Impact on mortality of a community-based programme to control acute lower respiratory tract infections*

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Acute lower respiratory tract infections (ALRIs) are a major cause of death among young children in developing countries. A targeted programme designed to treat children with ALRI was implemented in 1988 in a primary health care project in rural Bangladesh. In the 2 years preceding the introduction of the programme (1986–87), non-ALRI-specific health services were provided, including promotion of oral rehydration therapy, family planning, immunization of children and mothers, distribution of vitamin A, referral of severely sick children to field clinics, and nutritional rehabilitation of malnourished children. The targeted ALRI programme, which was in place in 1988–89, was based on systematic ALRI case detection and management by community health workers, who were linked to a referral system for medical support. These two levels of intervention have been evaluated by comparing the ALRI-specific mortality in the programme area and a neighbouring control area during the two periods.

During the first phase (1986–87), the ALRI mortality among under-5-year-olds was 28% lower in the intervention than in the comparison area (P<0.01). During the second phase (1988–89), the ALRI mortality was 32% lower in the intervention area than during the preceding phase, while there was no significant difference for the comparison area. These findings suggest that in the study region the combination of specific and nonspecific interventions can reduce ALRI mortality by as much as 50% and the overall mortality among under-5-year-olds by as much as 30%.

Acute lower respiratory infections (ALRIs) cause the death of 4 million under-5-year-olds annually in the world, and in developing countries they are associated with a third of all deaths in childhood (*1–4*). However, ALRI control has only recently been promoted as a component of child survival programmes. WHO has developed guidelines to treat acute respiratory infections (ARIs) at the primary health care level, using community and first-level health workers to detect cases, assess the severity, and provide antibiotic treatment at home or refer severely affected children to a field health centre (*5, 6*).[a] The WHO approach is based on the assumption that a substantial proportion of life-threatening ALRIs are bacterial and respond to antimicrobials (*7, 8*).

A number of field trials have evaluated the effect of community-based ALRI treatment on mortality (*9–11*).[b] However, the relative impacts on ALRI mortality of a general primary health care programme and of a specific case-management programme have never been clearly evaluated.[b]

We have implemented sequentially these two types of programmes in Matlab, the field station of the International Centre for Diarrhoeal Disease Research, Bangladesh. The results obtained permit comparison of their respective and cumulative effects on ALRI mortality.

Subjects and methods

Study area

Matlab is a rural subdistrict of the large Ganges–Meghna delta, approximately 50 km southeast of Dhaka, the capital of Bangladesh. This flood-prone area is typical of rural Bangladesh, with its lack of infrastructure and limited communication facilities. The population subsists mainly by rice cul-

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[a] *Case management of acute respiratory infections in children in developing countries: report of a Working Group meeting, Geneva, 3–6 April 1984.* Unpublished document WHO / RSD / 85.15.Rev.2.

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[b] *Programme for the Control of Acute Respiratory Infections: report of the fourth meeting of the Technical Advisory Group, Geneva, 6–10 March 1989.* Unpublished document WHO / ARI / 89.4, pp. 10-11.

tivation, fishing, and through wage-labour. The literacy rates are 30% for men and 17% for women; in 1986 the total fertility was 5.5 per woman and the infant mortality, 93 per 1000 live births.

Demographic surveillance and assessment of cause of death

A demographic surveillance system (DSS) was instituted in Matlab in 1966, combining periodic censuses and longitudinal reporting of births, deaths, marriages, and migrations in a population that was approximately 200 000 at the time of the present study (*12*).

A total of 110 female community health workers (CHWs) visit each household in their village once every two weeks, and report deaths to their supervisors. Whenever a death is reported, a health assistant visits the family within a month and fills in a form with details of the symptoms and events preceding the death. The forms are then read by a medical assistant, who assigns the primary and underlying causes of death, under the supervision of a physician (*13*). This assignment is not based on the use of algorithms, as is the case with lay health workers, but on diagnoses made by medically trained persons. The causes of death are coded according to a system derived from the International Classification of Diseases (*14*). Although this system had no separate codes for deaths primarily attributed to pneumonia or bronchiolitis, such deaths were classified as ALRI in the study. There were, however, distinct codes for deaths caused by pertussis and post-measles pneumonia, and they were included in the study.

Health services in the study area

In 1978, a community-based family planning and health services project was launched in one half of the DSS study area (the intervention area), whose original goal was to increase contraceptive use and reduce fertility and mortality (*15*); however, since 1986 the development of maternal and child health (MCH) interventions has been emphasized (*13*).

The other half of the DSS study area (the comparison area) receives only government health services. Its primary health care services are somewhat limited, with poor coverage and utilization.

The key providers of health services in the intervention area are the village CHWs. These individuals deliver a range of family planning methods, monitor and manage adverse effects of contraceptives, administer vaccines for the six common childhood diseases, promote the use of oral rehydration therapy for diarrhoea, distribute vitamin A capsules, provide nutritional education, and detect and refer seriously ill or malnourished children for care at a higher level. Seriously ill children are referred to one of four decentralized MCH clinics staffed by paramedics or to the central Matlab clinic, where at least one MCH physician is always available.

The specific ALRI intervention

Training of health workers. In January 1988, the CHWs were trained to detect children with ALRIs, assess the severity, and treat or refer them. At the initial training session the workers received a copy of a local version of the WHO guidelines for management of ALRIs. Slides produced by WHO were translated into Bangla, the local language, and shown to help workers identify signs of ALRI. Lastly, the CHWs, were given case demonstrations of ALRIs in the field by their paramedic supervisors. The paramedics had previously received similar training, but were given practical experience by carrying out rotational duties in Matlab and by working with physicians in the clinic and hospital.

Diagnosis of ALRIs. The CHWs carried out active case detection during scheduled house visits, while passive detection occurred when they were informed of cases in their village during the intervals between their visits. A diagnosis of severe ALRI was based on the presence of chest retractions with a respiratory rate greater than 50 per minute. Children with associated signs of severe disease, including high fever, convulsions, extreme lethargy, or inability to suck or drink, were also diagnosed as having severe ALRI. Moderate cases were defined as those with a respiratory rate greater than 50 per minute without chest retractions or other signs of severe disease. Children presenting with only a cough and/or low-grade fever were diagnosed to have mild ARI.

Case management. All cases diagnosed as severe were referred to Matlab for evaluation and management by medical officers. All neonates, children with a cough that had lasted for more than 30 days, and children with a wheeze or stridor were also referred to Matlab. After assessment by the physician, the ALRI cases that were considered to be severe were admitted to hospital for treatment with oxygen and, if necessary, intravenous antibiotics.

When the project was initiated, one intention was to examine, for similar cases, the impact of home treatment on children with moderate ALRI compared with that following referral to the subcentre clinic. Therefore, in one half of the intervention area, moderate ALRIs were managed by CHWs at home using five daily injections of procaine penicillin in doses of 400 000–800 000 IU, depending on age. In the other half of the intervention area, moderate cases were treated in the subcentre clinics with ampicillin syrup. Since ALRI mortality was not different in the two subareas in the 2 years following initiation of the project in 1986, the data from them were pooled for the analysis. All the facilities were provided with drugs and equipment to manage potential adverse reactions caused by the antibiotics, but no such reactions were reported.

Mild cases were not managed with antibiotics, but were given supportive care. The mothers of these children were advised about worsening signs and symptoms and asked to seek help if any of these developed.

Supervising and monitoring the CHWs. The CHWs were supervised in the field by paramedics, who provided technical support. The workers attended fortnightly meetings with their supervisors, to report the numbers of cases detected and case-management methods, and to discuss problems and referrals.

Concurrent activities in the intervention area. The only other new service introduced in one half of the intervention area during the study period was a maternity care project that was initiated in April 1987. This project targeted pregnant women and would not be expected to have had an impact on ALRI-specific deaths among under-5-year-olds. The addition of the ALRI case-management component was therefore the only difference in child health services between the two phases (1986–87 and 1988–89) in the intervention area.

Programme monitoring and analysis

The methods used to detect vital events and assess the cause of death were identical in both study areas. In the intervention area, the CHWs also recorded morbidity information along with details of the services provided. The outcome of these interventions was analysed by comparing ALRI-specific mortality rates within the following age groups: all children aged under 5 years; children aged 1–4 years; and post-neonates aged 1–11 months (excluding neonates because of difficulties in diagnosing under-1-month-olds). The rates were calculated by dividing the number of ALRI deaths in each period and area by the number of child-years of exposure to the risk of ALRI death. The total number of child-years was obtained by adding the mid-year populations of children in each year.

Standard Mantel–Haenszel tests for person–time comparisons were used to assess the statistical significance of the differences in mortality rates between areas and between periods. A χ^2 test for heterogeneity, based on stratification of rate-ratios, was used to evaluate the differences in rates between periods, while stratifying by area (*16*).

Results

Table 1 shows the coverage rates for various maternal and child health and family planning services (MCH–FP), other than specific ALRI control, during the pre- and post-intervention periods in the intervention and comparison areas. Immunization and family planning were the services that exhibited the greatest differences in use between the two areas.

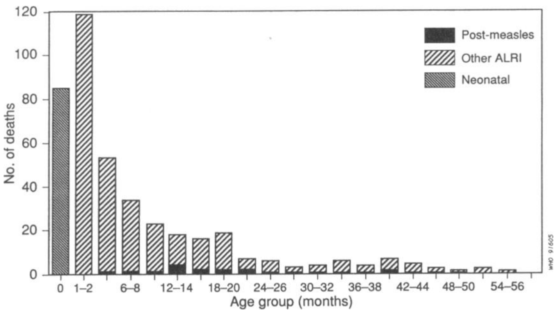
Table 1: **Coverage rates for maternal and child health services during the pre- and post-intervention periods in the two study areas, Matlab ALRI control project, 1986–89**[a]

	Comparison area	Intervention area
Measles immunization coverage (% of children aged 9–59 months) in:		
1986–87	2–5 [b]	69
1988–89	13 [b]	81
DPT–polio coverage (3 injections) (% of children aged 6 weeks–2 years) in:[c]		
1986–87	1–2 [b]	57
1988–89	5–9 [b]	64
Vitamin A distribution coverage (% of children aged 6–59 months) in:		
1986–87	90	96
1988–89	88	95
Contraceptive use (% of eligible couples) in:		
1986–87	18 [b]	47
1988–89	22 [b]	52
Admission rate to Matlab diarrhoea hospital (% of under 5-year-olds) in:		
1986–87	4.4	4.7
1988–89	5.7	6.3
Mean weight for age (% of NCIH standards for children aged 6–47 months) in:		
1986–87	NA [d]	NA [d]
1988–89	74 [b]	73

[a] Whenever possible, the rates shown are those for the mid-period point.
[b] Estimated from nationwide surveys.
[c] DPT = diphtheria–pertussis–tetanus.
[d] NA = not available.

During the 4 years covered by the study, the deaths of 649 under-5-year-olds were reported as ALRI deaths in the whole study area. The age distribution of 417 such deaths that occurred in the comparison area in 1986–89 (Fig. 1) is strongly skewed towards younger age groups, with 61% involving under-6-month-olds. With the exception of deaths from post-measles pneumonia, the age-distribution

Fig. 1. **Age distribution of deaths from acute lower respiratory infections in the Matlab comparison area, 1986–89.**



of ALRI deaths in the intervention area prior to the start of the programme was very similar for all causes, with 69% of deaths occurring among under-6-month-olds.

During the first 2-year phase of the programme, the ALRI-specific mortality rate for all children under 5 years of age was 28% lower in the intervention than in the comparison area (P <0.01, Table 2). In the second 2-year phase, over 3000 ALRI episodes were reported by CHWs and other health workers in the intervention area, 57% of which were seen and managed by the CHWs (73% at their own home and 27% at the patient's home), 35% were treated by village practitioners, 6% were not treated, while 2% were lost to follow-up. The ALRI-specific mortality rate among under-5-year-olds was 48% lower in the intervention than in the comparison area (P <0.001). This difference was responsible for one third of the 30% lower overall mortality among under-5-year-olds in the intervention than in the comparison area (211 versus 30.7 per 1000; see Table 3).

Within the intervention area, the ALRI-specific death rate was 32% lower during the second phase of the programme than during the first (P = 0.003, Table 2). In contrast, the rate decreased by 6% in the comparison area (not significant). The difference in the reduction of ALRI-mortality was, however, found to be significant when the risk of dying from ALRI in the two areas was compared for the two phases (χ^2 test for heterogeneity: 4.1, P < 0.05).

The mortality patterns varied according to age group. During the first phase, for children aged 1–4 years, the ALRI-specific death rate in the intervention area was half that in the comparison area. Although it was halved again during the second phase, the reductions in the ALRI-specific death rates in the two areas were not significantly different between the two phases (χ^2 test for heterogeneity = 0.6, Table 2).

Among infants aged 1–11 months (post-neonates), the ALRI-specific death rate during the first phase was not significantly lower in the intervention than in the comparison area, but in the intervention area was 30% lower during the second phase than during the first (P < 0.05, Table 2). The difference in the reduction between the two areas was of border-

Table 2: **ARLI-specific mortality during the two phases of the Matlab ALRI control programme, 1986–89**

	Comparison area		Intervention area		% difference in rates between the areas
	No. of ALRI deaths	Rate[a]	No. of ALRI deaths	Rate[a]	
All under-5-year-olds					
1986–87	210/32 237	6.5	136/29 011	4.7	– 28; P < 0.01
1988–89	207/33 679	6.1 (– 6; NS)[b]	96/30 350	3.2 (– 32; P < 0.01)	– 48; P < 0.001
χ^2 test for heterogeneity 4.1, P = 0.04					
Children aged 1–4 years					
1986–87	61/24 560	2.5	27/22 331	1.2	– 52; P < 0.01
1988–89	42/25 701	1.6 (– 36; P < 0.05)	14/23 700	0.6 (– 50; P < 0.05)	– 63; P < 0.001
χ^2 test for heterogeneity 0.6, NS					
Infants aged 1–11 months (post-neonates)					
1986–87	108/6979	15.5	79/6057	13.0	– 16; NS
1988–89	116/7238	16.0 (+ 3; NS)	56/6136	9.1 (– 30; P < 0.05)	– 43; P < 0.001
χ^2 test for heterogeneity 3.4, P = 0.06					

[a] Per 1000 child-years of exposure.
[b] Figures in parentheses are the percentage change in mortality rates between the two periods; NS = not significant.

line statistical significance (χ^2 test for heterogeneity = 3.4, $P = 0.06$).

The death rates for causes other than ALRI and for all causes are shown in Table 3. The former rates were lower in the intervention than in the comparison area, both for all under-5-year-olds and those aged 1–4 years, but not for post-neonates who died aged 1–11 months. In both areas and for all age groups, death rates from causes other than ALRI decreased during the second phase of the programme, ruling out any "replacement" phenomenon in the assignment of cause of death during the second phase. None of the differences in the reduction of non-ALRI mortality or overall mortality was significant between the two periods after stratifying by area, making it unlikely that the decline in ALRI-specific mortality was merely part of a secular trend.

Discussion

Our findings suggest that the nonspecific MCH–FP interventions reduced ALRI mortality among under-5-year-olds by one fourth and that the additional specific community-based ALRI treatment programme reduced it further by one third. It is not surprising that the impact of the targeted intervention was particularly marked in post-neonates, in view of the importance of ALRI as a cause of death among this age group.

The study was not designed by randomly allocating children to treatment and control groups. Rather, it was based on comparisons of mortality between areas and its results therefore do not necessarily imply that the reduction in mortality in the intervention area was caused by the intervention itself. However, geographical, socioeconomic, demographic and mortality data collected before the beginning of the MCH programme suggest that the two study areas were comparable (*17*) and that observed differences can reasonably be attributed to the intervention. This is reinforced by the observation that the decline in ALRI-specific mortality was statistically significant, while the decline in mortality due to other causes was not.

The enumeration of deaths and exposed populations was probably exhaustive in the study, because of the intensive supervision of demographic surveillance in Matlab. The "verbal autopsy" method used to determine the cause of death does, however, result in possible misclassification of some causes of death. In this respect malaria is often difficult to distinguish from ALRI, but is very rare in the study area. The lack of clear criteria to diagnose death from neonatal pneumonia through verbal autopsy prevented the inclusion of neonatal deaths in the analysis. Since 95% of all child deaths take place at home without medical attendance, and necropsies are impossible to perform, there was no systematic validation of the diagnoses made.

Because the assignment of the cause of death was not specifically designed for the study, and was independent of the intervention itself, in making their diagnoses the medical assistants and physicians were unlikely to be biased. Moreover, the decrease of deaths from other causes in both study areas rules out any spurious replacement of ALRI by such causes.

The selective impact of the two phases of the programme on different age groups supports the hypothesis that the programme itself was the cause

Table 3: **Mortality rates (per 1000 child-years of exposure) from non-ALRI causes and from all causes during the two phases of the Matlab ALRI control programme, 1986–1989[a]**

	Comparison area		Intervention area	
	Non-ALRI causes	All causes	Non-ALRI causes	All causes
All under-5-year-olds				
1986–87	29.0	35.5	22.5	27.2
1988–89	24.5 (– 15)[b]	30.7 (– 14)	17.9 (– 21)	21.1 (– 23)
Children aged 1–4 years				
1986–87	15.1	17.6	9.9	11.1
1988–89	11.0 (– 27)	12.6 (– 28)	6.2 (– 37)	6.8 (– 38)
Infants aged 1–11 months (post-neonates)				
1986–87	27.5	43.0	27.2	40.3
1988–89	25.2 (– 9)	41.2 (– 4)	24.9 (– 9)	34.1 (– 15)

[a] χ^2 tests for heterogeneity for the comparison between non-ALRI mortality rates in the intervention and comparison areas were not significant.

[b] Figures in parentheses are the percentage change in mortality rates between the two periods.

of the observed differences in ALRI mortality. At least the three following nonspecific components of the MCH–FP programme during the first phase might have contributed to the lower mortality from ALRI and other causes among 1–4-year-olds: immunization, through its effect on measles and pertussis; referral and treatment of severely sick children at the field clinics; and family planning, which resulted in fewer children, less crowding, and prolonged breast-feeding. Of these, measles vaccination was likely to have had the greatest impact on mortality from ALRI (*18–20*). In the comparison area the reductions of 36% in ALRI-mortality and 27% in non-ALRI mortality between the two periods are probably also explained in these terms: an increase in immunization coverage and family planning services occurred in the comparison as well as in the intervention area (Table 1), while the availability and use of village practitioners also increased over time (*21*).

Infants aged 1–11 months seem to be the age group with the highest potential for reduction in ALRI mortality through a specific control programme. Such deaths amounted to 36–40% of all deaths in this age group, and, compared with children aged 1–4 years, the scope for mortality reduction through the use of conventional vaccines at 1–11 months of age is somewhat limited (*20*). As shown in Table 3, the other components of the MCH–FP programme appeared not to have had much influence on the post-neonatal death rate from causes other than ALRI. Moreover, anthropological data reveal that mothers in Bangladesh are less likely to seek allopathic treatment outside the home for young infants than for older children. Therefore, infants with ALRI may have benefited more from home treatment (M.K. Stewart et al., unpublished observations, 1990).

In view of the staffing and financial constraints on the health programme in Bangladesh, we recommend that a modified version of this experimental project be implemented as follows:

— physicians and nurses at the referral hospitals should receive training on the clinical management of severe cases and be provided with reliable supplies of antibiotics and oxygen-delivery equipment;
— medical assistants and family welfare visitors posted at union level should be trained and properly supplied with ampicillin or sulfamethoxazole + trimethoprim for the management of ALRI cases as outpatients;
— village-level workers should be trained to recognize ALRI cases and to inform families about the risks, symptoms, and treatment possibilities; and
— home treatment with injectable penicillin should be replaced by sulfamethoxazole + trimethoprim paediatric tablets, which are easier to handle and less expensive.

An ongoing modification of the Matlab project along these lines should provide more insight into its feasibility.

In conclusion, ALRI control programmes, through their specific and nonspecific components, emerge as most promising elements of child survival strategies. The impact of such programmes is particularly important among under-1-year-olds, although their effect on neonatal mortality has still to be assessed. While the implementation of a such a targeted programme on a large scale may not produce the same level of impact in the short term, it can still be expected to result in significantly fewer deaths from ALRI.

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Résumé

Impact sur la mortalité d'un programme à base communautaire de lutte contre les infections aiguës des voies respiratoires inférieures

Dans les pays en développement, les infections aiguës des voies respiratoires inférieures (ALRI) sont responsables d'un tiers de l'ensemble des décès chez les jeunes enfants. L'OMS a récemment élaboré des directives sur le traitement des infections respiratoires aiguës au niveau des soins de santé primaires. Un programme ciblé conçu pour le traitement des enfants atteints d'ALRI a été mis en place en 1988 dans le cadre

d'un projet de soins de santé primaires dans une zone rurale du Bangladesh. Au cours des 2 ans précédant la mise en place du programme (1986–1987), des services de santé non spécifiques des ALRI ont été fournis, avec notamment la promotion de la thérapie par réhydratation orale, la planification familiale, la vaccination des enfants et des mères, la distribution de vitamine A, l'envoi des cas graves dans un dispensaire, et la réadaptation nutritionnelle des enfants souffrant de malnutrition. Le programme ciblé sur les ALRI, mis en place en 1988–1989, était fondé sur la détection systématique des cas d'ALRI et leur prise en charge par les agents de santé communautaires, eux-mêmes reliés à un système de recours en cas de besoin. Ces deux niveaux d'intervention ont été évalués par comparaison de la mortalité spécifique des ALRI au cours des deux périodes—1986–1987 et 1988–1989—dans la zone couverte par le programme et dans une zone voisine prise comme témoin. Les causes de décès ont été évaluées indépendamment de l'étude selon les mêmes critères dans les deux régions, au moyen d'une procédure d'"autopsie verbale", qui consiste à interroger rétrospectivement les soignants et à analyser les symptômes rassemblés. En raison d'incertitudes quant au diagnostic de la pneumonie néonatale par une telle méthode, les ALRI du nouveau-né n'ont pas été incluses dans l'étude.

Les décès dus aux ALRI frappaient les très jeunes enfants, 61% survenant chez les nourrissons de 1 à 6 mois. Lors de la première phase de l'étude (1986–1987), la mortalité spécifique des ALRI chez les moins de 5 ans était inférieure de 28% dans la zone d'intervention à sa valeur dans la zone témoin (4,7 pour 1000 enfants contre 6,5, P<0,01). Au cours de la deuxième phase (1988–1989), ce taux était dans la zone d'intervention inférieur de 32% au taux de la phase précédente (3,2 pour 1000 contre 4,7, P<0,01), alors qu'il n'y avait aucune différence significative entre les deux périodes dans la zone témoin. Les différences d'une phase à l'autre étaient particulièrement sensibles chez les enfants de 1 à 11 mois, ce qui laisse à penser que l'impact de ce type de programme est plus grand chez les nourrissons (nouveau-nés exceptés) que chez les enfants plus âgés. Il semble que chez les enfants âgés de 1 à 4 ans, les interventions de soins de santé primaires non spécifiques (par exemple vaccination, planification familiale, envoi des cas graves dans un dispensaire) aient un impact significatif sur la mortalité par ALRI, mais qui n'est que très peu amélioré par les interventions spécifiques. D'après nos observations, il semble que dans cette région, l'association d'interventions spécifiques et non spécifiques des ALRI puisse réduire d'au moins 50% la mortalité par ALRI, et d'au moins 30% la mortalité globale chez les moins de 5 ans. Ces interventions devront donc recevoir la priorité dans les programmes de soins de santé primaires.

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