also conducted with the husband or cohabiting partner of each woman (if he was present). The geographical coordinates of households and anthropometric data on women and children were also collected during the home visits.

In order to ensure comparability of our data with nationally representative data, questions were worded similarly to those in the DHS. Care was taken to ensure that interviews were conducted with sufficient privacy. Wave 1 of the study lasted approximately 40 minutes, including the time taken for obtaining informed consent. Three experienced female enumerators conducted the interviews in Kiswahili, Luo or Luhya depending on the language preferences of the subjects.

Table 1 presents summary statistics of several key variables, for the entire sample as well as the sub-samples of women who report low and high priors that they are HIV-positive. The average age of the women interviewed in both waves of the survey is 24.7 years, and 59 percent of them report having completed primary school. Just over one third of the women report being married, while 40 percent report living with their partner and 20 percent report being unmarried or living separately from their partner. 77 percent of women enrolled in our study and located in wave 2 were tested for HIV during one of their antenatal clinic visits. Among those tested, nearly 20 percent were HIV-positive. For 91 percent of the women, a PMTCT nurse was present on the day of their first ANC clinic visit. Several outcomes pertaining to the pregnancy and delivery are of interest.

First, women's self-reports during wave 2 on whether testing and counseling services were offered at the ANC clinic correspond well to the actual testing rate indicated by the PMTCT logbooks (the self-reported rates are in fact slightly higher). While nearly half the women

[5] In the majority of cases we could not complete the household interview because the respondent could not be located, despite considerable efforts to track down respondents as far as Nairobi.

in our sample report that they delivered their child with the assistance of a traditional birth attendant and at home, 39 percent reported having delivered in a public or private health facility or hospital.

Table 1 also summarizes the other key variables used in our empirical strategy. Subjective beliefs about one's chances of being HIV-positive were measured in each wave on a scale of 1-4 (with 1 indicating "great chance" and 4 indicating "no chance at all" of being HIV-positive). The mean for this subjective measure of beliefs is 2.76 in wave 1. For women who report high priors of being HIV-positive, the mean in wave 1 is clearly lower than the mean for low prior women. On most dimensions of baseline household characteristics, women who report low priors of being HIV-positive are similar to high-prior women. Two covariates stand out however. Women with high priors are slightly older and attend church less frequently than low prior women.

Our ANC sample is very similar to the population of young or expecting mothers in this part of Kenya. Nearly three quarters of the women in both ours and the DHS Nyanza province sample live in houses with a durable materials roof. Along the dimension of desired fertility, both samples report a similar average desired number of 4 children. Knowledge about HIV/AIDS is very high in both samples. Nearly 90 percent of women in both samples report knowing that an individual who appears healthy can have HIV and that HIV can be transmitted from a mother to a child. A similar proportion of women in both samples report knowing someone who has died of HIV/AIDS. Finally, HIV testing rates appear considerably higher in our sample; women enrolled at the ANC clinic are 3 times more likely to have had an HIV test. This difference is likely driven by temporal differences in testing rates possibly related to the recent availability of anti-retroviral medications.[6]

[6] There is also a sharp difference in mosquito net ownership: nearly twice as many women in our sample report owning a mosquito net compared to the DHS sample. The difference likely arises from recent aggressive marketing and distribution of mosquito nets that has taken place in this area in the period between the surveys.

3 Empirical Strategy

The first step of our analysis is to obtain the reduced form effect of nurse absence on a range of health outcomes. We estimate regressions of the form:

$$Y_i = \beta_o + \beta_1 X_i + \beta_2 W_i + \beta_3 P_i + \varepsilon_i \tag{1}$$

where Y is an outcome variable of interest; X is a set of individual characteristics, such as education, age, distance from the clinic and marital status, W represents visit date characteristics such as the day of the week or month, and P is an indicator for whether the counseling and testing nurse was present on the first visit to the ANC clinic. β_3 represents the reduced form effect of nurse attendance on health outcomes such as learning HIV-status as a result of a test at the clinic, the choice of delivery location, receipt of PMTCT medication and breast-feeding.

Our estimation strategy will not reproduce the reduced form effect of nurse absence on outcomes (β_3) if nurse absence is correlated with unobserved patient characteristics that affect outcomes $(Cov(P_i, \varepsilon_i) \neq 0)$. The identifying assumption underlying our analysis is that after controlling for observable household and ANC user characteristics, visit date characteristics and priors about HIV-status, the demand for the information and services provided by the PMTCT nurse for women who visit the clinic on days when the nurse is present is the same as on days when she is absent. Our empirical strategy would be invalid if for example a selected subsample of women with particular unobservable characteristics who want to avoid CTS come to the clinic for antenatal care on days when the PMTCT nurse is absent or more likely to be absent.

In order to address this concern, we first start by showing that the presence or absence of a PMTCT nurse on the day of a woman's first antenatal visit is uncorrelated with observable characteristics of pregnant women, their beliefs about their perceived probability of having HIV/AIDS and visit date characteristics. In Table 2, we report the results from a cross-sectional regression of an indicator of nurse presence on ANC user and first visit date characteristics. In column (1) we include a range of socioeconomic characteristics of the woman and her household. The results in column (1) suggest that the likelihood that a nurse is absent on the woman's first antenatal visit is uncorrelated with observable characteristics such as the age, education, marital status and other measures of household well-being.[7] To address additional sources of bias we include in column (2) the quarter in which the baby was conceived.[8] The results suggest the lack of a systematic association between nurse attendance patterns and the timing of conception. In column (3) we include self-reported beliefs that the woman is HIV-positive to control for a wide variety of observable and unobservable determinants of the demand for counseling and testing. Holding observable characteristics constant, we find no systematic association between reported beliefs and the nurse's likelihood to be absent. Finally it is possible that women can use information about patterns of absence unknown to the researcher to select visit dates where the nurse is more or less likely to be absent. We examine this possibility by including controls for visit date characteristics in column (4). In particular we include indicator variables for each day of the week and a quadratic in the day of the month. While there is evidence that Fridays are associated with greater absence, the variation is not particularly large with a narrow range from absence rates of 4% on Mondays to 19% on Fridays. Of note is the fact that we find no evidence of a systematic relationship between absence patterns and the day of the month. In sum our evidence suggests that the composition of women whose first visit coincides with the nurse's presence is not measurably different from those who visit when she is absent.

A number of institutional details and additional robustness checks may help assuage any remaining doubts about this identification strategy. Firstly, for selection bias to be

[7]Anecdotal evidence from the study area suggests that the reasons for absence include official reasons such as collection of salaries and attendance at workshops, illness of self/members of the family and funeral attendance. It is unlikely that information about these 'shocks' to attendance would be available to any of the ANC users.

[8]We use the quarter rather than the month of conception to deal with measurement error associated with premature birth as well as to conserve degrees of freedom.

present, potential ANC visitors need to be able to observe and predict patterns of nurse absence. Based on our two year long experience working with the clinic this is unlikely to be the case since absences of the medical staff are rarely pre-announced or advertised (and consistent with the results in Banerjee, Deaton and Duflo 2004). Moreover since the majority of women travel significant distances to the clinic it is unlikely that they could have access to such information at home, even if it were available. Secondly, the average rate of nurse absence (9 percent of days) and the variation by day of week, which ranges from 4 percent on Mondays to just under 20 percent on Fridays, is small enough that strategically choosing to visit on a day when the nurse is absent seems unlikely.[9] This possibility is made all the more implausible by the fact that women can always opt out of CTS (20 percent of women who visit on a day when the nurse is present do indeed decline to be tested). Third, we have performed a number of additional robustness checks (not reported) and found no consistent relationship between the characteristics of women and the day of the week when they visit the ANC clinic. For example, there is no significant relationship between the distribution of pre-test beliefs that women have about their HIV status and the day of the week of their first visit. In addition, there is no relationship between the distribution of pre-test beliefs about HIV status and the presence of the PMTCT nurse.

Next we extend our main framework to capture the heterogenous treatment effects of absence by HIV status. Understanding these heterogenous responses are of particular interest in this setting, because the benefits from contact with the PMTCT nurse are expected to be larger for women who are HIV-positive as well as their infants. It is worth noting that since we do not observe in our data the HIV status of women who do not get testing and counseling services, we are unable to use actual HIV status as the variable that is interacted with nurse attendance. Instead, our specifications use the self-reported belief from the baseline survey as a proxy for actual HIV status.We thus estimate the following regression model:

[9] It should be emphasized that the nurse's rate of absence at the clinic is considerably lower than levels that have been documented in other developing country settings . Average levels of absence for nurses from a multi-country study are more than three times as large (see Chaudhury et al., 2005).

$$Y_i = \beta_o + \beta_1 X_i + \beta_2 W_i + \beta_3 P_i + \beta_4 low_i + \beta_5 P * low_i + \varepsilon_i \quad (2)$$

Most variables are defined in equation 1. low_i is a dummy taking value 0 for women who in the baseline survey believe that they have a moderate or great chance of being HIV-positive and value 1 for women who believe that they have little or no chance of being HIV-positive. The main coefficient of interest are β_3 and β_5, as they indicate the impact of nurse attendance for women with high priors (β_3) and the impact for women with low priors ($\beta_3 + \beta_5$) of having HIV.

Before proceeding, we discuss two identification challenges for our analysis of heterogenous treatment effects by HIV status. The first identification issue is that our measure of self-reported beliefs of HIV status may be correlated with a number of observable and unobservable characteristics of the women. For example, one might worry that if age and self-reported beliefs about HIV are correlated, our coefficient of interest (β_5) might also pick up the differential effect of nurse absence by age. As a robustness check we will show specifications where we also add as a control the interaction of nurse absence with an index of socioeconomic status that includes age (quadratic), marital status, education, distance from the clinic, housing characteristics and livestock holdings. This principal components index captures potential earnings and/or wealth during the life cycle and conserves degrees of freedom..

The second issue is whether self-reported beliefs of HIV status is a good proxy for underlying HIV status. A priori, bias in self-reported beliefs about HIV status might arise from stigma-related concerns that prevent women from revealing their true beliefs to an enumerator or from poor survey comprehension. As mentioned earlier, not all women tested for HIV at the ANC clinic, but for the 77% who do get tested we can confirm that the reported beliefs are good predictors of actual HIV status.[10] Column (1) of Table 3 shows

[10] The regressions in Table 3 suffer from potential sample selection bias given that the choice to test

that compared to women who reported "no chance at all" of being HIV-positive at the time of enrollment, women who reported a "moderate" or a "great" chance were approximately 17 and 27 percentage points more likely, respectively, to test HIV-positive (these differences are statistically significant). These results persist when we control for visit date characteristics as well as the timing of conception in column (2). Adding observable characteristics of women in column (3) (such as age, education, and wealth) reduces the predictive power of beliefs slightly, as indicated by the change in the p-value of the Chi-squared test of no predictive power of self-reported beliefs. Even then, we reject the null of no-information in self-reported beliefs at the 5% level. It is noteworthy that conditional on HIV status priors, only age significantly predicts HIV status. In column (4) we show that sample selection driven by non-response on some control variables does not drive the results. In columns (5)-(8), we show that an indicator of whether the woman reports a moderate/great chance of HIV increases the likelihood that she tests positive by 12 percentage points. Overall, these results provide support for the strategy we implement to uncover heterogenous reduced form effects of absence.

4 Results

4.1 Impact of Nurse Presence on Uptake of HIV Testing

We begin with the impact of the PMTCT nurse presence on the likelihood that women learn their HIV status during the observed pregnancy. The dependent variable for the regressions in Table 4 is an indicator for whether or not a woman learns her HIV status during the course of this pregnancy. In column (1), we present the unconditional estimate and add visit date, self-reported beliefs and ANC user and household characteristics in columns (2), (3) and (4) respectively. In column (5), we show that sample selection due to non-response does not

is endogenous. A Heckman selection model (not reported) using the nurse absence as an instrument for selection into HIV testing corroborates the findings here that self-reported beliefs predict HIV status.

drive our results. Across all specifications we find a very large and statistically significant effect of nurse presence during the first ANC visit on the likelihood that women learn their HIV status. The point estimates from our different specifications range between 55 and 59 percentage points. The robustness of these results to the inclusion of different controls also alleviate the earlier concerns that the absence of the PMTCT nurse might be correlated with types of women who attend the clinic on such days. Despite the fact that women whose first visit coincides the PMTCT nurse's absence make additional visits to the clinic, only one out of four women learns their HIV-status during other ANC visits. In comparison, a woman whose first visit coincides with the nurse's attendance is three times more likely to learn her HIV status. The very large effect of absence on the uptake of HIV-testing suggests that the referral system at this health center is broken. While women whose first visit coincides with nurse's absence should in principle have about three more opportunities to learn their HIV-status, poor records management implies that three out of four such women are not identified as needing HIV counseling and testing. Overall, the estimates in Table 4 suggest that the presence of the PMTCT nurse is critical to important health outcomes.

4.2 Impact of Nurse Presence on Delivery and PMTCT Outcomes

The immediate impact of the absence of a PMTCT nurse is that it can affect the likelihood that women take-up important services that influence child delivery outcomes. The principal reason for offering HIV testing and counseling during antenatal care is that it identifies HIV-positive women who can be given medications for the prevention of mother-to-child transmission of HIV. To enhance the chances that PMTCT medications are taken at the time of delivery, it is typically advised that HIV-positive women deliver in a health center or at the very least use a professional birth attendant who can administer the PMTCT medications. More broadly, for all women who take advantage of HIV testing and counseling, the PMTCT nurse reinforces the importance of delivering at a health center or using sufficiently trained birth attendants.[11] Since pregnant women and their households may weigh the costs of delivery in a formal setting against the perceived benefits, information gained during pre- and post-test counseling sessions may alter the trade-offs towards safer delivery and greater take-up of PMTCT medications.

The reduced form impact of nurse presence on antenatal, delivery, and postnatal outcomes is reported in Table 5. In columns (1)-(3) of Table 5 we examine the impact of nurse presence on the likelihood the women deliver in an environment where they can obtain relatively high quality obstetric care. Columns (4)-(6) examine the impact of nurse attendance on the self-reported uptake of medication to prevent the vertical transmission of HIV, columns (7)-(9) looks at the effects on whether mothers breast-feed, while columns (10)-(12) examine the effect on enrollment into the AIDS treatment program. We include controls for visit date characteristics and HIV-status priors in all specifications, and in specifications (2), (5), (8) and (11) we also add socioeconomic characteristics of the ANC user. Specifications (3), (6), (9) and (12) are similar to those in columns (1), (4), (7) and (10) but the sample is restricted to women with complete data on all controls. Our preferred estimates are drawn from specifications (2), (5), (8) and (11) which have the full set of controls. We find a large and significant effect of nurse attendance on the choice to deliver in a hospital or health center. The estimate suggests that women whose first ANC visit coincides with the nurse's attendance are 13 percentage points more likely to deliver in a hospital or health center than women whose first visit coincides with the nurse's absence. This represents a large – nearly 50% – increase in the likelihood of delivering in a considerably safer environment. We find no effects of nurse presence on the likelihood of reporting the use of medication to prevent the vertical transmission of HIV. While the point estimates on PMTCT uptake are economically large they are imprecisely estimated. This finding could also be explained by the fact that in our reduced form regressions the sample includes a large fraction of HIV-negative women for

[11] This evidence is based on an interview at the clinic with the PMTCT nurse.

whom the use of PMTCT medications is generally not recommended. In columns (8) and (11) we find no effect of nurse absence on breast-feeding patterns and enrollment into the AIDS treatment program. These results are not surprising since during prenatal counseling, HIV-positive and HIV-negative women receive opposite advice regarding breast-feeding and AIDS treatment programs are only appropriate for those testing positive.

4.3 Do impacts of health worker presence differ by HIV status?

Table 6 explores the differential impact of PMTCT nurse presence by HIV status for the same outcome variables used in Table 5. We estimate equations in which the variable for nurse absence on the day of the first PMTCT visit is interacted with an indicator of whether at baseline the pregnant woman believes she has a low probability of being HIV-positive. As discussed above, we use the self-reported beliefs instead of the actual results from the HIV test since about 23 percent of women in our sample do not get tested at the clinic during their pregnancy. Nevertheless, since our data from the sample of testers indicates that baseline self-reported beliefs are good predictors for underlying status, it suggests that pre-test beliefs can be used to understand the heterogenous reduced form impacts of nurse absence.

The two key estimates are drawn from the main and interacted effects of nurse presence. The main effect measures the impact of nurse attendance for women who report a high likelihood of being HIV-positive, while the sum of the main and interacted effects measure the impact of nurse presence on low-prior women. As in Table 5, we control for visit date and ANC user characteristics and our preferred estimates are drawn from columns (2), (6), (10) and (14) which also include a set of background controls.

We find considerable heterogeneity in the impact of health worker attendance on child delivery outcomes. High prior women whose first visit coincides with the nurse's attendance are 25 percentage points more likely to deliver in a health center or hospital than high prior women whose first visit coincides with nurse absence. This effect is large and statistically significant at the 5% level. For low prior women, the effect size indicated by the sum of the main and interacted terms is considerably smaller relative to the impact on high prior women. Low prior women whose visit coincides with the nurse's attendance are only 10 percentage points more likely to deliver in a health center or hospital than low prior women who arrive when the nurse is absent. The low prior effect is also imprecisely estimated with a p-value of 0.19.

In columns (5)-(8) we document the heterogenous impact of health worker presence on the likelihood of receiving medication to prevent vertical transmission of HIV. High prior women whose first visit is on a day when the PMTCT nurse is present are 7.4 percentage points more likely to report receiving PMTCT medication than high prior women whose visit coincides with the nurse's absence. As we would expect for this outcome, health worker absence has no statistically significant effect on low prior women. Similarly in columns (9)-(12), we estimate the differential effect of health worker presence on breast-feeding behavior for high and low prior ANC users. The impact of health worker presence on high prior women is to reduce the likelihood that they breast-feed by nearly 9 percentage points. For low prior women, we estimate a very small and statistically insignificant impact of attendance on the likelihood of breast-feeding. The uptake of PMTCT medication and abstaining from breast-feeding are both strategies to reduce vertical transmission of HIV to children. Any impact of the health worker's presence should only matter for those women most likely to be HIV-positive. In particular, it suggests that information delivered in the pre- and particularly the post-HIV test counseling sessions has large impacts on child health outcomes.

Finally in columns (13)-(16) we examine the impact of nurse presence on enrollment in the free AIDS treatment program at the health center. Only 5% of our sample enrolls in this treatment program. Our preferred results in column (14) suggest that for women most likely to test HIV-positive, arriving on a day when the nurse is present increases the likelihood that you enroll in the treatment program by 10 percentage points relative to when the nurse is absent. This point estimate suggests that nurse attendance has a three fold effect on the likelihood of enrolling in a treatment program. Given recent evidence that AIDS treatment outcomes are considerably better when treatment starts earlier (Thompson et al. (2010)), these results imply large long-term benefits to women likely to test positive and arriving on a day when the nurse is present. As with the breast-feeding and PMTCT result, the effect of nurse attendance on low prior women is small and statistically insignificant.

The results above are robust to including interactions between nurse presence and an index that summarizes age, education, marital status,distance and wealth holdings of ANC users. In columns (3), (7), (11) and (15), including an interaction of absence and this principal components index of social economic status does not change the magnitude or significance of the coefficients reported above. The results suggest that over and above visiting an antenatal clinic, the PMTCT nurse's presence has large effects on the behavior of pregnant women that translate into large gains in child and maternal health. In addition to the public resources leakage associated with health provider absence, these results suggest considerable adverse effects on the health of the intended beneficiaries of HIV testing and their newborn children.

5 Discussion and Conclusion

Using a panel dataset of pregnant women who sought antenatal care in a high HIV prevalence region of Kenya, we assess the impact of healthcare provider absence on a number of health outcomes. Our results show that in the study area, health worker absence is one of the important determinants of uptake of HIV testing and counseling services and that it also influences the probability that pregnant women give birth in a hospital or health center. We test for differential impacts of nurse attendance using pre-test beliefs which predict HIV-status for those who test. For those women who are more likely to be HIV-positive, we find that the presence of the PMTCT nurse increases the probability of receiving PMTCT medications at the time of delivery, decreases the probability of breast-feeding and increases the probability of enrollment in an HIV treatment program.

While our analysis has focused on the reduced form impacts of PMTCT nurse presence on health outcomes, at least two plausible and possibly overlapping mechanisms could underpin this relationship and merit a brief discussion. First, the presence of the PMTCT nurse is required for being tested for HIV and for the provision of HIV and pregnancy counseling. Learning one's HIV status and receiving counseling are the main channels for helping women learn about the risks and benefits of breast feeding for HIV-positive mothers and the benefits of delivery in a safe setting. Nonetheless, an alternative mechanism may also be at play here. If women who arrive at the clinic on a day that the nurse is absent lose confidence in the medical system, then they may similarly be less likely to demand downstream health services, independent of their knowledge regarding the potential benefits of those services. While the absence in our setting does not preclude patients from accessing all forms of antenatal care apart from PMTCT counseling and testing during that visit, we nonetheless cannot rule out this discouragement explanation as at least a partial driver of our results. That nurse absence during the initial ANC visit does not appear to affect the number of subsequent ANC visits (Table 7), provides at least suggestive evidence that this is not the primary mechanism through which these absence effects operate.

Given the pervasiveness of health worker absence across the developing world, it is instructive to translate these impacts into an estimate of the number of new HIV cases averted (see Appendix A for details on calculations). The lone PMTCT nurse in our setting is absent 9 percent of the time and this absence results in a 58 percentage point reduction in the likelihood that patients test at any point during their pregnancy. Combining this with data on patient flow at the antenatal clinic and the effectiveness of medications in reducing mother-to-child transmission yields the result that PMTCT nurse absence contributes to an additional 3.7 mother-to-child infections per 10,000 live births. If we apply these estimates to the 35 percent absence rate documented in some other developing country settings (Chaudhury et al., 2006) and assume a similar population and quality of health facility, then nurse absence contributes to about 14.6 additional infections per 10,000 live births. This number appears staggeringly large when compared to the seemingly small expenditure that would be required to provide substitute nurse coverage in the clinic. In addition, improvements in the referral system such as the deployment of well designed electronic medical records systems could mitigate the effects of absence in this setting (Siika et. al. 2005). Of course, implementing effective and long lasting reductions in absence or interventions meant to reduce the effects of absence may be hard when the system is not conducive to change (Banerjee, Duflo, and Glennerster 2008). National and global policy makers need to take the costs and benefits associated with these effects into account when deciding on priority investments for health.

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Table 1: Summary Statistics

	All women enrolled			Low prob HIV+ women			High prob HIV+ women		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Variables									
Age in years	24.69	6.36	587	24.33	6.25	409	25.51	6.53	178
Fraction completed primary school	0.59	0.49	583	0.60	0.49	406	0.58	0.50	177
Fraction married or cohabiting	0.76	0.42	587	0.77	0.42	409	0.76	0.43	178
Freq. church attendance, past 4 weeks	3.34	2.53	587	3.43	2.57	409	3.13	2.44	178
Number of sexual partners	1.02	0.31	587	1.02	0.33	409	1.01	0.27	178
Fraction boils water	0.77	0.42	586	0.77	0.42	408	0.78	0.41	178
Number of livestock	2.09	3.48	585	2.07	2.93	407	2.14	4.52	178
Fraction iron roof	0.73	0.44	587	0.73	0.44	409	0.73	0.45	178
Fraction located with Maseno Division	0.74	0.44	587	0.75	0.43	409	0.74	0.44	178
Tested for HIV	0.77	0.42	587	0.75	0.44	409	0.83	0.38	178
Tested HIV-positive	0.15	0.36	587	0.12	0.32	409	0.24	0.43	178
Nurse present at first ANC visit	0.91	0.29	587	0.89	0.31	409	0.94	0.24	178
Received counselling/testing - self-report	0.88	0.32	586	0.88	0.33	408	0.90	0.30	178
Delivered in the health center or hospital	0.39	0.49	587	0.41	0.49	409	0.34	0.48	178
Delivery assistance from a TBA	0.48	0.50	587	0.46	0.50	409	0.52	0.50	178
Data from Waves 1 and 2									
Subjective belief about HIV status (Scale 1-4 decreasing in risk)									
Wave 1	2.76	0.88	587	3.25	0.44	409	1.61	0.49	178
Wave 2	2.78	1.06	572	2.87	1.03	399	2.58	1.11	173
Data from Wave 2 only									
Received PMTCT medication at birth	0.06	0.24	582	0.06	0.24	406	0.07	0.25	176
Mother reports breastfeeding newborn child	0.95	0.22	587	0.96	0.19	409	0.92	0.27	178

Notes: SD is the standard deviation and N is the sample size. Source: Sample of women enrolled during first ANC clinic visit (wave 1) and interviewed at home after delivery (wave 2).

Table 2: Correlates of Nurse attendance

	Nurse present at time of woman's first visit			
	(1)	(2)	(3)	(4)
Age in years	-0.013	-0.013	-0.015	-0.012
	(0.012)	(0.013)	(0.013)	(0.013)
Age in years, squared	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Completed primary school	-0.012	-0.011	-0.012	-0.010
	(0.022)	(0.022)	(0.022)	(0.024)
Married	0.037	0.036	0.041	0.042
	(0.027)	(0.027)	(0.028)	(0.030)
Frequency of church attendance in past four weeks	-0.002	-0.002	-0.001	-0.000
	(0.004)	(0.004)	(0.004)	(0.004)
Boils drinking water	-0.026	-0.021	-0.018	-0.018
	(0.027)	(0.023)	(0.024)	(0.025)
# of livestock held at enrollment	-0.000	-0.000	-0.000	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)
Lives in a non-thatched house	-0.009	-0.007	-0.006	-0.005
	(0.031)	(0.030)	(0.028)	(0.029)
Lives in Maseno division	-0.005	-0.005	-0.006	-0.006
	(0.026)	(0.027)	(0.026)	(0.026)
Log distance from clinic	-0.004	-0.005	-0.005	-0.003
	(0.021)	(0.021)	(0.020)	(0.019)
Quarter of conception ==2		0.017	0.017	0.013
		(0.038)	(0.038)	(0.034)
Quarter of conception ==3		-0.030	-0.035	-0.039
		(0.057)	(0.058)	(0.054)
Quarter of conception ==4		-0.045	-0.047	-0.066
		(0.050)	(0.052)	(0.052)
Moderate chance HIV +ve			0.017	0.012
			(0.039)	(0.040)
Small chance HIV +ve			-0.027	-0.029
			(0.036)	(0.037)
No chance at all HIV +ve			-0.069	-0.075
			(0.054)	(0.054)
Day of week = Tuesday				-0.028
				(0.048)
Day of week = Wednesday				-0.045
				(0.043)
Day of week = Thursday				-0.098
				(0.068)
Day of week = Friday				-0.188
				(0.093)*
Day of the month				0.004
				(0.011)
Day of the month squared				-0.000
				(0.000)
Constant	1.086	1.086	1.140	1.151
	(0.217)**	(0.231)**	(0.252)**	(0.242)**
Observations	581	581	577	577
R-squared	0.01	0.01	0.02	0.07

Notes: The variables are defined in Table 1. "Nurse present at time of woman's first visit" takes value 1 if the PMTCT nurse was present at the ANC clinic on the day of the first visit during this pregnancy, 0 otherwise. Standard errors in brackets clustered at the visit date level. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 3: Subjective beliefs before HIV test and actual test results

	Dependent variable: Indicator tested positive							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chance of having HIV- great	0.272	0.247	0.208	0.263				
	(0.097)**	(0.098)*	(0.099)*	(0.097)**				
Chance of having HIV- moderate	0.171	0.156	0.111	0.166				
	(0.081)*	(0.082)+	(0.079)	(0.082)*				
Chance of having HIV- small	0.077	0.060	0.021	0.069				
	(0.059)	(0.060)	(0.061)	(0.060)				
Chance of having HIV - great or moderate					0.126	0.125	0.120	0.129
					(0.043)**	(0.043)**	(0.043)**	(0.043)**
Day of week = Tuesday		0.004	-0.001			0.004	-0.000	
		(0.057)	(0.056)			(0.057)	(0.056)	
Day of week = Wednesday		-0.005	0.004			-0.002	0.005	
		(0.058)	(0.059)			(0.058)	(0.059)	
Day of week = Thursday		-0.019	-0.041			-0.011	-0.038	
		(0.052)	(0.050)			(0.053)	(0.050)	
Day of week = Friday		0.083	0.073			0.089	0.077	
		(0.072)	(0.071)			(0.072)	(0.072)	
Day of the month		0.006	0.001			0.005	0.001	
		(0.009)	(0.009)			(0.009)	(0.009)	
Day of the month squared		-0.000	-0.000			-0.000	-0.000	
		(0.000)	(0.000)			(0.000)	(0.000)	
Quarter of conception ==2		0.006	0.018			0.004	0.017	
		(0.047)	(0.048)			(0.047)	(0.048)	
Quarter of conception ==3		0.069	0.089			0.073	0.092	
		(0.057)	(0.060)			(0.057)	(0.060)	
Quarter of conception ==4		-0.120	-0.115			-0.126	-0.118	
		(0.054)*	(0.054)*			(0.052)*	(0.052)*	
Age in years			0.087				0.087	
			(0.027)**				(0.026)**	
Age in years, squared			-0.001				-0.001	
			(0.000)**				(0.000)**	
Completed primary school			-0.049				-0.045	
			(0.041)				(0.041)	
Married			-0.073				-0.079	
			(0.061)				(0.061)	
Frequency of church attendance in past four weeks			0.007				0.007	
			(0.008)				(0.008)	
Boils drinking water			0.007				0.005	
			(0.045)				(0.046)	
# of livestock held at enrollment			-0.005				-0.005	
			(0.005)				(0.006)	
Lives in a non-thatched house			-0.007				-0.009	
			(0.043)				(0.043)	
Lives in Maseno division			0.009				0.009	
			(0.044)				(0.044)	
Log distance from clinic			-0.011				-0.011	
			(0.031)				(0.031)	
Observations	453	452	446	446	453	452	446	446
F-Stat:Test No Effect of Priors on Actual Status	12.55	11.41	9.98	12.29				
prob>Chi2	0.01	0.01	0.02	0.01				

Notes: The variables are defined in Table 1. Table reports marginal probit estimates. Tested positive takes value 1 if the subject was tested positive during the pregnancy and 0 if HIV-negative. Standard errors in brackets clustered at the visit date level. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 4: Effect of nurse absenteeism on testing

	Independent Variable: Indicator for Tested for HIV during pregnancy				
	(1)	(2)	(3)	(4)	(5)
PMTCT Nurse Present	0.587	0.568	0.558	0.557	0.587
	(0.067)**	(0.066)**	(0.065)**	(0.065)**	(0.067)**
Constant	0.241	0.200	0.252	0.469	0.241
	(0.065)**	(0.099)*	(0.101)*	(0.279)+	(0.065)**
Visit Date Controls		X	X	X	
HIV Priors			X	X	
Household controls				X	
Observations	588	588	584	577	577
R-squared	0.16	0.19	0.19	0.22	0.17

Notes: Standard errors in brackets clustered at the visit date level. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Table 1. "Tested for HIV" takes value 1 if a pregnant woman was given an HIV test during any visit at the ANC clinic during pregnancy, 0 otherwise. PMTCT Nurse Present takes value 1 if the PMTCT nurse was present at the ANC clinic on the day of the first visit during a particular pregnancy, 0 otherwise. Visit date controls include the day of the week, day of the month and day of the month squared. Controls include age, age squared, an indicator for primary school completion, married, church attendance, reports boiling water, has permanent roof, location in the district, number of initial livestock holdings and log distance to the clinic.

Table 5: Effect of nurse absenteeism on Health Outcomes

	Delivered at hospital or health center			Given any medication to prevent Mother to child HIV transmission			Breastfed baby			Enrolled in Ampath Treatment Program		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
PMTCT Nurse Present	0.115	0.132	0.115	0.045	0.037	0.045	-0.012	-0.008	-0.011	0.035	0.037	0.034
	(0.058)+	(0.054)*	(0.058)*	(0.035)	(0.033)	(0.035)	(0.039)	(0.039)	(0.039)	(0.021)	(0.023)	(0.021)
Constant	0.281	0.304	0.287	0.025	-0.246	0.011	0.995	1.330	1.010	-0.013	-0.372	-0.027
	(0.098)**	(0.321)	(0.100)**	(0.064)	(0.129)+	(0.063)	(0.042)**	(0.119)**	(0.040)**	(0.043)	(0.144)*	(0.043)
Visit Date Controls	X	X	X	X	X	X	X	X	X	X	X	X
HIV Priors	X	X	X	X	X	X	X	X	X	X	X	X
Household controls		X			X			X			X	
Observations	576	564	564	571	559	559	576	564	564	576	564	564
R-squared	0.03	0.12	0.03	0.02	0.06	0.02	0.03	0.06	0.03	0.05	0.07	0.05
Mean of dependent variable|nurse absent	0.28			0.04			0.94			0.05		

Notes: Standard errors in brackets clustered at the visit date level. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Table 1. All specifications include controls for day of the week, date and HIV status priors. PMTCT Nurse Present takes value 1 if the PMTCT nurse was present at the ANC clinic on the day of the first visit during a particular pregnancy, 0 otherwise. Visit date controls include the day of the week, day of the month and day of the month squared. Controls include age, age squared, an indicator for primary school completion, married, church attendance, reports boiling water, has permanent roof, location in the district, number of initial livestock holdings, and log distance to the clinic.

Table 6: Effect of nurse absenteeism on Health Outcomes: interactions with beliefs about HIV Status

	Delivered at hospital or health center				Given any medication to prevent Mother to child HIV transmission				Breastfed baby				Enrolled in Ampath Treatment Program			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
PMTCT Nurse Present	0.266	0.246	0.234	0.257	0.086	0.074	0.076	0.081	-0.090	-0.089	-0.102	-0.085	0.111	0.098	0.111	0.107
	(0.099)**	(0.117)*	(0.122)+	(0.100)*	(0.026)**	(0.028)**	(0.031)*	(0.026)**	(0.025)**	(0.024)**	(0.027)**	(0.025)**	(0.029)**	(0.030)**	(0.033)**	(0.029)**
Low prior HIV +ve	0.246	0.216	0.204	0.248	0.045	0.051	0.052	0.045	-0.050	-0.062	-0.074	-0.050	0.020	0.011	0.023	0.019
	(0.122)*	(0.136)	(0.138)	(0.123)*	(0.036)	(0.038)	(0.032)	(0.036)	(0.045)	(0.049)	(0.054)	(0.045)	(0.021)	(0.029)	(0.033)	(0.021)
PMTCT Nurse Present * Low prior HIV +ve	-0.193	-0.148	-0.138	-0.182	-0.053	-0.049	-0.051	-0.047	0.099	0.103	0.115	0.094	-0.097	-0.076	-0.088	-0.092
	(0.130)	(0.142)	(0.144)	(0.131)	(0.044)	(0.046)	(0.041)	(0.044)	(0.050)*	(0.053)+	(0.057)*	(0.050)+	(0.036)**	(0.042)+	(0.044)*	(0.036)*
Constant	0.097	0.127	0.081	0.086	-0.009	-0.292	-0.286	-0.024	1.011	1.355	1.303	1.028	0.009	-0.348	-0.297	-0.006
	(0.125)	(0.334)	(0.339)	(0.128)	(0.051)	(0.127)*	(0.125)*	(0.051)	(0.042)**	(0.123)**	(0.117)**	(0.040)**	(0.039)	(0.135)*	(0.151)+	(0.037)
Visit Date Controls	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Household controls		X	X			X	X			X	X			X	X	
SES Index*Present interaction			X				X				X				X	
Observations	576	564	564	564	571	559	559	559	576	564	564	564	576	564	564	564
R-squared	0.02	0.12	0.12	0.03	0.02	0.06	0.06	0.02	0.03	0.06	0.06	0.02	0.04	0.06	0.06	0.04
Test: Presence no effect on low prior subjects	0.98	2.08	1.98	1.03	0.61	0.36	0.35	0.64	0.04	0.09	0.07	0.04	0.30	0.51	0.72	0.32
prob>F	0.32	0.15	0.16	0.31	0.44	0.55	0.56	0.43	0.84	0.76	0.78	0.85	0.59	0.47	0.40	0.57

Notes: Standard errors in brackets clustered at the visit date level. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Table 1. All specifications include controls for day of the week and date. PMTCT Nurse Present takes value 1 if the PMTCT nurse was present at the ANC clinic on the day of the first visit during a particular pregnancy, 0 otherwise. Visit date controls include the day of the week, day of the month and day of the month squared. Controls include age, age squared, an indicator for primary school completion, married, church attendance, reports boiling water, has permanent roof, location in the district, number of initial livestock holdings, and log distance to the clinic. The SES index is a principal component of the information contained in age, age squared, distance from the clinic, marital status, education, livestock holdings and roof material.

Table 7: Effect of nurse absenteeism on Visits to the Clinic

	Number of times visited Clinic for this pregnancy		
	(1)	(2)	(3)
PMTCT Nurse Present	0.056	-0.031	0.047
	(0.288)	(0.276)	(0.288)
Constant	3.339	1.658	3.277
	(0.434)**	(1.461)	(0.438)**
Visit Date Controls	X	X	X
HIV Priors	X	X	X
Household Controls		X	
Observations	570	558	558
R-squared	0.03	0.08	0.03
Mean of dependent variable: number of ANC visits	3.74		

Notes: The dependent variables are defined in Table 1. All specifications include controls for day of the week, date and HIV status priors. PMTCT Nurse Present takes value 1 if the PMTCT nurse was present at the ANC clinic on the day of the first visit during a particular pregnancy, 0 otherwise. Visit date controls include the day of the week, day of the month and day of the month squared. Controls include age, age squared, an indicator for primary school completion, married, church attendance, reports boiling water, has permanent roof, location in the district, number of initial livestock holdings, and log distance to the clinic. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Appendix A:
Below we provide a more detailed explanation for the imputation of the number of HIV infections that could be averted by the elimination of nurse absences. First we provide an estimate of the prevalence rate of eventual non-testers whose first ANC visit happened on a day when the nurse is absent. Second we combine these estimates with information from the medical literature on the relationship between PMTCT medication and reductions in HIV transmission at birth. Third we calculate the impact of absence on the number of transmissions in a given year for the absence level at our clinic, as well as for typical absence rates in the health sector in developing countries more generally.

Based on a number of plausible assumptions, we generate five distinct estimates of the prevalence rate of pregnant women who did not test due to nurse absence on the first ANC visit:

1.) We assume that the prevalence rate of non-testers is equal to the prevalence rate of testers (19.7%)

2.) We assume that the prevalence rate of non-testers is equal to the adult prevalence rate in the 2003 Kenyan DHS for the Nyanza region (18.3%).

3.) We assume that the prevalence rate of women who turn up for their first ANC visit on days when the nurse is absent (group 1) is the same as on days when she is present (group 2). Among eventual testers for these two groups, the prevalence rate is 19.9% (group 2) and 15.4% (group 1). The testing rates for these groups are 82.5% (group 2) and 24.1% (group 1). The resulting prevalence rate for non-testers who would have tested if the nurse was present is 21.8%.

4.) We use the background characteristics of the women who test to predict in a regression framework the prevalence of all non-testers (20.7%).

5.) We use the background characteristics of the women who test to predict the prevalence of all non-testers whose first visit is on a day when the nurse is absent (19.1%).

Across each of the five different assumptions, the calculated prevalence rate for the population of interest is roughly 20% and varies between 18.3% and 21.8%.

Next we turn to estimates of the efficacy of PMTCT interventions. Using the estimates reported in UNAIDS (2005), rates of mother-to-child transmission and the impact of different PMTCT regimens are as follows:

1. Default mother to child transmission rate without any intervention: 32%
2. No intervention, long breastfeeding (18-24 months): 35%
3. No intervention, short breastfeeding (6 months): 30%
4. No intervention, replacement feeding: 20%
5. Single-dose NVP[1] (mothers & infants), combined with short (6 months) breastfeeding (6 months): 16%
6. Single-dose NVP (mothers & infants), combined with replacement feeding: 11%
7. AZT[2] long (from 28 weeks) and single-dose NVP (mothers & infants), combined with short breastfeeding (6 months): 10%
8. AZT long (from 28 weeks) and single-dose NVP (mothers & infants), combined with replacement feeding: 2%

[1] NVP – nevirapine.
[2] AZT – azidothymidine

According to the treatment regimen in place at the time of the survey, the most common PMTCT intervention was AZT long with single-dose NVP combined with short breastfeeding, which has an estimated transmission rate of 10%. Therefore the treatment with PMTCT in our setting reduces the transmission rate at birth among HIV positive women by approximately 22 percentage points (32% to 10%).

On a typical day, a PMTCT nurse conducts testing and counseling to an average of 4.1 pregnant women. When she is absent, about 58% of first time ANC visitors do not test during the pregnancy. Since the prevalence rate is estimated to be around 20% for this population and testing increases the chance of receiving medication to prevent MTCT for those who are positive by 18 percentage points, this means that a one day absence results in roughly .09 (= 4.1*.58*.2*.18) positive women do not receive PMTCT. This translates into an *increase* in the HIV transmission from the mother to the child of .019 (.09*.22) cases. If we apply this estimate to the typical absence rate in our clinic (9%), then nurse absence contributes to an additional .42 infections per year (assuming 250 working days in a year). If we apply these estimates to the much larger absence rates found in the literature (35%), then nurse absence contributes to about 1.65 infections per year per nurse.

Taking into account the fraction of women that visit ANC clinics (88%) and neonatal mortality (33 per 1000 live births), these numbers translate into 0.37 infections per 1000 live births (9% absence) and 1.46 infections per 1000 live births (35% absence rates).