Trans R Soc Trop Med Hyg 2020; **0**: 1–7
doi:10.1093/trstmh/traa097 Advance Access publication 0 2020

A cross-sectional study comparing case scenarios and record review to measure quality of Integrated Community Case Management care in western Uganda

James S. Miller [a,b,c,*,†], Rapheal Kisolhu Mbusa[c], Stephen Baguma[c], Palka Patel[a,b,c,‡], Michael Matte[c], Moses Ntaro[c,d], Andrew Christopher Wesuta[c], Nobert Mumbere[c], Shem Bwambale[e], Sara Mian-McCarthy[a,c,§], Jessica Kenney[a,c], Daniel Guiles[a,b,c,¶], Edgar Mugema Mulogo[c,d], and Geren S. Stone[a,b,c]

[a]*Massachusetts General Hospital, Boston, MA, USA;* [b]*Harvard Medical School, Boston, MA, USA;* [c]*Global Health Collaborative, Mbarara, Uganda;* [d]*Mbarara University of Science and Technology, Mbarara, Uganda;* [e]*Bugoye Health Center, Bugoye, Uganda*

*Corresponding author. Tel: +1 617-726-2000; E-mail: jsmiller@post.harvard.edu
†Present address: Epidemic Intelligence Service, Centers for Disease Control and Prevention, Shoreline, Washington, USA.
‡Present address: Indiana University School of Medicine, Indianapolis, Indiana, USA.
§Present address: UNICEF USA, New York City, New York, USA.
¶ Present address: Vanderbilt University School of Medicine, Nashville, Tennessee, USA.

Received 17 June 2020; revised 28 August 2020; editorial decision 6 September 2020; accepted 12 September 2020

Background: In Integrated Community Case Management (iCCM), village health workers (VHW) assess and treat malaria, pneumonia and diarrhea using a clinical algorithm. Study objectives included: 1) Compare VHWs' performance on case scenario exercises to record review data; 2) assess impact of formal education on performance in the case scenario exercises.

Methods: 36 VHWs in Bugoye Subcounty, Uganda completed the case scenarios exercise, which included video case scenarios and brief oral case vignettes, between July 2017 and February 2018. We obtained clinical records for all iCCM encounters in the same time period.

Results: In the video case scenarios, 45% of mock patients received all correct management steps (including all recommended education), while 94% received all critical management steps. Based on the level of data available from record review, 74% of patients in the record review dataset received overall correct management compared to 94% in the video case scenarios. In the case scenarios, VHWs with primary school education performed similarly to those with some or all secondary school education.

Conclusions: The case scenarios produced higher estimates of quality of care than record review. VHWs often omitted recommended health education topics in the case scenarios. Level of formal education did not appear to influence performance in the case scenarios.

Keywords: community health workers, education level, educational status, Integrated Community Case Management, quality of health care, village health workers

Introduction

Since the late 1990s, programs in a wide range of countries have implemented home-based or village-based evaluation and treatment of malaria and sometimes other priority health conditions in children under 5 years of age.[1] Some programs have focused on evaluation and treatment of pediatric malaria alone, while others have employed an Integrated Community Case Management (iCCM) approach in which village health workers (VHW) or other trained community members evaluate and treat multiple conditions, usually malaria (or fever), pneumonia (or fast breathing) and diarrhea, with some programs adding other conditions as well. Many evaluations of quality of iCCM care have employed direct observation of VHWs' care, direct reexamination of patients by research staff or trained clinicians, or often both.[2–10] These evaluations have documented substantial variation in quality of care. Some evaluations have documented appropriate evaluation and treatment in 70–90% of

cases.[2,3,7,8,10] Conversely, the control group or pre-assessment evaluation in several intervention studies showed much lower performance for some metrics,[4,5,9] and another study in Burkina Faso showed broadly poor quality of care.[6] This variation in quality highlights the need for local monitoring and evaluation of iCCM programs. While direct reexamination of patients may be the gold standard for research, this approach is time-intensive and often uses scarce clinician time, making it less feasible for routine monitoring. Prior research on quality of iCCM care in Uganda specifically has relied on a range of approaches, including direct observation of VHWs,[10] record review,[11] surveys of caregivers after their children received iCCM care[12] and a mixed methods approach[13]; these studies have generally demonstrated high quality of iCCM care.

Two prior studies have compared different methods of measuring quality of care. One study in Malawi compared record review and case scenarios to direct observation and reexamination of patients, and found that record review slightly overestimated quality of care for fever (+6%) and slightly underestimated performance for diarrhea (−8%), while significantly overestimating performance for fast breathing (+34%). Case scenarios slightly overestimated performance for fever (+8%) and diarrhea (+9%), while significantly overestimating performance for fast breathing (+22%). Correspondingly, sensitivity and specificity for both methods were high for fever and diarrhea, with lower sensitivity for fast breathing.[14] Of note, in this study direct observation alone overestimated quality to a similar degree when compared with direct observation with reexamination. Another study in Ethiopia assessed record review compared to direct observation and reexamination (but not case scenarios), and reported a sensitivity of 84% for diarrhea and specificity of 69%; for pneumonia, sensitivity was high at 93% with exceedingly low specificity at 10%, while results for fever were not reported due to low case numbers.[15]

Based on these studies, it appears that record review and case scenarios somewhat overestimate quality of care but offer a reasonable approximation for management of fever/malaria and diarrhea; by comparison, they are less useful for fast breathing/pneumonia, perhaps because these methods fail to capture errors in respiratory rate measurement. Of note, both of these comparison studies evaluated iCCM care provided by full-time, salaried workers.

In this study, we sought to compare quality of iCCM care as measured by case scenarios versus record review in a different population of part-time, volunteer VHWs who provide care to patients in the home setting. We also hypothesized that VHWs with primary school education might demonstrate lower performance in the case scenarios compared with those who have completed some or all secondary school.

Materials and methods

This study took place in Bugoye, a rural subcounty in western Uganda. In this setting, all VHWs are selected by their community and serve as part-time volunteers. VHWs are required to have achieved basic literacy, with most having completed at least 7 years of primary schooling. They receive three days of initial general training, five days of initial iCCM training and half-day refresher training sessions quarterly that include material on iCCM care. These sessions also include training on performing a rapid diagnostic test for malaria (RDT). The program in Bugoye uses the 'SD BIOLINE Malaria Ag P.f/Pan' test kit. At the time of this study, VHWs had between one and four years of experience providing iCCM care. In Bugoye, VHWs provide iCCM care to children aged 2 months to 5 years, as well as completing wellness checks (but not home-based treatment) for younger infants. The exact details of iCCM implementation in Bugoye have changed slightly since national guidelines were published in 2010.[16] This VHW program also benefits from a strong monitoring and evaluation initiative based on a longstanding collaboration between Bugoye Health Center and Mbarara University of Science and Technology, including prior research on iCCM referrals and quality of iCCM care based on record review.[17,18]

For this study, two trained interviewers visited VHWs at their homes or another mutually convenient location and conducted the case scenarios exercise individually with each VHW between July 2017 and February 2018. VHWs viewed video cases depicting a caregiver of a sick child being interviewed, and were asked to describe all elements of their care plan based on the iCCM job aid. The interviewers also read aloud brief case vignettes portraying children with or without danger signs of severe illness, and asked VHWs to identify whether or not the child described in the vignette had danger signs. Additionally, VHWs completed exercises measuring their ability to perform and interpret rapid diagnostic tests for malaria, as well as a brief qualitative interview; these results will be reported separately. VHWs received a small incentive in recognition of the time required to participate.

Video cases were scored on completion of all steps in the clinical algorithm (including all recommended education topics and anticipatory guidance) and a subset of 'critical steps' required to achieve correct clinical management of the acute condition. For a patient with fever with negative RDT, critical steps included the decision to perform the RDT and a plan for referral or accompaniment to the health center after being informed of the negative test result. For a patient with presumed pneumonia without danger signs, critical steps included assessing respiratory rate, recognizing the respiratory rate as elevated and treating with the correct dose of amoxicillin. For a patient with diarrhea without danger signs, critical steps included giving adequate oral rehydration solution (ORS) immediately, giving ORS packets to take home, giving zinc and advising the caregiver to continue food and fluids. For a patient with fast breathing and danger signs, critical steps included recognizing the presence of danger signs and making a plan for referral or accompaniment to a health center (pre-referral treatment was not included as a critical step, as administration of oral amoxicillin could reasonably be considered unsafe in a child with significant respiratory distress as depicted in the case).

Data were entered into a customized REDCap database[19] and analyzed in Stata Version 15 (StataCorp, College Station, TX), with Wilcoxon rank sum tests used to assess the association between formal education and performance.

At the time of the case scenarios exercise, VHWs used paper records for each episode of iCCM care. VHWs submit these records monthly to program staff, who enter patient-level data into a clinical database. All iCCM visits completed in the same date range

Table 1. Village health worker demographics

Measure	% (n)
Female gender	53% (19)
Primary school education only	31% (11)
Age <40	44% (16)

as the case scenarios exercise were extracted from the larger database. Decision rules in Stata were used to assess whether the child had received correct care in each encounter (within the limits of the information available from the paper registers) and calculate disease-specific quality measures for diagnosis and treatment.

All VHWs provided written consent prior to completing the case scenarios exercise. Ethical approval for this study was granted by the Massachusetts General Hospital/Partners Healthcare IRB and the Research Ethics Committee at the Mbarara University of Science and Technology. All records used for this study were deidentified.

Results

At the time of the study, there were 36 VHWs in eight villages in Bugoye subcounty providing iCCM care; all 36 VHWs agreed to complete the case scenarios exercise. Of the 36 VHWs, 53% were women, 44% were younger than 40 years of age and 31% had completed primary school only while 69% had completed some or all of secondary school (Table 1).

During the same dates in July 2017 to February 2018 in which the case scenarios were completed, VHWs completed a total of 3126 clinical visits. Of the patients seen by VHWs during this period, 48% were female; 18% were aged 2–11 months, 36% 12–35 months and 45% 36–60 months; and 58% presented with fever, 42% with cough/fast breathing and 27% with diarrhea.[1] Additionally, 1.3% of patients were noted to have danger signs of severe illness, and 65% of patients received a rapid diagnostic test (RDT) for malaria; of the 2033 RDTs performed, 77% were positive (Table 2).

For patients presenting with fever, almost all received an RDT (100% in case scenarios, 97% in record review). In the record review data, 92% of patients with positive RDT for malaria received correct treatment with artemisinin combination therapy or rectal artesunate (there was not a positive RDT case in the case scenarios). There was a large discrepancy in referral of patients with negative RDT for malaria (100% in the case scenarios vs. 21% in the record review data); see Table 3. Of note, for the record review data this includes patients who are not recorded as presenting a fever but nonetheless received an RDT; patients presenting with fever who had a negative RDT were somewhat more likely to be referred (26% vs. 13% for those without fever, p=0.001 by Chi-squared test).

Table 2. Patient characteristics in record review dataset

Measure	% (n)
Total patient visits	100% (3126)
Female gender	48% (1503)
Age group[a]	
2–11 months	18% (567)
12–35 months	36% (1112)
36–60 months	45% (1406)
Presenting complaints[b]	
Fever	58% (1817)
Cough/fast breathing	42% (1326)
Diarrhea	27% (840)
Patients with danger signs	1.3% (41)
Patients receiving RDT for malaria[c]	65% (2033)
Positive RDTs	77% (1568)
Negative RDTs	23% (465)

[a]There were six patients younger than 2 months (and thus not eligible for iCCM care) also included in the dataset.
[b]Percentages add to >100%, as some patients presented with multiple complaints.
[c]More patients received an RDT than presented with fever because some children without fever incorrectly received an RDT (273 children without fever received an RDT, while 57 children with fever failed to receive an RDT).

For patients presenting with cough/fast breathing, almost all had a respiratory rate recorded (100% in case scenarios, 93% in record review data). Of those with elevated respiratory rate, most correctly received amoxicillin (100% in case scenarios, 87% in record review data); in the case scenarios, 97% received the correct age-based dose of amoxicillin, but only 5.6% received all appropriate education (Table 3; dosage administered is not available in the record review data).

For patients presenting with diarrhea, most correctly received oral rehydration solution (ORS) and zinc (100% in case scenarios, 90% in record review data). In the case scenarios, 92% received correct treatment and education about maintaining hydration and nutrition, but only 19% received education on all other recommended topics (Table 3).

Inappropriate use of medications was low overall in both the case scenarios and the record review data. In the case scenarios, 2.1% of patients received artemisinin combination therapy inappropriately, and no patients received amoxicillin, ORS or zinc inappropriately. In the record review data, 1.9% of patients received artemisinin combination therapy inappropriately, 4.4% received amoxicillin inappropriately and 1.3% received ORS or zinc inappropriately (Table 3).

Comparison of patients presenting with danger signs is limited by the small number of patients in the record review dataset with danger signs. For the specific situation of a patient with cough/fast breathing and danger signs included in the case scenarios, there were only four patients in the record review dataset. In the case scenarios, 92% of these patients were

[1] There were six patients younger than 2 months (and thus not eligible for home-based treatment in iCCM care) also included in the dataset. Percentages for presenting conditions add to > 100%, as some patients presented with multiple complaints.

Table 3. Quality of care measures from case scenarios and record review for uncomplicated illness and overall management

Measure	Case scenarios[a] % (n)	Record review[a] % (n)	Difference in percentages
Fever/malaria measures			
Malaria rapid diagnostic test (RDT) performed for patient presenting with fever	100% (36)	97% (1760)	+3%
Malaria patients (positive RDT) receiving correct treatment with artemisinin combination therapy or rectal artesunate	-	92% (1504)	-
Patients with negative RDT referred appropriately	100% (36)	21% (96)	+79%
Patients with negative RDT referred appropriately with appropriate caregiver education	100% (36)	-	-
Cough/fast breathing/pneumonia measures			
Respiratory rate recorded for patient presenting with cough/fast breathing	100% (36)	93% (1238)	+7%
Patients with presumed pneumonia (elevated respiratory rate) receiving amoxicillin	100% (36)	87% (1214)	+13%
Patients with presumed pneumonia receiving amoxicillin at correct dose	97% (35)	-	-
Patients with presumed pneumonia receiving amoxicillin at correct dose and all recommended education	5.6% (2)	-	-
Diarrhea measures			
Patients with diarrhea receiving ORS and zinc	100% (36)	90% (797)	+10%
Patients with diarrhea receiving ORS, zinc, and education on continuing food/fluids (all critical steps)[b]	92% (33)	-	-
Patients with diarrhea receiving all appropriate acute treatment and all recommended education	19% (7)	-	-
Inappropriate use of medications			
Patients inappropriately treated with ACT	2.1% (3)	1.9% (58)	+0.2%
Patients inappropriately treated with amoxicillin	0% (0)	4.4% (136)	−4.4%
Patients inappropriately treated with ORS, zinc or both	0% (0)	1.3% (41)	−1.3%
Inappropriate prescriptions (out of total prescriptions)	2.7% (3)	5.8% (268)	−3.1%
Overall measures			
Patients receiving overall correct management based on level of data available from record review	94% (136)	74% (2298)	+20%
Patients with all 'critical steps' completed in case scenarios[b]	94% (136)	-	-
Patients with all correct steps completed in case scenarios (including all recommended education)	45% (65)	-	-

[a]Dash indicates the measure was not available for this data source.
[b]Completion of all steps required to correctly treat the acute condition (does not include more general recommended education or anticipatory guidance).

appropriately referred, 86% received amoxicillin as pre-referral treatment, 78% received both amoxicillin and referral and 56% received all appropriate treatment including recommended caregiver education. In the record review data, of the four relevant patients, two received amoxicillin, two received appropriate referral and none received both. Of the 41 patients with any danger sign in the record review data, 81% were appropriately referred, 60% received appropriate pre-referral treatment and 49% received both (Table 4). VHWs correctly classified 82% of the brief danger signs case vignettes (Table 4).

Overall, 94% (95% CI: 0.91, 0.98) of patients in the case scenarios received appropriate management based on the level of data available in the record review dataset, compared with 74% (95% CI: 0.72, 0.75) in the record review dataset (Table 3). VHWs also completed all critical steps for 94% of patients in the case scenarios, but completed all steps including recommended education and anticipatory guidance for only 45% of patients (Table 3).

In the case scenarios, VHWs' level of formal education did not appear to be correlated with VHWs' performance. For overall score, the mean was slightly higher for the primary school group (27.8 vs. 27.5, $p = 0.66$), with a similar result for number of cases with critical steps completed (3.82 vs. 3.76, $p = 0.86$). For the number of brief danger signs case vignettes classified correctly, the primary school mean was slightly lower (7.18 vs. 7.48, p=0.45); see Table 5.

Table 4. Quality of care measures from case scenarios and record review for 'danger signs' patients

Measure	Case scenarios[a] % (n)	Record review % (n)	Difference in percentages
Patients with fast breathing and danger signs appropriately referred to health center	92% (33)	50% (2)	+42%
Patients with fast breathing and danger signs receiving amoxicillin[b]	86% (31)	50% (2)	+36%
Patients with fast breathing and danger signs receiving amoxicillin at correct dose[b]	81% (29)	-	-
Patients with fast breathing and danger signs receiving amoxicillin and referral to health center[c]	78% (28)	0% (0)	+78%
Patients with fast breathing and danger signs receiving all appropriate treatment, referral and caregiver education	56% (20)	-	-
Patients with any danger sign appropriately referred to health center[c]	-	81% (35)	-
Patients with any danger sign receiving appropriate pre-referral treatment[c]	-	60% (26)	-
Patients with any danger sign appropriately referred and receiving appropriate pre-referral treatment[c]	-	49% (21)	-
Correct identification of presence/absence of danger signs in brief case vignettes	82% (266)	-	-

[a]All measures refer to the video case scenarios except where brief danger signs case vignettes are specifically mentioned.
[b]The case scenario depicts a child with significant respiratory distress, so while administration of oral amoxicillin is correct according to the clinical algorithm used in this program, the VHW could also have reasonably decided that administration of an oral medication was unsafe.
[c]Due to limited data available from clinical records, we could not assess the correctness of dose administered for the record review data.

Table 5. Village health worker performance in case scenarios and education level

	Primary school only			Some or all secondary school			
Measure	Median	Mean	SE	Median	Mean	SE	p-value[a]
Overall score for video cases (total of 32 correct steps to complete for four cases)	28	27.8	0.63	28	27.5	0.47	0.66
Number of cases with critical steps completed (out of four)	4	3.82	0.12	4	3.76	0.10	0.86
Number of brief danger signs case vignettes correctly classified (out of nine)	7	7.18	0.35	8	7.48	0.26	0.45

[a]By Wilcoxon rank sum test.

Discussion

While the magnitude of the difference varied, the case scenarios consistently produced higher estimations of quality of care compared with record review. Perhaps the most striking discrepancy is for referral of patients with a negative RDT for malaria to the health center (100% vs 21%). In this study we compared case scenarios to record review but not to direct observation or reexamination of patients, which may mean that the cases scenarios overestimate quality to an even larger extent than our results suggest. Thus, this study offers additional evidence that case scenarios may not be a reliable means of monitoring quality of care in iCCM programs.

There are a number of potential explanations for the discrepancies between estimates from case scenarios and record review. First, VHWs may find it easier to recognize the necessary clinical information in a video case vignette, rather than having to obtain that information in their clinical interview. Second, the Hawthorne effect may play a role—i.e. VHWs may pay particular attention to following the algorithm during an observed exercise. Alternatively, in their actual practice VHWs may choose not to follow the algorithm due to personal beliefs or community preference—e.g. VHWs may know that the algorithm requires referral for fever with negative RDT, and thus provide this answer during an assessment, but may feel that these referrals are

unwarranted in their actual practice. Third, for record review we can only assess quality of recorded care rather than quality of actual care. Record-keeping errors may decrease quality of recorded care; conversely, recorded care may overestimate actual quality (e.g. if a VHW measures a respiratory rate incorrectly or reads an RDT for malaria incorrectly these errors will not be captured). In prior studies, record review overestimated quality of care compared with direct observation with reexamination—though it is worth remembering that prior comparison studies assessed full-time, salaried VHWs who may be more practiced at record-keeping.[14,15]

The case scenarios also demonstrated that VHWs in this program often omitted recommended health education topics in these mock encounters. Further training may help to reinforce VHWs' core role as community health educators.

We were concerned that measuring VHWs' performance using case scenarios might partially measure level of formal education rather than actual performance in providing iCCM care. Performance in the case scenarios did not appear to be related to education level, though the importance of this finding is limited by the case scenarios' likely overestimation of quality of care.

This study has a number of limitations. First, and most significantly, it lacks a 'gold standard' measure of quality of care. In prior studies, direct observation with reexamination of patients by a trained clinician or researcher functioned as the gold standard—though it is worth noting that this approach is equally susceptible to the Hawthorne effect. Additionally, direct observation alone, as is used in some studies, also appears to overestimate quality of care.[14] Second, the case scenarios were conducted in pre-arranged sessions in which VHWs were aware that they were being observed and likely knew the interviewers, all of which may have affected their performance. Third, for the record review data, VHWs record a limited amount of clinical information, which means certain errors cannot be assessed, and may function to overestimate actual quality of care. Fourth, the record review portion uses routine clinical data that have not been double-entered and likely contain some data entry errors. Fifth, given time constraints, the case scenarios used in this study did not include all relevant categories of patients. Sixth, this study assesses a fairly small number of VHWs in a single geographic area.

Conclusions

While not definitive, this study calls into question the use of case scenarios to measure quality of iCCM care. As implemented here, case scenarios appear to overestimate quality of care substantially in comparison to record review (which itself may somewhat overestimate quality of care). Though record review has its own limitations, for the purposes of long-term monitoring and evaluation where ongoing direct observation of VHWs with reexamination of patients is not feasible, record review may be a preferable approach. For programs that choose to use case scenarios, perhaps as part of training sessions, performance on video case scenarios and brief oral case vignettes did not appear to be associated with level of formal education.

List of abbreviations

iCCM	Integrated Community Case Management
ORS	Oral rehydration solution
RDT	Rapid diagnostic test
REDCap	Research Electronic Data Capture
VHW	Village health worker

Authors' contributions: JSM, EMM, MN, JK and GSS conceived and designed the study. RKM, SB, PP, MM, ACW, NM, DG, SB, SMM, JK and JSM contributed to data collection. JSM led data analysis and primarily drafted the initial version of the manuscript. All authors contributed to manuscript drafting and approved the submitted version of the manuscript. JSM and GSS are guarantors of the paper.

Acknowledgements: We are grateful to all the village health workers for volunteering their time both for this study and, more importantly, to care for their communities. We also thank Sarah Masika for her work in administering the village health worker program in Bugoye.

Funding: This work was supported by the Mooney-Reed Charitable Foundation; Massachusetts General Hospital Department of Medicine [trainee research funding to JSM]; Doris Duke Charitable Foundation [trainee research funding to JSM]; and Harvard Medical School Center for Primary Care [trainee research funding to JSM].

Competing interests: The authors declare that they have no competing interests.

Ethical approval: All village health workers provided written consent prior to participation in the case scenarios. Caregivers were not consented for the record review portion as this involved only fully deidentified records of care received. Ethical approval was granted by the Massachusetts General Hospital/Partners Healthcare Institutional Review Board and Research Ethics Committee at the Mbarara University of Science and Technology.

Data availability: The data used for this article will be shared on reasonable request to the corresponding author.

References

1 Smith Paintain L, Willey B, Kedenge S, et al. Community health workers and stand-alone or integrated case management of malaria: a systematic literature review. Am J Trop Med Hyg. 2014;91:461–70.

2 Sinyangwe C, Graham K, Nicholas S, et al. Assessing the quality of care for pneumonia in integrated community case management: a cross-sectional mixed methods study. PloS One. 2016;11:e0152204.

3 Baynes C, Mboya D, Likasi S, et al. Quality of sick Child-Care delivered by community health workers in Tanzania. Int J Health Policy Manag. 2018;7:1097–109.

4 Langston A, Wittcoff A, Ngoy P, et al. Testing a simplified tool and training package to improve integrated Community Case Management in Tanganyika Province, Democratic Republic of Congo: a quasi-experimental study. J Glob Health. 2019;9:010810.

5 Boyce SP, Nyangara F, Kamunyori J. A mixed-methods quasi-experimental evaluation of a mobile health application and quality of care in the integrated community case management program in Malawi. J Glob Health. 2019;9:010811.

6 Munos M, Guiella G, Roberton T, et al. Independent evaluation of the rapid scale-up program to reduce under-five mortality in Burkina Faso. Am J Trop Med Hyg. 2016;94:584–94.

7 Zakus D, Moussa M, Ezechiel M, et al. Clinical evaluation of the use of an mhealth intervention on quality of care provided by Community Health Workers in southwest Niger. J Glob Health. 2019;9:010812.

8 Graham K, Sinyangwe C, Nicholas S, et al. Rational use of antibiotics by community health workers and caregivers for children with suspected pneumonia in Zambia: a cross-sectional mixed methods study. BMC Public Health. 2016;16:897.

9 Aftab W, Rabbani F, Sangrasi K, et al. Improving community health worker performance through supportive supervision: a randomised controlled implementation trial in Pakistan. Acta Paediatr Oslo Nor. 1992 2018;107(Suppl 471):63–71.

10 Mukanga D, Babirye R, Peterson S, et al. Can lay community health workers be trained to use diagnostics to distinguish and treat malaria and pneumonia in children? Lessons from rural Uganda. Trop Med Int Health. 2011;16:1234–42.

11 Awor P, Wamani H, Tylleskar T, et al. Drug seller adherence to clinical protocols with integrated management of malaria, pneumonia and diarrhoea at drug shops in Uganda. Malar J. 2015;14:277.

12 Soremekun S, Kasteng F, Lingam R, et al. Variation in the quality and out-of-pocket cost of treatment for childhood malaria, diarrhoea, and pneumonia: community and facility based care in rural Uganda. PloS One. 2018;13:e0200543.

13 Kalyango JN, Rutebemberwa E, Alfven T, et al. Performance of community health workers under integrated community case management of childhood illnesses in eastern Uganda. Malar J. 2012;11:282.

14 Cardemil CV, Gilroy KE, Callaghan-Koru JA, et al. Comparison of methods for assessing quality of care for community case management of sick children: an application with community health workers in Malawi. Am J Trop Med Hyg. 2012;87:127–36.

15 Miller NP, Amouzou A, Hazel E, et al. Assessing the quality of sick child care provided by community health workers. PloS One. 2015;10:e0142010.

16 The Republic of Uganda Ministry of Health. Integrated Community Case Management of Childhood Malaria, Pneumonia and Diarrhoea: Implementation Guidelines. 2010.

17 English L, Miller JS, Mbusa R, et al. Monitoring iCCM referral systems: Bugoye Integrated Community Case Management Initiative (BIMI) in Uganda. Malar J. 2016;15:247.

18 Miller JS, English L, Matte M, et al. Quality of care in integrated community case management services in Bugoye, Uganda: a retrospective observational study. Malar J. 2018;17:99.

19 Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42:377–81.