Treatment Costs for Community-Based Management of Malaria and Pneumonia Versus Malaria Alone in Children Aged 4-59 Months in Eastern Uganda.

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Abstract

An integrated home and community-based management for both malaria and pneumonia using community medicine distributors (CMDs) has been piloted in Uganda since 2010. However, little is known about the treatment cost for combined treatment compared to malaria treatment alone. This paper addresses this gap using data from a randomised controlled trial in Iganga and Mayuge districts in Eastern Uganda.

A total of 66 CMDs, 30 from the treatment (malaria and pneumonia) and 36 in control group (malaria alone) were interviewed to obtain data on the time spent treating children and the numbers treated per week. Using another tool, 470 caretakers were interviewed on the costs incurred in seeking treatment from CMDs. The direct costs of the intervention were extracted from the programme documents and the cost per case treated for the two arms were compared.

The cost per child treated in the treatment group was 1.6 times higher (US$ 7.65) compared to the control group (US$4.85). However, indirect unit costs per child treated were about the same for the treatment (US$2.20) and control group (US$ 2.13)(P=0.704). The incidence of severe pneumonia was about 3 times lower in the treatment compared to the control areas in the post-intervention period (1.3% versus 4.6%). Likewise, the incidence of severe malaria was lower within the treatment group (2.8%) compared to the control (8.3%). Compared with 'doing nothing' villages within the DSS where there was either malaria-pneumonia combined treatment or malaria treatment alone reported a lower incidence of both severe malaria (4.4%) and severe pneumonia (2%) than those where there was no treatment at all (17% and 22.7% respectively).

Although the direct costs for the combined treatment approach was found to be higher than malaria treatment alone, , overall it is a cost-minimising strategy compared to 'stand alone' vertical intervention after adjusting for indirect costs. The malaria-pneumonia combined treatment also resulted in greater health impact in terms of reducing severe pneumonia and malaria. Similarly, community-based treatment for febrile illness, whether combine or stand alone approach, significantly reduced the incidence of severe malaria and pneumonia. Thus,

community-based combined treatment of febrile illness is a cheaper strategy compared to stand-alone interventions and also is shown to result in greater health impacts and should be promoted. Given the fairly high indirect costs, in terms of time, borne by the CMDs for which they are not adequately compensated, other desirable considerations for scaling up new interventions such as equity and sustainability should also be assessed.

Keywords: Treatment Cost, Community-based Management, Malaria, Pneumonia.

Introduction

Malaria remains one of the leading causes of childhood morbidity and mortality in most sub-Saharan African countries, which account for nearly 90 percent of malaria death globally and children below 5 years accounting for 75% of all deaths [1]. This is despite recent progress made towards achieving the target for the Millennium Development Goal 6 globally – to reduce malaria burden by 75% by 2015 [1]. In Uganda, malaria-related morbidity accounts for 36 percent of total outpatient visits for all ages, and about 20 percent of hospitalisation for children aged five years and below (under5s) [2,3]. Much effort is currently directed towards community and home-based management of malaria to increase access to effective malaria treatments, particularly among low income settings with limited formal healthcare facilities [4].

Pneumonia-related illnesses such as cough or cold are reported to account for 19 percent of cases although confirmed cases of pneumonia are much lower at 2 percent [2]. Studies have shown that there is considerable overlap between the symptoms of malaria and pneumonia among infants [3, 5]. In Nigeria, a study of malaria-pneumonia overlap among children showed that 23% of children enrolled in the study presented with symptoms of both malaria and pneumonia case definition [5]. Another study of childhood illness at 14 health centres in Uganda showed that of 3671 under-5s, 30 percent had symptoms compatible both with malaria and pneumonia, and of the 2944 malaria cases, 37 percent also had pneumonia [3]. Despite this level of co-morbidity, the ministry of health 2009 report shows that only 46 percent of children below five years with pneumonia receive appropriate antibiotic treatment, against the 80 percent target of the Health Sector Strategic Plan II HSSP2 for Uganda [6].

Given the overlap in presentation of symptoms between malaria and pneumonia in children, an integrated approach for presumptive treatment of both illnesses becomes plausibly justifiable [4].

Home-based and Community case management (HCCM) of malaria and pneumonia have both been shown to significantly reduce under-five mortality [7-10], and are recommended by the WHO [6, 11–12]. Since mid 2010 Uganda has adopted a national policy on integrated community case management (ICCM) for malaria, pneumonia and diarrhoea [2]. As well as impacting on the health of individuals, morbidity due to malaria and pneumonia imposes considerable costs on households [13–18] communities [19, 20] and hampers a country's economic development [21–23]. According to the malaria fact sheet [24, 25], sub-Saharan Africa incurs a cost of 35.4 million USD per Disability Adjusted Life Years (DALYS) averted per year. Therefore, cost-effective control measures to reduce the burden of illness due to malaria and pneumonia are a priority from both public health and economic perspectives. However, there is limited evidence on the treatment costs of the home-based and community-based combined treatment of pneumonia and malaria compared to stand alone vertical interventions despite being adopted as policy in Uganda since mid 2010. This study addresses this gap in knowledge.

Methods

Study setting

This study was conducted within the Demographic Surveillance Site (DSS) covering Iganga and Mayuge districts in Eastern Uganda. The DSS covers 7 sub-counties, 18 parishes and 65 villages, with an estimated population of about 67,000 people, 16% of which are below five years of age. [26] The main economic activity in both districts is subsistence farming with communities living near the water bodies largely involved in fishing, while those in urban areas are engaged in trade of merchandise and agricultural products in shops and community markets. About 90% of the DSS catchment area is rural.

Formal healthcare providers in the DSS catchment area include one main hospital (Iganga Hospital),

one HC-IV, 4 health centre-IIIs and 11 HC-IIs. The DSS covers 65 villages each with 2-3 Community Medicine Distributors (CMDs). CMDs are members of the community who are selected by the community (mostly based on their high standing and willingness to participate) and given basic training in management of febrile illness under the ICCM framework. In addition to the formal health care providers, there are a number of private providers: clinics, drug shops and medicine vendors who sell antimalarials and antibiotics for malaria and pneumonia treatment respectively. Within the DSS, malaria is endemic and stable with very high transmission rates. The standard treatment for malaria by the formal health care providers and CMDs is Artemether Lumefantrine and Amoxycillin antibiotics for pneumonia.

Study design

This paper is based on a randomised controlled trial of home and community-based combined treatment of malaria and pneumonia and malaria alone in children aged 4-59 months conducted in the Iganga-Mayuge Demographic sentinel site (DSS), Eastern Uganda conducted between December 2009 and August 2011. Within the trial sites, CMDs were randomised into those distributing both Artmether Lumefantrine (AL) and Amoxycillin (the treatment group) and those distributing AL alone (the control group). Treatment by CMDs was done asymptomatically. In case a child in the control group presented with symptoms of pneumonia or other respiratory tract infections (RTI), CMDs would refer the child to a formal health facility. In addition, severe cases of malaria in each group would be referred to formal health facilities. CMDs in the treatment group were given watches to help in detecting possible pneumonia based on the breathing rate of the child. If the breathing rate did not suggest presence of pneumonia, then the child would only receive an antimalaria. The intervention covered a total of 65 villages of which 30 villages were randomised to the treatment group and 35 villages to the control group. Each of the 65 villages had 2 CMDs, with the exception of one village with 3 CMDs. The randomisation was such that if a village is randomised to a given study group (treatment or control), then both CMDs belonged to that same group. Drug packages were procured by the researchers and distributed to CMDs during their monthly training meetings. A health worker (a nurse or nursing assistant) from the nearby health facility supervised the CMDs periodically. Prevalence rates for severe malaria and severe pneumonia were then compared between the control and treatment groups (25). This paper however mainly focuses on the treatment-related costs for the two groups.

Sampling

Sampling was done in three stages. In the first stage, public health centres were stratified into rural and urban areas. At the second stage, all the 4 health centres in the urban were selected and 4 out of the 10 health centres in the rural areas were randomly selected. Lastly, three villages within the health centres' catchment area were randomly selected from the treatment and/or the control group. Since the trial randomisation was done at village level, some of the villages within the catchment area of a given health facility could be in the treatment group while others in the control. In total, 16 villages were selected from the treatment group and 18 villages from the control. All the CMDs in the selected villages were included in the sample. One village in the experiment group had 3 CMDs while 2 CMDs sampled in the control group were not available. The sample represents 51% and 53% of all the CMDs from the treatment and control groups respectively.

For caretakers, 5-10 caretakers that had visited a sampled CMD in the last two months were selected at random from the CMD registers. Both CMDs and caretakers were interviewed from their homes. In total, 66 CMDs (30 from the treatment group and 36 from the control group) and 470 caretakers were interviewed.

Data collection

Data were collected from two types of sources: internal programme documents and interviews with CMDs and caretakers. Interviews were conducted in local languages common in the study areas (Luganda and Lusoga). Data collection, both secondary data and primary interviews was done between January and March 2012. Data on direct costs of the intervention were extracted from the programme documents. Cost data were collected in Uganda shillings and converted to US dollars (at 1US$ to 2400/= UGX). The data collected from CMDs included: the number of children treated per week and the time cost of CMDs while distributing medicines and in some cases following up children at their homes 2-3 days after treatment. Caretakers provided information on the financial costs incurred and time spent seeking care from the CMDs.

Data management and analysis

Data from the CMD interviews and caretaker interviews were entered in Epi-data database and analysed using STATA version 12. Secondary data

and computations of direct costs of the intervention were done in Microsoft Excel.

Direct financial costs included: personnel allowances, training costs, transport costs, IEC materials costs, drug costs, program management costs, and capital costs. Economic costs included the opportunity cost of time for CMDs. Time costs of CMDs relate to the value of time spent while providing treatment (examining the child and administering drugs) and following up treated children within the community, as some CMDs reported to have done so. Caretaker time costs, (travel time to and from the CMDs) were very negligible and were not considered in the analysis. All non-recurrent costs, (except buildings) were annualised at 7% annuity rate, while for the case of buildings, the rental value of office and store space was estimated based on on-going rental rates in Iganga town. Time costs of CMDs were estimated using their reported total time spent on treatment and follow up and an assumed daily wage of 7000 Uganda shillings (about US$ 2.90); which is equivalent to the average casual worker or agricultural plantation worker rate in the study areas. The primary outcome of the analysis was the cost per case treated.

Health outcomes for each study arm were derived from separate studies on efficacy of the treatment and control arms, i.e. incidence of morbidity and severity of malaria, pneumonia and anaemia among children below five years in each study group. In the efficacy studies, a team of health workers made up of medical doctors and senior nursing officers was used to screen and abstract all available records which met the inclusion criteria for severe malaria, severe pneumonia and severe anemia using WHO classification. The abstracted records were for the period January 2007 to August 2011 at 14 health facilities in the DSS.

Records were reviewed for all the 7 admitting health facilities serving the study villages in the HDSS. These included one hospital, one health centre (HC) IV, four HC IIIs, and one HC II. Records dated before December 2009 were categorized as incidence of severe morbidity before intervention with study drugs began, while records from December 2009 up to August 2011 were categorized as severe morbidity incidence post-intervention. Severe malaria was expressed as the proportion of all cases of severe malaria presenting in a health facility over the total number of children suffering from both severe and non-severe malaria in the specified category. Likewise, severe pneumonia was expressed as a proportion of all cases of severe pneumonia presenting in the health facility over the sum of all children presenting with severe pneumonia, non-severe pneumonia and upper respiratory tract infections. Based on the number of children treated, the cost per case treated was computed for each group. Standard t - tests were performed to test for statistical difference in means of variables.

Results

Socio-demographic characteristics of CMDs

Table1 describes the socio-demographic characteristics of the CMDs included in the sample.

Table 1: Socio-demographic characteristics of CMDs respondents

Characteristic	All CMDs combined Freq (%)	Treatment group Freq (%)	Control group Freq (%)	p-value
Location				
Urban	31 (47)	14 (46.7)	17 (47.2)	
Rural	35 (53)	16 (53.3)	19 (52.8)	0.964
Gender				
Female	45 (68.2)	24 (80)	21 (58.3)	0.060
Marital status				
Married	50 (75.8)	24 (80)	26 (72.2)	
Widow	6 (9.1)	2 (6.7)	4 (11.1)	
Never married	5 (7.6)	2 (6.7)	3 (8.3)	
Divorced/separated	5 (7.6)	2 (6.7)	3 (8.3)	0.961
Education				
Primary	9 (13.6)	3 (10)	6 (16.7)	
Secondary	46 (69.7)	19 (63.3)	27 (75)	

Post-secondary	11 (16.7)	8 (26.7)	3 (8.3)	0.251
Occupation				
Farmer	29 (43.9)	6 (20)	23 (63.9)	
Business	24 (36.4)	14 (46.7)	10 (27.8)	
Employed	4 (6.1)	3 (10)	1 (2.8)	
self-employed	1 (1.5)	1 (3.3)	0 (0.0)	
Unemployed	8 (12.1)	6 (20)	2 (5.6)	0.002
Mean age (SD) in Years	41.6 (10.09)	42.2 (10.16)	41.1 (10.16)	0.676

Source: *Own computations using field survey data*

Majority of the CMDs were female, married, and a large number of them engaged in farming activities and had secondary education and above. Except for occupation, there was no statistically significant relationship between the CMD being in the control or treatment arm and the other socio-demographic characteristics.

Financial and Economic costs of the intervention

Table 2 shows estimated financial and economic costs per child for the treatment and control group. Costs include both recurrent and capital costs. The estimates for recurrent costs are for a period of one year (2010). The number of children treated under the intervention group was 12031 and 12737 in the control group.

Table 2: Total Direct unit cost for Intervention and Control

Cost Category	**Intervention**				**Control**			
	Financial Cost		**Economic Costs**		**Financial Cost**		**Economic Costs**	
	UGX	**USD**	**UGX**	**USD**	**UGX**	**USD**	**UGX**	**USD**
Recurrent Costs								
Personnel	726.74	0.30			726.74	0.30		
Malaria drugs	1652.40	0.69			1652.40	0.69		
Antibiotics for pneumonia	6806.40	2.84						
Other Drug-related costs, repackaging	1097.46	0.46			1147.00	0.48		
Other Drug-related costs	205.13	0.09			205.13	0.09		
Material & supplies	168.40	0.07			168.40	0.07		
Training Costs for CMDs	1267.89	0.53			1469.62	0.61		
Training Costs for HWs	336.36	0.14			336.36	0.14		
Other trainings	0.00	0.00			0.00	0.00		
Equipment & supplies	347.46	0.14			347.46	0.14		
Equipment operating cost	0.00	0.00			0.00	0.00		
Overheads	64.00	0.03			64.00	0.03		
Sub-total	12672.25	5.28			6117.12	2.55		
Capital Costs								
Building (Rent)	20.19	0.01	96.90	0.04	20.19	0.01	153.87	0.06
Equipment	115.82	0.05			115.82	0.05		
Transport	232.15	0.10			232.15	0.10		
Other capital costs	47.32	0.02	13.32	0.01	47.32	0.02	9.39	0.00
Sub-total	415.48	0.17	110.22	0.05	415.48	0.17	163.26	0.07
Total Unit Cost	**13087.74**	**5.45**	**110.22**	**0.05**	**6532.61**	**2.72**	**163.26**	**0.07**

Source: *HCMM&P Program documents (The average exchange rate USD: UGX=1: 2400)*

Table 2 shows that the direct financial unit costs in the treatment arm were 2 times higher than in the control. This difference is largely due to the higher cost of antibiotics compared to antimalarials. Antibiotics alone account for over 50% ($2.84/$5.45) of the total cost for the treatment arm.

The cost of antibiotics, in fact more than covers the total unit cost of the control arm. Another noticeable difference between the treatment and the control arm is the training costs of CMDs. The unit cost of training CMDs was slightly higher in the control than for the treatment group. However, the reasons for this divergence could not easily be established.

Table 3 shows the average time spent in treatment and follow-up and the corresponding imputed value of CMDs time.

Table 3: Indirect costs of CMDS for the intervention

Time and monetary cost	Overall (N=66)		Intervention (N=30)		Control (N=36)		
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	P=value
Treatment time (minutes)	22.5 (13.7)	20 (20)	24.7 (12.8)	30 (15)	20.6 (14.3)	15 (20)	0.096
Follow-up time (minutes)	28.4 (39.7)	14 (25)	27.1 (41.4)	12.5 (25)	29.6 (38.8)	16.5 (25)	0.933
Total time spent per child (minutes)	50.9 (43.0)	40 (30)	51.8 (45.4)	40 (25)	50.1 (41.6)	40 (32.5)	0.713
Children treated per CMD per week	6.7 (3.9)	5 (5)	6.8 (4.3)	5.5 (4)	6.5 (3.7)	5 (5)	0.912
Total time spent per week (minutes)	336.9 (318.5)	240 (280)	368.3 (358.5)	270.5 (360)	310.8 (283.5)	205 (212.5)	0.558
Value of CMDs' time per week (UGX)	34,393 (32,516)	24,500 (28,583)	37,597 (36,598)	27614 (36,750)	31,722(28,941)	20,927(21,693)	0.558
Indirect cost per child (UGX)	5,194 (4,394)	4,083(3,063)	5,288 (4,633)	4,083 (2,552)	5,115 (4,250)	4,083 (3,318)	0.704
Indirect Cost per child (USD)	2.16 (1.83)	1.70 (1.28)	2.20 (1.93)	1.70 (1.06)	2.13 (1.77)	1.70 (1.38)	0.704

Source: *Authors' computations using field survey data (Note: IQR is inter-quartile range and SD is standard deviation. p=values compare statistical differences between outcomes for intervention and control groups)*

The estimates in Table 3 show that overall, CMDs spent an average of 23 minutes providing treatment – that is examination and administering the first dose and explaining dosage instructions to the caretaker. A few CMDs reported that they spent some time observing how children reacted to the first dose before discharging the child. CMDs in the control group were spending an average of 20 minutes to treat a child compared 24 minutes for those in the treatment group. By and large there were no significant differences in the time spent providing medication between the two groups (p =0.096). In terms of time cost, both groups spent about the same time and on average were treating the same number of children per week – suggesting that there are no significant differences in time spent for treatment between the intervention and control groups (p = 0.704). Our estimates show that on average, the value of CMDs' time spent on treatment in the intervention group is $15.67 per week as compared to $13.22 for those in the control group[1]. Likewise, there is no significant difference between the indirect cost per child treated for the two groups (US$2.20 in intervention group vs US$2.13 in control: p-value = 0.704). Table 4 shows summary of costs for the treatment and control group.

[1] The cost incurred by CMDs is comparable to the poverty line of US$ 1 per day and therefore significant for rural households.

Table 4: Summary cost for the intervention and control

Summary costs	Intervention			Control			p-value
	UGX	US$	%age	UGX	US$	%age	
Direct cost per child	13,088.00	5.45	71%	6,532.61	2.72	56%	0.002
Indirect cost per child	5,288.00	2.2	29%	5,115.51	2.13	44%	0.704
Total economic cost per child	18,376.00	7.65	100%	11,648.12	4.85	100%	0.023

***Source**: Own computations using field survey data*

Overall, the economic cost of treatment per child was significantly higher in the treatment group compared to the control group. The difference is largely due to the direct costs – mainly the cost of drugs. From a cost perspective, the combined treatment for malaria and pneumonia costs US$2.80 more than for malaria treatment only, of which US$ 2.73 (97.5%) extra cost per child were direct costs. There was however no significant difference in average indirect costs between the two groups (p=0.704). The indirect costs suggest that if CMDs were to treat malaria and pneumonia separately, the total indirect cost for stand-alone interventions would be about US$2 higher than the combined treatment.

Health outcome of the treatment and control arms

Table 5 below shows a summary of the health outcomes.

Table 5: Health facility incidence of severe malaria, and severe pneumonia

Health outcome	Pre-intervention	Post-intervention
Severe Malaria		
Intervention arm alone	436/13616 (3.2%)	444/16015 (2.8%).
Control arm alone	507/7154 (7.1%)	555/6659 (8.3%)
All Non-study villages	2759/17306 (15.9%)	2929/17238 (17%)
All study villages	943/20770 (4.5%)	999/22674 (4.4%)
Severe Pneumonia		
Intervention arm alone	18/1603 (1.1%)	29/2189 (1.3%).
Control arm alone	14/620 (2.3%)	24/525 (4.6%).
All Non-study villages:	83/702 (11.8%)	143/644 (22.7%)
All study villages	32/2223 (1.4%)	53/2714 (2%)

***Source:** HCMM&P program documents (Morbidity survey 2010-2011)*

The results of the morbidity study show that the post-intervention incidence of severe pneumonia was marginally lower in the treatment arm compared to the control arm. There was only a 3.3 percentage point difference in the incidence of severe pneumonia between the treatment and the control group post-intervention. The incidence of severe pneumonia was about 3 times lower in the treatment compared to the control areas in the post-intervention period (1.3% versus 4.6%). Likewise, severe malaria incidence was lower within the treatment group (2.8%) than in the control (8.3%). Compared with 'doing nothing' villages within the DSS where there was either combined or malaria treatment alone reported a lower incidence of both severe malaria (4.4%) and severe pneumonia (2%) than those where there was no treatment at all (17% and 22.7% respectively). The results show a 12.4% point fewer children presenting with severe malaria from intervention villages compared to control after the intervention. Similarly the incidence of severe pneumonia was 20% points lower in the intervention group compared to the control group, post- intervention. These findings suggest that, compared to 'doing nothing', the intervention reduced the incidence of malaria and pneumonia overall.

Thus, the findings of this paper show that the combined treatment of malaria and pneumonia at the community level is cost minimising comapred to stand alone interventions and results in health impacts in form of lower incidence of severe malaria and pneumonia.

Discussion

This paper assesses the treatment costs for the home and community-based combined treatment of malaria and pneumonia versus malaria alone among children 0- 59 months using data from a

randomised controlled trial undertaken in the Iganga-Mayuge DSS in Eastern Uganda. The morbidity studies conducted to evaluate the effectiveness of the intervention showed that the incidence of severe pneumonia and malaria were lower in the treatment compared to the control group in the post-intervention period. The morbidity studies were based on cases reporting to formal health facilities within the study areas and therefore are likely to have underestimated the effects of the intervention.[2] These results suggest that the community-based combined treatment of malaria and pneumonia result into significant health impact. Similarly, the incidence of severe malaria and severe pneumonia were lower in those villages within the DSS where there was either malaria treatment alone or combined treatment than those without any form of treatment. Thus, , compared to 'doing nothing' both the control and treatment arms, led to significantly better health outcomes - a reduction in incidence of severe malaria and pneumonia. These results compare with those from a study in India on community-based management of pneumonia by traditional birth attendants which reported that case fatality rates were only 0.8% among the intervention group compared to 13% in the control [27].

From a cost perspective, the direct cost per case treated in the treatment group was significantly higher than in the control. However, the indirect unit cost per case for the treatment group (combined treatment of malaria and pneumonia) and the control group (malaria alone) were similar (about US$2) per child. This result suggests that if CMDs were to treat malaria and pneumonia separately, the total indirect cost (largely time cost) would be US$2 higher than the combined treatment. In essence, the combined treatment is cheaper than stand-alone vertical health interventions.

While home management of febrile illnesses and malaria is a common approach which has been promoted in Uganda since the early 2000s [29], combined treatment of malaria and pneumonia is a relatively new approach for which there has been limited evidence on treatment costs to the provider. This study reveals that community-based combined treatment of malaria and pneumonia is cheaper than stand-alone interventions and also results in lower incidence of severe cases among children. Furthermore, it confirms that community-based interventions are effective in reducing severe cases of malaria and pneumonia among infants.

[2] Health care seeking at formal health facilities in rural areas remain below 40% [28]

Study limitations

The findings of this study should be assessed within the context of the morbidity studies and the way CMDs operate. The health outcomes were assessed based on a morbidity survey which considered confirmed cases of severe illnesses presenting at health facilities. Thus those who did not seek care from the health facilities (and those who received care from outside the study areas) were not accounted for. Secondly, time cost of CMDs was computed based on reported time spent in administering treatment, which is more subjective and prone to biases than when time and motion methodology is used to record actual time spent on treatment activities. However, reliance on reported time by the CMDs could not have significantly affected the cost estimates given the generally low opportunity cost of CMDs who are largely involved in subsistence production. Nonetheless, the value of CMDs' time spent per week on treatment of about US$ per day is relatively high when compared to the International poverty line of US$1.2 per day. This implies if the CMDs were fully compensated for their time, that payment would be enough to keep them above the poverty line. For CMDs to commit this amount of time to treatment is therefore a significant sacrifice on their part.

Conclusion

The results of this study show that the direct cost of treatment was higher for the community-based combined treatment of malaria and pneumonia compared to malaria alone by CMDs, but the indirect costs were very similar. Overall, , the combined treatment is cheaper than stand-alone treatment of malaria and pneumonia.

The proportion of severe malaria and severe pneumonia cases were lower within the treatment group compared to the control. Similarly, the incidence of severe malaria and severe pneumonia were lower in those villages within the DSS implementing either malaria treatment alone or combined treatment than those without any form of treatment.

The findings of this study suggest that compared to stand-alone vertical interventions, the combined treatment of malaria and pneumonia is cost-minimising, and does result in significant health impact in reducing severe pneumonia. Thus the study reflects benefits of combined treatment of pneumonia and malaria at the community level. It also highlights the generally high indirect costs incurred by CMDs and community health workers

generally in implementing community-based health interventions for which community health workers are usually not compensated appropriately. Thus the community-based combined treatment of malaria and pneumonia among children is a cost-minimising strategy and leads to greater health impacts and therefore is a viable approach for resource-poor settings where access to formal health facilities remain a big constraint.

Ethical Approval

Ethical approval for the main randomised trial (trial registration number ISRCTN52966230) of which this analysis is part was sought from Makerere University School of Public Health Higher degrees Research and Ethics committee Board and from the Uganda National Council for Science and Technology (HS 72). Permission to conduct the surveys was obtained from the Iganga and Mayuge District Health Offices. Verbal informed consent was obtained from each CMD and caretakers interviewed.

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