Pneumonia in neonates: can it be managed in the community?

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Abstract
Neonatal pneumonia kills about two million children a year worldwide. The World Health Organisation recommends hospitalisation of all cases of pneumonia in the first two months of infancy. In a field trial of community based management of childhood pneumonia in Gadchiroli, India, neonatal pneumonia contributed more than half of the pneumonia deaths. Parents refused referral even when advised therefore community based health workers and traditional birth attendants managed cases of neonatal pneumonia with co-trimoxazole. Case fatality was 15% (10/65) in all cases and 6% (3/52) in cases without high risk or referral indications. Case fatality in 56 babies aged 30–59 days treated for pneumonia was zero. During the two years of the trial, pneumonia specific mortality rate in the intervention area was 40% less in the neonates and about 80% less in the second month and rest of infancy compared with the control area. Pneumonia in the second month of infancy and uncomplicated cases of neonatal pneumonia can be safely and effectively managed in the community using co-trimoxazole.

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Pneumonia competes with diarrhoea for the number one position among fatal childhood diseases and is responsible for about four million or 25% of childhood deaths in developing countries.[1] In the early 1980s the World Health Organisation (WHO) initiated a programme for control of acute respiratory infections in children.[2] Early diagnosis and treatment ('case management') by health workers in the community was proposed as a strategy to reduce childhood deaths from pneumonia. Based on clinical studies,[3] WHO suggested a simple diagnostic criteria of cough with a respiratory rate of 50 or more; and treatment at home with oral co-trimoxazole or amoxycillin. Children with complications or with signs of very severe disease, such as unconsciousness, convulsions, stridor, or inability to suck or take feeds, were advised referral to hospital.[4] A few field studies have demonstrated that the case management approach was feasible and effective in reducing pneumonia mortality in children below 5 years of age.[5 6] The WHO and UNICEF are now supporting wider applications of this strategy through national acute respiratory infection control programmes in 47 countries.[7] The acute respiratory infection control

programme of the WHO has identified pneumonia in infants below 2 months of age as a problem of the highest research priority. The diagnosis and treatment of pneumonia in this age group is difficult and efficacy of domiciliary management has not been established. The first two months of infancy have been labelled as the 'extended neonatal period' and all cases of pneumonia at this age have been recommended for referral to hospital.[8] The WHO has also recently suggested severe chest indrawing or a respiratory rate of 60 or more per minute as a new diagnostic criteria of pneumonia in the first two months of infancy.[9]

As no study or experience of community based management of pneumonia in the neonatal period has been published, it is difficult to support or refute WHO recommendations about pneumonia in the first two months.

Systemic bacterial infections in the neonatal period, such as pneumonia, septicaemia, and meningitis are aetiologically and clinically similar and can be divided into two groups: early onset (in first week) and late onset.[10] The common causative organisms, believed to originate from the birth canal of the mother, were group B streptococci and *Escherichia coli* as found in the studies in hospitals of developed countries. Combination of ampicillin and an aminoglycoside, gentamicin or kanamycin, is recommended as the treatment.[10 11] Causative organisms in the cases of neonatal septicaemia and pneumonia in the hospital based studies in developing countries were *E coli*, *Klebsiella* species, and *Staphylococcus aureus*.[12-15]

Community based data were not available from rural areas of developing countries where most of the deaths due to neonatal pneumonia took place. After reviewing the reports of 18 hospital based studies on the aetiology of neonatal infections, a WHO group recently concluded that the aetiology of community acquired pneumonia in neonates in developing countries remained unknown.[16] In the absence of this information it was difficult to choose appropriate antimicrobial agents for community based management of neonatal pneumonia.

We have analysed our experience of a field intervention trial on childhood pneumonia to answer the following research questions: (1) What is the relative importance of pneumonia as the cause of death in different months of infancy in rural areas? (2) Can cases of pneumonia in the first two months of infancy, the so called extended neonatal period, be managed in the community? What is the safety and effectiveness of such management? Which antibiotic should be used for treatment? (3) Is

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extension of the high risk neonatal period to the first two months of infancy justified?

Subjects and methods

A controlled field trial to test the feasibility and effectiveness of community based case management of pneumonia in children below 5 years of age was conducted in a rural area of a backward district, Gadchiroli, in the central part of India. The area, population characteristics, and methods have been described in detail in an earlier publication.[6] After a census, all births and childhood deaths from July 1988 to June 1990 were prospectively recorded in the intervention area of 58 villages and an adjacent control area of 44 villages. The control area was similar in every respect, including the health care and the baseline childhood mortality rate, to the intervention area. In the absence of medical certification of deaths, the causes of deaths in children were determined by 'verbal autopsy'.[17] Pneumonia was considered a cause of death in children having a history of cough and tachypnoea continuously for more than six hours before death. The presence of cough was not an essential criterion in infants up to 2 months of age.

Extensive health education was provided in the intervention area on when to suspect pneumonia in a child and where to seek immediate care. Thirty paramedics belonging to government primary health centres in the intervention area, 25 village health workers of our organisation, SEARCH, and 86 traditional birth attendants in the intervention area were trained to examine sick children and diagnose pneumonia. The presence of cough and a respiratory rate of 50 or more per minute were the criteria of diagnosis of pneumonia in children aged 0–5 years as advised in the then prevailing guidelines of the WHO.[4] Respiratory rate was counted when the baby was quiet. If the respiratory rate was raised in neonates, the count was repeated once for confirmation.
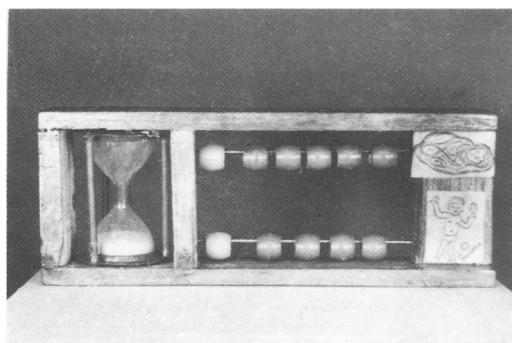
Traditional birth attendants were involved because they had a natural and easier access to neonates due to their traditional responsibility of looking after the mother and newborn baby for one to two weeks after delivery. However, because they were illiterate they could not count the respiratory rate. Therefore they were trained to diagnose pneumonia using their visual judgment of tachypnoea. Their judgment of tachypnoea and chest indrawing was cultivated by being shown cases and a video

Breath counter to assist illiterate traditional birth attendants in the diagnosis of pneumonia. Two rows of beads correspond with the age specific respiratory rates for infants below 2 months and 2 to 11 months suggested recently by the WHO. The last bead in each row is red coloured – to announce the diagnosis of pneumonia.

film on childhood pneumonia that was distributed by WHO. Later on some of them were taught the use of a 'breath counter', a simple device developed by us to diagnose pneumonia in children (figure).[18] This instrument had a one minute sand timer and an abacus. By turning the instrument upside down, the sand timer was started. Most traditional birth attendants could not count up to 50 but could correctly count up to 10 or 12. Traditional birth attendants counted the breaths of the sick baby and moved one bead for every 10 breaths counted. If the last bead (sixth, coloured red) in the row for the neonates was moved within one minute, it denoted a respiratory rate of more than 60 per minute, diagnosing the presence of pneumonia.

Management of pneumonia cases included continued breast feeding, syrup co-trimoxazole (sulphamethoxazole 200 mg and trimethoprin 40 mg/5 ml) 2·5 ml twice a day for seven days in children below 6 months and 5 ml twice a day for five days in children of 6 to 59 months. Fever was treated with paracetamol. Cases of pneumonia with stridor, unconsciousness, convulsions, or inability to suck or drink were advised immediate referral. If parents refused to take the child to hospital the health workers were asked to treat the child with co-trimoxazole. The child's age was not a criterion for referral and neonates with pneumonia were also treated in the villages. A case record was completed including clinical signs and symptoms, side effects of treatment, follow up, and outcome of treatment in every case so diagnosed. Field supervisors later visited homes and verified the records. Traditional birth attendants were also trained in safe and hygienic delivery and better care of the neonates; no other intervention targeted to children was introduced.

The population based rates presented here pertain to two years (July 1988 to June 1990) of trial. As the case management service was continued, the cases managed from July 1988 to December 1990 have been included in the analysis. Analysis of causes of death can include more than one cause. Thus when a neonate died of prematurity and pneumonia, the death was included in both the cause specific rates. Such inclusion of multiple causes of death more faithfully represents the multicausal processes leading to death than attributing death to only one underlying cause.[17] The data were analysed using the statistical software SPSS/PC+. The study protocol of the original field trial was reviewed and approved by a committee of the Indian Council of Medical Research.

It was neither ethical nor feasible to perform lung puncture or blood culture on neonates with pneumonia in the villages. As the organisms causing neonatal pneumonia, especially in the first week, come from the maternal birth canal[10 11] and as no community based information on bacterial flora in the female genital tract was available for rural areas, we have used data from our earlier population based study of gynaecological diseases of rural women in the same area.[19] In this study swabs were taken

Table 1 Pneumonia specific mortality in different periods of infancy in control area (July 1988–June 1990)

	Neonatal period			Postneonatal period		
	0–7 days	8–29 days	0–29 days	30–59 days	2–11 months	0–11 months
Pneumonia deaths	31	30	61	9	23	93
Total No of children	2098	1982	2098	1923	1884	1874*
Total period of observation (in child years)	40	119	158	157	1573	1873
Pneumonia mortality rate/1000 children	14·78	14·30	29·08	4·68	12·21	49·63
Pneumonia mortality rate/1000 child years	770	251	386	57	15	50

*Mid-year population.

Table 2 Aerobic bacteria grown from the vagina of rural women and their sensitivity to antimicrobial agents*

Bacteria	Frequency (%)
Escherichia coli	135 (48)
Staphylococci	
Coagulase positive	35 (12·3)
Coagulase negative	39 (13·9)
Klebsiella species	20 (7·2)
Pseudomonas aeruginosa	11 (3·9)
Micrococci	12 (4·3)
Enterococci	10 (3·6)
Streptococci (β haemolytic)	9 (3·2)
Proteus	9 (3·2)
Total	280

Antimicrobial agent (concentration)	No (%)
Penicillin (10 units)	79 (28·2)
Erythromycin (15 μg)	149 (53·2)
Tetracycline (30 μg)	227 (81·1)
Amoxycillin (10 μg)	245 (87·5)
Chloramphenicol (30 μg)	240 (85·7)
Ampicillin (10 μg)	243 (86·8)
Streptomycin (10 μg)	258 (92·1)
Co-trimoxazole (25 μg)	263 (93·9)
Gentamicin (10 μg)	266 (95·0)
Gentamicin+co-trimoxazole	280 (100)

*All bacteria combined.

from the vagina in 546 symptomatic as well as asymptomatic women from the villages. Culture for anaerobic bacteria, gonococci, or chlamydia could not be performed and the culture for aerobic bacteria yielded 280 positive results. This information was an indirect indicator of the bacteria possibly causing early onset neonatal pneumonia in the area and their antimicrobial sensitivity.

Results

Pneumonia mortality rates in different periods of infancy in the control area are presented in table 1. Mortality rates are presented first as per thousand children. As the periods of observation are not uniform in various age groups, the rates are also presented as per 1000 child years of observation. The pneumonia mortality in 0–29 days contributed 66%

(61/93) of pneumonia mortality in infancy and 54% (61/113) in the children under 5 years.

The aerobic organisms grown from the vaginas of women in the community and their sensitivity to the antimicrobial agents is presented in table 2.

Table 3 presents details of diagnostic clinical features in 65 cases of pneumonia in the first month and 56 cases in the second month of infancy, treated by different types of health workers. The agreement of the health workers' diagnoses with the revised WHO criteria (1990) is presented in table 4. Referral indications were present in nine neonates between 0–29 days of age (convulsions in two, unconsciousness in five, inability to take feeds in five, and stridor in one) and in two infants between 30–59 days of age (inability to take feeds in both). Despite the advice of health workers, parents of 10 out of 11 babies needing referral refused to take them to a doctor or hospital and hence health workers treated these cases. One referred and one unreferred neonate were taken to a doctor and co-trimoxazole discontinued; both died. These two deaths have been included as case fatalities with the respective health workers in the analysis.

The outcome of case management by different types of workers expressed as case fatality ratio was as follows: in the group aged 0–29 days, village health workers managed 25 cases, out of which two died (8%); paramedics managed seven cases, out of which one died (14%); and traditional birth attendants managed 33 cases, out of which seven died (21%). The difference in case fatality was not statistically significant. Overall case fatality in the treated neonates was 15% (10/65). Fifty six cases of pneumonia in the age group 30–59 days were managed with no deaths (village health workers, 34 cases; paramedics, three cases; and traditional birth attendants, 19 cases). The outcome of community based management in various risk groups in 0–29 days old children is presented in table 5.

Table 3 Clinical features in cases of pneumonia managed by community based workers (July 1988–December 1990)

	Age 0–29 days					Age 30–59 days				
		Respiratory rate		Severe chest Indrawing			Respiratory rate		Severe chest Indrawing	
Type of worker	No of cases	Rate	No of cases	Present	Absent	No of cases	Rate	No of cases	Present	Absent
Village health workers	25	50–59	3	1*	2	34	50–59	11	1*	10
		>60	22	11*	11*		>60	23	7*	16*
Paramedics	7	50–59	2	2*	–	3	50–59	3	1*	2
		>60	5	4*	1*					
Traditional birth attendants	33	Not counted		13*	20	19	Not known		7*	12
Total	65		65	31	34	56		56	16	40

*Cases fulfilling revised (1990) WHO criteria of pneumonia.[9]

Table 4 Diagnosis by revised WHO criteria in cases of pneumonia managed by community based workers (July 1988–December 1990). Results are number (%)

	0–29 days	30–59 days
Cases fulfilling WHO criteria*	43 (66)	32 (57)
Cases not fulfilling WHO criteria	2 (3)	12 (21·5)
Information inadequate to judge by WHO criteria†	20 (31)	12 (21·5)
Total	65 (100)	56 (100)

*Revised WHO criteria (1990) of pneumonia in infants[9]: respiratory rate >60 per minute or presence of severe chest indrawing or both.
†Respiratory rate not counted, no indrawing of chest but traditional birth attendant judged baby to be tachypnoeic.

Impact of interventions on the pneumonia specific mortality rate in different months of infancy in the intervention and the control area are presented in table 6. In the intervention area the pneumonia mortality in neonatal period constituted 84% (54/64) of the pneumonia mortality in infants and 67·5% (54/80) in children below 5 years. The impact of interventions on acute respiratory infections on the total mortality in different months of infancy is presented in table 7.

Discussion

Neonatal pneumonia contributed more than half of the pneumonia deaths in children below 5 years of age. Thus it deserved the highest priority in the acute respiratory infection control programme. In the intervention area, parents refused to take seriously ill neonates to hospital even when referred. Domiciliary management by the community based workers

using co-trimoxazole syrup resulted in zero case fatality in the second month of infancy. In the first month, case fatality was 15% in all cases and 6% in cases without referral indication or high risk factor. Traditional birth attendants provided half of the case management of pneumonia in the neonatal period. The case management led to a 40% reduction in the pneumonia specific mortality rate in the neonatal period, 78% in the second month, and 80% for the rest of infancy. Study of vaginal flora in the community suggested that co-trimoxazole could be a good choice to cover the aerobic bacteria, however, a combination of gentamicin and co-trimoxazole should produce the best results.

There was definite evidence that community based management of neonatal pneumonia was necessary, feasible, and effective. Pneumonia in the second month of infancy was like that of remaining postneonatal infancy and could be safely and effectively managed by community based health workers. It should not be combined with the first month of infancy and need not be an indication of referral by itself. WHO guidelines need to be reconsidered in this light.

Earlier studies have found good correlation between the *pathogenic bacteria* colonising neonates and bacteria in the maternal vagina.[13 20] Moreover, the bacteria found in the maternal vagina in this study were very similar to the bacteria grown by blood culture from neonates with sepsis in earlier hospital based studies. Hence bacterial flora in the maternal vagina may be accepted as a surro-

Table 5 Outcome of community based management of neonatal pneumonia in different risk groups (July 1988–December 1990)

Description	Dead	Survived	Total	% Case fatility (95% CI)
0–7 days (all cases)	5	16	21	24 (6 to 41)
8–29 days (all cases)	5	39	44	11 (2 to 20)
0–29 days (all cases)	10	55	65	15 (6 to 24)
Cases with referral indications*	3	6	9	33 (2 to 64)
Cases without referral indications	7	49	56	13 (4 to 22)
Cases without referral indications or without risk factors of death†	3	49	52	6 (0 to 12)

*Referral indications: see result section in text.
†Risk factors were associated with seven deaths: prematurity (n=4), small sized full term (n=2), birth injury (n=4), failure of feeding (n=1). The presence of these risk factors in those who survived is not known.

Table 6 Impact of community based management on pneumonia specific mortality rate in different months of infancy (July 1988–June 1990)

Age group	Control area			Intervention area			
	No of pneumonia deaths	Total No of children	Rate per 1000 children (95% CI)	No of pneumonia deaths	Total No of children	Rate per 1000 children (95% CI)	% Reduction
0–29 days	61	2098	29·1 (21·9 to 36·3)	54	3100	17·4 (12·8 to 22·0)	40
30–59 days	9	1923	4·7 (1·6 to 7·7)	3	2904	1·0 (0 to 2·2)	78
2–11 months	23	1884	12·2 (7·3 to 17·2)	7	2856	2·5 (0·6 to 4·3)	80
0–11 months	93	2098	44·3 (35·5 to 53·1)	64	3100	20·1 (15·6 to 25·7)	55

Table 7 Impact of interventions for acute respiratory infection on total mortality in different months of infancy (July 1988–June 1990)

Age group	Control area			Intervention area			
	No of total deaths	Total No of children	Rate per 1000 children (95% CI)	No of total deaths	Total No of children	Rate per 1000 children (95% CI)	% Reduction
0–29 days	176	2098	83·9 (72·0 to 95·8)	197	3100	63·6 (55·0 to 72·1)	24
30–59 days	16	1923	8·3 (4·3 to 12·4)	11	2904	3·8 (1·6 to 6·0)	57
2–11 months	43	1884	22·8 (16·1 to 29·6)	53	2856	18·6 (13·6 to 23·5)	19
0–11 months	235	2098	112·0 (98·5 to 125·5)	261	3100	84·2 (74·4 to 94·0)	25

gate indicator of organisms causing neonatal pneumonia and sepsis, especially the highly fatal early onset disease. The data presented in table 2 provide a glimpse of the vaginal flora in the community where most of the cases of neonatal pneumonia occur. It showed that aminoglycosides (gentamicin or streptomycin) or co-trimoxazole were the most *appropriate antibiotics*. The therapeutic results to co-trimoxazole, as observed in this study, substantiate the in vitro findings. Combining an aminoglycoside, gentamicin, with oral co-trimoxazole may produce the best results as the sensitivity to this combination was 100%. The use of penicillin as reported in a study from Haryana, India,[21] would have been wrong.

In the natural setting of the *control area* (table 1), 29 neonates per 1000 live births died of pneumonia in the first month of life (95% confidence interval (CI) 21·9 to 36·3) compared with 4·68 in the second month (CI 1·6 to 7·7). When converted to a uniform time scale of pneumonia mortality rate/1000 child years of observation, the mortality rate in the neonatal period (0–29 days) was about 25 times higher than in 2–11 months of infancy, establishing the importance of pneumonia in the first month of life. Pneumonia mortality rate in the second month was about seven times less compared with the first month. The two periods were distinctly different.

The overall *case fatality* in the 65 cases of neonatal pneumonia managed in the community was 15% (95% CI 6% to 24%) (table 5). This was very high compared with less than 1% case fatality in all childhood pneumonia cases managed by the same workers in this trial[6] or zero fatality in the 56 treated cases of pneumonia in the second month. The neonates were obviously a high risk group and their management was difficult. However a 15% case fatality compared favourably with the 22% to 55% fatality in cases of neonatal pneumonia managed in Indian hospitals.[22-24] The lower fatality in this study compared with the hospital studies could reflect the differences in diagnostic criteria and seriousness of cases managed in the community compared with the hospital. This may reflect the advantage of community based management because the pneumonia was diagnosed and treated at the early stage. There are no published data on fatality in cases of neonatal pneumonia acquired and managed in the community for comparing with our experience.

As shown in table 5, the case fatality was higher (24%) in the first week (many of these could be cases of hyaline membrane disease or aspiration), and in cases with referral indications (33%). The data on the presence of risk factors such as birth injury, prematurity, small size, or failure of feeding were available only for dead children. If such deaths with risk factors and children with referral indications were excluded from the analysis (13/65), the case fatality in the remaining 52 cases of uncomplicated neonatal pneumonia was 6%. Thus community based case management in neonates with pneumonia without referral indication or a high risk factor was effective. Parents refused

referral in 10 out of 11 indicated cases and health workers had no alternative but to manage the sick neonates at home.

The case fatality ratio was least (8%) with the village health workers and highest (21%) in the cases managed by traditional birth attendants, though the difference was not statistically significant. Traditional birth attendants managed about 50% of the cases in the neonatal period, underscoring their strategic position in access to the neonates. Higher case fatality ratio in cases managed by traditional birth attendants could be partly because of their illiteracy and therefore lower potential for learning, but it was compensated for by their traditional access to neonates that was often denied to other workers. In any case, the case fatality with the traditional birth attendants (21%) was less than 22 to 55% as reported from the hospitals.[22-24]

The zero case fatality in the 56 cases of pneumonia in the second month of infancy suggested that these cases need not necessarily be referred to hospital as currently recommended by the WHO.

Impact: the interventions for the two years were associated with 40% reduction in the *pneumonia mortality rate* in babies of 0–29 days compared with the control area. The two areas were similar at baseline.[6 25] Training of traditional birth attendants in safe delivery and neonatal care also contributed to the reduction in neonatal mortality by other causes such as birth asphyxia and prematurity[6] but did not contribute directly to reduction in pneumonia specific mortality. The reduction in pneumonia mortality in the neonatal period was only about half of the reduction in the second month or between 2–11 months of infancy (40% as against 78% or 80%) again underscoring difficulties in overcoming pneumonia mortality in the neonatal period. The 40% reduction in the neonatal period contributed greater absolute reduction in the infant mortality than 78% reduction in the second month because the rate was very high in the neonatal period. The 78% reduction in the second month and 80% between 2–11 months again showed that pneumonia in the second month behaved like the rest of the infancy and not like the neonatal period.

Despite intervention, neonatal pneumonia emerged as the most prominent problem contributing 67·5% of the pneumonia deaths in childhood in the intervention area as against 54% in the control area. This was because pneumonia mortality in the neonatal period declined by 40% compared with an 80% decline in the postneonatal age. Hence the proportion of deaths caused by neonatal pneumonia in the *residual pneumonia deaths* increased, though the absolute number of deaths due to pneumonia decreased. Thus, as the acute respiratory infection control programme becomes effective, relative importance of neonatal pneumonia will increase.

The reduction in pneumonia mortality was accompanied by a reduction in the *total neonatal and infant mortality* (table 7). Neonatal mortality rate in the intervention area declined

from 83·9 to 63·6/1000. Reduction in pneumonia specific mortality could explain 57% of this reduction in neonatal mortality. The remaining 43% was probably due to the training and supervision of traditional birth attendants resulting in an improved quality of neonatal care in the intervention area.

The *reasons for successful results* were:
- Extensive health education of the adult population.
- Good community acceptance.
- Involvement of traditional birth attendants in case management.
- Training of traditional birth attendants using video film and the breath counter.
- Choice of co-trimoxazole, validated by the study of vaginal flora. No side effects of co-trimoxazole were recorded despite active inquiry in all treated cases.
- Early diagnosis and treatment at home.

What were the sources of possible artefact? There could have been some diagnostic errors by health workers. In this study cough with a respiratory rate of 50 or more was considered diagnostic of pneumonia by the then prevailing WHO guidelines; subsequently the WHO revised its criteria. Yet, as shown in table 4, 66% of the managed cases in the 0–29 day period met new WHO criteria, 3% did not, and in 31% the respiratory rate was not known but traditional birth attendants judged the cases as pneumonia. A similar pattern was seen in cases in the second month. In another study we found that traditional birth attendants' visual judgment of tachypnoea matched in 60 to 90% of cases (depending upon the range of the respiratory rate) with the diagnosis of the new WHO criteria.[18] Traditional birth attendants and other workers were trained by being shown video films from the WHO to recognise chest indrawing. So this judgment too should match. Thus most of the diagnosed cases were true cases of pneumonia by the WHO criteria. But the WHO criteria themselves may have picked up some false positive cases thereby lowering the case fatality.[26] However that could not have lowered pneumonia mortality rate or the neonatal mortality rate at the population level in the intervention area.

Some excessive diagnosis of pneumonia as the cause of death, especially in the early neonatal period, was possible because the criterion of tachypnoea for more than six hours before death would also include deaths due to hyaline membrane disease or aspiration. This may be partly responsible for the high (24%) case fatality in the 0–7 day age group. The verbal autopsy method also was less than perfect. But its use has been validated by many studies.[6 17] Moreover as the same definition of pneumonia as cause of death and the same method of verbal autopsy were employed in the intervention and the control area, the observed reduction was true and not an artefact.

There were several *problems* that had to be faced in the management of neonatal pneumonia.

(1) Near total (10/11) refusal by parents to take the neonate with indications of referral to hospital. The hospitals are too far and, traditionally, a neonate even if sick is not taken outside the home. Hence the management for neonatal pneumonia must be improved and provided in the community.

(2) A substantial number of neonates with pneumonia in the intervention area were still unattended, mostly because parents did not seek care. We do not have an estimate of the incidence of neonatal pneumonia, hence we cannot estimate the proportion of unattended neonatal pneumonia.

(3) Co-trimoxazole was less than an ideal choice of antibiotic because not all organisms were sensitive and because the oral route of administration may not be reliable in the neonates. Part of the case fatality could be due to this. We believe that the addition of gentamicin should overcome these deficiencies and should further reduce fatality due to pneumonia as well as sepsis in the neonatal period.

(4) Pneumonia in the first week or in babies with risk factors such as prematurity, birth injury, and small size was associated with high case fatality despite treatment and they need hospitalisation.

(5) Illiteracy of the traditional birth attendants limited their learning. To improve the traditional birth attendants' diagnosis of pneumonia, we have developed a simple device, the 'breath counter'. Using this device, traditional birth attendants could make a correct diagnosis in 82% of cases with a borderline respiratory rate (difficult for diagnosis).[18]

The *significance* of the findings of this study are threefold:

(1) It presents the first definite evidence that pneumonia in the neonatal period can be managed in the community. Approximately half of the total pneumonia deaths or about 2 million childhood deaths take place due to neonatal pneumonia. This approach can prevent most of these deaths.

(2) It refutes the WHO's recommendation that all cases of pneumonia in the second month of infancy should be referred to hospital. These cases can be safely and effectively managed in the community.

(3) Community based management of pneumonia in the first two months will cut down unnecessary referral, reducing the workload in hospitals and cost and anxiety to the parents. It will also enhance credibility of community based workers.

It is fit to end this discussion with some anecdotal experiences. Maruti, our village health worker from a village called Wasa, successfully managed a case of neonatal pneumonia that a doctor practising in the rural area had earlier refused to treat because of the high risk. Traditional birth attendants have successfully treated neonatal and childhood pneumonia. Yashodabai, an illiterate traditional birth attendant, successfully treated a case of neonatal pneumonia that a private nursing home (without a paediatrician) in the town could not manage. The health workers' reputation spreads by word of mouth and many rural medical practitioners now refer cases of childhood pneumonia to our village health workers

and traditional birth attendants in the intervention area. Is this not one more step towards 'health by the people'?

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