Reduction in pneumonia mortality and total childhood mortality by means of community-based intervention trial in Gadchiroli, India

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In a community-based intervention trial to reduce childhood mortality from pneumonia the intervention area included 58 villages (6176 children aged 0–4 years) and the control area 44 villages (3947 children) in Gadchiroli, India. The interventions included mass education about childhood pneumonia and case-management of pneumonia by paramedics, village health workers, and traditional birth attendants (TBAs) who were trained to recognise childhood pneumonia and treat it with co-trimoxazole. Parents sought treatment, and coverage was 76% without active case-detection efforts. The case-fatality rate among the 612 cases treated by health workers was 0·8%, compared with 13·5% in the control area. After a year of intervention pneumonia-specific childhood mortality was significantly lower in the intervention than in the control area (8·1 vs 17·5 deaths per 1000 children under 5 years); the difference between the areas was greatest in children under 1 year. The differences in infant mortality (89 vs 121 per 1000) and total under-5 mortality (28·5 vs 40·7 per 1000) were highly significant. Mortality from other causes remained similar in the two areas but neonatal mortality due to birth injury and prematurity was significantly lower in the intervention area, presumably owing to the combination of better maternal and neonatal care by the TBAs trained in the project and the availability of treatment for pneumonia. The cost of co-trimoxazole was US $0·025 per child per year ($2·64 per child saved).

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Introduction

Pneumonia accounts for more than 25% of deaths in children under 5 years (about 4 million deaths per year); two-thirds of these occur in infancy and more than 90% in developing countries.[1] Although the incidence of upper respiratory infections in children is similar in the developed and the developing countries, the mortality from lower respiratory infections is at least thirty times greater in the developing countries.[1] Since pneumonia accounts for most of these deaths, we have taken it as a practical equivalent of acute lower respiratory infections. The most common causative organisms of pneumonia in children are *Streptococcus pneumoniae* and *Haemophilus influenzae*.[2] After a report on detection and treatment of pneumonia in children by medical auxiliaries[3] the World Health Organisation recommended this case-management approach for further research.[4] The findings that a respiratory rate of more than 50 per min is a reliable criterion for diagnosis of pneumonia in a child with cough[5] and that careful observation of respiratory rate and movements is generally more reliable than auscultation with a stethoscope in assessing the severity of respiratory infection in children[6] suggested the possibility of training non-physicians in the case-management of childhood pneumonia in rural areas.

The technical advisory group of the WHO has lately reviewed the results of seven studies (two published[7,8] and five unpublished)[9] which have used a case-management approach to control childhood mortality from pneumonia. They identified three types of limitations of these studies: in the absence of active case-detection of pneumonia by periodic household visits to all children by the health worker results were poor; simultaneous introduction of other interventions (control of diarrhoeal diseases, immunisation, nutritional care, treatment of malaria) made it difficult to evaluate the usefulness of the case-management approach; and though the rate of deaths from pneumonia fell, the infant mortality rate did not fall significantly or could not be measured. Thus, proof of the usefulness of case-management in reducing childhood mortality in rural populations has been lacking. Neonatal pneumonia and neonatal mortality have remained the main problems without effective solutions.

In this study we have tried to overcome most of these limitations. We studied the morbidity and mortality from acute respiratory infections in children under 5 years old in a rural area and aimed to develop a feasible and effective population-based intervention to reduce pneumonia mortality by at least 30% in 2 years by means of the case-management approach.

Subjects and methods

The study was carried out in the Gadchiroli district, in the central part of India. This is an undeveloped area with low income, low rates of literacy, and poorly developed health services provided by the Government through one primary health centre for approximately 20 000 people. One male and one female paramedic worker per 3000 population provide the rural outreach. The Government agreed to allow SEARCH (Society for Education, Action and Research in Community Health) to carry out the population trial involving the paramedic workers of the primary health centre in the intervention against childhood pneumonia.

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The necessary sample size was calculated to be 4000 children aged 0–4 years for 2 years in the intervention and control areas ($\alpha = 0.05$, two-tailed, baseline proportion of children dying of pneumonia $= 0.01$, minimum difference to be detected $= 30\%$). Assuming 12% of the population to be under 5 years old, the total population needed in each area was 32 000.

A contiguous area of 120 villages previously not served by SEARCH was selected as the study area. Within it, an area covered by two primary health centres was designated as the intervention area, since the area served by one primary health centre was insufficient to provide the necessary sample size. The intervention area therefore had a larger than necessary population. Two parts of the study area, on either side of the intervention area, were designated the control area. Since primary health centres in the control area were not involved in the trial, it did not have to correspond to a primary health centre area and could be limited to the necessary sample size. The intervention and control areas were similar in their socioeconomic characteristics and health services and were a continuous area except for "buffer" zones of a few villages.

A preliminary census of both areas was carried out in August, 1987, with the help of 200 village volunteers, 43 of whom were selected for further work with the project as part-time village health workers (VHWs: 25 intervention area, 18 control area). Each VHW had on average 2000 people in 2·4 villages to look after. They carried out a repeat census in December 1987, and prepared a population register and a list of children under 5 years old in each village. All births and deaths of children under 5 years old were recorded by the VHWs; they were paid for each recorded and verified birth or death. In addition to this prospective recording, a house-to-house survey was conducted every 6 months by the VHW from another village to detect missed births and deaths. These two methods together provided 98% complete reporting of births and childhood deaths in the intervention and control areas; the estimate of 2% missed was made by the Chandrasekar-Deming method.[10]

Field supervisors with at least 12 years' schooling were trained in the projects. They visited each VHW once every 15 days. They verified all births and childhood deaths and carried out an inquiry about the cause of death by means of a pretested structured questionnaire. This method (called verbal autopsy) was developed in the Narangwal projects to determine the cause of childhood death where medical certification of death is non-existent.[3] Since then, various symptoms have been evaluated for making simplified diagnosis of illness and validated with a physician's diagnosis as the reference.[5,11-13] The method of determining the cause of death has been validated[14-16] and widely used in various field studies of childhood pneumonia and childhood mortality.[7-9,16,17] The supervisors practised the technique on children in hospital for 4 weeks before using it in the field. A physician (A. B.) went through the completed proformas and in discussion with the supervisors decided the cause of death. A minimum list of causes of childhood death was prepared from the WHO guidelines[18] with modifications. Criteria for determining each cause were decided. Local terms commonly used to describe respiratory problems were investigated through a survey on 300 rural women and men, besides many unstructured discussions. "Dabba" is a non-specific term for respiratory and abdominal disorders, "dama" means recurrent or chronic breathlessness, and "chipad odhane" intercostal indrawing. "Lahak" and "dhapa" were consistently used to describe visible tachypnoea. The criteria for diagnosing pneumonia as the cause of death were taken as cough and at least 6 h continuous tachypnoea ("lahak" or "dhapa") before death. In newborn infants the presence of cough was not an essential criterion. A video film on childhood pneumonia produced by the WHO helped develop common understanding of what was meant by tachypnoea. When a history of tachypnoea was reported by parents during the cause of death inquiry, it was confirmed by the supervisor who demonstrated tachypnoea. In hospital-based studies a mother's report of her child's breathlessness came close to the physician's diagnosis of pneumonia.[5,11]

Up to three causes of death and one associated disorder were diagnosed when present.[19] When there was more than one cause of

death, we attempted to decide which was the primary or underlying cause of death, but this is arbitrary when many childhood deaths have multiple causes (eg, prematurity and pneumonia, malnutrition and diarrhoea). The difficulties of trying to determine a single underlying cause instead of using multiple causes have been recognised.[9,16,19-21] Attribution of death to a single cause is also against the modern understanding of causality. We therefore decided to include all causes of death in the mortality analysis.

The vital statistics registration and methods of determining cause of death were field-tested and corrected in an initial pilot period, and the intervention and data collection then went smoothly into operation from July 1988.

43 villages (25 intervention area, 18 control area, uniformly distributed) in which VHWs lived were selected for a morbidity study. From the list of 0–4-year-old children prepared in December 1987, 17 children in each village were randomly selected by means of numbers drawn from random tables. 39 of the selected children had to be excluded because they were 5 years old by the time the morbidity study started in July 1989. 692 children remained in the study (about 15 per village). Each VHW visited the same 15 children once a fortnight and asked whether any upper respiratory infection (cough and/or nasal discharge) or pneumonia (cough with tachypnoea) had occurred. The source of care, if any, and the outcome of the attack were recorded. Children were weighed twice a year.

The intervention was started on July 1, 1988, and is continuing. It included mass health education about childhood pneumonia and case-management of pneumonia in the intervention villages. Training of traditional birth attendants (TBAs) for better maternity and neonatal care was added in 1989. Primary health care and immunisation (including measles vaccine) were provided in both areas by the Government primary health centres and were similar.

In the mass health education four messages were given: cough in a child without fast breathing or difficulty in breathing is simple and can be managed at home without special medicines; fast breathing and/or difficulty in breathing may indicate pneumonia, which is life-threatening; treatment for pneumonia is available in your village with the paramedic, VHW, or TBA (their names were announced); the medicine is called "kotra" (for co-trimoxazole) which is effective, safe, and available free.

The health education was carried out by means of a set of flash cards used by paramedics, VHWs, and TBAs in the villages; a wall poster (SEARCH); a slide show (prepared by SEARCH and by Teaching Aids at Low Cost, UK); a video cassette on "child with

TABLE I—POPULATION CHARACTERISTICS IN INTERVENTION AND CONTROL AREAS*

	Control	Intervention
No of villages	44	58
Total population†	34 856	48 377
Population aged 0–4 yr†	3947	6176
Percentage lower castes (scheduled castes and tribes)	33·0	33·8
Female literacy (%)	25·7	27·3
Birth rate/1000*	30·1	31·7
0–4 yr children with third-degree malnutrition (%)†	14·6	15·2

*July 1988–June 1989.
†Mid-year.

TABLE II—OUTCOME OF MANAGEMENT OF PNEUMONIA CASES IN INTERVENTION AREA

Type of health-worker (n)	No of children treated	No (%)		
		Cured	Alive but no relief*	Dead
Paramedic (30)	256	252 (98·4%)	3 (1·2%)	1 (0·4%)
VHW'(25)	256	251 (98·0%)	3 (1·2%)	2 (0·8%)
TBA (80)	100	95 (95·0%)	3 (3·0%)	2 (2·0%)
Total (135)	612	598 (97·7%)	9 (1·5%)	5 (0·8%)

*Health workers advised that the child should be taken to a doctor or to hospital.

TABLE III—EXPECTED NUMBER OF PNEUMONIA CASES AND PROPORTION TREATED IN INTERVENTION AREA

—	No of children	Pneumonia attack rate* (per child year)	Expected no of pneumonia cases†	No treated	Coverage (%)‡
<1 yr	1364	0·14	191	278	146
1–4 yr	4812	0·13	626	334	53
0–4 yr	6176	0·13	803	612	76

*From morbidity study.
†Calculated from no of children and pneumonia attack rates.
‡Percentage of expected attacks treated.

cough" produced by the WHO; and a health carnival (Women's Health and Awareness Jatra) organised by SEARCH, in which 25 000 people took part.

For the case-management of pneumonia 30 paramedics from Government primary health centres and 25 VHWs in the intervention area were trained to diagnose and treat pneumonia in children. The experience was encouraging but their outreach was inadequate and case-management did not become available in about half of the villages. Moreover, in the neonatal period, when most deaths occurred, children were inaccessible because traditionally parents never take a newborn infant out of its home, even if it is sick. Only the TBAs living in each village had regular and natural access to newborn infants. We decided, therefore, to involve the TBAs in pneumonia case-management. Eighty TBAs, almost all illiterate, were trained in the intervention area. They showed keen interest, because they were being offered a curative role for the first time, and started functioning from January 1989. No active case-detection of pneumonia by home visiting was done and no incentives were offered for case-management.

Paramedics and VHWs were trained to manage children with cough by means of the algorithm suggested by WHO.[6] A respiratory rate of 50 per min or more in a child with cough was used as the diagnostic criterion for pneumonia, which was treated with co-trimoxazole syrup. Children with chest indrawing, unconsciousness, fits, or inability to drink were referred to hospital, though no special referral care was provided by the project. The TBAs could not count up to 50, so they were trained to use their visual impression of tachypnoea and difficult breathing, which was made more precise by demonstrating pneumonia cases and by the video film. The TBAs had been trained to carry out safe deliveries in a nationwide Government programme 8 years earlier, but this training was repeated and reinforced in intervention villages.

A case-record was developed which guided the workers in history-taking, examination, diagnosis, and choice of treatment. It was a powerful tool and reduced errors substantially. Paramedics and VHWs filled in a case-record whenever they treated pneumonia, but the illiterate TBAs could not use the proforma. Supervisors visited the children treated by TBAs about 15 days later, verified the correctness of the diagnosis and treatment, inquired about the outcome and any side-effects, and filled in the case-record. Errors made by the TBAs or parents were also recorded.

Co-trimoxazole in 50 ml bottles (Locost, Vadodara) was given to children with pneumonia. The advised dose was half a teaspoonful twice a day for 7 days in children under 6 months and 1 teaspoonful twice a day for 5 days in children aged 6 months–4 years.[6] Paracetamol tablets were given for fever above 100°F (37·7°C) and

salbutamol tablets for wheezing by paramedics and VHWs but not by TBAs. The TBAs were given antiseptic lotion, clean blades, and nipple shields to be used in deliveries and neonatal care. Avoiding the use of popular brand names of co-trimoxazole and popularising a new name, "kotra", created an impression among people, health workers, and even local rural practitioners that this was a special medicine for pneumonia only. This belief was vital in preventing misuse of co-trimoxazole for other illnesses.

The community was informed about and involved in all stages of development of the programme, which was important in generating demand, the use of case-management services, and collection of mortality statistics. The data were analysed on a microcomputer with the SPSS/PC program. Probability values were calculated by means of the chi-square with continuity correction, or, when the values in the cell were less than 5, by Fisher's exact test.

Results

The control and intervention areas were similar in relevant characteristics (table I).

In the morbidity study in 692 children (July 1988–June 1989) the attack rate of upper respiratory infections (cough or nasal discharge) was 6·47 per child per year (95% confidence interval [CI] 6·30–6·63) and that of pneumonia was 0·13 (0·09–0·17) per child year. There was no significant difference in these rates between the control and intervention areas or between infants and 1–4-year-old children (0·14 vs 0·13 per child per year). Owing to its short duration and the difficulty of access, the neonatal period was under-represented in these observations, which might have caused an underestimate of the pneumonia attack rate in infancy.

The case-fatality rate in the treated cases of pneumonia in intervention area was very low (0·8%) and the outcome of treatment by the three types of workers was comparable (table II). The number of cases treated by TBAs was small, partly because they were introduced late in the programme.

Table III gives coverage (percentage of estimated pneumonia cases treated) by the health workers. There was excess coverage (146%) in infancy which may be due to overtreatment of infants or to underestimation of attacks among infants in the morbidity study. The estimated number of pneumonia attacks, actual deaths from pneumonia, and the case-fatality rates in the control and intervention areas are summarised in table IV.

The effect of the case-management intervention on childhood mortality rates in different age groups is summarised in table V. The rates were significantly lower in intervention than control areas in all age groups except 1–4 years. There were significant differences between intervention and control areas in cause-specific mortality rates (CSMR) for pneumonia, birth injury, prematurity/ small baby, and bleeding disorders in newborn infants but not for other causes (table VI). Bleeding in newborn infants is

TABLE IV—CASE-FATALITY RATES IN TREATED AND UNTREATED CHILDREN WITH PNEUMONIA

—	Control area	Intervention area
Pneumonia cases		
Expected	513	803
Treated by health workers	..	612
Pneumonia deaths	69	50 (5 treated)
Case-fatality rate		
All cases	69/513 (13·5%)	50/803 (6·2%)
Treated by health workers	..	5/612 (0·8%)
Not treated by health workers	..	45/191* (23·6%)

*Denominator = expected cases minus those treated by healthworkers.

TABLE V—CHILDHOOD MORTALITY RATES IN CONTROL AND INTERVENTION AREAS

—	Deaths/children in age group* (rate per 1000)		% difference in mortality rate	p
	Control area	Intervention area		
Neonatal (0–28 days)	102/1049 (97·2)	104/1533 (67·8)	30·2	<0·01
Infant	127/1049 (121)	136/1533 (88·7)	27·1	<0·01
Age 1–4 years	34/3042 (11·2)	40/4812 (8·3)	25·6	NS
Age 0–4 years	161/3947 (40·7)	176/6176 (28·5)	30·0	<0·005

*Denominator = number of livebirths in the year for neonatal and infant mortality; mid-year population for children aged 1–4 and 0–4 yr.

TABLE VI—CAUSE-SPECIFIC MORTALITY RATES*

Cause of death	Control area		Intervention area		
	No of deaths (in 3947 children)	CSMR†	No of deaths (in 6176 children)	CSMR†	p
Pneumonia	69	17·5	50	8·09	<0·001
Birth injury	42	10·6	31	5·01	<0·005
Prematurity/small baby	56	14·2	57	9·22	<0·05
Bleeding disorders of newborn	14	3·54	8	1·29	<0·05
Septicaemia/meningitis	29	7·35	39	6·31	NS
Diarrhoea	33	8·36	45	7·28	NS
Malnutrition	29	7·35	37	5·99	NS
Fever of unknown cause	5	1·26	9	1·45	NS
Accident	3	0·76	4	0·64	NS
Measles	2	0·50	4	0·64	NS
Whooping cough	1	0·25	0	0·00	NS
Tetanus	1	0·25	3	0·48	NS
Other	12	3·04	11	1·78	NS
Not known	1	0·25	2	0·32	NS

*Primary and additional causes of death included.
†per 1000 children aged 0–4 years.

often a sign of prematurity or infection such as pneumonia. The very low CSMR for measles, whooping cough, and tetanus in both areas may be due to good immunisation coverage as a part of universal immunisation programme which is in operation in the whole district. The training of TBAs in both areas for hygienic delivery in 1980 and immunisation of pregnant women may account for the low rates of tetanus.

The difference between the control and intervention areas in the CSMR for pneumonia (9·4 per 1000 children) accounted for 77% of the difference in total mortality among children under 5 years (40·7 *vs* 28·5 per 1000 = 12·2/1000). The decline in pneumonia CSMR is further examined in different age groups in table VII. It was significantly lower in the intervention area than the control area in all age groups except 1–4 years. The percentage difference in the pneumonia CSMR was similar when only one, primary, cause of death was included (table VII) rather than primary and additional causes of death.

The cost of co-trimoxazole used in 1 year was 2600 Rupees ($153). For other costs it is difficult to break

TABLE VII—PNEUMONIA-SPECIFIC MORTALITY RATES BY AGE GROUP

	Pneumonia deaths/children in age group* (rate/1000)		% difference in mortality rate	
—	Control area	Intervention area		p
Primary and additional causes of death				
0–7 days	21/1049 (20·0)	12/1533 (7·82)	61	<0·02
0–28 days	41/1049 (39·1)	31/1533 (20·2)	48	<0·01
29 days–11 mo	18/803 (22·4)	7/1260 (5·55)	75	<0·005
0–11 mo	59/905 (65·2)	38/1364 (27·9)	57	<0·001
1–4 yr	10/3042 (3·28)	12/4812 (2·49)	23	NS
0–4 yr	69/3947 (17·5)	50/6176 (8·09)	54	<0·001
Primary cause of death only				
0–7 days	11/1049 (10·5)	8/1533 (5·21)	50	NS
0–28 days	28/1049 (26·7)	18/1533 (11·7)	56	<0·01
29 days–11 mo	10/803 (12·4)	6/1260 (4·76)	62	NS
0–11 mo	38/905 (42·0)	24/1364 (17·6)	58	<0·005
1–4 yr	5/3042 (1·64)	9/4812 (1·87)	−11	NS
0–4 yr	43/3947 (10·9)	33/6176 (5·34)	51	<0·005

*Denominator = live births in the year for 0–7 and 0–28 days; mid-year population for other age groups.

expenditure down into research and service costs. The cost of co-trimoxazole was 2·47 cents per child aged 0–4 years in the intervention area, 25 cents per pneumonia case treated, and $2·64 per pneumonia death prevented.

No case of drug reaction to co-trimoxazole was recorded even after active inquiry. No adverse effects were seen even in newborn infants. Bronchial asthma in 0–4-year-old children was safely and effectively treated by paramedics and VHWs except one case of overdose of salbutamol. TBAs did not treat asthma.

Discussion

In this intervention study a high level of community awareness about childhood pneumonia was generated. Without any active case-detection effort by the project, parents sought early care for a child when they suspected pneumonia. The involvement of TBAs in mass education and management of pneumonia improved outreach and access, particularly to neonatal pneumonia. An estimated 76% coverage of pneumonia cases in children was achieved. The healthworkers successfully managed cases of pneumonia with a case-fatality rate of less than 1%. Significant reductions in pneumonia-specific and total childhood mortality were obtained without other simultaneous interventions.

Since the trial used a concurrent control, to assess whether the differences in mortality were real and due to the intervention we must establish whether the intervention area had lower mortality rates than the control area at baseline. This seems unlikely: the important determinants of childhood mortality, such as socioeconomic level, female literacy, birth rate, and nutritional status of children were similar in the two geographically adjacent areas. Moreover, childhood mortality from causes such as diarrhoea, malnutrition, tetanus, measles, septicaemia, and fever was similar.

Can the results be attributed to the intervention? The significant difference in mortality rates between the areas was limited to pneumonia, birth injury, prematurity, and bleeding in newborn infants (table VI). The greatest absolute reduction (9·4/1000 children under 5 years) was in the pneumonia-specific death rate, which accounts for 77% of the difference in total childhood mortality. Improved maternal and neonatal care due to training of TBAs probably also contributed to the differences in neonatal mortality. Pneumonia case-management may also have been important in this age group because many deaths from prematurity or birth injury are finally caused by pneumonia. The 75% difference in the CSMR for pneumonia in the postneonatal period seems to be due solely to the case-management.

Use of several causes of death (primary and additional) did not significantly affect the mortality analysis (table VII). We believe that several causes should be used rather than a single cause. In special studies, when the investigator is particularly interested in one disease, selection of one cause as the primary or underlying cause of death can be biased. For example, in two studies on childhood mortality in Bangladesh, one[22] on deaths from malnutrition and diarrhoea attributed only 6% of deaths to pneumonia, whereas the other[17] on respiratory infections attributed 29% of deaths to pneumonia.

The first important element in our approach was to generate awareness in the community by extensive health education and community participation. Use of local terms

to describe tachypnoea and difficulty in breathing ensured fast and precise communication. Successful management of cases of pneumonia by the health workers increased the popularity of the programme. The outreach of the programme was greatly improved by the involvement of three types of workers; on average there were 2·3 providers of treatment per village. Combining intervention against pneumonia with better maternal and neonatal care by TBAs enhanced the access to pregnant women and newborn infants. Special training methods for VHWs and TBAs, educative supervision, and continued training ensured good quality of care, as seen from the very low case-fatality rates. The project ensured an uninterrupted supply of medicines so that patients need not be turned away. The successful management of pneumonia by workers and TBAs greatly increased their credibility. Some rural medical practitioners began referring cases of childhood pneumonia to TBAs and VHWs. Some reasons for our success were not related to medical technology but to less visible factors. The project offered the health workers and TBAs dignity and respect. The professionals in the project sat on the ground, ate meals, sang and danced with the workers, and treated them as equals. A hierarchical or autocratic organisational structure may not produce a good performance from the village workers.

Despite the significant reduction in neonatal pneumonia mortality, it remains the major problem. 31 of 50 pneumonia deaths in the intervention area were in newborn infants. The high case-fatality rate (23·6%) in untreated children (table IV) suggests that the residual mortality is in high-risk groups, such as newborn infants and the poorest or most isolated families, who do not or cannot seek care. The diagnostic criteria for neonatal pneumonia are far from satisfactory and need to be improved.

The sample size was not designed to provide significant results in age subgroups which may explain why the difference in pneumonia morality in children aged 1–4 years between the intervention and control areas was not significant. Coverage was lower in this age group than in infants, possibly because the diagnostic criterion of 50 breaths per min for pneumonia is sensitive in infants but not in toddlers,[11] and workers may have missed many cases of pneumonia in children aged 1–4 years. New criteria of 60/min for newborn infants, 50/min for infants, and 40/min for children of 1–3 have been suggested.[11] Such a change may improve coverage and outcome in children of 1–4 years and may reduce the false-positive rate and overtreatment among infants.

The illiteracy of TBAs necessitated special training and supervision. They did make many errors at first, but the error rate was gradually reduced with continued education and corrective supervision. Some cases of unnecessary use of co-trimoxazole in upper respiratory infection by TBAs were noted. Their inability to count up to 50 prevented their using the respiratory rate as the main diagnostic criterion. We have developed an instrument to enable TBAs to count respiratory rate. It is being field tested. More experience and data on TBAs need not to be collected.

The cause of death and morbidity data were dependent on the history given by the parents, so the diagnosis of pneumonia as a cause of death may be less than precise,[14] especially in newborn infants. This difficulty does not preclude valid comparison because most studies on pneumonia and childhood mortality have used the same method.[7-9,15,17] Various studies of methods in the past 5 years

are strong evidence that the parents' history alone can be used to diagnose the illness or cause of death.[5,11-16,23] An exploration of the meaning of the terms used by people in our area was helpful in improving precision.

Long-term careful observation will be necessary to see whether the fall in total childhood mortality is maintained or lost owing to replacement mortality or the emergence of antibiotic resistance.

Our approach is replicable in other developing countries because the problem is universal. The approach depends upon health workers who are part of virtually all primary health care programmes. The dignity of these workers and democratic relationships are crucial to the successful implementation of this approach. The results will be better if the intervention is combined with maternal care and implemented as a part of community-based primary health care.

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