**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 efforts (ref) both in absolute and relative terms, but is growing proportionally with global health investment as a whole (ref). Often primary care – or longitudinal, first contact health care delivered at the first level of the health system - can be contained within efforts toward “health systems strengthening”, which focus closely on structural and bureaucratic interventions to develop information systems, strengthen the health workforce, improve infrastructure, etc (ref: WHO pillars), but not specifically addressed as a mode of care or service in itself. Investment into the clinical quality of primary care programs is typically rooted within maternal and child health (MCH) services, which are critically important to population health and to measuring health systems performance in LMICs (ref). But MCH only captures X percent of overall population mortality. Interventions to reduce adult and adolescent mortality are generally organized around specific epidemic diseases like HIV, TB, and malaria. But relatively little attention is placed on basic primary care conditions like pneumonia, diarrheal disease, and emerging chronic non-communicable diseases which are treated at the front lines of health systems and contribute Y percent to mortality in LMICs (refs). More importantly, limited definitions of ‘primary care’ that focus only on certain demographic groups and vulnerable populations neglect the burden of general medical illness the adult and adolescent populations in LMICs, and also fail to recognize the important and wider systems benefits that could be gained from investing in the quality of genera primary care services, in addition to disease and population-specific programs.

It has been suggested repeatedly (refs) that integrated models of care delivery that merge efforts to improve services for specific diseases and populations with those for general primary care, would be mutually beneficial and reinforcing (ref). But little data exists to support this hypothesis. A Cochrane systematic review of integrated primary care failed to show an unequivocal benefit, but mostly highlighted the paucity and poor quality of available data (ref). The STRETCH trial from South Africa attempted to integrate HIV and antiretroviral therapy services into rural outpatient departments (OPDs) at 32 health centers, using a clustered randomized controlled design, but found no significant difference in overall mortality nor HIV-specific endpoints like CD4 count or viral load, between the clinics that did and did not implement integrated HIV and primary care services in their OPDs (ref). That study did not, however assess non-HIV endpoints or those that reflected improved quality of general OPD care at these health centers.

Additionally, few data exist describing the quality of services for basic primary care conditions themselves. The Practical Approach to Lung Health (PAL) developed by the World Health Organization (WHO) and partners, was studied in South Africa (ref) and Malawi (ref) and measured the effect of integrating algorithms for lung health and HIV, respectively, into primary care services, and found…. A baseline survey of primary care quality conducted by our team in rural Rwanda found that basic OPD care provided for acute primary care conditions in adults and adolescents, was of generally poor quality, with less than 50 percent agreement between the providing nurse and the gold standard clinician, and very low rates of basic clinical functions performed during routine OPD service delivery, such as taking vital signs, screening for prevalent conditions and behavioral counseling, let alone assignment of follow-up and referral visits(ref).

The most comprehensive attempt at designing a program of integrated primary care service delivery at the point of care has been the WHO Integrated Management of Adolescent & Adult Illness (IMAI) (ref), which is a standardized protocol, based on syndromic care and treatment, and targeted at front-line health workers (mainly nurses and other non-physician cadres). IMAI is organized into a single algorithm and decision support module that allows health care workers to deliver integrated care within a single patient encounter that encompasses: (1) identification, management and triage of basic emergencies, (2) diagnosis and care for non-emergent acute symptoms such as fever, cough, and diarrhea, (3) basic routine screening, identification, and referral for chronic diseases or prevalent conditions in the community, (4) in-consult prevention and lifestyle counseling, and (5) assignment of appropriate follow-up visits to the OPD and/or referral to higher levels of the health system or more specialized care. While much effort has gone into the design and adaptation of IMAI to a variety of settings, little rigorous study has been done as to its validity or its impact on quality of care and health worker performance. What few studies do exist are largely unpublished validations (ref) or are focused on HIV care within OPDs, using adapted versions of IMAI (ref). The lack of data on IMAI to-date could be explained, in part, by general difficulty in garnering funding and bringing attention to the issue of general primary care for adults and adolescents. But importantly, it also reflects a series of very practical and operational challenges to implementing a comprehensive and integrated approach to the patient in adult and adolescent general medicine within in weak health systems, with a health workforce that often lacks adequate support and baseline training, and who already work under significant time pressures and clinical demands from vertical interventions delivered at the front lines of health systems.

The literature also suggests that initial training, while necessary, is alone insufficient to sustain improved health worker performance. Evidence from the WHO Integrated Management of Childhood Illness (IMCI) from Uganda (ref), Benin (ref), Brazil (ref), Bangladesh (ref) and from this same project in Rwanda (ref) has shown that routine, sustained, and frequent supportive supervision and clinical mentoring leads to improvements in fidelity to IMCI guidelines and quality of care. The positive association with supportive supervision and performance or quality of care, has also been demonstrated with respect to general primary care in the Philippines (ref), services for sexually transmitted infections in India (ref) and many others, which suggests that any intervention to improve health worker performance per guidelines and to strengthen quality of care, must focus both on building core skills but also on sustaining those gains through routine and supportive supervision and mentorship.

In light of the gaps in evidence for IMAI, and our understanding of effective performance improvement interventions for front-line health workers in LMICs, this study investigates the impact of a combined training and mentorship/supervision initiative on the quality of nurse performance and quality of care in rural Rwanda.

**Methods**

*Study setting*

The study setting has been previously described in detail (ref). In brief, the study was conducted at all eight Rwandan Ministry of Health (MoH) health centers - which are the front line facilities within the health system led by nurses – in one district in Rwanda’s Eastern Province bordering Tanzania and Burundi and with an approximate population of 190,000 (2010 Census). Within these health centers, the study specifically took place within the OPDs, which are staffed by generalist nurses with equivalent of secondary school training in nursing, human science, and health behavior. Other than currently working in the OPD service at the study health center, there was no additional eligibility criteria set for nurses to participate in the study.

*Study population*

Baseline or pre-intervention data collection occurred in February and March of 2011. Endline or post-intervention data collection 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, [ref], and thus age 13 was chosen for this study based on definitions used by the United States’ Centers for Disease Control (CDC) [ref].

*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* (ref) 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 (ref). In brief, the mentoring intervention involved visits every four to six weeks to each health center OPD by a district-based clinical mentor with extensive training in IMAI and OPD clinical care, as well as additional training in mentoring techniques, data collection, and quality improvement methodologies. 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. Additionally, quarterly review meetings were held with the mentor at the district, and used the aggregated data from the observation checklists to assess systems-level gaps and to plan near-term quality improvement solutions to these gaps.

*Data collection*

Data was collected by a clinical mentor for IMAI based in the district. Baseline data collection was conducted prior to the start of supervision activities; while endline data was collected during routine supervisory visits to district health centers by the clinical mentor. Data was 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, part of the larger IMAI guideline [ref]. During the endline data collection, the mentor could also consult the IMAI Case Recording Form (CRF), used by the facility nurse as a decision-support tool and completed by them during the clinical encounter. Prior to data collection and to development of the observation checklist and CRF, 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 in detail elsewhere (ref).

*Outcomes*

The primary outcomes of interest were agreement between the OPD nurse and the clinical mentor in diagnosis and treatment plan. Agreement was defined on a per patient complaint basis as the unit of observation, with up to three complaints recorded for each patient, one of which was recorded as the primary, or chief complaint. Treatment agreement was defined as full agreement in all elements of the treatment plan, including laboratory or additional diagnostic testing ordered, medications selected and referral or follow-up visits prescribed, as appropriate. Secondary outcomes included the effect of covariates such as nurse years of experience in OPD care, time since initial training, health center, etc. on the quality of nurse case management. Additional quality indicators such as frequency of vital signs collection, appropriate screening conducted, etc. were reported and examined for the effect of the intervention on their rates.

*Data analysis*

Sample size was calculated to detect at 20% difference with power (β) of 0.8 and upward adjustment for clustering, which set a target of 250 observations in each sample (pre- and post-intervention). Frequency differences pre- and post-intervention were calculated using t-tests for continuous variables and Chi-square tests for categorical data. For the primary outcomes, mixed effect logistic regression was employed. Univariate models were constructed to identify effect modifiers, and then those significant modifiers were included in multivariate analysis. Mixed effects regression was employed to account for any potentially distorting effects that an individual nurse could cause; we assumed a random distribution of nurses in Rwanda, each with their own ability and variance from the mean. Mixed effect modeling, as opposed to fixed effect, accounts for their inherent variability in performance. Of note, a conservative approach to missing data was employed; for the primary outcomes of interest (diagnosis and treatment agreement), missing values were treated as errors in assessment for diagnosis and treatment, suggesting that failure to complete a diagnosis was an indicator of poor performance and fidelity to the IMAI protocols. Data analysis was conducted using SAS v. 9.2 (Cary NC, USA).

*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. No identifying nurse or patient informationwas collected, though nurses provided written informed consent to observation after explanation of the study and its objectives. The IRB approved awaiver of informed consent for 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, and prior to their consultation with the nurse.

**RESULTS**

*Patient characteristics*

Four hundred and sixty-four (464) cases were observed at baseline, while 506 were observed during the endline. Patient demographics and characteristics are shown in detail in Table 1. Significantly more female patients were seen than males (p=0.05) at baseline and follow-up, but patient age was not significantly different at baseline and end-line at approximately 35 years on average. The most common presenting complaint during both baseline and end-line 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).

*Nurse characteristics*

A total of 25 nurses were observed during baseline data collection at the eight study sites, none of whom had been previously trained in IMAI. A total of 16 nurses – two from each health center - were then initially trained in April 2011, prior to initiation of mentoring and supervision activities. Due to turnover from out-migration to different MoH facilities or out of the public sector altogether, IMAI training was repeated for another group of 17 different nurses in October 2011, none of whom received the initial training in April. At endline, 33 nurses were observed, 15(45%) of whom were captured in the baseline nurse cohort. Approximately 70 percent of observed patient consultations by these 33 nurses, were performed by an IMAI-trained nurse. This reflects expected turnover as described above, but also is impacted by MoH regulations that require nurses to assume generalists roles and to staff multiple services at the health center, given absolute staffing deficits. As a result, IMAI-trained nurses could have been staffing another clinical service at the health center on the pre-determined day of observation.

At baseline, nurses had an average of approximately 5.2 years of practice experience in health center OPDs, versus endline where nurses had approximately 6 years of experience (p=0.03). Consultation time was not significantly increased by the introduction of the IMAI algorithm, averaging about 14 minutes per patient at baseline and 15 minutes during end-line (p=0.85). Over 90 percent of nurses at baseline and end-line were designated as “A2” using the old Rwandan MoH classifications; this indicates that they had the equivalent of secondary school education in health behavior and nursing. There were zero A1 nurses at baseline, but 8.5 percent of consultations were seen by an A1 at end-line. This reflected MoH efforts to upgrade all A2 nurses nationally to A1 through distance learning (ref) which entails an additional Z years of nursing-specific education (p<0.001). Additional detail on nurse characteristics is shown in Table 2.

*Quality of care indicators*

Changes in basic quality of care indicators, including taking 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 performance of all categories of vital signs, including height (+16.6%), weight (+32%), pulse (+66%), temperature (49%), and blood pressure (+54%). Routine screening for prevalent diseases or conditions, as well as key lifestyle behaviors and preventive strategies, increased (p<0.001) across the board. 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 bednets 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% in patients referred for HIV testing was seen, along with a 14% increase in counseling on safe sex.

*Agreement in diagnosis and treatment*

In the 970 total patients encounters observed, 1236 complaints were recorded, the most frequent of which were women with genitourinary complaints or pelvic pain (16.7%), cough or difficulty breathing (16.2%), and fever (10.8%). There was an approximately 28% overall increase in agreement between the health center nurse and mentor for both diagnosis and treatment plan after the intervention. For agreement in diagnosis, these increases 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 pronounced for cough/difficulty breathing (38.7%), headache/neurological conditions (36.4%) and oral or throat problems (35.8%). Results are presented in greater detail in Table 4.

*Logistic regression*

**Table 1. Patient characteristics at baseline and endline\***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***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 |  |

\* Note: table only includes chief complaints reported by 10 or more patients

**Table 2. Nurse characteristics at baseline and endline**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Pre** | **Post** | **Δ%**  **Post - Pre** | **P-value** |
| ***Nurse characteristics*** |  |  |  |  |
| Total number of nurses observed | 25 | 33 |  |  |
| Nurses observed who were trained in IMAI | 0 |  |  |  |
| Percentage of observed patients |  |  |  |  |
|  |  |  |  |  |
| ***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 baseline and endline\***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *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\***

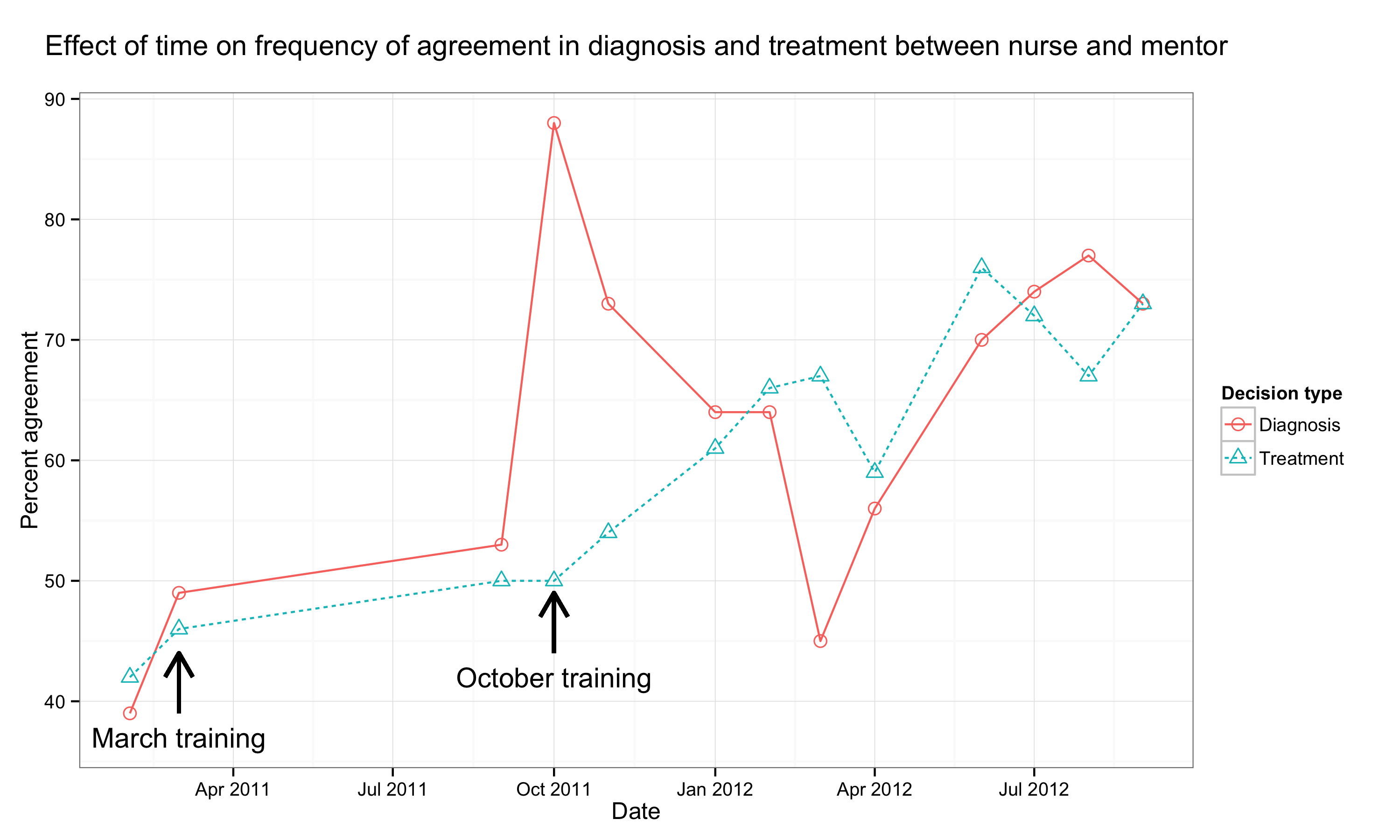
|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Complaints** | | | | **Diagnosis** | | | **Treatment** | | |
|  | Total Number with complaint | Pre (n) | Post (n) | Pre (n%) | Post (n%) | Δ%  Post - Pre | Pre (n%) | Post (n%) | Δ%  Post - Pre |
| TOTAL | 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) | - |

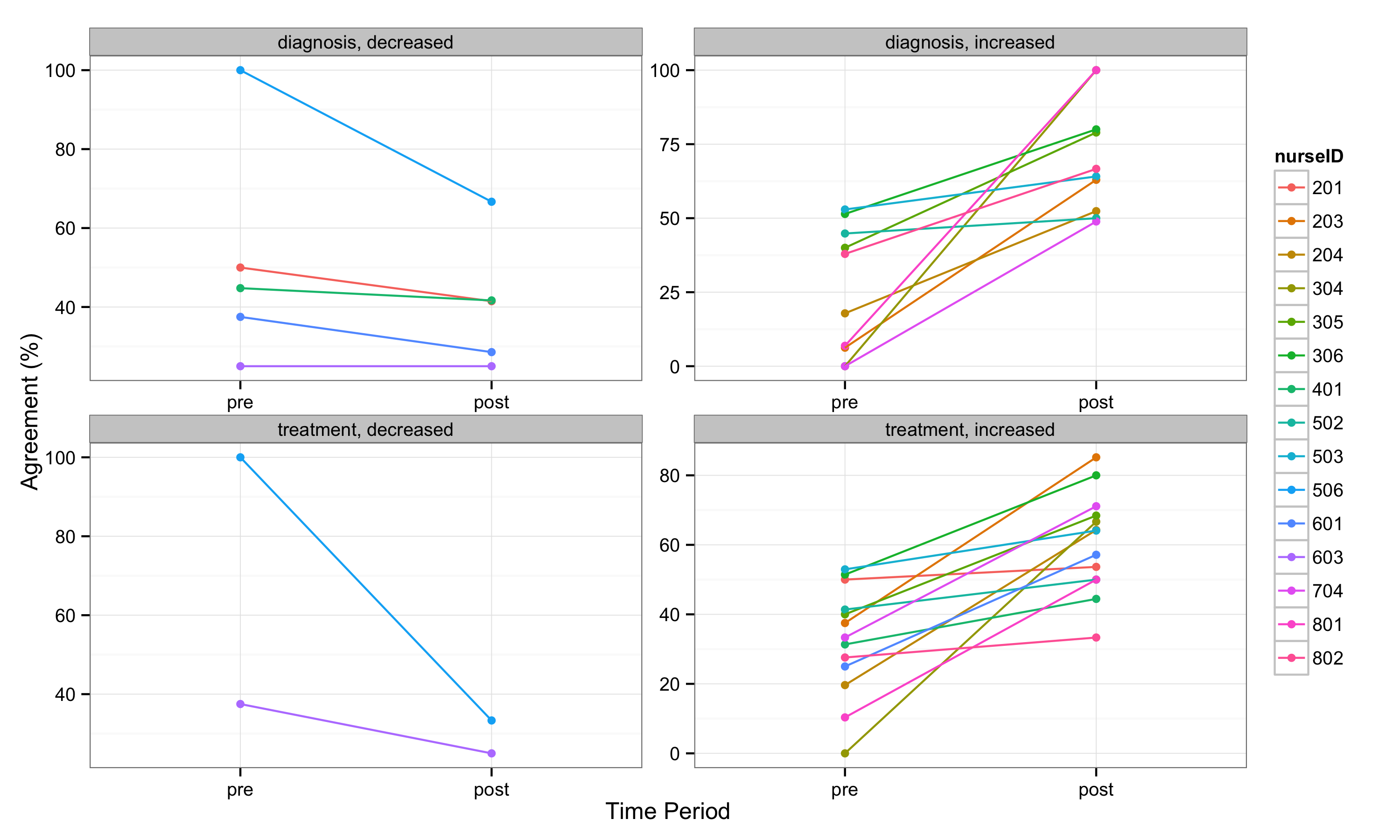
\* Note: patients could report up to three (3) recorded complaints per encounter

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Diagnosis** | | | **Treatment** | | |
|  | Total (N=1236) N, % total | 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** |  |  |  | 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 |
| **IMAI Nurse** |  |  |  | <.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) |  |
| **Obs (cont)** |  | 4.7 +/- 3.3 | 5.8 +/- 2.8 | <.0001 | 4.2 +/- 2.9 | 6.1 +/- 3.0 | <.0001 |
| **Obs (cat)** |  |  |  | <.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) |  |
|  |  |  |  |  |  |  |  |

‡†ˇ

**Multivariate Model**

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