Linking distribution of insecticide-treated nets to a measles vaccination campaign achieves high, equitable and rapid coverage at low cost

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Objectives: In order to achieve high and equitable coverage with ITNs, we integrated ITN distribution into a measles vaccination campaign.

Methods: In December, 2002, in Lawra District in Ghana, a measles campaign targeted all children 9 months to 15 years of age and lasted one week. Families with one or more children under five years of age were targeted to receive a free ITN. The Ghana Health Service, with support from the Ghana Red Cross and UNICEF, provided logistical support, volunteer workers and social mobilization during the campaign. Volunteers visited homes to inform caretakers and encourage them to attend the campaign. We assessed pre-campaign coverage with interviews of caretakers leaving vaccination/distribution posts. Five-months post distribution, a two-stage cluster survey with population proportional sampling assessed ITN coverage, retention, and use. Both surveys assessed household wealth through an asset inventory.

Findings: At distribution, 636/776 (82.0%) of caretakers reported that they received a home visit by a Red Cross volunteer before the campaign and 32/776 (4.1%) of children less than five years of age slept under an ITN. Five months post distribution; caretakers reported that 220/250 (93.2%) of their children 9 months to 5 years of age were vaccinated during the campaign, 234/248 (94.4%) of households were observed to have an ITN in the home, and 170/249 (68.3%) were observed to have a net hung over a bed. Caretakers reported that 222/248 (89.5%) had received at least one ITN during the campaign and 153/254 (60.2%) slept under a net received during the campaign. For the poorest quintile, post-campaign household coverage for ITNs was ten times higher than

the pre-campaign coverage of the wealthiest quintile [46/51 (90.2%) vs 14/156 (9.0%)]. The marginal operational cost was $0.32 per ITN delivered.

Conclusion: These findings suggest that linking ITN distribution to measles campaigns may be an important opportunity to achieve high and equitable ITN coverage..

INTRODUCTION

A key goal for malaria control is to provide insecticide-treated nets (ITNs) to 60% of African children less than five years of age.[1] However, in 2001, WHO and UNICEF reported that ITN coverage in 19 sub-Saharan African countries was 2%.[2] While commercial markets for ITNs can theoretically be expanded substantially, they have not yet demonstrated the capacity to do so and the poorest households may be unable to afford to purchase nets and insecticide at any price. Alternative methods of subsidy or distribution of ITNs are needed.[3] Mass vaccination campaigns may offer a model for an alternative approach. In sub-Saharan Africa, mass vaccination campaigns for polio vaccine, tetanus toxoid and measles vaccine routinely achieve very high coverage. These campaigns target large segments of the population and usually include high risk populations and difficult to reach areas. They integrate logistics, social mobilization and careful assessment. Since 2001, the Measles Initiative has supported mass measles vaccination campaigns in 25 sub-Saharan countries, delivering vaccine to over 120 million children, and achieving very high coverage (>90%) in virtually all campaigns.[4,5] The Measles Initiative is a partnership which supports WHO/UNICEF measles control strategies in Africa.[6] In order to demonstrate high coverage and equitable distribution of ITNs at low cost, we integrated free ITN distribution into a mass measles vaccination campaign.

METHODS

Population and geographic area

During the week of December 9-13, 2002, a mass measles campaign was conducted in 9 of the 10 provinces in Ghana, targeting 7.9 million children 9 months to 15 years of age. Lawra District, in the Upper West Region of Ghana, is a rural area of extreme poverty with no ITN social marketing schemes. An estimated 68.3% are below the extreme poverty line of 700,000 cedis ($86) per adult per year.[7] The literacy rate is approximately 10%. Household ITN coverage was estimated at 4.4% in northern Ghana.[8]

The official estimate of the total population in Lawra is 90,642 with 18,128 under five years of age.[9] During a recent polio national immunization day, 28,973 children under five were reportedly vaccinated in the district.[10] We assumed an equal number of children would attend a measles vaccination campaign as had attended the polio campaign From previous measles campaigns in Ghana, we estimated that each caretaker brought an average of two children under than five years of age. Therefore, in order to provide one ITN to each family that had one or more child less than five years of age, we estimated that a total of 14,500 ITNs would be needed.

There were 28 vaccination/distribution posts in the district. The posts were staffed by three or four persons: a trained health worker or vaccinator, a recording clerk, and one or two Ghana Red Cross Volunteers (RCVs). Each vaccination/distribution post served an average of approximately 500 households. The fixed posts were typically at health centers, the temporary posts were located at places convenient to the rural population

(such as in villages, at markets or in churches), and the mobile sites targeted schools.

Materials

A total of 14,600 ITNs were obtained through Agrimat, Inc. (SiamDutch, Inc., Bangkok, Thailand) and the UNICEF/Ghana country office. This included 4,520 long-lasting nets (DAWA®) and 10,080 pre-treated nets (treated with 20 mg/m2 deltamethrin), which met WHO standards for safety and effectiveness. All nets were rectangular, extra-large sized (150cm x 180cm x 190cm), which could accommodate several persons sleeping in the covered bed.

Social mobilization

The logistics demands of transporting, distributing and monitoring ITN distribution precluded house-to-house distribution. Because measles vaccination was to be given at fixed sites, we sued those fixed sites as the ITN distribution sites. Intensive social mobilization was conducted to assure high rates of attendance at the fixed-sites. One year prior to the campaign, community-wide registration was done throughout the district in preparation for a filariasis treatment campaign. Those registration lists were updated and made available to each vaccination/distribution post. Beginning several days before the campaign, one RCV from each vaccination post attempted to visit every home in the catchment area of the vaccination post. They informed caretakers about the measles vaccination campaign, whether they were eligible for ITN distribution, and how to

properly use the ITNs. Local radio broadcasts, posters and banners were used to advertise the measles campaign. Only person-to-person communication was used to inform the community about ITN distribution. Mass media (i.e., radio and posters) were not used as it might have resulted in large numbers of persons outside the target district coming to the vaccination/distribution posts expecting to receive ITNs.

ITN distribution

All children 9 months to 14 years of age coming to the vaccination post received measles vaccination. Caretakers accompanying one or more children under five years of age were given an ITN. The children and caretaker names were checked against the filariasis registry or added if it was not there. At the end of the vaccination campaign, RCVs were instructed to deliver an ITN to the child's home if a person on the list did not come to the post to receive an ITN (and if there were remaining ITNs),

Assessment

We conducted two assessments, a pre-campaign exit interview and a post-campaign population-based survey. On the days of distribution/vaccination, caretakers leaving the vaccination posts were asked about their experience with ITNs and social mobilization for the campaign. GRCS volunteers recruited by the Lawra district Red Cross conducted this exit interview. The volunteers were adults who could read and write English. Assessors were instructed to choose specific field sites for assessment that had the

following characteristics: 1) they were in a geographic area known to the volunteer, 2) they were community-based sites at which care givers would be present (not schools), 3) and ITNs were being distributed. As the vaccination posts were mobile, the assessors moved with the post to various sites. Each volunteer visited approximately four sites in the course of three days.

The second assessment was a household survey conducted five months after the campaign. The purpose of this survey was to measure whether households received, retained and used the bed nets. A two-stage cluster sampling was used with clusters selected on the basis of population-proportional sampling. Within each cluster, a random starting point was selected and households were chosen based on their proximity to the starting point. There were a total of 28 surveyors and 3 supervisors.

In both surveys, the wealth of each respondent's household was determined through a series of standard questions and scoring system derived from the Ghana Demographic and Health Surveys (DHS) as developed and reported by the World Bank.[11] The questions assessed the family possessions and living conditions, such as whether or not they owned a radio, the type of house, and their source of water. The lowest 20% of asset scores were designated the first (poorest) quintile, the second lowest 20% as the next poorest quintile and so on.

In both surveys, the volunteers read and recorded the survey questions on handheld computers, referred to as Personal Digital Assistants (PDAs). The PDAs in this study

were Visor Neos (Handspring, Inc.) using the Palm Operating System, version 3.5 (Palm, Inc.). The PDAs were supplied by Satellife, Inc. Programming was done prior to shipping to the field by using Pendragon Forms 3.2. A data analysis specialist (R.D.) oversaw training and data collation and analysis. The assessment data was transferred from the PDAs to a database in a laptop computer using the synchronizing software and cradle supplied with the PDA. Data was analyzed in EpiInfo 6.0 and EpiInfo 2002, and proportions were compared using chi-square tests. Non-responses were excluded from the analysis.

For determination of the rate of children sleeping under ITNs, we included in the analyses only those children in families that reported receiving campaign ITNs, ignoring pre-existing nets (as it was not possible to reliably determine if they were treated with insecticide). For determination of measles vaccination status, we assessed children 9 to 59 months of age. For all other analyses, we included all children under 59 months of age, or their families. To assess whether an outcome measure was correlated with increasing wealth status, we considered each wealth quintile as a a separate strata and applied the chi square test for trend (EpiInfo 6.0). Cost information was taken directly from the funded budgets for the Ghana Red Cross and the Ministry of Health. Records with missing responses were excluded from analyses.

Role of the funding source

Rotarians Against Malaria, Rotary Foundation, ExxonMobil and World Bank provided principal funding. One person from RAM (D.Z.) participated in the study design and

writing of the report. The measles campaign was conducted by the Ghana Health Service with primary support from the Measles Initiative[12], with core partners of American Red Cross, UN Foundation, Centers for Disease Control and Prevention, WHO, and UNICEF.

RESULTS

Exit-interview survey

Exit interviews were conducted at 78 sites of which 70 were in villages and eight were in towns. Of these, 65 were at temporary outreach posts, seven were at fixed health centers and six were at schools. A total of 818 surveys were completed of which 802 were valid. There was a mean of 30 completed surveys per surveyor, 10.1 per day, and 11.6 per site. Of the 802 respondents, 94.7% were female with a median age of 30 (range 10-70). They lived a median of 1.0 km from the vaccination site (range 0-48 km), with 75% living less than 2.0 km. Among these respondents, 776 accompanied children under five years of age. A total of 1519 children lived in the homes of these caretakers (mean 1.9, range 1-12). A total of 1613 children were brought by the caretakers to the sites (mean 2.1, range 0-9), with 89.6% bringing three or fewer children. In the community survey, there were 262 completed surveys, of which 254 were for children under five years of age and 221 were for children 9 months to five years of age.

Pre-campaign social mobilization and ITN ownership from exit interviews

Of those attending the campaign, 82.0% reported that a Red Cross volunteer visited their home before the campaign (Table 1). Prior to the campaign, 145/776 (18.8%) of caretakers reported that they had a bednet in their home, 34/776 reported that bednet had been treated with an insecticide in the previous six months, and 32/776 (4.1%) reported their youngest child under five years of age slept under a treated bednet within the previous six months (Table 2). While these rates were low for all income levels, there was a significant trend towards higher rates among the wealthier quintiles.

Post-campaign ITN coverage

Post-campaign, 222/248 (89.5%) of the caretakers reported that they received an ITN during the campaign. On inspection of the houses by the survey teams, 234/248 (94.4%) homes had a bednet and 170/249 (68.3%) had a net hung over the child's bed. This represented a mix of nets owned prior to the campaign and campaign nets. The caretakers reported that in 168/247 (68.0%) of the homes, the youngest child slept under a net the previous night. In 153/254 (60.2%) of homes, the child slept under an ITN provided during the campaign. For each of these indicators of net coverage, there was no trend towards higher coverage among wealthier quintiles.

ITN retention

Of those who reported receiving an ITN at the campaign, 216/222 (98.8%) were observed to have a net in their home on visual inspection six months post-campaign. However,

some of these nets may have been in the home prior to the distribution and it was not possible to distinguish with certainty whether all of these were nets distributed during the campaign. Of those who reported receiving nets, 5/227 (2.2%) households reported that they had sold it.

Impact of ITN distribution of measles vaccination coverage

The measles vaccination coverage for all children 9 months to 5 years of age was 200/213 (93.2%). Among children eligible for measles vaccination who received ITNs during the campaign, the measles vaccination coverage was 183/192 (95.3%). Those who reported receiving an ITN had a higher rate of receiving measles vaccine than those who did not receive an ITN (Table 2, Risk Ratio = 2.20, 95% CI = 0.99, 4.90)

Costs of vaccination and ITN distribution

The cost of measles vaccination during the campaign was approximately $0.76 per child which included $0.46 for logistics and social mobilization, and $0.30 for the vaccine, syringes and other commodities.[13] The total cost of procuring the 14,600 ITNs was $49,400, or $3.42 per ITN distributed. The contributions of the measles campaign to ITN distribution were program planning, social mobilization, some health workers salaries, some transportation of personnel and supervision. The marginal costs of ITN distribution are those costs that were in addition to the costs of the measles campaign. The total costs for ITN distribution was $4,650, including $2,355 for training and

supervision, $1,745 for transportation and $450 for community education. The total cost of distribution was $4650 for 14,600 ITNs or an average of $0.32 per ITN.

DISCUSSION

These findings suggest that ITN distribution can be rapidly achieved at low-cost by linking it to measles vaccination campaigns. The key features of this approach were intensive social mobilization, distributing ITNs at the time children were vaccinated, and use of community organizations for logistics. This approach may be particularly appropriate in poor, rural areas without other distribution schemes.

The costs are substantially below those reported for other distribution schemes. Nets were given away without charge and because it was integrated into a measles campaign, the marginal costs of accessing this additional service were negligible. The total distribution cost to the providers was $0.32 per ITN delivered. In a large and well-planned ITN social marketing program in Tanzania, costs were $1.70 per ITN for marketing and logistics.[14] A leading social marketing scheme cites programmatic costs of $6 to $15 above the sales price for every net.[15] The total operational costs for the combined measles, vitamin A and ITN campaign was $0.87 per child (excluding the cost of vaccine, syringes, vitamin A and ITNs). If all costs of distribution were assigned to ITNs, the distribution cost was less than $1.00 per child.

Vaccines are considered a pubic good and part of the benefit of disease prevention accrues directly to the public, through averted costs of treatment. Providing free services and continuously reducing other non-cost barriers to accessing these services is a hallmark of successful vaccination programs. Any cost associated with accessing ITNs, including the consumer costs of accessing free nets, presents a barrier which may lower uptake. Recent calls for increasing ITN coverage in developing countries suggest making its distribution similar to vaccination, that is, freely available to all who would benefit from it.[16]

The location chosen for this project is one of the poorest and most isolated regions in Ghana and had no social marketing schemes for ITNs or retreatment. The level of extreme poverty (68.3%) meant that most families could only purchase an ITN by choosing to buy less food than was needed for their family's minimum caloric or other basic needs. Because ITNs were free and the barriers to accessing them were low during the campaign, our approach achieved high levels of equity. For the poorest quintile, post-campaign coverage for ITNs was ten times higher than the pre-campaign coverage of the wealthiest quintile (90.2% vs 9.0%). Despite this poverty, the free nets were retained at a very high rate and only 2.2% reported that they sold the net they received. It seems unlikely that this low rate of "leakage" would have any commercial impact. For this study population, we have made provisions for retreatment of the nets according to MoH and WHO guidelines.

Based on clinical trials of ITNs in Western Kenya, Hawley et al have demonstrated that

the key determinants of the effectiveness of large scale ITN programs are the proportion of households with ITNs (coverage), the proportion of individuals properly deploying ITNs each night (adherence), and the proportion of nets properly treated with insecticide (treatment) . [17] For this project, we demonstrated high levels for coverage (89.5%) and adherence (68.3%) while 100% of nets distributed were pre-treated. Hawley et al also suggest that the impact on disease reduction depends upon the proportion of nearby households with ITNs, not just on the prevention of mosquito bites to individuals who sleep under nets. To maximize their public health impact, high coverage with treated nets is essential.[18] Mass distribution provides a mechanism for achieving this high coverage and the proposed community effect.

There are several features of ITNs and mass measles campaigns which favor the sustainability of a combined approach. First, high coverage and low cost favor investing in this combined approach as compared to, for example, subsidized net sales. Second, the underlying measles campaigns are recommended in all sub-Saharan African countries.[19] As practiced in the Americas and in Africa, after an initial campaign for children 9 months to 15 years of age, subsequent campaigns are conducted every 3-4 years for children 9 months to five years of age – a total of 150 million children receiving campaign vaccination each year.[20] Each vaccination represents a potential missed opportunity to deliver ITNs. Third, long-lasting ITNs should last three years under normal usage - the ITNs require replacing on the same interval as measles campaigns. Finally, there are substantial resources provided to countries for ITN distribution (such as those through the Global Funds for AIDS, TB and Malaria) which are not being used as

quickly or as effectively as originally envisioned. The approach outlined here may offer a mechanism to achieve the intended coverage, equity and cost goals for those funds.

We believe that linking ITNs to measles campaigns presents an important opportunity for reaching malaria control goals and merits larger-scale implementation and evaluation.

Contributors

M. Grabowsky, G. Amofah, T. Nobiya, M. Ahun, and D. Zimmerman conceived and designed the project. T. Nobiya, M. Ahun and A. Baffoe-Wilmot, and A. Bello designed and conducted the mass distribution in Ghana. M. Grabowsky, R. Donna, H. Ladd, and M. Lengor designed and conducted the assessment. E. Hoekstra designed the intervention and helped prepare the manuscript. M. Grabowsky analyzed the data and wrote the first draft. All investigators contributed to the interpretation of data and review of the paper, and contributed to the writing of the final draft.

Conflict of interest statement

The authors have no conflict of interest.

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Table 1. ITN indicators, pre- and post-campaign

	Wealth Quintile, [No. (%)]						
	Lowest	2	3	4	Highest	Total (%, 95% CI)	p-value
Pre-campaign, exit interview							
N	151	157	153	159	156	776	
RCV visited home	118 (78.1)	135 (86.0)	130 (85.0)	116 (73.0)	137 (87.8)	636 (82.0, 79.3-84.7)	.10
Net in home	23 (15.3)	27 (17.2)	30 (19.9)	26 (16.4)	39 (25.0)	145 (18.8, 16.1-21.5)	.06
Treated net in home	4 (2.6)	2 (1.3)	9 (5.9)	5 (3.1)	14 (9.0)	34 (4.4, 3.0-5.8)	<.01
Child slept under ITN	4 (2.6)	2 (1.3)	9 (5.9)	5 (3.1)	12 (7.7)	32 (4.1, 2.7-5.5)	<.02
Post campaign, community survey							
Campaign vaccination	47/51 (92.2)	43/51 (84.3)	45/50 (90.0)	44/50 (88.0)	41/48 (85.4)	220/250 (88.0, 83.3 – 91.8)	
ITN received	46/51 (90.2)	47/ 50 (94.0)	42/48 (87.5)	46/50 (92.0)	41/49 (83.7)	222/248 (89.5, 85.7-93.3)	.28
Net observed in home	47/51 (92.2)	48/50 (96.0)	48/49 (98.0)	47/50 (94.0)	44/48 (91.7)	234/248 (94.4, 90.7-96.9)	.79
Net over bed	35/52 (67.3)	36/49 (73.5)	31/49 (63.3)	29/50 (58.0)	39/49 (79.6)	170/249 (68.3, 62.1-74.0)	.73
Child slept under net	33/53 (62.3)	34/48 (70.8)	32/52 (61.5)	31/53 (58.5)	38/51 (74.5)	168/257 (65.4, 56.6-71.2)	.67
Child slept under campaign ITN	30/52 (57.7)	32/48 (66.7)	29/51 (56.9)	30/52 (57.7)	32/51 (62.7)	153/254 (60.2, 54.2-66.2)	.94
Measles vaccine received	45/49 (91.8)	41/45 (91.1)	44/45 (97.8)	38/39 (97.4)	36/41 (87.8)|	204/219 (93.2, 90.1-96.3)	.92

Table 2. Impact of receipt of ITN on receipt of measles vaccine, caretaker report, population-based survey.

		Received Vaccination		
		Yes	No	Risk of vaccination
Received ITN	Yes	196	3	8.52
	No	20	6	3.33

Risk Ratio = 2.20 (95% CI, 0.99, 4.90)

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