**Title:** The effect of Integrated Management of Adolescent & Adult Illness (IMAI) training plus enhanced mentoring and supervision on the quality of primary care delivery and health worker performance in Rwanda.

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**Abstract:**

*Background*: Primary care delivery in low- and middle-income countries is often viewed through the lens of specific diseases or specific populations. Little specific attention has been paid on how to improve the quality of care delivery for general ambulatory services for adults and adolescents.

*Objective:* We sought to measure the impact of the World Health Organization’s Integrated Management of Adolescent and Adult Illness (IMAI), combined with a sustained program of mentoring and supervision, on the quality of ambulatory primary care provided in rural Rwanda.

*Methods:* We employed a pre- / post- intervention plausibility design at eight health center outpatient departments in one district in rural Rwanda. Data was collected by standardized observation of case management by nurses at the study health centers. Baseline data was collected between February and March 2011, and follow-up data between April 2011 and September 2012. Quality was defined as agreement between the nurse and a clinical mentor in their diagnosis and treatment plan, as well as based on rates of key quality indicator practices such as vital signs and screening. We applied chi-square and t-tests for significance and conducted mixed effects regression to calculate the probability of agreement between the nurse and mentor in their diagnosis and treatment plan.

*Results*: Four hundred and sixty four (464) patients were observed in the pre-intervention survey, and 506 in the post-intervention period, with consultations addressing a total of 1236 clinical complaints overall. After IMAI training and mentoring, significant (p<0.05) improvements were seen in basic quality metrics such as taking of vital signs (increases in taking of temperature (+49%), pulse (+66%), and blood pressure (+54%), etc.) as well as in essential screening for TB, HIV and other conditions. Frequency of agreement in diagnosis and treatment increased by +28% each in the post-intervention period. After adjustment for effect modifiers such as education level and number of observations per nurse, the odds of agreement post-intervention was more than doubled for diagnosis (OR 2.32, 95%CI 1.63 - 3.30) and treatment (OR 2.27, 95%CI 1.65-3.12). This effect remained consistent for nurses who were not exposed to initial training, but did receive the mentoring intervention, but only for diagnosis agreement (OR 2.24, 95%CI 1.26-3.97).

*Conclusions*: When combined with a program of sustained clinical mentorship and supportive supervision, IMAI can lead to significant improvement in quality of primary care delivery in Rwanda, and is an important step to strengthening integrated primary care delivery in low- and middle-income settings.

**Background**

Historically, attention and investment in primary care delivery in low- and middle-income countries (LMICs) has been less than for disease- and population-specific health interventions (1, 2) both in absolute and relative terms. However, this is now growing in proportion to overall global health investment (3). Despite this investment, primary care – or longitudinal, first contact health care delivered at the front lines of the health system - is often subsumed within efforts in ‘health systems strengthening’, which focus closely on structural, bureaucratic, and administrative interventions to develop information systems, strengthen the health workforce and improve infrastructure (4, 5). Typically primary care in global health is not specifically addressed as a mode of care or as a service in itself. Investment into the clinical quality of primary care programs is usually rooted within maternal and child health (MCH) services, which are critically important and yet an incomplete measure of population health and health systems performance in LMICs (6).

Interventions to reduce adult and adolescent mortality have been largely organized around specific diseases such as HIV, TB or malaria (7). Less attention has been given to other common acute conditions that typically present to basic primary care facilities such as pneumonia, diarrheal disease, or emerging chronic non-communicable diseases, though this trend is slowly shifting (8). These conditions continue to be major contributors to mortality and years lost to disability in LMICs (9). In addition, limited definitions of ‘primary care’ that focus on certain demographic groups and vulnerable populations, neglect the burden of general medical illness in the adult and adolescent populations in LMICs, and fail to recognize the important and wider systems benefits that could be gained from investing in the quality of general primary care services, as a foundation to complement and support disease and population-specific programs.

It has been suggested that integrated models of care that merge efforts to improve services for specific diseases and populations with those for general primary care would be mutually beneficial and reinforcing for health outcomes and quality of care (10-12). But limited data exist to support this hypothesis. A Cochrane systematic review of integrated care, for instance, failed to show clear benefit, and rather highlighted the paucity and poor quality of available data (13). One notable exception is a large randomized trial from South Africa that integrated HIV services into rural outpatient departments staffed by nurses, but this study found no significant mortality benefit or improvement in HIV-specific endpoints (14).

Additionally, limited data exists describing the quality of services for basic primary care conditions. The Practical Approach to Lung Health (PAL) developed by the World Health Organization (WHO) and partners, was studied in South Africa (15, 16) and Malawi (17). It measured the effect of integrating algorithms for lung health and HIV, respectively, into primary care services and found improvement in TB case detection (18, 19), but has yet to publish quantitative benefit on patient outcomes or quality. A baseline survey of primary care quality conducted by our team in rural Rwanda found that basic outpatient care provided for acute primary care conditions in adults and adolescents was of low quality; it reported low rates of performance of basic clinical tasks during routine primary care delivery, such as measuring and recording vital signs, screening for key prevalent conditions and behavioral counseling, and assignment of follow-up and of referral visits (20).

The most comprehensive design of a program of integrated primary care service delivery at the point of care has been the WHO Integrated Management of Adolescent & Adult Illness (IMAI) (21), described elsewhere in detail (X). Briefly, IMAI is a standardized protocol, based on syndromic management and targeted at front-line health care workers (HCWs), which is organized into a single protocol that supports HCWs to deliver integrated care within a single patient encounter. While much effort has gone into the design and adaptation of IMAI to a variety of settings, little rigorous research has been done to assess its validity or its impact on quality of care and health worker performance. What few studies do exist are largely unpublished validations [*Simoes E, et al: Preliminary Analysis of IMAI Validation Studies*] or are focused on HIV and respiratory care within outpatient departments (OPDs), using adapted versions of IMAI (22, 23). The lack of data on IMAI to-date could be explained, in part, by a general difficulty in garnering funding and attention to the issue of general primary care for adults and adolescents. But importantly, it also reflects a series of very practical operational challenges to implementing a comprehensive and integrated approach to the patient within weak health systems, where HCWs often lack adequate support and pre-service education, and work with significant demands from vertical interventions.

The literature also suggests that while initial training is critical, it alone is insufficient to sustain improved health worker performance. For example, evidence from Uganda (24), Benin (25, 26), Brazil (27) Bangladesh (28) and from this project in Rwanda (29) has shown that routine, sustained, and frequent supportive supervision and mentoring leads to improvements in quality and fidelity to the WHO IMCI guidelines. This has also been demonstrated in general primary care services in the Philippines (30), for sexually transmitted infections in India (31) and a number of other settings, which suggests that interventions to improve health worker performance and to strengthen quality of care must focus both on building core skills and on sustaining gains through post-training supports.

In light of the evidence gaps for IMAI and primary care delivery, and combined with our understanding of the role of post-training support and supervision in improving health worker performance and quality, this study investigates the impact of IMAI training in concert with a program of sustained mentorship and quality improvement (32), on the performance of front-line nurses and on the quality of care provided for adult and adolescent ambulatory primary care services in rural Rwanda. The objective of this study is to investigate whether IMAI leads to improved decision making and routine behaviors and practices in the ambulatory primary care setting, when compared to the standard of the IMAI protocol implemented by a senior clinician-mentor.

**Methods**

*Study setting*

The study was conducted at eight Rwandan Ministry of Health (MoH) health centers. These are the front line facilities within the health system, led by nurses – in one district in Rwanda’s Eastern Province bordering Tanzania and Burundi, which has an approximate population of 190,000 (2010 Rwanda National Census). Within these health centers, the study took place within the OPDs, which are staffed by generalist nurses with the equivalent of secondary school training in nursing, human science, and health behavior. The study setting has been described in detail elsewhere (20).

*Study population*

The baseline or pre-intervention survey occurred in February and March of 2011. The post-intervention survey occurred from April 2011 through September 2012. Consecutive patients 13 years or older presenting to any one of the health center OPDs on a day of observation were eligible for the study. The official start of adolescence in Rwanda is not clearly defined by law (33), and thus age 13 was chosen for this study based on definitions used by the United States’ Centers for Disease Control (CDC) (34).

*Study design*

The study was designed as a pre- / post-intervention plausibility trial. The intervention itself was defined as nurse exposure to a one-week didactic training course in IMAI *Acute Care* (21) followed by enhanced mentoring and supervision visits focused on clinical performance improvement and systems-based quality improvement. The structure of this mentoring intervention has been described in detail elsewhere (32, 35). In brief, health centers were visited every four to six weeks by a district-based clinical mentor with the equivalent of bachelor’s degree registered nurse (RN) education and at least five years of clinical experience, along with extensive training and experience in IMAI and OPD clinical care, mentoring techniques, data collection, and quality improvement methods. Mentoring visits included clinical skills-based mentoring, coaching, and feedback in IMAI based on data gathered through direct case observation, as well as facility- and systems-based quality improvement, focusing on non-clinical and operational challenges. Quarterly review meetings were also held with the mentor at the district, during which aggregated data from the observation checklists was used to assess systems-level gaps and to plan near-term quality improvement solutions.

*Data collection*

Data were collected by the clinical mentor for IMAI. The baseline survey was conducted prior to the start of supervision activities; while post-intervention survey was during routine supervisory visits to district health centers by the clinical mentor. Data were collected through direct observation of routine OPD care by health center nurses, using a standard data collection tool developed to document critical components of the clinical encounter relevant to IMAI. This observation checklist was structured on the WHO-IMAI Case Management Observation Form, and included the standard triage checklist for emergency conditions contained within the IMAI Quick Check protocol, (36)part of the larger IMAI guideline (21). Prior to data collection and the development of the observation checklist the IMAI guideline was adapted to adhere to Rwandan national treatment guidelines and to local epidemiology through consensus guideline review and development. Data collection procedures, including the origin and type of data collected in the observation checklist, has been described elsewhere (20).

*Outcomes*

The primary outcomes of interest were agreement between the nurse and the clinical mentor in diagnosis and treatment plan. Agreement was defined on a per complaint basis, with up to three complaints recorded for each patient. Treatment agreement was defined as full agreement in all elements of the treatment plan, including requests for laboratory or additional diagnostic testing, medications prescribed and referral or follow-up visits planned, as appropriate. Covariates for agreement included nurse-level factors such as years of experience in OPD care, time since initial training, and patient-level factors such as sex, age and reported signs and symptoms were also reported, as well as. additional quality indicators such as frequency of vital signs collection and appropriate screening conducted .

*Data analysis*

Sample size was calculated to detect a 20% difference between the pre- and post intervention outcome (agreement) at the 5% significance level, with power (β) of 0.8, which set a target of 250 observations in each sample (pre- and post-intervention), allowing for the clustered study design. For categorical variables frequencies and chi-squared tests were used for initial comparisons, while means and t-tests were used for continuous variables. For the primary outcome, a mixed effects binomial logistic regression was employed to adjust for confounders and to identify effect modifiers. We assumed the study nurses were a random selection from all nurses in Rwanda and that health centers also represented national health centers. Therefore baseline heterogeneity in nurse and health center performance was incorporated into the model using nested random intercepts, accounting for inherent nesting of observations within nurses and nurses within health centers. To minimize bias we estimated covariate effects using maximum likelihoods based on adaptive Gauss-Hermite Quadrature with the PROC GLIMMIX function in SAS v 9.2 (Cary NC, USA). A mixed random-effects model of the probability of agreement between nurse and mentor, per patient complaint, was reported (37, 38). A conservative approach to missing data was employed whereby missing values for the primary outcomes of interest (agreement on diagnosis and treatment) were treated as errors in assessment, suggesting that failure to complete a diagnosis or treatment plan was an indicator of poor performance and fidelity to the IMAI protocols.

*Ethics*

This study was approved by the Rwandan NationalEthics Committee, and the Institutional Review Boards(IRB) at Partners Healthcare in Boston and the London School ofHygiene & Tropical Medicine. Data were collected aspart of routine program monitoring of an ongoingmentorship and quality improvement intervention inthe study districts, previously described (32). No identifying nurse or patient informationwas collected. The IRB approved awaiver of informed consent for nurses and patients under the routine use ofprogram monitoring data. However, both patients and nurses were explainedthe purpose of the data collection, and both couldopt-out of the study if desired, prior to the consultation.

**RESULTS**

*Patient characteristics*

Four hundred and sixty-four patients were observed pre-intervention while 506 were observed during the post-intervention period. Patient demographics and presenting symptoms are presented in Table 1. Significantly more female patients were seen than males (p=0.05) both pre- and post-intervention, but patient age was not significantly different, at approximately 35 years on average. The most common presenting complaint in both the pre- and post- intervention surveys was cough and/or difficulty breathing (17.6 and 21.4 percent, respectively), followed by females presenting with pelvic pain or genitourinary complaints (16.3 and 20.3 percent, respectively). Apart from these two conditions the presenting symptoms for the two surveys were similar (Table 1).

*Nurse characteristics*

Twenty-five nurses were observed during pre-intervention data collection at the eight study sites, none of whom had been previously trained in IMAI. A total of 16 nurses were trained in IMAI at the end of March 2011, prior to the start of mentoring and supervision activities, and a further 17 nurses were trained in October 2011. In the post-intervention survey 33 nurses were observed, 15 (45%) of whom were also contained in the pre-intervention dataset. Eighteen of 33 nurses (55%) in the post-intervention survey received IMAI training, and these trained nurses managed 350 (69.2%) of the 506 patients seen and 70 percent of complaints assessed in the post-intervention survey.

Comparison of nurse characteristics in the pre- and post-intervention surveys showed similar years of OPD experience and consultation times. Additional detail on nurse characteristics is shown in Table 2.

*Quality of care indicators*

The basic quality of care indicators in each survey, including measurement and recording of vital signs, conducting routine emergency triage, and performing routine screening and counseling activities during the patient encounter, are summarized in Table 3. Notable results include significant (p<0.001) increases in routine measurement of height (+16.6%), weight (+32%), pulse (+66%), temperature (+49%), and blood pressure (+54%) in the post-intervention survey compared to the pre-intervention survey. Routine screening for prevalent conditions, and recording of key lifestyle behaviors and preventive strategies, also increased in the post-intervention survey (Table 3). Notable results include a +53.3% increase in screening patients for chronic cough, a +48.8% increase in screening for involuntary weight loss, a +52.3% increase in screening for insecticide-treated bed nets for malaria prevention, a +51% increase in screening for tobacco use, and a +52% increase in screening for alcohol abuse. Additionally, an increase of +26.1% was seen in patients referred for HIV testing, along with a 14% increase in patients counseled on safe sex practices including condom use.

*Agreement in diagnosis and treatment*

During 970 total patient encounters observed, 1236 complaints were recorded. There were 207 (16.7%) women reporting genitourinary complaints or pelvic pain, 200 (16.2%) patients reporting cough or difficulty breathing, and 134 (10.8%) reporting fever (Table 4). In the pre-intervention survey the agreement between nurse and mentor was 22% for the diagnosis, and 23% for the treatment of cough and difficulty breathing, which increased to 49% and 62% in the post-intervention survey, respectively. Similar increases were seen for the treatment and diagnosis of other reported complaints. Overall there was an increase in agreement between nurse and mentor of 28.2% for diagnosis and 28.1% for the treatment plan, after the intervention (Table 4). Increases in diagnosis agreement were most pronounced for back/joint pain (+67.9%), fever (+58.3%), headache or neurological conditions (+46.9%), and cough/difficulty breathing (+28.2%). For agreement in treatment plan, the positive effect of the intervention was most notable for cough/difficulty breathing (+38.7%), headache/neurological conditions (+36.4%) and oral or throat problems (+35.8%) (Table 4).

*Covariate analysis*

The frequency of agreement between nurse and mentor in diagnosis and treatment in the pre- and post-intervention surveys is shown in Table 5. Significant differences were found between health centers, in the magnitude of change in the frequency of correct diagnosis (p=0.0042) and treatment (p=0.0395) between the pre- and post-intervention surveys. In addition, significant differences were found in the magnitude of change in frequency of correct diagnosis and treatment between nurses who were and were not trained in IMAI (p<0.0001), as well as timing of training (March vs. October). Years of OPD experience and patient sex were not significantly different in the two surveys, but number of observations per nurse – as a crude proxy for “dose” of the mentoring intervention – was associated with a significant change in both diagnosis and treatment agreement (p<0.0001). Covariates were also tested for effect modification through univariate logistic regression. IMAI training was significantly associated with increased odds of agreement for diagnosis versus no training (March: OR 1.53, 95%CI 1.02-2.32; October: OR 3.30, 95%CI 2.15-5.06) as well as for treatment agreement. (March: OR 1.93, 95%CI 1.49-2.51; October: OR 6.77, 95%CI 3.61-12.70). For diagnosis agreement, patient sex, years of nurse OPD experience, and nurse workload (number of complaints managed), were not found to be significant, whereas for treatment agreement patient sex and numbers of observations per nurse were significant

*Multivariate results*

The results of multivariate mixed effects logistic regression for diagnosis and treatment agreement in the intervention period versus the baseline period is shown in Table 6. Overall results are shown as well as stratified results by training cohort, as this was highly correlated to the primary outcomes. Adjustment was made for significant effect modifiers described above. Overall, both odds of diagnosis agreement and treatment agreement increased significantly and over two-fold in the post-intervention period compared to pre-intervention for the entire nurse population under study (diagnosis: OR 2.32, 95%CI 1.63 - 3.30; treatment: 2.27, 95%CI 1.65-3.12). This effect was larger for nurses trained in March than in October, both when compared to themselves at baseline, and compared to all nurses at baseline (Table 6). Notably, nurses who did not receive IMAI training, but were exposed to the mentoring intervention also showed significant and greater than two-fold increase in the odds of diagnosis agreement compared to untrained nurses at baseline (OR 2.24, 95%CI 1.26-3.97) and compared to all nurses at baseline (OR 2.14, 95%CI 1.22-3.85), though no significant effect was seen in this cohort for treatment agreement. Also of note from the baseline data, nurses who were subsequently trained in March had a nearly 1.5 times increase in the odds of diagnosis agreement compared to baseline nurses who were never trained (OR 1.44, 95%CI 1.00-2.08), but nurses subsequently trained in October had only 0.8 of the odds of diagnosis agreement, and this effect was not significant (Table 6).

*Effect of time on agreement*

A line plot of diagnosis and treatment agreement per month, overall and stratified by IMAI training status, is shown in Figure 1. As expected, the effect of the intervention was greater for trained nurses than for untrained nurses, but both groups experienced gains over the course of the intervention and from baseline. IMAI trained nurses improved by 33.9% in diagnosis agreement from April 2011 until the end of the 18-month intervention period in October 2012, and they improved by 51.5% in treatment agreement over this period. Untrained nurses also improved by 27.0% in diagnosis agreement and 12.8% in treatment agreement. When time is modeled as a continuous variable rather than pre- and post-intervention, multivariate logistic regression resulted in a 5% average monthly increase in the odds of diagnosis agreement (adjusted OR=1.05, CI 1.012-1.081) and 3% monthly increase in odds of treatment agreement (adjusted OR=1.03, CI 0.994-1.06), though the latter effect was not significant.

*Effect on nurses exposed to full intervention*

Fifteen nurses were present in both the pre- and post-intervention surveys. All of these nurses received IMAI training, in addition to the mentoring and supervision intervention. These 15 nurses accounted for 285 of 574 (46.4%) complaints managed in the pre-intervention survey, and 343 of 662 (53.6%) in the follow-up period. A plot of the isolated effects of the intervention for these individual nurse pairs is shown in Figure 2. The majority of nurses (66.6%) showed improvement in their performance following the intervention, and mean improvement in frequency of agreement for these nurses was 32%. When stratified by timing of training, regression also showed that trained nurses improved significantly in diagnosis and treatment against themselves at baseline, with nurses trained in October driving the majority of improvement post-intervention (diagnosis: OR 4.20, 95%CI 1.82-9.74; treatment: OR 5.00, 95%CI 2.29-10.94) versus March (diagnosis: OR 1.32, 95%CI 0.99-1.79; treatment: OR 1.73, 95%CI 1.38-2.16) (Table 6).

**DISCUSSION**

These results strongly suggest that IMAI training in concert with routine and enhanced mentoring and supervision, leads to significant improvement in the quality of ambulatory primary care provided to adults and adolescents. It also demonstrates that IMAI leads to significant improvements in routine primary care quality metrics such as conducting basic assessment and triage for emergency conditions, taking of vital signs, routine screening for tuberculosis, HIV, sexually transmitted infections, anemia, and malnutrition, as well as routine screening and preventive counseling on bed nets for malaria prevention, tobacco and alcohol cessation, as well as family planning and safe sex practices.

The effect of the IMAI and mentoring intervention on the odds of diagnosis agreement was durable and remained significant after adjustment for effect modifiers. And notably, the effect for diagnosis agreement remained similar in magnitude and significance for nurses who did not receive the initial IMAI classroom training, but were exposed to sustained on-site mentoring and supervision. This reinforces the suggestion that training alone without additional supports is likely inadequate to ensure high quality care. However, for treatment agreement this did not hold true. This could be explained by the fact that IMAI training was a pilot project and not yet integrated into MoH guidelines and standard operating procedures for health centers. Because it was a pilot outside of current MoH mandate, and because we gave no additional incentives to participating HCWs, it is likely that many reverted to existing treatment guidelines when selecting therapies. Also, while IMAI introduced a new protocols and decision tools for nurses, health center OPDs were not simultaneously equipped with the range of additional drugs, diagnostics, and supplies suggested in the IMAI protocol, and thus despite choosing a correct diagnosis that agreed with the protocol and with the mentor, nurses were forced to select amongst their limited existing formulary and tools. It is also possible that lack of effect of the mentoring intervention on treatment agreement for untrained nurses was limited by the stringent definition of treatment agreement used in the study, which required 100 percent agreement in all aspects of the plan including diagnostic testing, medications prescribed, follow-up visits, and referrals made.

A notable issue from this study is the heterogeneity of exposure to the full intervention. Thirty percent of patients in the post-intervention survey were seen by a nurse that did not receive the initial IMAI didactic training, which reflects turnover in the nursing pool from out-migration to different MoH facilities or out of the public sector altogether, but is also affected by MoH regulations that require nurses to assume generalist roles and thereby have the capability at any time to staff one of multiple services at the health center. As a result, IMAI-trained nurses could have been staffing another clinical service at the health center on the pre-determined day of observation, though this was not systematically documented. Another notable phenomenon from the data is that bulk of the improvement in diagnosis and treatment agreement was driven by nurses trained in October versus March. This could be explained by the fact that these cohorts differed in their performance at baseline, as noted above, with higher-performing nurses eventually trained in March. This also likely reflects start-up challenges for the intervention in the first few months, and the maturity of the mentoring intervention six months after commencement in October, which may have been reflected in the performance of the mentor himself, though this was not formally studied.

Despite heterogeneity of exposure to IMAI training, both trained and untrained nurses experienced gains in performance after exposure to the mentoring and supervision intervention, which suggests that sustained, on-site, in-service training, and practice-based supervision and clinical mentoring is an important complement to traditional classroom-based training (24, 39, 40) courses, and in this case, can produce benefits in quality and performance in the absence of classroom training. The need for sustained mentoring and supervision is supported by qualitative research amongst health care workers from the same project in Rwanda (35). Strength or ‘dose’ of implementation is not a well-researched issue in the global health literature, but has been investigated in the context of community case management for children under-five in Ethiopia (41) and with respect to a program to reduce maternal mortality in Uganda and Zambia (42). We suggest that the heterogeneity of exposure to IMAI training in this study reflects the reality of implementing complex interventions in a poor setting like rural Rwanda, and is, in fact, a strength rather than a limitation when considering the external validity of these results to similar challenging settings. The analysis of paired nurses who were present both in the baseline and follow-up surveys also lends support to the effectiveness of the intervention when able to maintain consistent exposure.

There were several limitations to this study. First, our definitions of quality of care are based entirely on process indicators and not from health outcomes, and thus only partially captures the spectrum of quality of care. It was beyond the scope and resources of the study to follow patients through an illness episode, nor did we capture demographic data or systems impacts (e.g. cost) of the intervention. Fidelity to protocols and health worker performance (43-45) are widely used as measures of quality of care in global health programs. There is evidence that improving the quality of care through improved health worker performance can have an impact on health outcomes, as shown in areas such as care for children under-five (28, 46, 47) and obstetrics (48), but often these performance improvement interventions are part of wider quality improvement efforts that include health system supports in addition to training and supervision. Additionally, we must consider the potential observation bias introduced by the Hawthorne effect (ref?), which could have resulted in improved nurse performance simply from being closely observed by the mentor. Another limitation involves IMAI itself, which has not been adequately validated as a clinical protocol. Validation studies were also beyond the scope of this study, but in general it is preferable to first establish the diagnostic and therapeutic validity of a protocol, before assessing its impact on quality and performance.

This is the first study of its kind to assess the impact of IMAI with sustained and enhanced mentoring and supervision, on the quality of adult and adolescent primary care. Not only does it begin to fill the evidence gap for IMAI, but also for primary care delivery and quality improvement in poor settings. As well the study reinforces the importance of post-training supervision and mentoring as a critical part of quality improvement programs; as vitals the training itself. Integrated approaches to transforming primary care delivery in LMICs are much needed, particularly in light of attempts to complement programs targeted at specific diseases and populations with stronger health systems (49, 50). Developing front line primary care systems that deliver integrated services to patients is a crucial step towards leveraging the success of vertical programs for systems-wide improvement. IMAI, in turn, is an important first attempt to integrate primary care services at the point-of care, and it is an approach worthy of further investigation and iteration. Future research is needed on the population health and systems impacts of IMAI training, on other dimensions of quality including patient and provider perceptions, and research on the role of other health systems supports. Together, and with further improvement and research, IMAI and similar approaches to integrated ambulatory care have the potential to improve the delivery of primary care in front-line health systems across the developing world.

**Table 1. Patient characteristics in pre- and post-intervention survey**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Patient (N= 970)*** | **Pre**  **(N=464)** | **Post**  **(N=506)** | **Δ%**  **Post - Pre** | **P-value** |
| ***Sex*** |  |  |  | 0.0487 |
| Male | 146 (31.5) | 189 (37.5) |  |  |
| Female | 318 (68.5) | 315 (62.5) |  |  |
| Age, years, mean +/- SD | 35.4 +/- 15.8 | 35.3 +/- 15.5 |  | 0.9770 |
| ***Chief complaint*** |  |  |  |  |
| Cough/difficulty breathing | 81 (17.6) | 118 (24.1) | +6.5 |  |
| Female with GU symptoms or pelvic pain | 75 (16.3) | 99 (20.3) | +4 |  |
| Epigastric pain | 43 (9.4) | 39 (8.0) | -1.4 |  |
| Fever | 41 (8.9) | 38 (7.8) | -1.1 |  |
| Headache or neurological condition | 37 (8.0) | 30 (6.1) | -1.9 |  |
| Mouth or throat problem | 35 (7.6) | 30 (6.1) | -1.5 |  |
| Skin problem or lump | 32 (7.0) | 21 (4.3) | -2.7 |  |
| Back or joint pain | 32 (7.0) | 55 (7.8) | +0.8 |  |
| Male with GU symptoms of lower abdominal pain | 29 (6.3) | 28 (5.7) | -0.6 |  |
| Diarrhea | 26 (5.7) | 18 (3.7) | -2 |  |
| Other problem | 20 (4.4) | 8 (1.6) | -+2.8 |  |
| Genital or anal sore, ulcer, wart | 5 (1.1) | 3 (0.6) | -0.5 |  |
| Mental problem | 4 (0.9) | 0 (0) | -0.9 |  |
| Lower extremity edema | 0 (0) | 2 (0.4) | +0.4 |  |

**Table 2. Nurse characteristics in pre- and post-intervention survey**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Pre** | **Post** | **Δ%**  **Post - Pre** | **P-value** |
| ***Nurse characteristics*** |  |  |  |  |
| Total number of nurses observed | 25 | 33 |  |  |
| Nurses observed who were trained in IMAI | 0 | 18 |  |  |
| ***Nurse characteristics by patient encounter*** |  |  |  |  |
|  | N=464 | N=506 |  |  |
| Was nurse trained in IMAI? |  |  |  | <.0001 |
| Yes | 0 (0) | 350 (69.2) | +69.2 |  |
| No | 464 (100.0) | 156 (30.8) |  |  |
| Years’ experience, mean +/- SD | 5.2 +/- 4.1 | 6.0 +/- 7.7 | +0.8 | 0.0381 |
| Consultation time in minutes, mean +/- SD | 0:14 +/- 0:04 | 0:15 +/- 0:02 | +0:01 | 0.8568 |
| Education level |  |  |  | <.0001 |
| A1‡ | 0 (0) | 43 (8.5) |  |  |
| A2† | 461 (99.4) | 461 (91.1) |  |  |
| Missing | 3 (0.7) | 2 (0.4) |  |  |

**Table 3. Quality of care indicators at pre- and post-intervention, per patient\***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Vital signs*** | **Baseline** | **Endline** | Δ % | **p-value** |
| Taken by Registration clerk | 258 (55.6) | 415 (82.0) | +26.4 | <.0001 |
| Taken by Nurse | 168 (36.2) | 388 (76.7) | +40.5 | <.0001 |
| Taken by Other Health center staff | 77 (16.7) | 3 (0.6) | -16.1 | <.0001 |
| Recorded BP | 77 (16.6) | 357 (70.6) | +54 | <.0001 |
| Recorded height | 0 (0) | 84 (16.6) | +16.6 | <.0001 |
| Recorded weight | 291 (62.7) | 479 (94.7) | +32 | <.0001 |
| Recorded pulse | 0 (0) | 334 (66.0) | +66 | <.0001 |
| Recorded temperature | 123 (26.5) | 382 (75.5) | +49 | <.0001 |
| ***Quick check for Emergencies*** |  |  |  | <.0001 |
| Yes | 7 (1.5) | 312 (61.7) | +60.2 |  |
| No | 447 (96.3) | 150 (29.6) | -66.7 |  |
| Missing | 10 (2.2) | 44 (8.7) | +6.5 |  |
| ***Screening performed*** |  |  |  |  |
| Cough or difficulty breathing | 45 (9.7) | 319 (63.0) | +53.3 | <.0001 |
| Involuntary weight loss | 2 (0.4) | 249 (49.2) | +48.8 | <.0001 |
| Pallor | 9 (1.9) | 251 (49.6) | +47.7 | <.0001 |
| GU lesions | 18 (3.9) | 258 (51.0) | +47.1 | <.0001 |
| Urethral discharge (Male) | 12 (2.6) | 103 (20.4) | +17.8 | <.0001 |
| Scrotal pain or swelling (Male) | 1 (0.2) | 93 (18.4) | +18.2 | <.0001 |
| Mosquito net | 3 (0.7) | 268 (53.0) | +52.3 | <.0001 |
| Counseled on use of bed net | 0 (0) | 52 (10.3) | +10.3 |  |
| Reported having a bed net | 2 (0.4) | 179 (35.4) | +35 |  |
| Smoking/tobacco use | 2 (0.4) | 258 (51.0) | +50.6 | <.0001 |
| Counseled on cessation | 0 (0) | 39 (7.7) | +7.7 |  |
| Symptom present | 1 (0.2) | 41 (8.1) | +7.9 |  |
| Alcohol use | 2 (0.4) | 265 (52.4) | +52 | <.0001 |
| Counseled on cessation | 0 (0) | 117 (23.1) | +23.1 |  |
| Reported alcohol abuse | 1 (0.2) | 122 (24.1) | +23.9 |  |
| Sexually active | 32 (6.9) | 226 (44.7) | +37.8 | <.0001 |
| Counseled on safe sex practices | 2 (0.4) | 73 (14.4) | +14 |  |
| Reported sexually active | 29 (6.3) | 176 (34.8) | +28.5 |  |
| Pregnant | 67 (14.4) | 172 (34.0) | +19.6 | <.0001 |
| Reported to be pregnant | 24 (5.2) | 20 (4.0) | -1.2 |  |
| Family planning methods | 10 (2.2) | 46 (9.1) | +6.9 | <.0001 |
| Refer to family planning clinic | 0 (0) | 25 (4.9) | +4.9 |  |
| HIV test in the last 12 months | 7 (1.5) | 192 (37.9) | +36.4 | <.0001 |
| Confirmed HIV testing within last 12 months | 2 (0.4) | 102 (20.2) | +19.8 |  |
| Refer for HIV testing | 1 (0.2) | 133 (26.3) | +26.1 | <.0001 |

\*Note: percentages that do not add up to 100% are due to missing data within those categories

**Table 4: Correct nurse diagnosis and treatment of patient illnesses by patient complaint**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | **Diagnosis** | | | **Treatment** | | |
| Complaint | Total No. with complaint | Pre (n) | Post (n) | Pre (n%) | Post (n%) | Δ% | Pre (n%) | Post (n%) | Δ% |
| TOTAL | 1236 | 574 | 662 | 173 (30.1) | 386 (58.3) | +28.2 | 173 (30.1) | 385 (58.2) | +28.1 |
| Cough/difficulty breathing | 200 | 82 | 118 | 18 (22.0) | 58 (49.2) | +27.2 | 19 (23.2) | 73 (61.9) | +38.7 |
| Female with GU symptoms or pelvic pain | 207 | 88 | 119 | 28 (31.8) | 68 (57.1) | +25.3 | 23 (26.1) | 60 (50.4) | +24.3 |
| Epigastric pain | 128 | 59 | 69 | 35 (59.3) | 48 (69.6) | +10.3 | 10 (17.0) | 29 (42.0) | +25 |
| Fever | 134 | 56 | 78 | 9 (16.1) | 58 (74.4) | +58.3 | 37 (66.1) | 58 (74.4) | +8.3 |
| Headache or neurological condition | 96 | 52 | 44 | 4 (7.7) | 24 (54.6) | +46.9 | 26 (50.0) | 38 (86.4) | +36.4 |
| Mouth or throat problem | 80 | 37 | 43 | 16 (43.2) | 28 (65.1) | +21.9 | 10 (27.0) | 27 (62.8) | +35.8 |
| Skin problem or lump | 60 | 32 | 28 | 21 (65.6) | 14 (50.0) | -15.6 | 11 (34.4) | 9 (32.1) | -2.3 |
| Back or joint pain | 126 | 42 | 84 | 5 (11.9) | 67 (79.8) | +67.9 | 20 (47.6) | 63 (75.0) | +27.4 |
| Male with GU symptoms of lower abdominal pain | 61 | 31 | 30 | 16 (51.6) | 10 (33.3) | -18.6 | 6 (19.4) | 16 (53.3) | +33.8 |
| Diarrhea | 51 | 31 | 20 | 19 (61.3) | 9 (45.0) | -16.3 | 10 (32.3) | 9 (45.0) | +12.7 |
| Hypertension | 5 | 3 | 2 | 0 (0) | 0 (0) |  | 0 (0) | 0 (0) | - |
| Genital or anal sore, ulcer, wart | 8 | 5 | 3 | 1 (20.0) | 2 (66.7) | +46.7 | 0 (0) | 3 (100.0) |  |
| Mental problem | 6 | 6 | 0 | 0 (0) | 0 (0) | - | 1 (16.7) | 0 (0) | - |
| Lower extremity edema | 11 | 5 | 6 | 1 (20.0) | 0 (0) | -20 | 0 (0) | 0 (0) | - |
| Other problem | 63 | 45 | 18 | 0 (0) | 0 (0) | - | 0 (0) | 0 (0) | - |

\* Note: patients could report up to three (3) recorded complaints per encounter

**Table 5: Frequency of select covariates pre- and post- intervention**

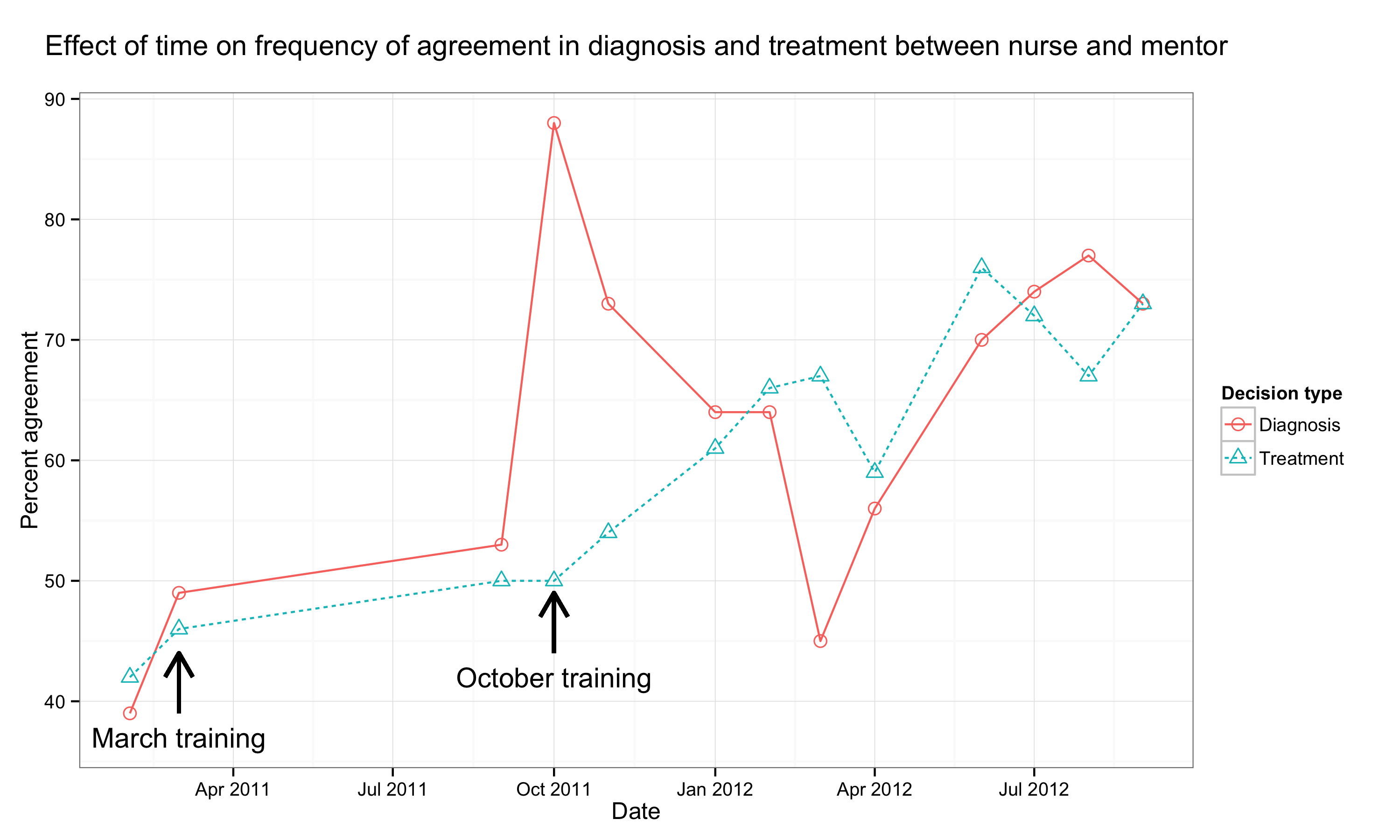
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Diagnosis Agreement = YES** | | | **Treatment Agreement = YES** | | |
| **Total patient complaints** | 1236 | Pre | Post |  | Pre | Post |  |
| (N=173) | (N=386) | P-value | (N=173) | (N=385) | P-value |
| N, % correct | N, % correct |  | N, % correct | N, % correct |  |
| ***Health center*** | N, % total |  |  | 0.0042 |  |  | 0.0395 |
| Cyarubare | 109 (8.8) | 11 (6.3) | 31 (8.0) |  | 10 (5.8) | 37 (9.6) |  |
| Kabarondo | 200 (16.1) | 13 (7.5) | 63 (16.3) |  | 19 (11.0) | 79 (20.5) |  |
| Karama | 133 (10.7) | 33 (19.1) | 45 (11.6) |  | 25 (14.5) | 41 (10.7) |  |
| Ndego | 127 (10.2) | 30 (17.3) | 33 (8.5) |  | 21 (12.1) | 32 (8.3) |  |
| Nyamirama | 199 (16.0) | 34 (19.7) | 71 (18.4) |  | 35 (20.2) | 59 (15.3) |  |
| Rutare | 144 (11.6) | 15 (8.7) | 38 (9.8) |  | 15 (8.7) | 40 (10.4) |  |
| Ruramira | 145 (11.7) | 16 (9.3) | 43 (11.1) |  | 27 (15.6) | 41 (10.7) |  |
| Rwinkwavu | 185 (14.9) | 21 (12.1) | 63 (16.3) |  | 21 (12.1) | 56 (14.5) |  |
| ***Years of nurse experience*** |  | 6.0 +/- 4.6 | 5.9 +/- 7.5 | 0.8639 | 5.4 +/- 4.0 | 6.2 +/- 8.0 | 0.2453 |
| ***Nurse trained in IMAI*** |  |  |  | <.0001 |  |  | <.0001 |
| No | 780 (62.8) | 173 (100) | 115 (29.8) |  | 173 (100) | 90 (23.4) |  |
| Yes | 462 (37.2) | 0 (0) | 271 (70.2) |  | 0 (0) | 295 (76.6) |  |
| ***Patient sex*** |  |  |  | 0.9071 |  |  | 0.188 |
| Male | 413 (33.4) | 58 (33.5) | 131 (33.9) |  | 58 (33.5) | 147 (38.2) |  |
| Female | 823 (66.6) | 115 (66.5) | 255 (66.1) |  | 115 (66.5) | 238 (61.8) |  |
| ***Observations per nurse (continous)*** | | 4.7 +/- 3.3 | 5.8 +/- 2.8 | <.0001 | 4.2 +/- 2.9 | 6.1 +/- 3.0 | <.0001 |
| ***Observations per nurse (categorical)*** | |  |  | <.0001 |  |  | <.0001 |
| 1 - 3 | 201 (36.0) | 106 (57.8) | 115 (29.8) |  | 106 (61.3) | 95 (24.7) |  |
| 4 – 7 | 183 (33.8) | 24 (13.9) | 148 (38.3) |  | 25 (14.5) | 158 (41.0) |  |
| 8 – 10 | 174 (31.2) | 49 (28.3) | 123 (31.9) |  | 42 (24.3) | 132 (34.3) |  |

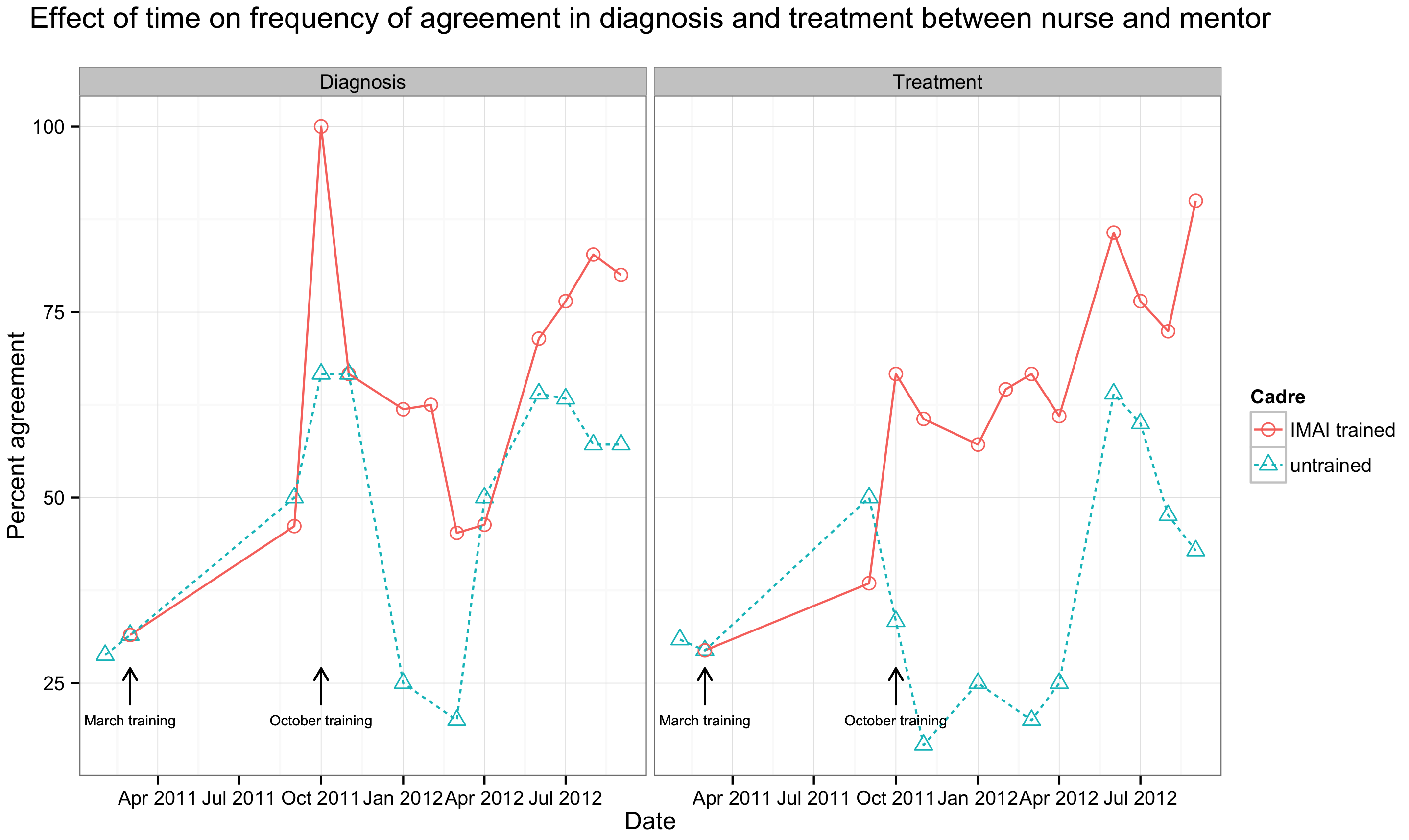
**Table 6: Results of mixed effects logistic regression of odds of nurse and mentor agreement in diagnosis and treatment**



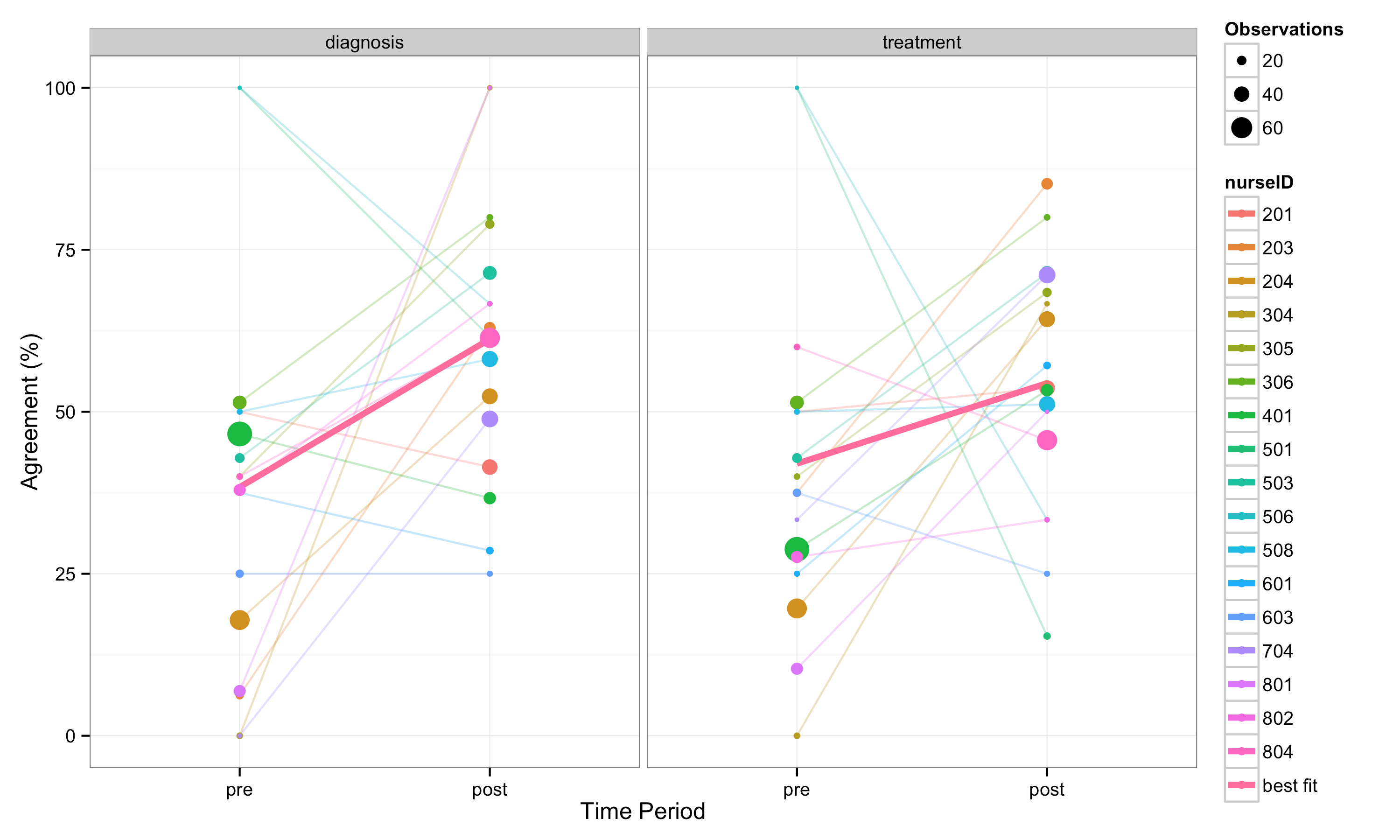
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Diagnosis** | | | | | | | | | | | | | | | | |
|  | *Effect vs. never trained at baseline* | | | | |  | *Effect within strata of training cohorts* | | | | |  | *Effect vs. all nurses at baseline* | | | | |
|  | *Pre-intevention* | |  | *Post-intervention* | |  | *Pre-intevention* | |  | *Post-intervention* | |  | *Pre-intevention* | |  | *Post-intervention* | |
|  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |
| **IMAI trained** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| No | 1 | ref |  | **2.24\*\*** | 1.26 - 3.97 |  | 1 | ref |  | **2.24\*\*** | 1.26 - 3.97 |  | 1 | ref |  | **2.16\*\*** | 1.22 - 3.85 |
| Yes (Mar. cohort) | **1.44\*** | 1.00 - 2.08 |  | **1.92\*\*** | 1.21 - 3.05 |  | 1 | ref |  | 1.32 | 0.99 - 1.79 |  |  | **1.85\*\*** | 1.20 - 2.86 |
| Yes (Oct. cohort) | 0.76 | 0.30 - 1.93 |  | **3.21\*\*\*** | 2.03 - 5.06 |  | 1 | ref |  | **4.20\*\*\*** | 1.82 - 9.74 |  |  | **3.10\*\*\*** | 2.11 - 4.54 |
| **All Nurses (post vs. pre)** | 1 | ref |  | **2.32\*\*\*** | 1.63 - 3.30 |  |  |  |  |  |  |  |  |  |  |  |  |
| Note: ORs are from binomial GLMMs estimated using maximum-likelihood from adaptive Gaussian-Quadrature and nested random effects by nurse and health center. | | | | | | | | | | | | | | ***\*****p ≤ 0.05;*  ***\*\*****p ≤ 0.01;* ***\*\*\*****p ≤ 0.001* | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Treatment** | | | | | | | | | | | | | | | | |
|  | *Effect vs. never trained at baseline* | | | | |  | *Effect within strata of training cohorts* | | | | |  | *Effect vs. all nurses at baseline* | | | | |
|  | *Pre-intevention* | |  | *Post-intervention* | |  | *Pre-intevention* | |  | *Post-intervention* | |  | *Pre-intevention* | |  | *Post-intervention* | |
|  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |  | OR | 95% CI |
| **IMAI trained** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| No | 1 | ref |  | 1.36 | 0.75 - 2.45 |  | 1 | ref |  | 1.36 | 0.75 - 2.45 |  | 1 | ref |  | 1.46 | 0.80 - 2.65 |
| Yes (Mar. cohort) | 0.96 | 0.50 - 1.82 |  | 1.65 | 0.79 - 3.48 |  | 1 | ref |  | **1.73\*\*\*** | 1.38 - 2.16 |  |  | **1.77\*\*** | 1.16 - 2.72 |
| Yes (Oct. cohort) | 0.84 | 0.34 - 2.07 |  | **4.20\*\*\*** | 2.12 - 8.34 |  | 1 | ref |  | **5.00\*\*\*** | 2.29 - 10.94 |  |  | **4.51\*\*\*** | 2.65 - 7.68 |
| **All Nurses (post vs. pre)** | 1 | ref |  | **2.27\*\*\*** | 1.64 - 3.15 |  |  |  |  |  |  |  |  |  |  |  |  |
| Note: ORs are from binomial GLMMs estimated using maximum-likelihood from adaptive Gaussian-Quadrature and nested random effects by nurse and health center. They are adjusted for the number of observations. | | | | | | | | | | | | | | ***\*****p ≤ 0.05;*  ***\*\*****p ≤ 0.01;* ***\*\*\*****p ≤ 0.001* | | | |

**Figure 1: Frequency of agreement in diagnosis and treatment between nurse and mentor over time (months)**

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**Figure 2: Isolated effect of intervention on frequency of diagnosis and treatment agreement by individual paired nurses**

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