

# BMJ Open Evaluating the use of job aids and user instructions to improve adherence for the treatment of childhood pneumonia using amoxicillin dispersible tablets in a low-income setting: a mixed-method study

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**To cite:** Sarma H, Gerth-Guyette E, Shakil SA, *et al.* Evaluating the use of job aids and user instructions to improve adherence for the treatment of childhood pneumonia using amoxicillin dispersible tablets in a low-income setting: a mixed-method study. *BMJ Open* 2019;**9**:e024978. doi:10.1136/bmjopen-2018-024978

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2018-024978>).

Received 25 June 2018  
Accepted 5 April 2019



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## ABSTRACT

**Objectives** We conducted a study to evaluate the use of job aids and simple user instructions to improve adherence for the treatment of childhood pneumonia with amoxicillin dispersible tablet (DT).

**Design** A mixed-method study implemented in three phases between October 2015 and February 2016.

**Settings** The study was implemented in two subdistricts of Bangladesh.

**Participants** Caregivers of children aged 2–59 months, health service providers and key stakeholders at national and district level.

**Interventions** An intervention including training and job aids and user-friendly instructions was introduced in one subdistrict while standard amoxicillin DT packaging and instructions with no training served as the control in the comparison subdistrict.

**Primary outcome** Adherence behaviour of caregivers of children aged 2–59 months for the treatment of childhood pneumonia with amoxicillin DT.

**Methods** We conducted a survey with 56 caregivers in the intervention subdistrict and 38 caregivers in the comparison subdistrict. We also conducted 44 in-depth interviews to evaluate the job aids and user-friendly instructions with healthcare providers and caregivers to assess the feasibility, usability and acceptability of the tools in intervention subdistrict.

**Results** For 5-day treatment course, 32.1% (95% CI 23.1% to 41.1%) of caregivers in the intervention subdistrict and 2.6% (95% CI 0.3% to 7.8%) in the comparison subdistrict maintained full adherence to the amoxicillin DT treatment for pneumonia. More children under 12 months were given age-appropriate treatment than older children. Key stakeholders and healthcare providers considered the use and integration of the tools into the health system to be feasible and acceptable.

**Conclusions** The provision of tools for the treatment of childhood pneumonia with amoxicillin DT had a positive influence on adherence behaviours. These tools can help close information gaps and overcome the barriers posed

## Strengths and limitations of this study

- The study used a real-world field setting to develop and test the interventions with job aids and user instructions, the evidences generated through this study might help other low-income countries with similar settings introduce amoxicillin dispersible tablet (DT) into their health systems.
- We involved study participants in a different phase of study implementations, including adapting job aids and user instructions, in the study design and for evaluating the intervention.
- The supply of amoxicillin DT was not readily available in both the subdistricts. These tools will be ineffective if there is no consistent supply of amoxicillin DT.
- This study was implemented in one district in Bangladesh, and the findings may not be able to be generalised to other contexts.
- Measurements of adherence behaviour and the qualitative findings on acceptability, feasibility and usability can be prone to recall and desirability bias. Moreover, this study did not consider the baseline adherence behaviour of the caregiver.

by medical illiteracy and remembering instructions from providers.

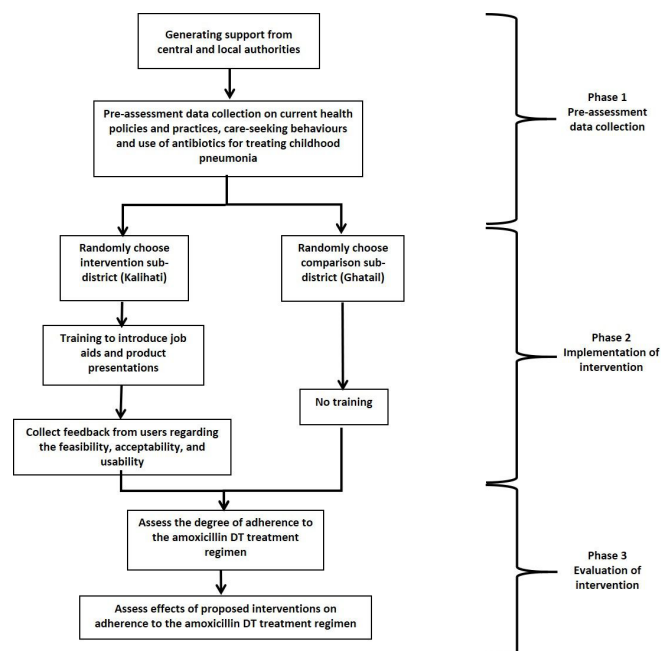
## INTRODUCTION

Child deaths due to pneumonia have declined slowly—and countries with the greatest burden have made the least progress. Over 70% of the burden of pneumonia is borne in 15 countries.<sup>1</sup> Bangladesh reported 17 500 pneumonia deaths in children under 5 in 2015.<sup>2</sup> The high burden of childhood pneumonia deaths belies the fact that pneumonia-related

mortality is preventable with simple interventions and appropriate treatment.<sup>3</sup> WHO integrated community case management strategy recommends that children between 2 months and 5 years of age diagnosed with fast-breathing pneumonia are treated with an oral antibiotic, and the recommended first-line treatment is oral amoxicillin.<sup>3</sup> Despite these recommendations, the Global Action Plan for Pneumonia and Diarrhoea reports that only one-third of pneumonia cases receive antibiotics as part of the treatment regimen.<sup>4</sup> Even when antibiotics are available, only two-thirds of children completed the full course of antibiotics.<sup>4</sup> Failure to complete the course of treatment as prescribed can lead to treatment failure, pneumonia relapse and the potential for the patient to develop drug resistance infections.<sup>5 6</sup>

The United Nations Commission on Life Saving Commodities (UNCoLSC)<sup>7</sup> identified the dispersible tablet (DT) formulation of amoxicillin as an underused, low-cost and high-impact commodity that, if used at scale, could make a great impact in reducing preventable deaths. For many countries, this represents a shift from other commonly used formulations of amoxicillin, such as syrups, non-DT and suspensions, and from other antibiotics. Amoxicillin DT has several advantages over other formulations. This includes simplified treatment administration as other formulas of amoxicillin such as syrup and other oral solution require refrigeration, reconstitution with clean water and accurate measuring devices to ensure correct dosages. Each dose of amoxicillin DT, equivalent to amoxicillin powder for oral solution, is a specific amount of drug, compacted into a tablet that quickly disperses in 5–10 mL of water or milk.<sup>8</sup> DT also conveys some logistical advantages. Compared with the amoxicillin DT, the liquid presentations of amoxicillin are more expensive, heavier to transport and require more space to store.<sup>8</sup> Unicef estimated that shifting the demand from amoxicillin dry syrup to DT has resulted in worldwide cost savings of US\$8.4 million during 2013–2015.<sup>8</sup>

Interventions that both expand coverage of antibiotics and improve adherence to the course of treatment can reduce the pneumonia burden.<sup>9</sup> Some of the drivers of poor treatment adherence have been described in the previous literature as low medical literacy,<sup>10–12</sup> lower level of education and low family income.<sup>13</sup> The potential to overcome barriers to treatment adherence using job aids and simple user instructions are outlined in Ebels *et al.*<sup>14</sup> When patients clearly understand the treatment regimen and are provided with support materials they are more likely to adhere to the recommended treatment.<sup>15</sup> Job aids and user instructions should be appropriate for their specific context of use and that can be achieved through engagement with potential users throughout the design and development process.<sup>14</sup> Visual tools with pictorial and graphical symbols help to convey intended meaning about the treatment instruction to the patients and caregivers, including those who are illiterate.<sup>16 17</sup>



**Figure 1** Study design and implementation process. DT, dispersible tablet.

As part of the UNCoLSC, a job aids and user instructions to support WHO recommendations on the use of amoxicillin DT to treat childhood pneumonia were created through an iterative user-centred design and development process, reported elsewhere.<sup>14</sup> These job aids and user instructions are intended to help countries introduce amoxicillin DT into their health systems and align their pneumonia treatment policies with global guidelines. In order to build evidence around the use of amoxicillin DT job aids and user instructions, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), an international health research organisation based in Dhaka, Bangladesh, introduced these tools into the health system in rural Bangladesh. The primary aim was to assess the influence of these tools and training on these tools to the healthcare providers on treatment adherence. The secondary aims were to explore the usability, acceptability and feasibility of introducing these tools to support new treatment regimens.

## METHODS

### Study design and settings

We conducted a mixed-methods study in three phases between October 2015 and February 2016 (figure 1). In phase 1, the study team worked with key stakeholders at the policy level to generate support for the study. Phase 2 was focused on the implementation of the interventions, and phase 3 was the post-implementation assessment of the interventions.

The study was implemented in two subdistricts, Kalihati and Ghatail of the Tangail district of Bangladesh. We selected these 2 subdistricts out of 12 subdistricts in Tangail district considering as they had similar

demographic characteristics and were in areas with a supply of amoxicillin DT supported by the Unicef. From these two subdistricts, we randomly selected Kalihati to be the intervention subdistrict and Ghatail to be the comparison subdistrict.

In 2011, the total population of Ghatail was 417 939, with 55 community clinics (CCs) and 17 Union Health and Family Welfare Centres. The total population of Kalihati was 429 141, with 54 CCs and 18 Union Health and Family Welfare Centres. In addition to these facilities, there are a number of private health facilities, including formal and informal/non-formal facilities available in both the subdistricts.

Amoxicillin DT is manufactured, registered and available in Bangladesh but it was not routinely used for the treatment of childhood pneumonia. During the study period, amoxicillin DT was made available to CCs and health centres in Tangail district from the supply procured and distributed by Unicef. Given the unreliable use of amoxicillin DT, the study team wanted to ensure that lack of access to the drug was not a factor that would confound use and adherence in either subdistrict. The study team intervened throughout the course of the study to ensure sufficient supply of the drug at the facility level.

### Intervention

The interventions included in this study are the provision of job aids, user-friendly instructions and training to the health providers for the treatment of childhood pneumonia with amoxicillin DT. PATH (Seattle, Washington, USA) in collaboration with icddr,b and other global partners developed a job aids and user-friendly instructions for amoxicillin DT (online supplementary file 1 and 1a) to increase community healthcare provider's (CHCP) ability to prescribe and dispense appropriate pneumonia treatment and to help caregivers in understanding amoxicillin DT instructions. These job aids and user-friendly instructions were further adapted for use in Bangladesh based on feedback from national stakeholders, healthcare providers and caregivers (online supplementary file 2 and 2a). The job aid and user-friendly instructions were introduced and used in the intervention subdistrict, while standard amoxicillin DT packaging and instructions were used in the comparison subdistrict. CHCPs working in the public and private sector in the intervention subdistrict participated in a day-long training to review pneumonia treatment guidelines, and in the introduction and distribution of the job aids and user-friendly instructions. The job aids and user-friendly instructions printed on paper envelopes were given to each healthcare provider. In the comparison subdistrict, no job aids and user-friendly instructions were distributed, and no training was held.

### Study population

We selected key stakeholders purposively based on expertise in pneumonia management and child health and their ability to provide insight into the implementation of the intervention. They included representatives from

Ministry of Health and Family Welfare (MOHFW) (at national, district and subdistrict level), Unicef, local pharmaceuticals, civil surgeons, health officials at subdistrict level, members of local government committees and members of the CC management team.

Community-based healthcare providers working in both the public and private health sector were identified and recruited. In the public sector, this included sub-assistant community medical officers (SACMO) and CHCPs. The SACMO is equivalent to a medical assistant. The training of the SACMO consisted of 3 years of didactic and clinical rotations with a compulsory internship of 12 months. The SACMO serves at Union Health and Family Welfare Centres as well in the subdistrict level health facilities, which provide primary care and hospitalisation services. The CHCP worked in primary health at CCs in rural areas, the lowest level of static facilities operated by the MOHFW. CHCP received 12 weeks of training divided between theoretical and practical training. A CHCP works in a CC, which serves an area of about 6000 people. All CHCPs are trained to diagnose pneumonia and prescribe antibiotics.

In the private sector, we recruited informal providers, those working in dispensaries who prescribe medicine as well as formal providers who have completed courses in primary health or pharmacy. Due to the high volume of care-seeking outside the public sector, it was deemed critical to include healthcare providers who work outside of the government system. Healthcare providers were selected based on their willingness to participate, the facility they worked in and whether they commonly provided treatment to children with suspected pneumonia. Finally, at participating CCs and health centres, all caregivers with children diagnosed with childhood pneumonia and prescribed amoxicillin were identified and recruited for participation in the study.

### Outcomes of the study

The primary outcome was assessing adherence behaviour for the treatment of childhood pneumonia with amoxicillin DT. Both quantitative and qualitative data were collected to assess the feasibility, usability and acceptability of the job aids and user-friendly instructions. These indicators were defined as follows:

- Adherence: the correct treatment regimen based on age, duration and timing of treatment administration. Adherence was assessed through caregiver self-report and pill count. For this study, full adherence was defined as:
  1. Using the appropriate dose of amoxicillin DT based on the child's age (one 250 mg amoxicillin DT for children 2 – 11 months or two 250 mg amoxicillin DT for children 12 – 59).
  2. Administering the DT twice per day.
  3. Completing the full 5-day course of treatment.
- Acceptability: the degree to which the job aids and user instructions are tolerated and appreciated by providers.



- ▶ Usability: refers to the extent to which healthcare providers and caregivers understand and can interpret the job aids and user instructions and can recall the information used in the tools.
- ▶ Feasibility: refers to how possible, easy and convenient it is to integrate these tools into current practices and systems of care, the way in which medicine is given to the caregivers at present at both the individual provider and health system level (the primary health-care system operated at community level).

### Sample size and sampling

We did not conduct power calculations for the semi-structured survey with caregivers, as the goal was to achieve an initial understanding of the effect of using job aids and user instructions on adherence behaviour. Instead, we performed a 3-month follow-up of our intervention and included all caregivers with the child who received treatment for pneumonia from the selected health service providers in both the study subdistricts. A total of four caregivers refused to participate in the study. For qualitative data collection with caregivers, we collected data until saturation was achieved. We conducted key informant interviews and focus group discussion with all key opinion leaders and providers managing pneumonia for children <5 years of age at the study sites.

### Data collection

In phase 1, we conducted key informant interviews with the subdistrict health and family planning officers of both Kalihati and Ghatail, the residential medical officer and the civil surgeon of Tangail district. The purposes of the key informant interviews were to understand the current policies for prescribing amoxicillin DT for the treatment of childhood pneumonia, assessing the organisational feasibility of introducing job aids and user-friendly product presentations for amoxicillin DT given the current administrative practices, identify potential barriers and facilitators for the uptake of amoxicillin DT job aids and user-friendly instructions given current health policies, and assess the perceived importance of adding job aids and user-friendly instructions to facilitate adherence to amoxicillin DT treatment. We also conducted in-depth interview with caregivers of the children aged 0–23 months to understand their knowledge of pneumonia and related care-seeking behaviours.

In phase 3, we administered a semi-structured survey questionnaire to assess adherence among caregivers in both subdistricts. For this survey, we developed a questionnaire which covered a range of information of caregiver and the children including, socioeconomic characteristics of caregivers and their household, caregivers' knowledge and experiences in managing pneumonia for their children, experience in use of antibiotics, amoxicillin DT and adherence behaviour to amoxicillin DT for the treatment of recent pneumonia episode of their children. Additionally, in the intervention subdistrict, we conducted focus group discussions and in-depth

interviews with CHCP and caregivers respectively to assess the feasibility, usability, and acceptability of the tools.

### Ethical review

The research team informed participants about the study and about their voluntary participation, their right to withdraw from participation, and that refusal would not lead to adverse consequences. Confidentiality of data was strictly maintained.

### Data analysis

Qualitative data from interviews and focus group discussions were analysed using Atlas ti (<http://atlasti.com>). Three study team members participated in the thematic analysis. All the qualitative interviews were recorded and transcribed, and coded line by line prior to the thematic analysis. We followed both deductive and inductive approaches for coding data. We formulated a list of initial themes based on our experience and literature review, which guided us to develop a coding framework. These themes included: current policies and practices regarding amoxicillin and amoxicillin DT, barriers and facilitators to uptake the tools, perceived importance of adding tools, experiences of service providers about use of amoxicillin DT, experience of using job aids by the service providers, experiences of using instructions by the caregivers and experiences of caregivers receiving treatment from the service providers. We then revisit the initial codes when new themes emerged from the data. We considered some qualitative findings and triangulated them with quantitative data.

Data from the quantitative surveys were analysed using STATA V.14.1 (<https://www.stata.com>). We performed univariate analysis using descriptive statistics of selected variables such as household size, caregiver's age, child's age, caregiver's education and presented in percentage and frequency with 95% CI. For bivariate analysis,  $\chi^2$ /Fisher's exact test was employed to investigate the association between adherence of amoxicillin DT with selected variables. We adjusted univariate and bivariate estimates accounting for clustering by community health workers (CHWs) except the variable 'received treatment from' as under this variable, we distributed the prevalence of adherence behaviour across different CHWs. A  $p < 0.10$  was considered significant. Data from both subdistricts were used to compare and assess differences in adherence behaviours.

### Patient and public involvement

During first phase of the study, we considered feedback from caregivers of the patients (children who had been diagnosed with pneumonia) while adapting the tools in Bangladesh. This study also involved study participants in the study design and evaluation of interventions. We shared the results with study participants (mostly key stakeholders) through a power point presentation in a dissemination workshop and considered their comments

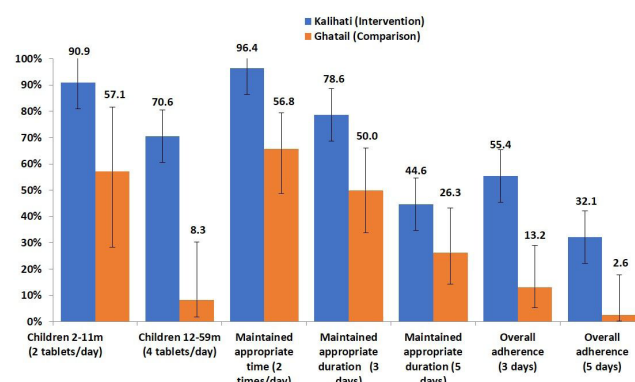
and feedback in our analysis, interpretation and formation of recommendations.

## RESULTS

We conducted 44 in-depth interviews with key stakeholders, service providers and caregivers in both subdistricts. Sixty healthcare providers in the intervention subdistrict attended a training, used the tools with their patients and later participated in focus group discussion. Fifty-six caregivers in intervention subdistrict and 38 caregivers in comparison subdistrict participated in the post-intervention survey.

All the caregivers who participated in the in-depth interviews reported their job to be 'housewife'. Most of them (34/44) have more than 5 years of schooling and the average age was 23 years. The average age of SACMO was 41 years and prior to attend the training for SACMO all had completed secondary level schooling. All SACMOs had more than 8 years of experience working as SACMO and two of them had more than 22 years of experience. The average age of CHCP was 33 and all CHCP completed secondary level schooling before becoming a CHCP. CHCP had an average of 5 years of experience. The average age of informal provider was 39 years. Most of informal providers completed 12 years of schooling, completed 3 months of pharmacy course, and on an average, they have been practising as informal provider in their communities for more than 12 years.

Table 1 describes the background characteristics of caregivers in both subdistricts participated in the survey in phase 3. The participants from the subdistricts were similar except for level of education of caregivers. The



**Figure 2** Adherence behaviour of caregivers in intervention and comparison subdistricts.

difference was significant among fathers, with 48.2% (n=27) (95% CI 35.1% to 61.5%) of fathers with more than 5 years of education in the intervention subdistrict compared with 76.3% (29) (95% CI 59.5% to 87.5%) in the comparison subdistrict. Also, a significantly higher proportion of caregivers (p=0.052) in the comparison subdistrict reported prior knowledge of antibiotics.

## Influence of the job aids and user instructions on adherence behaviours

Thirty-two per cent (18) (95% CI 23.1% to 41.1%) of caregivers in the intervention subdistrict and 3% (1) (95% CI 0.3% to 7.8%) of caregivers in the comparison subdistrict maintained full adherence to the recommended amoxicillin DT (figure 2). More children under 12 months were given age-appropriate treatment than older children in both subdistricts. Almost all (96.4% (54); 95% CI 89.7%

**Table 1** Sociodemographic and background characteristics of the caregivers

Variable	Kalihati (n=56)	Ghatail (n=38)	P value
Household size, mean (SD)	4.7 (1.5)	5.7 (2.9)	0.073
Mothers with more than 5 years of education, n (%)	36 (64)	32 (84)	0.034
Caregiver age in years, mean (SD)	24.9 (4.8)	25.0 (5.2)	0.872
Fathers with more than 5 years of education, n (%)	27 (48)	29 (76)	0.006
Age of fathers in years, mean (SD)	31.9 (5.6)	31.3 (5.8)	0.638
Age of children in months, mean (SD)	20.1 (14.8)	20.8 (14.0)	0.807
Children between 2 and 12 months, n (%)	22 (39)	14 (37)	0.811
Female children, n (%)	24 (43)	23 (61)	0.093
Decision-maker in household for child treatment, n (%)			
Child's mother	24 (43)	12 (32)	0.270
Child's father	9 (16)	6 (16)	0.971
Child's mother and father	19 (34)	16 (42)	0.421
Others	4 (7)	4 (11)	0.563
Household monthly expenditure in BDT*, mean (SD)	8627.3 (60700)	9605.3 (4246.1)	0.363
Caregiver reported some prior knowledge on antibiotics, n (%)	43 (77)	35 (92)	0.052

\*1BDT=US\$0.012.

BDT, Bangladeshi taka.

**Table 2** Association between adherence behaviour and other factors of study participants participated in the survey

	Adherence behaviour (5 days)		
	Yes	No	X <sup>2</sup> value (P value)
Variables	% (n) (95% CI)	% (n) (95% CI)	
Child age			
2–11 months, n=36	33.3 (12) (17.7 to 49.0)	66.7 (24) (51.0 to 82.3)	5.603 (0.018)
12–59 months, n=58	12.1 (7) (3.6 to 20.5)	87.9 (51) (79.5 to 96.4)	
Caregiver with ≥5 years of schooling			
No, n=26	15.4 (4) (1.2 to 29.5)	84.6 (22) (70.5 to 98.8)	0.520 *(0.471)
Yes, n=68	22.1 (15) (12.1 to 32.0)	77.9 (53) (68.0 to 87.9)	
Received user instruction			
No, n=40	2.5 (1) (0.0 to 7.4)	97.5 (39) (92.6 to 100.0)	3.37 (0.066)
Yes, n=54	33.3 (18) (20.6 to 46.0)	66.7 (36) (54.0 to 79.4)	
Used user instructions			
No, n=60	6.7 (4) (0.3 to 13.0)	93.3 (56) (87.0 to 99.7)	17.92 (0.000)
Yes, n=34	44.1 (15) (27.2 to 61.1)	55.9 (19) (38.9 to 72.8)	
Understanding of all parts of the user instruction			
Nothing, n=53	3.8 (2) (0.9 to 8.9)	96.2 (51) (91.0 to 100.0)	5.03 (0.081)
Partial understood, n=21	33.3 (7) (12.7 to 54.0)	66.7 (14) (46.0 to 87.3)	
Fully understood, n=20	50.0 (10) (27.5 to 72.5)	50.0 (10) (27.5 to 72.5)	
Prior knowledge about antibiotics			
No, n=16	37.5 (6) (13.0 to 62.0)	62.5 (10) (38.0 to 87.0)	3.57 (0.059)
Yes, n=78	16.7 (13) (8.3 to 25.0)	83.3 (65) (75.0 to 91.7)	
Made follow-up visits			
No, n=72	15.3 (11) (6.9 to 23.6)	84.7 (61) (76.4 to 93.1)	0.982 (0.322)
Yes, n=22	36.4 (8) (15.8 to 56.9)	63.6 (14) (43.1 to 84.2)	
Received treatment from†			
Subassistant community medical officer, n=39	12.8 (5) (5.2 to 28.2)	87.2 (34) (71.8 to 94.8)	6.10 (0.049)
Community healthcare provider, n=38	18.4 (7) (8.7 to 34.8)	81.6 (31) (65.2 to 91.3)	
Non-formal provider, n=17	41.2 (7) (19.3 to 67.3)	58.9 (10) (32.7 to 80.8)	
Received full dose of amoxicillin dispersible tablet			
No, n=43	0 (0) (–)	100 (43) (–)	5.853 *(0.016)
Yes, n=51	37.3 (19) (24.8 to 51.7)	62.8 (32) (48.4 to 75.2)	

\*We performed Fisher's exact test as expected cell frequency <5.

†The variable 'received treatment from' not estimated by cluster as we distributed the prevalence of adherence behaviour across CHWs. CHWs, community health workers.

to 100%) of children in the intervention subdistrict and about two-thirds (65.8% (25); 95% CI 50.5% to 81.1%) in the comparison subdistrict were given the appropriate dose two times per day. The weakest component of treatment adherence was completing the full 5-day course. Forty-five per cent (25) of caregivers in the intervention subdistrict completed all 5 days of treatment while 26% (10) in the comparison subdistrict completed the full 5 days of treatment (figure 2).

Table 2 shows the association between adherence behaviour and other factors. Factors that were significantly

associated with adherence to the treatment regimen included:

- ▶ The age of the child.
- ▶ Whether the caregiver (1) received the instructions, (2) used the instructions and (3) understood the instructions.
- ▶ Caregiver's prior knowledge about antibiotics.
- ▶ Whether the caregiver attended a follow-up visit with the provider.
- ▶ Whether the caregiver received the full dose of amoxicillin DT from the provider.

For example, caregivers of younger children (aged 2–11 months) had better adherence to the treatment regimen compared with caregivers of older children, aged 1–5 years (33.3% (12) vs 12.1% (7)). Full adherence to the treatment was only possible if caregivers received the full dose of amoxicillin DT from their provider. Seventy-three per cent (41) of caregivers in intervention subdistrict received the full dose, based on their child's age, compared with 26% (10) in comparison subdistrict. The type of provider also influenced adherence behaviours. If a caregiver went to informal providers for treatment, the likelihood of adherence was significantly higher ( $p=0.049$ ) compared with providers in the public sector (table 2).

Qualitative data were used to triangulate and explain findings from the self-report and pill count. The stated reason for having leftover medicine in the comparison subdistrict was that the caregiver forgot to give the full course of the medicine. In the intervention subdistrict, the most common reasons were that the child's health was improving and that the child refused to take medicine. During the qualitative interview, a mother in the comparison subdistrict mentioned:

I do not remember for how long the doctor had told me to give the medicine, so I gave it to my child three times a day for two days and then stopped as my daughter was not showing any sign of improvement.

The training on and access to the job aids was associated with better adherence to the recommended pneumonia treatment among healthcare providers. One provider from the public sector who participated in the training reported:

Because of this now I am more confident and can accurately diagnose and prescribe treatment of childhood pneumonia. Though we knew how to diagnose it (childhood pneumonia), the training had given us a refresher.

### Feasibility of introducing job aids and user instructions

Key stakeholders and healthcare providers considered the use and integration of the tools into the health system to be feasible. They were familiar with these types of tools, as similar materials are used for tuberculosis and immunisation programmes. They recommended that the following process is followed in order to introduce new tools for pneumonia treatment successfully.

1. Tools should be approved by the appropriate authority of the MOHFW in Bangladesh.
2. Advocacy should be conducted to achieve consensus on messaging among the health service providers and the stakeholders at district and subdistrict level.
3. Training should be conducted to ensure that providers know how to use the tools.

The perception of pneumonia was considered a driving factor in the feasibility of adopting the tools. The key stakeholders at the study area perceived

pneumonia as a high priority and major cause of child death.

Some barriers that could hinder the introduction of the tools were also reported. The availability of amoxicillin DT at the facility level, especially in the private sector, was a challenge. There were also concerns regarding how the informal providers, who are not subject to supervision and monitoring from the government health ministries, could access and use these tools.

Apart from the feasibility of the intervention, some providers doubted the efficacy of amoxicillin DT in treating pneumonia. They reported less trust in amoxicillin as compared with stronger second and third generation antibiotics. An informal provider said:

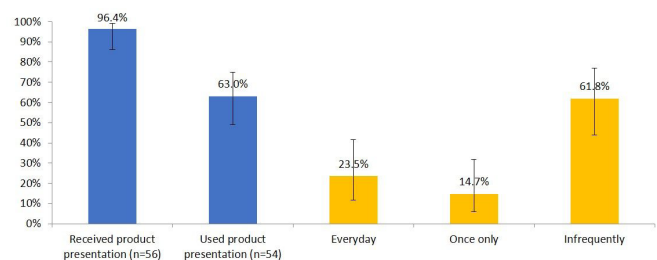
At present, we are usually not using Amoxicillin as treatment of childhood pneumonia. Most of the doctors and service providers are using second or third generation antibiotics to treat the children with pneumonia. The children are already [have] resistance to the higher-generic antibiotics. In that situation, if we use Amoxicillin DT, how would it be effective to treat pneumonia of the children?

### Usability of job aids and user instructions

Usability was assessed among both providers and caregivers in the intervention subdistrict only. Almost all of the caregivers (96%,  $n=54$ ) received user instructions but not all used them (63%,  $n=34$ ). Twenty-four per cent used the tool every day, while 62% (21) used it only once (figure 3). The most common reason not using the instructions was that the caregiver already knew how to use the medicine.

Providers explained the treatment to the caregiver using the tools, but comprehension of the tools varied among caregivers. More than 70% (41) of caregivers understood one or more components of the user instruction. One caregiver said:

The Service provider made the [user instructions] clear enough to me that I did not need to look at it again and it was beneficial to me in administering the medicine to my child.



**Figure 3** Use of job aids and user instructions by the healthcare providers and caregivers in intervention subdistrict.



### Acceptability of job aids and user instructions

Providers found the tools acceptable and considered them a better way of providing information than existing methods. They found it helpful for illiterate caregivers as most of the information was presented through pictures, making it easy to communicate and easy to memorise. Caregivers also found the tools acceptable, and providers reported that caregiver satisfaction with the tools encouraged their continued use over the study period.

Access to the tools, particularly for the non-formal providers, conveyed professional legitimacy and increased confidence in their skills. Providers reported that caregivers appreciated their services aligned with national guidelines. As one non-formal provider noted:

When we provide full course of medication to patients, and they usually think we provide it for our economic benefits. Patients think we have no professional degree, training on particular medication etc. They have little confidence on our treatments. But when we instruct them using [the tools], trustworthiness develops. [The tools] give us professional confidence.

These data suggest that informal providers were enthusiastic and empowered after participating in the training, as one non-formal provider stated:

After the training when I explain the dose administration procedure to pneumonia patients (childhood pneumonia) they trust me more. Now, my competitor's clients are even coming to me, especially those who have pneumonia and helping me to make more profit. I hope you could have more of such training with us in the future.

### DISCUSSION

The provision of job aids, user-friendly instructions and training to the health providers for the treatment of childhood pneumonia with amoxicillin DT had a positive influence on adherence behaviours among both caregivers and providers. The effect on adherence behaviour is strengthened when caregivers understood key parts of the instructions for using the treatment, as adherence is strongly associated with a user level of medical literacy.<sup>9–12</sup> Despite the positive influence of these tools, overall treatment adherence remained low: 32% in intervention subdistrict. Qualitative evidence generated in this study suggests that only some of the barriers to adherence can be overcome with better information, delivered through job aids, user instructions and training.

The tools were also deemed acceptable and usable as well as feasible to introduce. This finding aligns with other evidence generated in other low-income settings.<sup>18 19</sup> Key steps to introduce the tools into the health system in intervention subdistrict included official approval of tools, advocacy for consensus and training for the service providers. Once introduced,

providers liked and used the tools and gave them to the caregivers. Their use was driven by the perceived need—caregivers who already understood the treatment regimen did not frequently refer to the instructions. The locally adapted versions of the instructions were acceptable, though not all components of the tools were understood by all caregivers. Instructions may still need to verbally explain and reinforce by providers. A previous study demonstrated that key messages on adherence to an antibiotic regimen can be conveyed to largely illiterate caretakers through images and with reinforcement with verbal messages from health workers.<sup>20</sup>

Given the low rates of adherence observed, multiple barriers to full adherence to the amoxicillin DT treatment for childhood pneumonia persist beyond those that are addressed by the tools. An inadequate supply of amoxicillin DT at the community level, provider misconceptions about the efficacy of amoxicillin for pneumonia, inconsistent provider practices and caregiver behaviour all contributed to low adherence rates. At the facility level, the supply of amoxicillin DT was inconsistent during the study period, and there was lack of instruction to the health facilities at subdistrict level and to providers regarding how to properly use the supplied amoxicillin DT. Consistent supply of amoxicillin DT might help reinforce better adherence behaviour. However, the disruption of the supply was present across both the subdistricts.

Providers who attended to training more frequently provided the full course of amoxicillin DT, suggesting that training is essential along with the introduction of job aid and user instruction. Providers, particularly informal providers who questioned the efficacy of amoxicillin, suggested that evidence in support of WHO and national pneumonia treatment guidelines had not been widely disseminated or adopted into routine practice. Finally, suboptimal caregiver adherence behaviours persist, and the root cause of those behaviours warrant further exploration.

The inclusion of informal/non-formal provider in this study is an opportunity to explore how materials usually developed and deployed in public health facilities might work in the private informal sector. Previous studies in similar setting also suggesting that use of visual aids was helpful to improve services of the non-formal provider.<sup>21 22</sup> However, the channels for training and distribution to the non-formal provider may be more complex, as there is no formal authority in Bangladesh. Another key difference between the public and private sector is that non-formal providers sell amoxicillin and other drugs for a profit. Non-formal providers were willing to participate in the intervention and often reported strong positive feedback: the tools conveyed professional legitimacy and kept them updated of changing global and national guidelines. This formative positive feedback may warrant working to include private sector informal providers in other interventions and public health strategies to address childhood pneumonia.



## Limitations

The study has some limitations. The supply of amoxicillin DT was not readily available in both the subdistricts. These tools will be ineffective if there is no consistent supply of amoxicillin DT. During the study period, the study team members frequently requested the local managers to ensure an adequate supply of amoxicillin DT. This study was implemented in one district in Bangladesh, and the findings may not be able to be generalised to other contexts. Measurements of adherence behaviour and the qualitative findings on acceptability, feasibility and usability can be prone to recall and desirability bias. The low sample size possibly limited our analysis to sufficiently answer the research question, although, in the context of this study and the setting, this was the largest sample to measure the adherence behaviour as we considered all caregivers participated in the study in a 3-month follow-up period. Moreover, this study did not consider the baseline adherence behaviour of the caregiver.

## CONCLUSION

This study evaluated a simple and potentially scalable intervention, aimed at improving outcomes of childhood pneumonia treatment in Bangladesh by providing providers and caregivers with job aids and user instructions on proper use. These tools were created, tested and adapted with the participation of key stakeholders and beneficiaries in a real-world setting. Overall, these tools address some barriers to the use of amoxicillin DT for pneumonia. These tools can help close information gaps. They can also help overcome the barriers posed by medical illiteracy, support providers in the recall of correct use instructions and encourage alignment with global and national policies, and treatment guidelines. Still, other barriers will need to be addressed in order to improve adherence behaviours, the efficacy of amoxicillin DT, and ultimately, pneumonia treatment outcomes.

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**Acknowledgements** This study was funded by Unicef in collaboration with PATH, Seattle, USA. The authors acknowledge with gratitude the commitment of Unicef to its research efforts. icddr,b is also grateful to the governments Bangladesh, Canada, Sweden and the UK for providing core/ unrestricted support. The authors thank all study participants for their valuable participation. The authors also thank all of the research team members who assisted with data collection.

**Contributors** HS and EG-G conceived the study. HS, EG-G, SEA and TA involved in designing the study. HS, SAS, KRA, MD, MT and EG-G implemented the study, analysed the data and writing the manuscript. EA-H, SEA and TA were involved in finalising the manuscript provided technical and scientific inputs in preparing the final draft. All authors have contributed to this manuscript and all authors reviewed and approved the final version of the manuscript.

**Funding** Unicef.

**Disclaimer** The views, opinions, assumptions or any other information set out in this article are solely those of the authors and should not be attributed to Unicef or any person connected with Unicef.

**Competing interests** None declared.

**Patient consent for publication** Parental/guardian consent obtained.

**Ethics approval** This study was approved by the Research Review Committee and the Ethical Review Committee of icddr,b and the PATH Research Determination Committee.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data sharing statement** Data that support findings are restricted to authors who have permission from the Research Administration, icddr,b, and so are not publicly available. For further information regarding access, please contact HS (haribondhu.sarma@anu.edu.au).

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## REFERENCES

1. International Vaccine Access Center (IVAC), Johns Hopkins Bloomberg School of Public Health. Pneumonia and Diarrhea Progress Report 2015: Sustainable Progress in the Post-2015 Era. 2015. Retrieved from [www.jhsph.edu/research/centers-and-institutes/ivac/resources/IVAC-2015-Pneumonia-Diarrhea-Progress-Report.pdf](http://www.jhsph.edu/research/centers-and-institutes/ivac/resources/IVAC-2015-Pneumonia-Diarrhea-Progress-Report.pdf) (accessed on 25 Oct 2017).
2. The united nations children's fund. Statistics. Retrieved on 15 March.
3. World Health Organization. Revised WHO classification and treatment of childhood pneumonia at health facilities: Evidence summaries. WHO 2014.
4. Chopra M, Mason E, Borrazzo J, *et al*. Ending of preventable deaths from pneumonia and diarrhoea: an achievable goal. *Lancet* 2013;381:1499–506.
5. Costelloe C, Metcalfe C, Lovering A, *et al*. Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: systematic review and meta-analysis. *BMJ* 2010;340:c2096.
6. Kardas P. Patient compliance with antibiotic treatment for respiratory tract infections. *J Antimicrob Chemother* 2002;49:897–903.
7. Jonathan HGE, Stoltenberg RHJ. *UN commission on life-saving commodities for women and children*. New York:United Nations, 2012. [http://unfpa.org/webdav/site/global/shared/images/publications/2012/Final%20UN%20Commission%20Report\\_14sept2012.doc](http://unfpa.org/webdav/site/global/shared/images/publications/2012/Final%20UN%20Commission%20Report_14sept2012.doc). (Accessed on 1 Nov 2017).
8. Unicef Supply Division. Amoxicillin dispersible tablets: Product profile, availability and guidance. 2013. Retrieved from [https://www.unicef.org/supply/files/Amoxicillin\\_DT\\_Product\\_Profile\\_and\\_Supply\\_Update.pdf](https://www.unicef.org/supply/files/Amoxicillin_DT_Product_Profile_and_Supply_Update.pdf) (Accessed on 1 Nov 2017).
9. In: Brown MT, Bussell JK, eds. *Medication adherence: WHO cares?* Mayo Clinic Proceedings: Elsevier, 2011.
10. Raynor DK. Medication literacy is a 2-way street. *Mayo Clin Proc* 2008;83:520–2.
11. Kindig D, Affonso D, Chudler E, *et al*. *Health Literacy: a Prescription to End Confusion*. Washington, DC: Institute of Medicine of the National Academies, 2004.
12. Martin LR, Williams SL, Haskard KB, *et al*. The challenge of patient adherence. *Ther Clin Risk Manag* 2005;1:189–99.
13. Hussain SM, Boonshuyar C, Ekram A. Non-adherence to antihypertensive treatment in essential hypertensive patients in rajshahi, Bangladesh. *Anwer Khan Modern Medical College Journal* 2011;2:9–14.
14. Ebels K, Faulx D, Gerth-Guyette E, *et al*. Optimising adherence to childhood pneumonia treatment: the design and development of patient instructions and a job aid for amoxicillin dispersible tablets. *Arch Dis Child* 2016;101:57–62.
15. Kessels RP. Patients' memory for medical information. *J R Soc Med* 2003;96:219–22.
16. Dowse R, EHLERS MS. Pictograms in pharmacy. *Int J Pharm Pract* 1998;6:109–18.
17. Zimmerman ML, Perkin GW. Instructing through pictures: Print materials for people who do not read. *Information Design Journal* 1982;3:119–34.
18. Rothstein JD, Jennings L, Moorthy A, *et al*. Qualitative assessment of the feasibility, usability, and acceptability of a mobile client data

- app for community-based maternal, neonatal, and child care in rural ghana. *Int J Telemed Appl* 2016;2016:1–14.
19. Kurumop SF, Bullen C, Whittaker R, *et al.* Improving health worker adherence to malaria treatment guidelines in Papua New Guinea: feasibility and acceptability of a text message reminder service. *PLoS One* 2013;8:e76578.
  20. Edson W, Boucar M, Koniz-Booher P, *et al.* Operations research results. Published for usaid by the quality assurance project. 2004. Available at: <https://www.usaidassist.org/sites/assist/files/nigerjobaids.pdf> (Accessed on 2 Nov 2017).
  21. Sarma H, Oliveras E. Improving STI counselling services of non-formal providers in Bangladesh: testing an alternative strategy. *Sex Transm Infect* 2011;87:476–8.
  22. Gouws E, Bryce J, Habicht JP, *et al.* Improving antimicrobial use among health workers in first-level facilities: results from the multi-country evaluation of the Integrated Management of Childhood Illness strategy. *Bull World Health Organ* 2004;82:509–15.