Assessing the Clinical Management of Malaria in Under Five Children in Uganda: Exploring the Association Between Facility and Population-Based Data

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Abstract

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Introduction:

The Integrated Infectious Disease Capacity Building Evaluation (IDCAP) team evaluated two malaria case management interventions that were implemented in 36 health facilities in Uganda using facility-based and population-based data. The population survey was administered in the catchment areas surrounding the IDCAP facilities to measure utilization of care at the facilities as well as the effects of the intervention on mortality of children under five years of age (U5). The relationship between health facility-based data, population-based data, and the quality of malaria case management in children U5 is explored.

Methods:

Using malaria case management facility-based data, variables for health facility performance were created. Using the population survey, healthcare utilization questions were used to define the following three performance variables: delay in seeking care, whether a child had a blood test taken, and whether a child received a drug. Linear and logistic regressions were used to explore the relationship between the two sources of data on health facility performance.

Results:

The regression coefficients for the delay in seeking care variable regressed on having a blood test taken are as follows: best performing (reference): 0, 2nd best: 0.78 (0.43, 1.14), 3rd best: 0.19 (-0.20, 0.58), lowest performing: -0.39 (-0.76, -0.02); $p < 0.001$. The regression coefficients for the delay in seeking care variable regressed on being given a drug are as follows: best performing (reference): 0, 2nd best: -0.10 (-0.47, 0.27), 3rd best: -0.36 (-0.76, 0.04), lowest performing: 0.33 (-0.08, 0.74); $p = 0.01$. The odds ratios for the blood test taken variable are as follows: best performing (reference): 1, 2nd best: 0.96 (0.57, 1.61), third best performing: 0.92 (0.52, 1.62), lowest performing: 0.73 (0.43, 1.24); $p = 0.76$. The odds ratios for the drug(s) given variable are as follows: (reference): 1, 2nd best: 1.26 (0.54, 2.97), 3rd best: 0.66 (0.30, 1.45), lowest performing: 1.21 (0.51, 2.85); $p = 0.14$.

Discussion:

The delay in seeking care variable shows a statistically significant difference across categories of the facility-based measures of malaria test recorded and malaria drug(s)

given. Overall, there is the need for more research, as this study is one of the first of its kind.

Introduction

In Uganda, there have been successful interventions and evaluations to improve malaria case management. For example, Ssekabira et al. (2008) evaluated a malaria case management-training program at eight sentinel malaria surveillance system sites in Uganda. Upon completion of the training, the proportion of patients with suspected malaria that were referred for blood smears increased, while the proportion of patients with negative blood smears who received antimalarials decreased. Later at some of the same sites, Sserwanga et al. (2011) found that the training and ongoing support for the surveillance system lead to increased diagnostic testing in patients with suspected malaria and an increase in the appropriate prescription of antimalarials.

The Integrated Infectious Disease Capacity Building Evaluation (IDCAP) implemented two interventions in 36 healthcare facilities in Uganda in 2010 (see appendix for diagram of study design): 1) Integrated Management of Infectious Disease (IMID) for two mid-level practitioners per facility and 2) on-site support (OSS) (Mbonye et al., 2014). The IMID intervention focused on courses and distance learning, and the OSS intervention focused on educational outreach and continuous quality improvement (CQI). All 36 healthcare facilities received the IMID intervention beginning in March 2010. Arm A included 18 healthcare facilities that received nine monthly OSS visits from April-December 2010, while Arm B, the delayed arm, consisted of 18 healthcare facilities that received eight monthly OSS visits from March 2011-September 2011 (Burnett et al., 2015). The IDCAP trial from April to December 2010 showed the following results, relative to baseline, for four malaria case management facility performance indicators (Mbonye et. al, 2014): 1) proportion of patients with suspected malaria for whom a diagnostic test result for malaria was recorded increased in Arm A, 2) estimated proportion of patients who received an appropriate antimalarial increased in Arm A, 3)

proportion of patients with a negative diagnostic test result for malaria prescribed an antimalarial decreased in Arm A, and 4) proportion of patients with a positive diagnostic test result for malaria prescribed an antibiotic did not change in either arm. In a follow-up study by Burnett et al. (2015) from March 2011 to September 2011, when Arm B also received monthly OSS visits, Arm B showed a decrease in the proportion of patients with a negative malaria test result prescribed an antimalarial, relative to baseline.

Population-based data are available to validate the facility-based data in the aforementioned studies. The objective of the current study is to use population-based data on health care utilization to describe the quality of malaria case management data from Ugandan children, under five years of age (U5), with fever symptoms who visited an IDCAP healthcare facility. I explore the relationship between IDCAP facility-based data from both study arms and population-based data to potentially validate the facility-based data.

Methods

This study is a secondary analysis of cross-sectional data. Data from the following sources were utilized: 1) The Uganda Bureau of Statistics 2011 Under Five Mortality Survey: Household and Individual Women Questionnaires and 2) 2011 IDCAP Facility-Based Data.

Selection of Study Facilities

Thirty-six health facilities were selected from the four administrative districts of Uganda: central, east, north and west (Mbonye et al., 2014). Three key inclusion criteria for health facilities were: 1) health center IV (HCIV) or comparable facility such as small general hospital or non-governmental organization clinic, 2) accredited antiretroviral therapy (ART) site actively providing ART or scheduled to be active by April 2010, and 3) working laboratory defined as on-going performance of the following six laboratory tests: HIV rapid test, hemoglobin,

peripheral blood smear or rapid test of malaria, sputum microscopy for acid-fast bacteria, stool analysis, and urine analysis (Weaver et al., 2012). Three exclusion criteria were: 1) current participation in Ministry of Health continuous quality improvement (CQI) programs, 2) past or current partnership with the United States Department of Defense, and 3) patient population included primarily prisoners.

Selection of Subjects for the Population-Based Data

Respondents were selected from a five-kilometer radius surrounding each of the 36 facilities that participated in the IDCAP intervention. Six-hundred enumeration areas (EAs), or census tracts, were randomly selected from within the five-kilometer radius surrounding each of the facilities.

A listing of every household in each of the 600 EAs was prepared. The listing included the name of the household head, whether or not a death occurred within the household in the last three years, and if yes, the age of the person at the time of his/her death. If households fell into either of the following two categories, they were asked to participate in both the Household and Birth History Questionnaires: 1) reported an U5 child death in the last three years and 2) was selected in a random sample of 30 households from within each EA, including those who reported an U5 child death. A total of 87,189 households were listed in 597 EAs; of these households, 3,589 reported an U5 child death. In all, 20,379 households were asked to participate in the Household Questionnaire, of which 96% completed the interview. Among the households, there were 22,939 15-49 year old women who were eligible for the Birth History Questionnaire; of these women, 98% completed the interview. If a mother was a member of the household and unavailable to answer questions, a proxy completed her Birth History Questionnaire. Proxies were adults, preferably women, in the household who were able to answer questions on behalf of

the mother. Nineteen percent of Birth History Questionnaire respondents were proxies; these proxies did respond to questions about child healthcare utilization. If the mother was not a member of the household and unavailable to participate in the Household Questionnaire, proxies were asked to respond to relevant questions about her children's residential history and survival. Proxies accounted for 13% of respondents who provided information about children's residential history and survival; however, these proxies did not respond to questions about child healthcare utilization.

Additionally, only children who had a fever at their last visit to an IDCAP facility, reported in the Birth History Questionnaire, were included in the analysis of the population data. This is because fever is a symptom of malaria among other illnesses, and all children with fever should have a malaria test.

Data Collection

The survey staff consisted of 13 teams, organized by local language. Both the Household and Birth History Questionnaires were field-tested in September and October 2011. Actual interviewing and data collection began in December 2011 and lasted until May 2012. As part of the Household Questionnaire, staff interviewed the head of household or his/her designate about household membership, basic demographic characteristics (e.g. age, sex, marital status), and characteristics of the household's dwelling unit, such as source of water and cooking fuel and ownership of durable goods. Importantly, the Household Questionnaire was used to identify women, between the ages of 15 and 49, who were eligible to participate in the Birth History Questionnaire. As part of the Birth History Questionnaire, each woman was asked to give a complete birth history of every child to whom she had ever given birth. If her child was born after 2003, the respondent was also asked about her child's use of health services, date of death

(if the child had died), and child's history of household residence. In the field, team leads checked for and resolved issues surrounding inconsistencies and/or missing data. The surveys were double entered. If an inconsistency occurred, data editors crossed checked the entry, and entered the true value, if necessary.

Facility data were collected in September 2011 using the Ministry of Health's Medical Form 5 patient form that linked both clinical and laboratory data and included tick boxes for history, laboratory investigations, diagnoses, drug prescriptions, and drug availability (Mbonye et al., 2014). Malaria case management items on the form included: fever or history of fever in the history section; blood smear and rapid diagnostic test result for malaria in the laboratory section; malaria diagnosis (during and not during pregnancy) in the diagnosis section; and data on the drugs prescribed and their availability in the treatment section. Data were collected by, but not limited to, records, clinical staff at patient reception desks, clinicians during history taking, diagnosis, prescription and/or referrals, laboratory professionals during laboratory investigations, and pharmacists/dispensers when dispensing prescribed drugs. Five percent of the completed forms were randomly selected, reentered, and compared with previously entered forms each month during visits by technical officers; over a 99% level of concordance was observed (Mbonye et al., 2014).

Facility-Based Variable Definitions

Health facility performance was defined using variables for both malaria testing and treatment. The test variable was the proportion of patients with suspected malaria for whom a diagnostic result test for malaria was recorded (Mbonye et al., 2014). In creating the test variable, the number of patients with suspected malaria for whom a diagnostic test result for

malaria recorded, either by microscopy or rapid diagnostic test, was divided by the total number of patients with suspected malaria.

The treatment variable was the estimated proportion of patients who received an appropriate antimalarial (Mbonye et al., 2014). In creating the treatment variable, the estimated number of patients who received an appropriate antimalarial was divided by the total number of patients prescribed any antimalarial. As the data on drug availability were missing for some patients, appropriate treatment of malaria was estimated from two intermediate measures: (a) the proportion of patients who were prescribed the appropriate treatment and (b) the proportion of patients who received the appropriate treatment among those with both appropriate prescriptions and data on drug availability. The numerator for the proportion of patients who received appropriate treatment was estimated by multiplying the numerator of (a) by (b) at each facility for each month.

Based on the aforementioned health facility performance indicators that were collected in September 2011, the 36 IDCAP facilities were divided into four groups, ranging from lowest to best performing. The facilities were divided based on the number of children that visited each facility, with each group consisting of roughly 25% of the children in the sample.

Population-Based Variable Definitions

Specific variables of interest in the Birth History Questionnaire included delay of care, as defined by the number of days, after onset of illness, until the child visited an IDCAP health facility, if the child had their blood taken at their last health facility visit, and if the child was given drugs at their last health facility visit. Whether a child received a blood test, or not, was used as a proxy for performance of a malaria diagnostic test. Whether a child was given a drug, or not, was used as a proxy for whether an appropriate antimalarial was received.

In exploring the distribution of population-based (mother) reports vs. facility reports, variables for population-based (mother) reports were created. Population-based reports for the blood test taken variable are defined as the number of children with a fever and a blood test taken, divided by the number of facility visits by children with fever in September 2011. Population-based (mother) reports for the drug(s) given variable are defined as the number of children given a drug, divided by number of facility visits in September 2011.

Sample Size Calculations

The sample size for the Household and Birth History Questionnaires was calculated using mortality as the primary outcome. A mortality decline of 13% based on Integrated Management of Childhood Illness (IMCI) evaluations, 80% power, and a baseline U5 mortality rate of 28 per 1,000 person-years were used to determine how many EAs to include in the study and how many households within each EA to sample (Rajaratnam et al., 2012). The coefficient of variation in the mortality rate across clusters was determined from pilot data that were collected in six EAs in February 2010. In all, it was determined that there would be 600 EAs (300 in each study arm) and 30 households within each EA selected for the random sample.

Statistical Methods

Population-based (mother) vs. facility reports for the test and treatment variables for September 2011 were plotted in a scatterplot, with each facility representing a point. A Lowess smoother was used to find a curve of best fit. In sensitivity analyses, Cook's distance test was performed for both the test and treatment variable to identify influential points.

Simple linear regression was used to calculate the coefficient of the correlation between delay of care and health facility performance, as defined by the test and treatment variables. Cook's distance test was used to identify any influential points. Additionally, in describing the

relationship between the outcome and predictor variable, an F-test was performed to produce a single p-value. Logistic regression was used to calculate the odds ratio for the correlation between blood test taken and health facility performance, as defined by the test variable. Additionally, logistic regression was used to calculate the odds ratio for the correlation between drug(s) given and health facility performance, as defined by the treatment variable. For the logistic regressions, likelihood ratios were used to produce a single p-value. Health facility level is the only confounding variable considered in the analysis.

Hypotheses

The three hypotheses were that 1) the proportion of malaria suspects with a malaria test recorded would show a positive correlation with children having a blood test taken, 2) the estimated proportion of malaria suspects who received an appropriate antimalarial would show a positive correlation with children being prescribed and given a medication, and 3) both the proportion of malaria suspects with a malaria test recorded and the estimated proportion of malaria suspects who received an appropriate antimalarial would show a negative correlation with delay of care, as parents who take their children to higher performing health facilities would be less likely to delay care

Results

The number of children that were reported by their mother or proxy as visiting an IDCAP facility in September 2011 is 646. Demographic variables describing the families of these children are displayed in Table 1. Overall, compared to mothers of children who did not visit an IDCAP facility in September 2011, mothers of children in the sample were more likely to be in the poorest quintile, have no schooling, and be married.

Table 1: Population description

Variable	Children alive in September 2011, with a fever, who visited an IDCAP facility	Children alive in September 2011 who did not visit an IDCAP facility	Total Number of Children Alive in September 2011
Number of children	646	20,234	20,880
Average Age of Child's Mother	30.18	28.36	29.38
Average Birth Interval (months) of Child's Mother	28.1	27.61	27.86
Marital Status of Child's Mother			
Married or Living Together	553 (85.6%)	14,974 (74.0%)	15,527 (74.4%)
Divorced/Separated	46 (7.1%)	1,368 (6.8%)	1,414 (6.8%)
Widowed	16 (2.5%)	297 (1.5%)	313 (1.5%)
Never Married or Never Living Together	18 (2.8%)	836 (4.3%)	881 (4.2%)
Missing	13 (2.0%)	2,732 (13.5%)	2,745 (13.1%)
Wealth Quintile of Child's Mother			
Poorest	229 (35.4%)	4,454 (22.0%)	4,683 (22.4%)
Poorer	148 (22.9%)	4,318 (21.3%)	4,466 (21.4%)
Middle	99 (15.3%)	3,974 (19.6%)	4,073 (19.5%)
Richer	92 (14.2%)	3,731 (18.4%)	3,823 (18.3%)
Richest	78 (12.1%)	3,753 (18.5%)	3,831 (18.3%)
Missing	0	4 (0.02%)	4(0.02%)
Education Attainment of Child's Mother			
No School	136 (21.1%)	3,032 (15.0%)	3,168 (15.2%)
Some Primary or Completed Primary School	395 (61.1%)	11,955 (59.1%)	12,350 (59.1%)
Some Secondary or Completed Secondary School	89 (13.8%)	3,354 (16.6%)	3,443 (16.5%)
Tertiary or University	21 (3.3%)	627 (3.1%)	648 (3.1%)
Missing	5 (0.8%)	1,266 (6.3%)	1,271 (6.1%)
Child's Sex			
Female	316 (48.9%)	10,032 (49.6%)	10,348 (49.6%)
Male	327 (5067%)	10,163 (50.2%)	10,490 (50.2%)
Missing	3 (0.5%)	39 (0.2%)	42 (0.2%)
Urban or Rural Enumeration Area			
Rural	564 (87.3%)	17,504 (86.5%)	18,068 (86.5%)
Urban	82 (12.7%)	2,730 (13.5%)	2,812 (13.5%)
Health Facility Level			
Level 4	532 (82.4%)	16,726 (82.7%)	17,258 (82.7%)
Hospital	114 (17.6%)	3,508 (17.3%)	3,622 (17.3%)

Delay of Care Variable

The results of the full sample univariate and multivariate analyses that use the test variable as the independent variable demonstrate neither a positive or negative direction of association between delay in seeking care and facility performance; however, this relationship is statistically significant ($p < 0.002$) (Table 2a). The Cook's distance test for the delay of care variable identified eight influential points (99 days, 21 days, and 6 observations with 14 days); these points were omitted from the dataset in the estimates in Tables 2b and 2d. The results of the univariate and multivariate analyses with influential points removed also demonstrate no direction of association; this relationship is also statistically significant ($p < 0.001$) (Table 2b).

The results of the full sample univariate analysis that uses the treatment variable as the independent variable indicate that, as health facility performance decreases, delay in seeking care decreases; the multivariate analysis shows no direction of association (Table 2c). Neither the univariate nor multivariate results are significant. The results of the univariate and multivariate analyses with the influential observations removed demonstrate neither a positive or negative direction of association; however, the results are statistically significant (univariate: $p=0.005$; multivariate; $p=0.01$) (table 2d).

Table 2a: Delay in care and health facility performance, as defined by the test variable. Full sample; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=646) (* denotes $p<0.05$)

Dependent variable	Proportion of patients with suspected malaria for whom a diagnostic test result for malaria was recorded.	Univariate Coefficient of linear regression (95% CI) p-value = 0.002*	Multivariate Coefficient of linear regression (95% CI) p-value = 0.002*
Delay in seeking care, at an IDCAP facility, for a child with fever in September 2011.	Best Performing	0.0 (--)	0.0 (--)
	2nd	1.30 (0.40, 2.20)	1.41 (0.50, 2.32)
	3rd	0.11 (-0.89, 1.10)	0.002 (-1.00, 1.01)
	Lowest Performing	-0.36 (-1.33, 0.6)	-0.43 (-1.40, 0.53)

Table 2b: Delay in care and health facility performance, as defined by the test variable. Without influential observations; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=638) (* denotes p<0.05)

Dependent variable	Proportion of patients with suspected malaria for whom a diagnostic test result for malaria was recorded.	Univariate Coefficient of linear regression (95% CI) p-value <0.001*	Multivariate Coefficient of linear regression (95% CI) p-value <0.001*
Delay in seeking care, at an IDCAP facility, for a child with fever in September 2011.	Best Performing	0.0 (--)	0.0 (--)
	2nd	0.72 (0.40, 2.20)	0.78 (0.43, 1.14)
	3rd	0.25 (-0.89, 1.10)	0.19 (-0.20,0.58)
	Lowest Performing	-0.35 (-1.33, 0.6)	-0.39 (-0.76, -0.02)

Table 2c: Delay in care and health facility performance, as defined by the treatment variable. Full sample; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=646) (* denotes p<0.05)

Dependent variable	Estimated proportion of patients that received an appropriate antimalarial among those with any antimalarial prescription	Univariate Coefficient of linear regression (95% CI) p-value = 0.14	Multivariate Coefficient of linear regression (95% CI) p-value = 0.22
Delay in seeking care, at an IDCAP facility, for a child with fever in September 2011.	Best Performing	0.0 (--)	0.0 (--)
	2nd	-0.99 (-1.94, -0.04)	-0.99 (-1.93, -0.37)
	3rd	-0.96 (-1.91, -0.01)	-1.05 (-2.07, -0.03)
	Lowest Performing	-0.54 (-1.51, 0.43)	-0.64 (-1.67, 0.40)

Table 2d: Delay in care and health facility performance, as defined by the treatment variable. Without influential observations; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=638) (* denotes p<0.05)

Dependent variable	Estimated proportion of patients that received an appropriate antimalarial among those with any antimalarial prescription	Univariate Coefficient of linear regression (95% CI) p-value = 0.005*	Multivariate Coefficient of linear regression (95% CI) p-value = 0.01*
Delay in seeking care, at an IDCAP facility, for a child with fever in September 2011.	Best Performing	0.0 (--)	0.0 (--)
	2nd	-0.10 (-0.47, 0.27)	-0.10 (-0.47, 0.27)
	3rd	-0.34 (-0.72, 0.03)	-0.36 (-0.76, 0.04)
	Lowest Performing	0.35 (-0.03 0.73)	0.33 (-0.08, 0.74)

Blood Test Taken Variable

Population (mother) vs. facility reports of the blood test taken variable are displayed in Graph 1. The Loess curve demonstrates a clear positive relationship between the two sources of data. There are two influential points, or facilities, noted by boxes in the graph on the left. The graph on the right displays population (mother) vs. facility reports with the influential points omitted. The two influential points correspond to nine observations across the two facilities. Overall, there is a lot of variation in both of the graphs. Removing the influential points results in a Loess curve that is slightly less steep.

The results of the full sample univariate and multivariate analyses indicate that the odds of having a blood test taken decreases as health facility performance decreases; however, these results are not significant at the 0.05 significance level (Table 3a). Similarly, both the univariate and multivariate analyses that do not include influential points indicate that the odds of having a blood test taken decrease as health facility performance decreases; also similar to the full sample analysis, this relationship is not significant at the 0.05 significance level (Table 3b).

Graph 1: Blood test taken variable: Population (mother) vs. facility reports (graph on left includes influential points, noted by boxes; graph on right omits influential points)

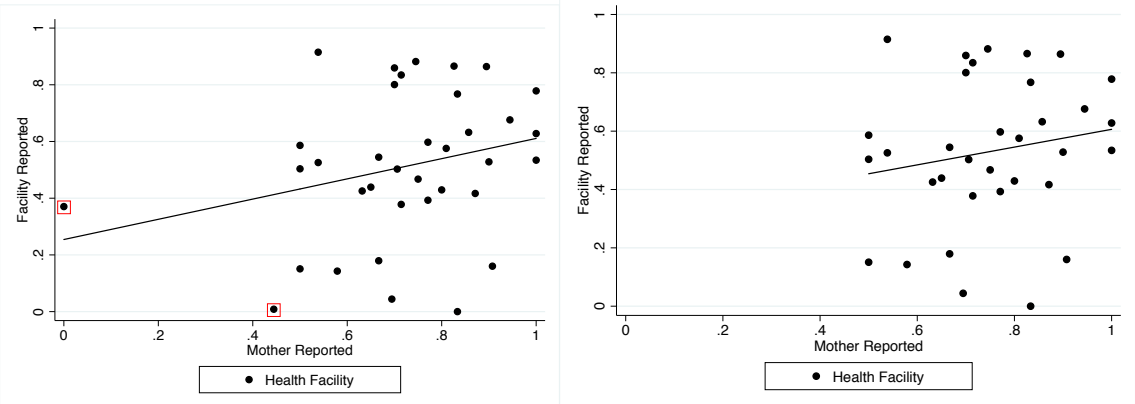

Table 3a: Blood test taken and health facility performance. Full sample; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=646) (* denotes $p<0.05$)

Dependent variable	Proportion of patients with suspected malaria for whom a diagnostic test result for malaria was recorded.	Univariate Odds Ratio (95% CI) p-value = 0.52	Multivariate Odds Ratio (95% CI) p-value = 0.62
O/1 Did the child with fever who visited an IDCAP facility in September 2011 have a blood test taken?	Best Performing	1.0 (--)	1.0 (--)
	2nd	0.88 (0.53, 1.46)	0.90 (0.54, 1.51)
	3rd	0.88 (0.50, 1.55)	0.86 (0.49, 1.52)
	Lowest Performing	0.68 (0.40, 1.15)	0.67 (0.39, 1.13)

Table 3b: Blood test taken and health facility performance. Without influential observations; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=637) (* denotes $p<0.05$)

Dependent variable	Proportion of patients with suspected malaria for whom a diagnostic test result for malaria was recorded.	Univariate Odds Ratio (95% CI) p-value = 0.77	Multivariate Odds Ratio (95% CI) p-value = 0.76
O/1 Did the child with fever who visited an IDCAP facility in September 2011 have a blood test taken?	Best Performing	1.0 (--)	1.0 (--)
	2nd	0.88 (0.53, 1.46)	0.96 (0.57, 1.61)
	3rd	0.88 (0.50, 1.55)	0.92 (0.52, 1.62)
	Lowest Performing	0.75 (0.43, 1.28)	0.73 (0.43, 1.24)

Drug(s) Given Variable

Population (mother) vs. facility reports of the drug(s) given variable are displayed in Graph 2, which also demonstrate a clear positive relationship between the two sources of data. Note that the majority of the facility-based measures are greater than 85%. There are four influential points, or facilities, noted by boxes in the graph on the left. The graph on the right displays population (mother) vs. facility reports with the influential points omitted. The four

influential points correspond to 47 observations across four facilities. Removing the influential points results in more points being clustered around the fitted line and therefore less variation.

The results of the full sample univariate analysis in Table 4a indicate that the odds of receiving a drug decreases as health facility performance decreases; however, these results are not significant at the 0.05 significance level. Removing influential options, the results of the univariate and multivariate analyses indicate that there is no clear direction of association between the drug(s) given variable and health facility performance; additionally, this relationship is not significant at the 0.05 significance level (Table 4b).

Graph 2: Drug(s) given variable: Population (mother) vs. facility reports (graph on left includes influential points, noted by boxes; graph on right omits influential points)

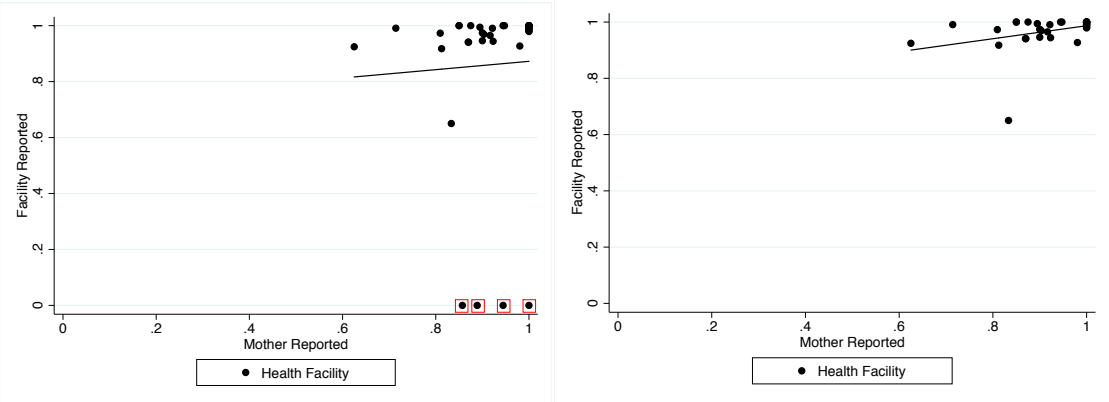

Table 4a: Drug(s) given and health facility performance. Full sample; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=646) (* denotes p<0.05)

Dependent variable	Estimated proportion of patients that received an appropriate antimalarial among those with any antimalarial prescription	Univariate Odds Ratio (95% CI) p-value = 0.25	Multivariate Odds Ratio (95% CI) p-value = 0.17
O/1 Was the child with fever who visited an IDCAP facility in September 2011 given drugs?	Best Performing	1.0 (--)	1.0 (--)
	2nd	0.83 (0.40, 1.99)	1.28 (0.58, 2.98)
	3rd	0.52 (0.23, 1.17)	0.68 (0.32, 1.43)
	Lowest Performing	0.52 (0.23, 1.17)	1.32 (0.58, 2.81)

Table 4b: Drug(s) given and health facility performance. Without influential observations; univariate analysis and multivariate analysis, adjusted for health facility level (level four or hospital) (n=599) (* denotes p<0.05)

Dependent variable	Estimated proportion of patients that received an appropriate antimalarial among those with any antimalarial prescription	Univariate Odds Ratio (95% CI) p-value = 0.18	Multivariate Odds Ratio (95% CI) p-value = 0.14
O/1 Was the child with fever who visited an IDCAP facility in September 2011 given drugs?	Best Performing	1.0 (--)	1.0 (--)
	2nd	1.42 (0.62, 3.27)	1.26 (0.54, 2.97)
	3rd	0.62 (0.29, 1.35)	0.66 (0.30, 1.45)
	Lowest Performing	1.18 (0.50, 2.77)	1.21 (0.51, 2.85)

Discussion

Summary of Main Findings

Neither the relationship between delay in seeking care and health facility performance, as defined by the test variable, nor the relationship between delay in care and health facility performance, as defined by the treatment variable, show a consistent direction of association; however, both regressions show significant differences across categories of performance at the 0.05 significance level. The relationship between having a blood test taken and health facility performance, as defined by the test variable, shows a positive relationship; the odds of having a blood test taken decrease as health facility performance decrease. However, this relationship is not significant. The relationship between the drug(s) given variable and health facility performance shows no clear direction of association and lacks significance. For example, patients in the 3rd best performing facility group were less likely to be given a drug than patients in the best performing group, whereas patients in the lowest performing were more likely to report receiving a drug than the best group. This does not follow the hypothesis that the number of patients being given a drug will increase as facility performance increases.

Implications

Currently, many malaria control programs utilize population-based surveys to evaluate their projects (WHO, 2015). Because of their use of large sample sizes and rigorous sampling methods, population-based surveys are advantageous in evaluating projects. In Uganda, examples of such surveys include the Malaria Indicator Survey, the Uganda Bureau of Statistics (UBOS) Demographic and Health Survey, and the surveys utilized in this study, the UBOS Under 5 Mortality Survey and Individual Women Questionnaire. However, such surveys are expensive and time-consuming to conduct. On the other hand, facility-based data may be less expensive to collect when data can be extracted from accurate patient records. However, recent articles (Skarbinski et al., 2008; Rowe et al., 2009) have discussed several drawbacks of using facility level data. Particularly, there are concerns of completeness, validity, and representativeness. While the results of the current study produced mixed results, they are an important step in exploring the use of facility-based data to validate population-based data.

To date, there have been few malaria-focused studies that have utilized both facility and population level data. In a study of malaria monitoring and evaluation, Oduro et al. (2011), used a population survey to validate facility level data in The Gambia. The sample for the study, however, was drawn from two separate populations: those that visited a facility and a representative sample from the catchment areas surrounding the facilities. Importantly, in the current study, only study participants who participated in the population survey and visited facilities were included in the analysis.

Limitations

There is a need for further research in this area, in which a shorter maternal recall period is used. In the current study, mothers were interviewed in either December 2011, January 2012,

February 2012, or March 2012 about their child(ren)'s health facility visit in September 2011 (a recall period of three months, four months, five months, six months, respectively). It is possible that a mother forgot when, or did not know whether, her child had a fever, blood taken, or was given a drug. For example, if a mother took her child to a facility in September 2011, but wasn't interviewed until March 2012, the six-month recall period may have been too long and led to inaccuracies in the mother's response. Several studies have shown that recall of symptoms by caregivers begins to decline after two to three days following a health facility visit (Feikin et al., 2010; Zafar et al., 2010, Alam et al., 1989). Additionally, a study of caregiver recall of documented clinic visits, prescriptions of antimalarials, and antibiotics in children aged less than five years found that recall declined by 7, 15, and 23% per week, respectively (Feikin et al., 2010**).**

Another limitation of this study pertains to the healthcare utilization questions from the Individual Women Questionnaire portion of the Under 5 Mortality Survey. Specifically, the questionnaire asks about the child(ren)'s fever history, blood test history, and medication history, but does not mention malaria. As previously mentioned, having a blood test taken was used as a proxy for having a malaria diagnostic test, and being given medication was used as a proxy for receiving the appropriate antimalarial. While fever is indicative of malaria, it is possible that the fever was being caused by something other than malaria. A malaria test should be taken for any child with fever. However, medication may have been given for a condition other than malaria or inappropriate malaria treatment may have been administered. In the future, with available data, a facility performance variable that is a better match to the population data, with regards to the drug given, could be created.

Finally, the odds ratios reported for the blood test taken variable and drug(s) given variable were not significant. It is difficult to determine exactly why there was no significance; however, on some level, the sample size was not big enough or there was too much variation in the data.

Conclusion

The current study did not reveal conclusive results. However, the results are valuable, as this study is one of the first of its kind; both the methods and results set precedence for the future study of the relationship between facility and population-based data. Overall, there is the need for additional research in this area. Specifically, there is a need to study the validation of health facility-based data with population surveys that are administered shortly after health facility visits.

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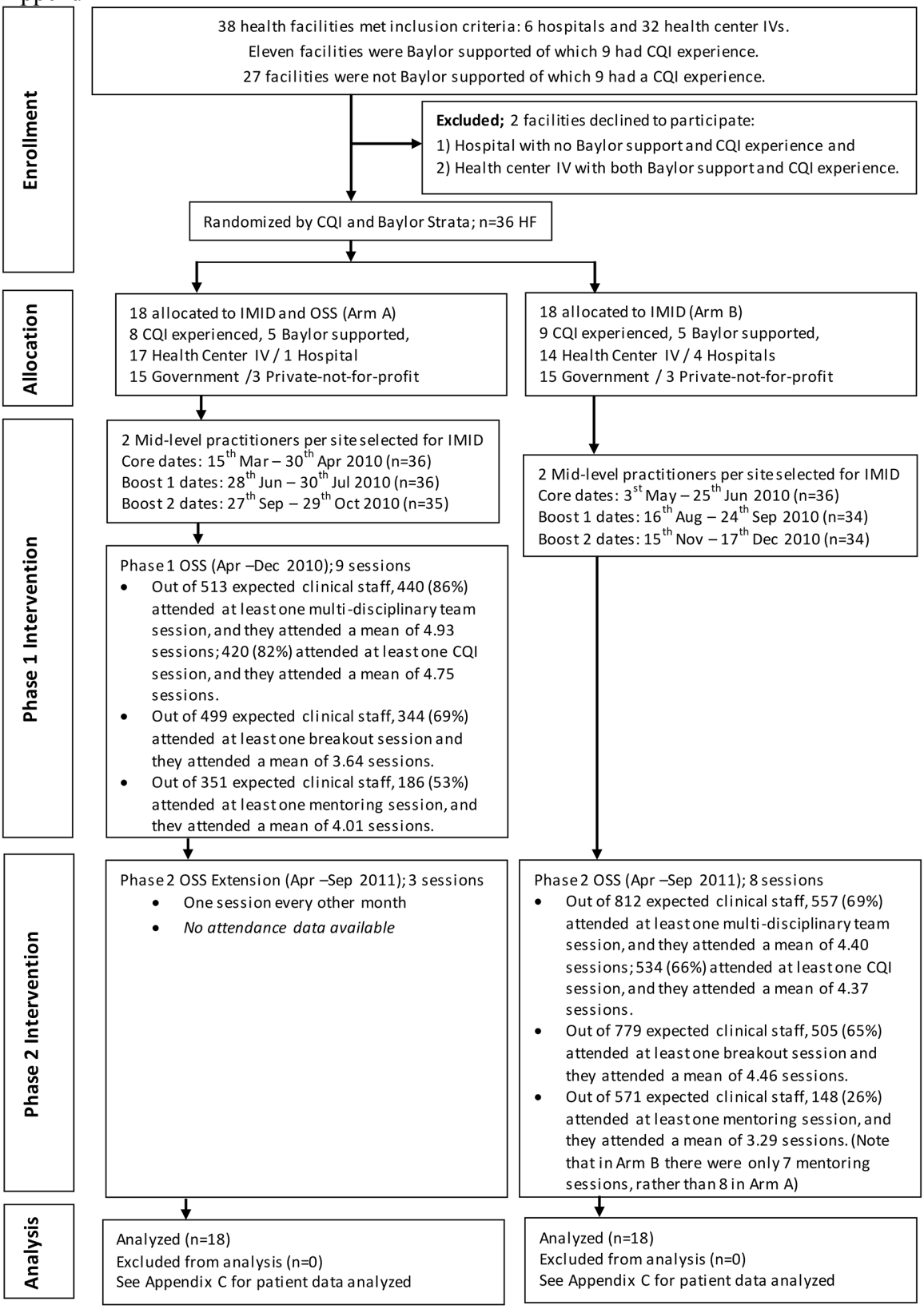
Appendix



From Burnett et al. (2015)