

Original Article

Home-Based Neonatal Care: Summary and Applications of the Field Trial in Rural Gadchiroli, India (1993 to 2003)

Abhay T. Bang, MD, MPH

Rani A. Bang, MD, MPH

Hanimi M. Reddy, PhD

High levels of neonatal mortality and lack of access to neonatal health care are widespread problems in developing countries. A field trial of home-based neonatal care (HBNC) was conducted in rural Gadchiroli, India to develop and test the feasibility of a low-cost approach of delivering primary neonatal care by using the human potential available in villages, and to evaluate its effect on neonatal mortality. In the first half of this article we summarize various aspects of the field trial, presented in the previous 11 articles in this issue of the journal supplement. The background, objectives, study design and interventions in the field trial and the results over 10 years (1993 to 2003) are presented. Based on these results, the hypotheses are tested and conclusions presented. In the second half, we discuss the next questions: Can it be replicated? Can this intervention become a part of primary health-care services? What is the cost and the cost-effectiveness of HBNC? The limitations of the approach, the settings where HBNC might be relevant and the management pre-requisites for its scaling up are also discussed. The need to develop an integrated approach is emphasized. A case for newborn care in the community is made for achieving equity in health care.

Journal of Perinatology (2005) **25**, S108–S122. doi:10.1038/sj.jp.7211278

BACKGROUND

The Global Problem

A high neonatal mortality rate (NMR) in developing countries accounts for nearly two-thirds of infant mortality. Annually, four million neonatal deaths, and about the same number of stillbirths, occur globally, 98% of them occur in developing countries.^{1,2} One of the reasons is a lack of access to health care. The neonatal period is inadequately addressed by national and international

I shall give you a talisman. When you are in doubt, or when the self becomes too much in you, bring before your eyes the weakest, most wretched and miserable human being that you ever saw, and ask yourself that the step you contemplate, "Will it reduce his misery? Will it reduce his helplessness?" You will get your answer.

Mahatma Gandhi

health programs in developing countries. (The same is true for the corresponding post-partum period in maternal health-care programs.³) Referral of sick neonates is recommended in most guidelines for field workers^{4–6} but usually not practiced due to lack of accessible facilities and unwillingness of families to take neonates out of the home.^{7–9} Most neonatal deaths in developing countries therefore occur at home.¹

Management of bacterial infections in neonates (sepsis/pneumonia), which account for 31% of neonatal mortality,¹⁰ is most often not included in community health programs. In fact, infections offer greater possibility for effective intervention because technology (antibiotics) is available. But simple methods for providing the benefits of antimicrobial therapy to neonates with serious infections have not been readily available in the field.¹¹

The Local Situation

Gadchiroli district in the Maharashtra state in India is a very poor, least developed rural agricultural area, with low female literacy and a limited access to health services (Figure 1). Society for Education, Action and Research in Community Health (SEARCH), a local non-governmental organization, had worked during 1986 to 1993 on women's reproductive health in rural Gadchiroli, training of traditional birth attendants (TBAs), and had conducted a field trial of the community-based management of pneumonia in children.^{11,12} These activities provided a field base as well as community acceptance for SEARCH.

The baseline situation¹³ in 39 intervention villages of SEARCH in a 2-year period (1993 to 1995) is presented in Table 1.

To study the traditional beliefs and practices about newborn care, we held focus group discussions with mothers and grandmothers (1995). These revealed a severe lack of information about neonatal care and a large number of taboos and harmful practices. Health care was almost never sought for sick neonates. Families had a helpless, fatalistic outlook towards neonatal survival. We found a large scope for health education and for empowering mothers and families by way of new knowledge and skills.¹³

SEARCH (Society for Education, Action and Research in Community Health), Gadchiroli, India

Financial support was provided by the John D. and Catherine T. MacArthur Foundation, The Ford Foundation, Saving Newborn Lives, Save the Children, USA, and The Bill & Melinda Gates Foundation.

Address correspondence and reprint requests to Abhay Bang, MD, MPH, SEARCH, Gadchiroli 442-605, India.

E-mail: search@satyam.net.in



Figure 1. India, Maharashtra and Gadchiroli.

On this background we planned the field trial of home-based neonatal care (HBNC) in Gadchiroli.

AIM OF THE STUDY

To develop a HBNC package that provides low-cost, primary neonatal care by using the human potential available in villages, and thereby, to reduce neonatal mortality and to improve neonatal health.¹³

The main hypotheses

1. It is possible to develop a home-based care package, and it will reach at least 75% of the neonates in the community and 60% of the neonates with sepsis.
2. The HBNC package will reduce the NMR in the intervention villages by at least 25% and the sepsis-specific NMR by at least 40% in three years.

STUDY DESIGN AND TIMEFRAME¹³

Adjacent blocks of villages in Gadchiroli, where SEARCH had been working since 1988, were selected as the intervention and the control areas in 1993 (Figure 2). A vital statistics surveillance system was already in operation in both areas. The census and the baseline phase (1993 to 1995) revealed that the populations in the two areas were similar on socio-economic and demographic characteristics, availability of health care and the vital rates such

Table 1 Baseline Situation in the 39 Intervention Villages in Gadchiroli

Characteristics	
Population (1994)	39,312
Occupation: agriculture	90%
Electricity at home	29%
Female literacy	38%
Primary health centers (managed by a doctor)	4
Health subcenter (managed by auxiliary nurse midwife)	16
Birth rate* (1993–95)	25.4
Neonatal mortality rate [†] (1993–95)	62.0
Infant mortality rate [‡] (1993–95)	75.5
Perinatal mortality rate [‡] (1993–95)	68.3
Proportion of deliveries at home [§] (1993–95)	95%

*Per 1000 population.
[†]Per 1000 live births.
[‡]Per 1000 births.
[§]Mostly conducted by traditional birth attendants (TBA).

as the birth rate, NMR, perinatal mortality rate (PMR) and the infant mortality rate (IMR).¹³

After the baseline phase, we observed the neonates in the 39 intervention villages for one year (1995 to 1996). This cohort study provided unique observational data and insights into the health of the neonates in rural community which we have presented in three articles.^{14–16}

STUDIES ON NEONATES IN RURAL GADCHIROLI

Neonatal Morbidities

We prospectively observed a cohort of 763 neonates in 39 villages (1995 to 1996) by way of a trained worker making eight or more home visits during the neonatal period.¹⁴

A high incidence of LBW (42%), clinical sepsis (17%), preterm births (9.8%), severe birth asphyxia (4.6%), hypothermia (17%) and breast-feeding problems (16%) was detected. In total, 48.5% of the neonates had high-risk morbidities (those associated with case fatality (CF) >10%). The burden of morbidity was a mean 2.2 morbidities per neonate. In all, 54% neonates needed medical attention. However, only 2.6% neonates received medical care, 0.4% were hospitalized.

New hypothesis. Many morbidities showed strong seasonal and day-wise variation probably due to inadequate protection from the environment. We developed a new hypothesis that better home-care will prevent the neonatal morbidities that showed a seasonal and temporal increase.

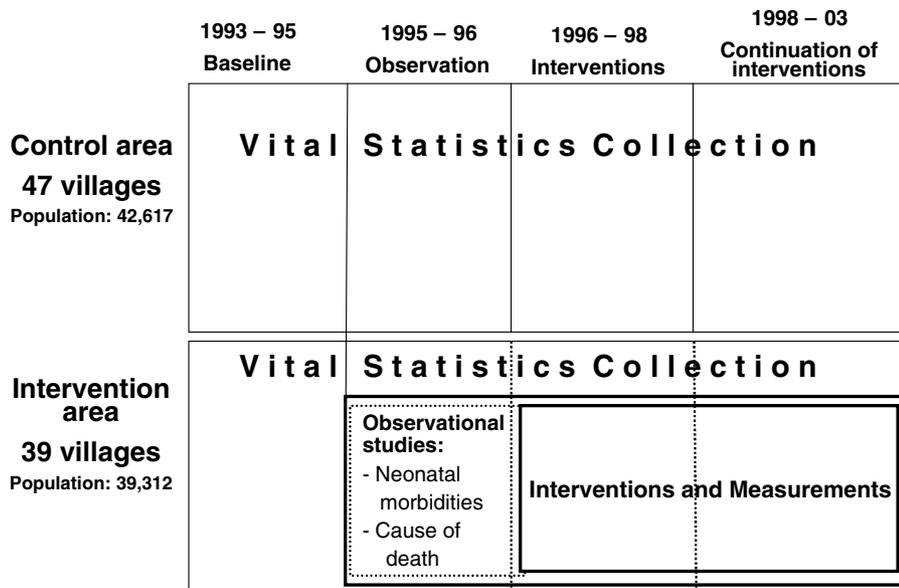


Figure 2. Study design of the field trial of HBNC in Gadchiroli.

Primary Cause of Death

An independent neonatologist assigned the primary cause of death, based on the prospectively observed records of 40 neonatal deaths in the cohort of 763 neonates observed in the community (1995 to 1996).¹⁵

Primary causes of death were the following: sepsis/pneumonia 52.5%; birth asphyxia 20%; prematurity 15%; hypothermia 2.5%; other and unknown 10%.

These data suggest that infection management is a high priority.

Contribution of Multiple Morbidities to Neonatal Deaths, and a Strategy for Intervention

The single primary cause assigned to each death may be arbitrary, and it does not take into account the contribution of simultaneous presence of multiple causes.¹⁶ Hence, we performed a multi-causal analysis of the morbidities and deaths recorded in the cohort of 763 neonates with 40 deaths (1995 to 1996) in 39 villages. The main findings are presented in Box 1.

Significance: Preterm birth and IUGR are ubiquitous components, but usually not sufficient to cause death. Most neonatal deaths occur due to a combination of preterm birth or IUGR with other co-morbidities, especially infection.

New hypothesis: Though the preterm births or IUGR cannot be prevented in a population, neonatal deaths can still be reduced by a strategy of prevention or management of co-morbidities. The order of priority is sepsis, asphyxia, hypothermia and feeding problems. Prevention and/or management of infections will reduce neonatal mortality by 40 to 50%.

DEVELOPMENT OF THE TOOLS FOR HBNC

Based on the baseline, ethnographic and observational data, we developed various methods for the HBNC. These included:

1. a simple and validated method of screening on the day of birth and identifying the neonates at high risk of death;¹⁹
2. a simple and validated clinical method for identifying neonates with suspected sepsis;²⁰
3. algorithms for the home-based management of birth asphyxia, LBW or preterm babies and of sepsis;^{21–23}
4. methods of health education to mothers/families for the adoption of better mother-newborn care practices;²⁴
5. selection of a village health worker (VHW), a resident literate woman in each village, as the provider of HBNC. A systematic method of selecting the appropriate woman as a VHW was developed;
6. a curriculum and the method of training VHWs (36 days of classroom training spread over a period of 12 months) including practicum periods in the community;
7. a mechanism of cooperation with TBAs;
8. a mix of social recognition, job satisfaction and performance-based remuneration to motivate the VHWs for a high level of performance.

EFFECTIVENESS OF HBNC INTERVENTIONS (1996 TO 2003)

The HBNC interventions were provided in 39 intervention villages. Though the training of VHWs, home visits and observations began during 1995 to 1996, the active interventions were introduced during 1996 to 1998. Subsequently, they were continued during 1999 to 2003 (Figure 2). The interventions in the HBNC package²⁵ are presented in Box 2 and Figure 3.

The effects of the interventions on morbidities and mortality were carefully monitored. We have presented these in four articles,^{21–24} which we summarize here.

Box 1 Why do neonates die in rural Gadchiroli

1. Population attributable risks, that is the proportion of deaths in a population which can be attributed to a cause, and hence, will be averted if that cause is removed,^{17,18} for the major morbidities were the following: (Since these causes overlap, the attributable risks of death also overlap.)

Preterm birth	0.74
Intra-uterine growth restriction (IUGR)	0.55
Sepsis	0.55
Birth asphyxia	0.35
Hypothermia	0.08
Feeding problems	0.04
2. Although pre-term birth was present in 63% of deaths and IUGR in 28% of deaths (and low birth weight (LBW) <2500 g in 90% of deaths), these alone, in the absence of other co-morbidities, were present in only 10% of the deaths.
3. The percent CF steeply increased with the mean number of morbidities per neonate. Most (83%) of deaths occurred in neonates with at least two or more morbidities. Thus, deaths occurred due to morbidity combinations.
4. The most common morbidity combinations and the proportion of deaths caused by these overlapping combinations were:

Preterm+sepsis	35%
IUGR+sepsis	22.5%
Preterm+asphyxia	20%
Preterm+hypothermia	15%
Preterm+feeding problems	12.5%
5. The CF in LBW alone or in suspected sepsis alone was low, but when these two occurred together, the CF increased up by 6 to 18 times.
6. Estimated excess deaths caused by sepsis, over and above LBW, was 44% of the total deaths.

Box 2 Home-based Neonatal Care: The Intervention Package

1. Selection and training of a village health worker in each village.
2. Ensuring cooperation of community, TBA and the health services.
3. Making a list of pregnant women in community, and updating it regularly.
4. Health education:
 - Group health education: using audio-visuals and group games.
 - To individual mother, by home visiting, twice during pregnancy and once on the second day after delivery.
 - To mothers of high-risk neonates.
5. Attending delivery, along with the TBA.
 - Encouraging the family and the TBA for referral when necessary.
 - Taking charge of the baby immediately at birth.
 - Assessment, and if necessary, management of asphyxia by following an algorithm, and using bag and mask.
6. Initiation of early and exclusive breast feeding, and supporting/teaching mother to breast-feed successfully.
7. Injection vitamin K1 mg, on the day of birth.
8. Thermal care of the neonate.
9. Assessing for high-risk status. If present, extra care.
10. Repeated home visits (8–12) during neonatal period to ensure breast-feeding, thermal care, hygiene, and to monitor the baby for any infection — superficial or systemic (sepsis).
11. Early diagnosis and treatment of neonates with sepsis, including administration of two antibiotics — co-trimoxazole and gentamicin.
12. Home-based care of LBW or preterm neonates.
13. Weekly weighing, problem solving, advising and helping mother.
14. Referral when necessary.
15. Supervision (twice in a month), support, supplies, records, performance-linked remuneration and continued training to VHWS.
16. Vital statistics and HBNC service data monitoring.



Figure 3. Home-based neonatal care in action.

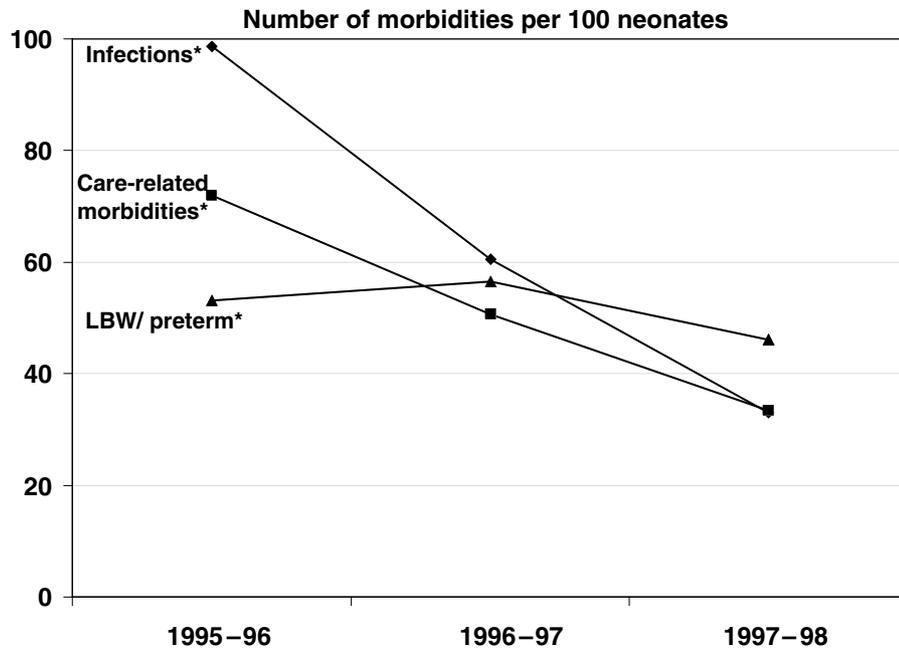


Figure 4. Reduced burden of neonatal morbidities.

Infections*: Neonatal sepsis, pneumonia, umbilical sepsis, skin infection, conjunctivitis, unexplained fever, diarrhea and upper respiratory syndrome. Care-related*: Mild and severe asphyxia, breast-feeding problems, hypothermia and inadequate weight gain in 0 to 28 days (<300 g). LBW/preterm*: LBW, preterm.

Effect on the Incidence of Neonatal Morbidities

We estimated the effect on the incidence of neonatal morbidities by comparing the incidence in early (1995 to 1996) vs. later (1997 to 1998) years of intervention (Figure 4).²⁴

- The mean number of morbidities/100 neonates decreased by nearly 50%.
- Infections, the care-related morbidities and the seasonal increase in morbidities showed large and significant reductions.
- The incidence of LBW decreased by 16%; preterm births did not change.

The possible explanation for the reduction in the incidence of neonatal morbidities was the high proportion of mothers with correct knowledge (79%) and behaviors (70%) in 1997 to 1998. The incrementally increasing score of interventions in 3 years and

the decreasing incidence of morbidities showed a dose-response relationship.

Home-based Management of LBW and Preterm Neonates

The VHVs assessed 93% of the 5919 neonates born in 39 villages, and provided home-based management to 97% of the detected LBW or preterm neonates.²¹ A comparison of the observation year (1995 to 1996) with the intervention years (1996 to 2003) revealed that:

- CF in 2015 LBW neonates declined by 58% (from 11 to 5%, $p < 0.001$), and in 533 preterm neonates by 70% (from 33 to 10%, $p < 0.0001$) (Figure 5). The CF declined in all grades of severity of LBW or prematurity, though it remained relatively high in <1500 g and <33 weeks.
- The incidence of major co-morbidities, viz., sepsis, asphyxia, hypothermia and feeding problems declined.

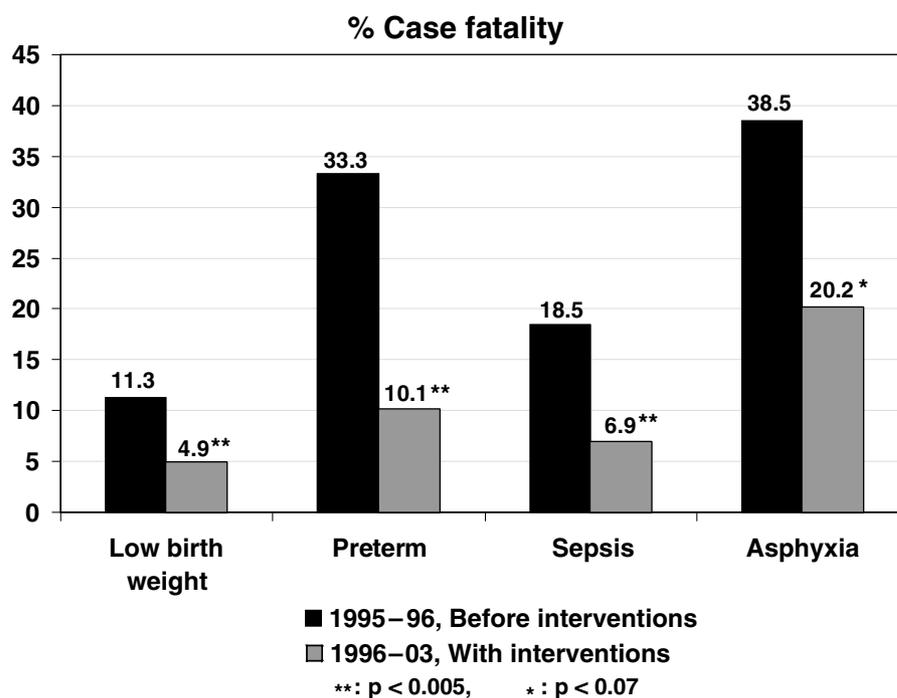


Figure 5. Effect of home-based newborn care on CF in life-threatening morbidities (1995 to 1996 vs 2001 to 2003).

- The deaths averted among the LBW neonates were explained as 55 deaths averted by supportive care and 35 by treatment with antibiotics.

Neonatal Sepsis

In 1996 to 2003, the VHWs monitored 93% of the 5919 neonates in 39 villages by frequent home visits.²² Out of the 552 cases of suspected sepsis diagnosed by the computer algorithm, the VHWs correctly diagnosed 492 (89%) cases of suspected sepsis.

- Parents opted for home-base management in 91% of the diagnosed cases, refused any treatment in 6.3% and agreed to hospitalize in 2.6% of cases. The VHWs treated a total of 470, that is, 9% of all neonates in community as suspected sepsis, out of which 448 were correct diagnoses. Thus, they correctly diagnosed and treated 81% (448/552) of the total sepsis cases in the community. In the last two years (2001 to 2003), this proportion was 90%.
- The CF in the 448 treated cases was 6.9%, as against 22% in the untreated or 18.5% in the pre-treatment year, April 1995 to March 1996 ($p < 0.0001$) (Figure 5).
- The CF in LBW sepsis cases declined by 72%, and in preterm sepsis cases by 67%.
- The sepsis-specific NMR decreased by 90%.

Birth Asphyxia

- The VHWs were present for 84% of the 5033 home deliveries and, in team with TBAs, managed the neonates at birth.²³

Comparison of the observation year (1995 to 1996) with the intervention years (1996 to 2003) revealed that:

- The incidence of mild asphyxia decreased by 60% (from 14 to 6%, $p < 0.001$)
- CF in severe asphyxia decreased by 47.5% (from 39 to 20%, $p < 0.07$) (Figure 5).
- Asphyxia-specific NMR decreased by 60%, from (11% to 4%, $p < 0.02$).

Resuscitation with bag and mask appeared to be more effective in reducing CF and fresh stillbirths than tube and mask or mouth-to-mouth resuscitation.

IMPACT ON NEONATAL AND INFANT MORTALITY

The baseline NMR, IMR and the stillbirth rate (SBR) were similar in the control and intervention areas.^{13,25,26} We estimated the impact of HBNC by comparing the change in the NMR and IMR in the intervention and the control areas during 10 years — from the baseline (1993 to 1995) to the last 2 years of intervention (2001 to 2003) (Figures 6 and 7).

- The NMR in the intervention area decreased from 62 to 25. The reduction in comparison to the control area was by 70% (95% CI 59 to 81%).
- The reduction in the NMR was contributed by the reduction in both the early NMR (24 points) and the late NMR (20 points).
- The SBR decreased by 49% (95% CI 31 to 66).
- The PMR decreased by 56% (95% CI 44 to 68).

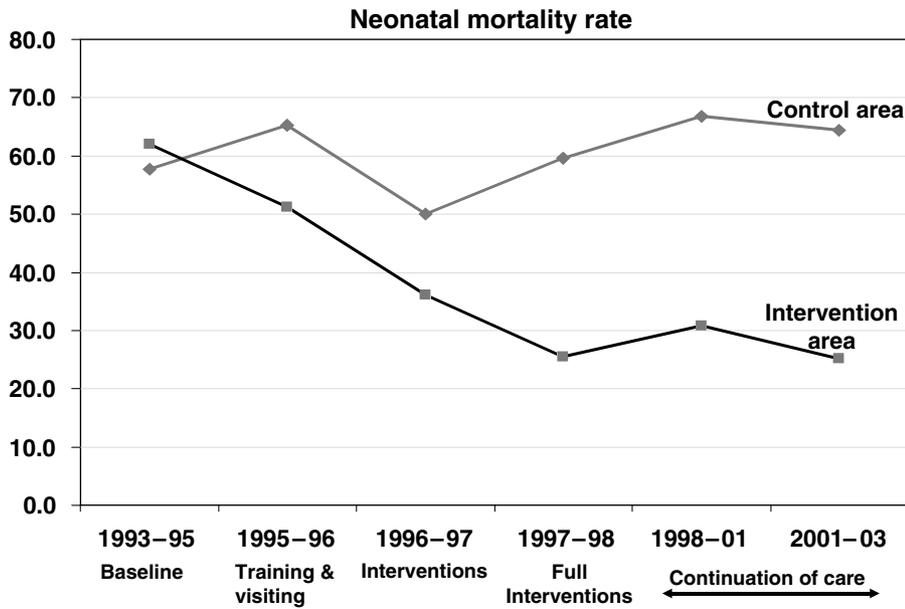


Figure 6. NMR in the intervention and control area: 1993 to 2003.

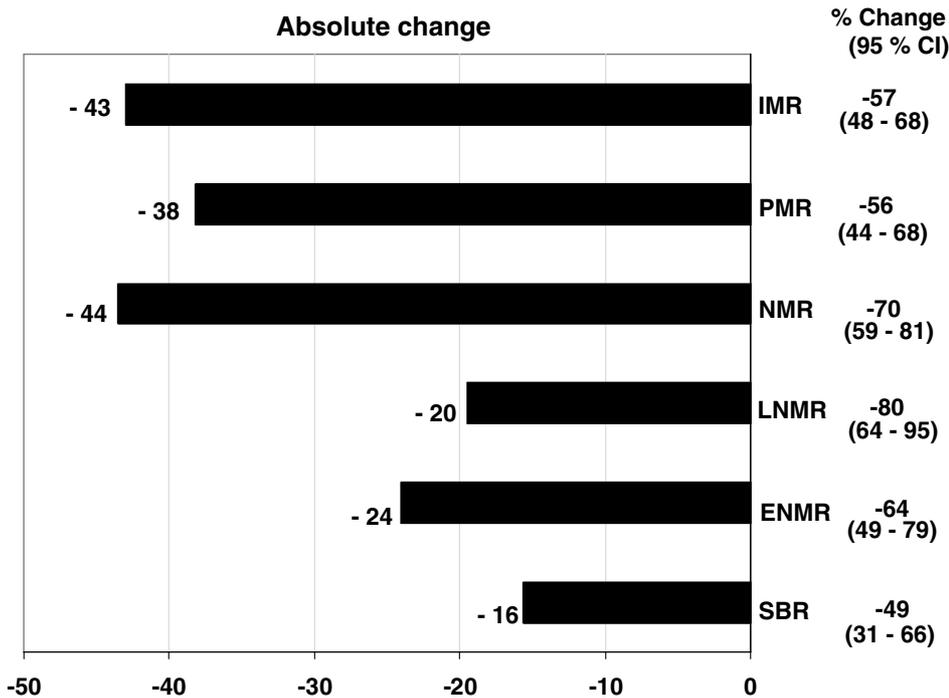


Figure 7. Effect on mortality rates: net reduction.

- The IMR declined from 76 to 31. In comparison to the control area, the reduction was by 57% (95% CI 46 to 68%).

THE PATHWAYS OF ACTION AND THE ATTRIBUTABLE CONTRIBUTION

The VHW acts through health education for behavior change, supporting the home-based care and management of sick neonates

(Figure 8). We estimated the contribution of different components of HBNC interventions. The reduction in the NMR was attributable to various component interventions, in a proportion shown in Figure 9.²⁶

HYPOTHESES TESTED

The field trial was started with two hypotheses, and two more were developed based on the data on neonatal health collected in the

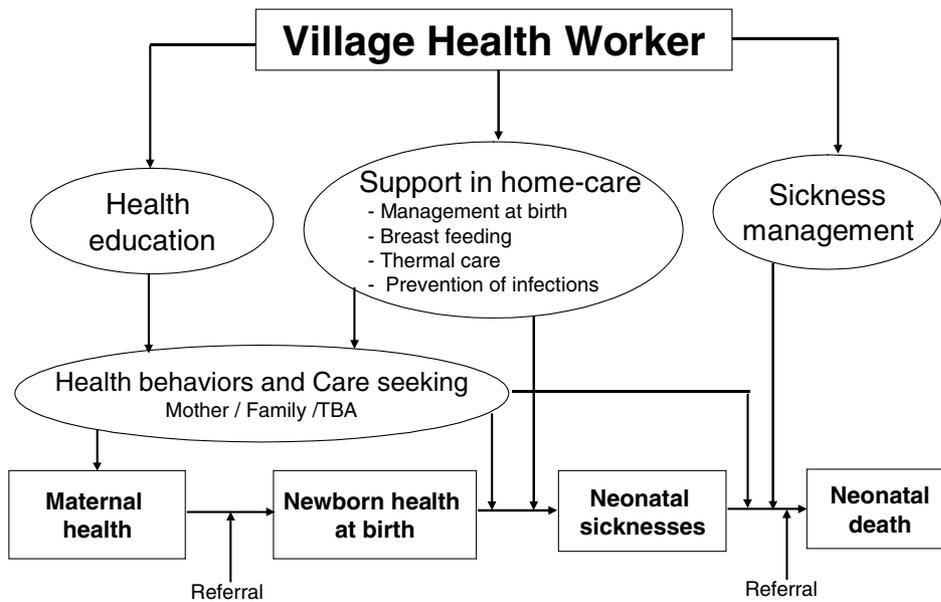


Figure 8. Pathways of action of the home-based neonatal care.

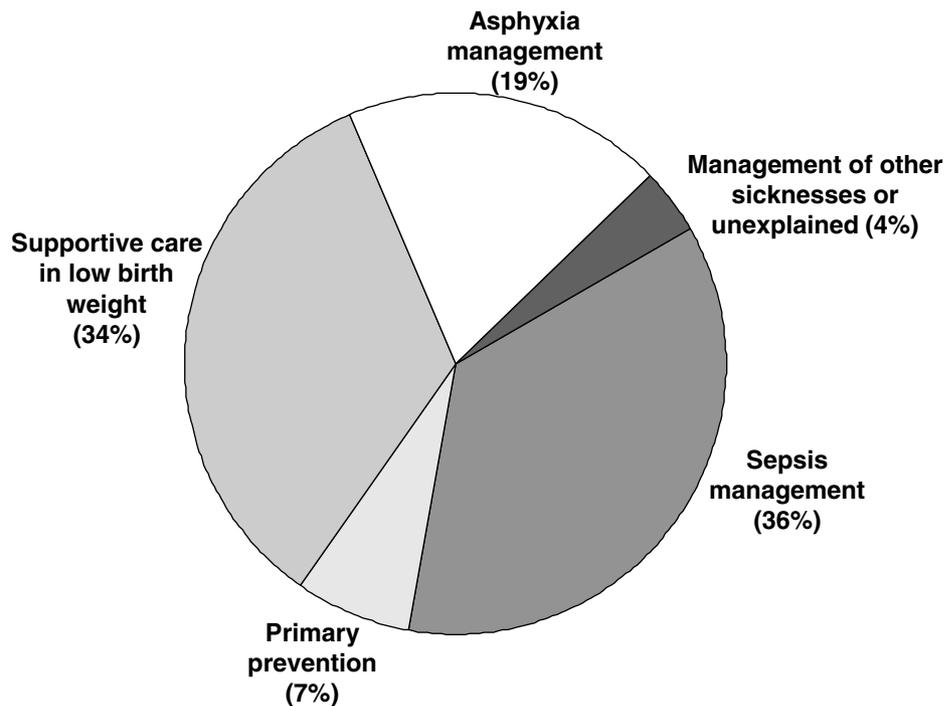


Figure 9. Proportion of neonatal deaths prevented by different components of home-based neonatal care (1996 to 2003) (total deaths prevented = 161).

observation year. The results of testing the hypotheses are presented in Box 3.

CONCLUSIONS

We conclude that in a poor, malnourished and semi-literate population such as in rural Gadchiroli, characterized by near-

complete absence of access to neonatal health services, high incidence (42%) of LBW neonates and high NMR (62) and IMR (76), it was possible to provide HBNC to most (93%) neonates in the community, to reduce neonatal morbidity load (by 50%), to reduce neonatal mortality (by 70%) and finally, to reduce the IMR (by 57%) to a level of around 30, the goal of the National Population Policy of India to be achieved by the year 2010.²⁷

Box 3 Hypotheses tested in the field trial

Hypothesis	Results
1. It is feasible to develop an HBNC intervention package that will cover 75% of neonates in the intervention area, and 60% of neonates with sepsis.	In all, 93% neonates received HBNC, including 84% attended at birth. An estimated 81% neonates with suspected sepsis were correctly diagnosed and treated by VHWs.
2. The NMR will decrease by 25% and sepsis-specific NMR by 40% in three years.	The NMR decreased by 62% in the third year (1997 to 1998) and by 70% in 2001 to 2003. The sepsis-specific NMR decreased by 76% in 1997 to 1998 and by 90% in 2001 to 2003.
3. Neonatal morbidities showing strong seasonal variation indicate inadequate protection. With the HBNC, the seasonal increase will disappear and the incidence of morbidities will substantially decrease.	The incidence of 17 morbidities decreased by a mean 50%, and the significant seasonal increase originally observed in six morbidities became insignificant except for fever in the summer.
4. Even if the incidence of LBW and preterm birth cannot be reduced, the HBNC will increase the survival of the LBW and preterm neonates by preventing or managing the co-morbidities.	The incidence of LBW decreased by 16% and that of preterm births was unchanged. During the 7 years of interventions, the incidence of co-morbidities in LBW or preterm neonates decreased, and the management of sepsis and other morbidities was feasible. As a result, the CF in LBW neonates decreased by 58%, and in preterm neonates by 70% ($p < 0.001$).

THE COST AND THE COST-EFFECTIVENESS OF HBNC

(1) **Time inputs:** Based on a time-motion study of 36 VHWs (3062 days of observations) in different seasons in a year, we estimated that the time spent by a VHW (approximately one per 1000 population) for the delivery of the HBNC package was as follows:

1. Time spent per day: 1 hour 23 minutes
2. Time per mother-neonate: 15 hours 39 minutes
3. Time per sepsis case managed: 10 hours 16 minutes

This was a unipurpose worker introduced for an intervention trial. If an existing worker such as a community health worker (CHW) is trained to deliver the HBNC, some of the overlapping tasks (maintenance of population register, preparing the list of pregnant women, health education, treatment of minor illnesses) will not need be duplicated.

Therefore, for such a multipurpose CHW, the additional time required for providing the HBNC to a population of 1000 was estimated to be 65 minutes per day.

(2) **The cost of the HBNC package:** estimated in the Gadchiroli trial in 2001 to 2003 is presented in Table 2. The costs were calculated after removing the research-related costs. (The proportion of time spent by the VHWs and supervisors on the service component in HBNC vs research component was assessed from the detailed time-input study mentioned above.)

The distribution of the annual recurring costs was as follows:

- (i) Personnel 70% (VHW 37%, TBA 9%, supervisors 22%, others 2%).

- (ii) Transport 9%.
- (iii) Medicines and supplies 9%.
- (iv) Support 12%.

The recurring cost per mother-newborn (\$6) is equivalent to the wages of 5 to 6 days for a female agricultural laborer in the Gadchiroli area.

These cost estimates are higher than those we published earlier for the year 1997 to 1998.²⁵ The main reasons for this are the increase in prices over the last 5 years (from 1997 to 1998 to the prices in 2002 to 2003) by nearly 30% and a reduction in the birth rate by nearly 20%, resulting in a smaller number of newborns served per VHW.

(3) **Cost for India:** With these costs, the estimated cost of a program like this for the whole of India (population 1 billion) will be the nonrecurring cost of \$155 million (in 2002 to 2003 prices), and the annual recurring cost of \$118 million. These estimates do not take into account the administrative cost of program development in a large system, nor the savings due to adding the activity onto ongoing health services. Moreover, a proportion of population in India, especially the urban middle class, may not need the HBNC.

(4) **Comparison of cost-effectiveness** (Table 3): The \$7 cost of saving one disability-adjusted life year (DALY)²⁸ by HBNC is much less compared to the cost of other interventions, as estimated by the WHO-CHOICE project, cited in Table 3. The main reasons for this are: (a) the high baseline level of NMR in Gadchiroli, (b) a

Table 2 Cost and Cost-Effectiveness of Home-Based Neonatal Care in Gadchiroli (2001 to 2003) (1 US\$ = 45 Indian Rs.)

	Nonrecurring costs (2002 to 2003 prices*) US\$	Annual recurring cost [†] (US\$)
1 Cost per village [‡]	Training: 89.1 Equipments: 65.9 Total: 155.0	117.8
2 Per capita cost [§]	0.14	0.11
3 Cost per mother-newborn served	0.89 [¶]	6.06
4 Cost per death averted ^{**}	21.1 ^{¶¶}	129.4 ^{††}
Total (nonrecurring + recurring)	150.5	
5 Cost per DALY ^{§§} saved	0.96	5.82
Total (nonrecurring + recurring)	6.78	

*Wholesale prices in India (base: 1993 to 1994), <http://eaindustry.nic.in/pib.htm>.
[†]Basis, 2001 to 2003 accounts, converted into annual cost.
[‡]39 villages.
[§]Population in 2002 to 2003 = 43, 397.
[¶]Non-recurring cost was spread over 8-years period (1995 to 2003).
^{||}Mean 758 live births per year during 2001 to 2003.
^{**}Averted neonatal deaths+averted still births.
^{††}71 deaths averted during 2001 to 2003, that is, 35.5 per year.
^{§§}Death of a neonate = 21.9 DALYs lost, estimated by the formula given by Murry CJL, in Murry and Lopez, WHO, 1994.²⁸

highly effective HBNC intervention package that reduced the NMR and SBR by a large margin, (c) the community-based strategy of providing care, which reduces the cost as compared to services by professionals or in hospital and (d) the cost-effectiveness of HBNC is based on a smaller research study.

The question, however, is, will the cost and the effectiveness remain the same when scaled up? The cost per unit service should decrease due to economies of scale and due to integration with other services, but at the larger scale in a regular service program, the effectiveness also may decrease.

LIMITATIONS OF THE HBNC APPROACH IN THE GADCHIROLI TRIAL

The trial was conducted in Gadchiroli with its particular geographic, rural and cultural characteristics by an organization (SEARCH) which had developed a service base and earned the trust of the local population. Many of the interventions were developed in response to the local situation and need. Hence, the HBNC package and the results in Gadchiroli are, to some extent, limited by the specific context.

1. The approach was developed and tested in a rural area with very limited access to health services. Most (95%) deliveries occurred at home. Sick neonates were rarely taken to hospitals (0.4%), or to a doctor (2.3%).¹⁴ The care gap, felt need, and the acceptance by the populations in other types of areas (urban slums, rural areas with better access) may vary. This is being tested in another project underway (ANKUR).

Table 3 Comparison with the Cost-Effectiveness of other Child Survival Interventions at 95% Coverage*

Ranking	Intervention	Cost per DALY saved (\$)
1	Home-based neonatal care	7
2	Zinc fortification	14
3	Zinc supplementation to children	47
4	Case management of pneumonia in children	86
5	Oral rehydration therapy	194
6	Vitamin A fortification	237
7	Vitamin A supplementation to children	2137
8	Growth monitoring and supplementary food to undernourished infants	8235

*World Health Organisation (WHO-CHOICE Cost-effectiveness analysis results 2000) for South-East Asia Region.
http://www3.who.int/whosis/cea/cea_data_process.cfm? path = evidence, cea, cea_r.... 21 July 2004.

2. Its efficacy has been shown in a population with high baseline levels of NMR and IMR. The baseline proportion of neonates with LBW was high (42%) and the morbidity load, especially the incidence of infections, too was high. The effect may vary with the baseline levels of morbidity and mortality.
3. In this trial, a new unipurpose VHW was introduced for delivering the HBNC. Similarly, the study was conducted by a non-government organization (NGO) outside the health

services system. How to integrate the HBNC approach into the routine health services and add the responsibility of delivering HBNC to the current job description of existing field workers is yet to be evaluated. We, at present, do not know how much drop in effectiveness may occur when, from the research mode, the HBNC will enter into the program mode.

4. The HBNC approach requires intensive training of VHWs (36 days) and field supervision (once in 15 days) to deliver a good quality care at home.
5. The work of a VHW involves some critical technical tasks such as resuscitating an asphyxiated neonate with bag and mask or managing a sepsis case with injection of gentamicin. Medical opinion and the national guidelines in each country may have reservations in accepting these advanced roles.
6. The HBNC intervention package evolved and was delivered by an interactive research team. The motivation and quality of managers will influence the outcome at other places.

The Gadchiroli trial shows a potential path. However, many operational issues need to be considered and tested in the field before this approach can be successfully scaled into a program.

IN WHICH SETTINGS IS HBNC ESPECIALLY RELEVANT?

1. Where the IMR is more than 30. HBNC has a proven record of reducing it to below 30. It is worth noting that Sri Lanka reduced its IMR down to the level of 15, despite having only 50 NICU beds in the entire country.²⁹ This was done mostly by a decentralized health care system reaching almost every mother and newborn.
2. Where a significant proportion of deliveries occur at home.
3. Even in settings with a higher proportion of institutional deliveries, the mother and the neonate are discharged within 48 hours and, hence, they need home-based post-natal and neonatal care.³
4. Where medical care to neonates is not available or not affordable or not acceptable to families. These could be rural areas, hilly and tribal areas and the urban slums.
5. Where marginalized population groups exist in relatively better developed areas.

Majority of the population in India or most developing countries belong to one or more of these categories.

ISSUES FOR FURTHER RESEARCH

- (1) Possible improvizations in HBNC, such as:
 - Use of oral antibiotics for treating sepsis.
 - Gentamicin delivered by way of the Unijet device (PATH, Seattle).
 - Nutritional management of LBW neonates for better weight gain.

- Home-based kangaroo mother care for management of preterm or LBW neonates in HBNC.
- (2) Developing referral linkages, especially for management of <1500 g or <33 weeks neonates.
 - (3) HBNC in urban slums (being tested in the ANKUR project).
 - (4) Integration of HBNC into existing maternal and child health programs or child nutrition and development programs such as the Integrated Child Development Scheme (ICDS) in India.
 - (5) Innovative approaches for the delivery and sustainability of HBNC.

BEYOND THE FIELD TRIAL: INTEGRATION INTO HEALTH PROGRAMS

Newborn health is rapidly emerging as a global health priority.¹ The home-based newborn care, or any newborn care for that matter, cannot be run in isolation, as a vertical program. How can the HBNC be integrated into the ongoing local, national and international health programs? There are multiple points of potential synergy and opportunities for integration.

1. Maternal Health and Reproductive Health

The HBNC approach in Gadchiroli was built upon the background of a high burden of gynecological³⁰ and maternal³¹ morbidity, and a community-based activity of women's reproductive health.^{11,32} The importance of maternal health and maternal care to neonatal health is too obvious to be emphasized. Now, it seems that the converse may also be true. We unexpectedly found that the HBNC interventions in the Gadchiroli trial resulted in a 49% reduction in maternal morbidities. This effect was highly significant ($p < 0.005$) and showed a clear dose-response relationship with the mean score of interventions in HBNC. The need for emergency obstetrical care also decreased by 31% ($p < 0.005$) (Bang et al, unpublished data).

This effect probably operated through health education, changes in maternal behaviors, the presence of a new semi-skilled VHW at delivery, improved practices of TBAs, continued support to the mother during the post-partum period and better care seeking. HBNC may offer the potential to fill the current gap of post-partum care — a period during which 61% of maternal deaths in developing countries occur.^{3,33} Thus, the HBNC and the Safe Motherhood may be complementary approaches.

A recent publication of the cluster randomized trial in Makwanpur, Nepal, supports this view. It reports that awareness generation and mobilization of rural women for better health care resulted in significant reduction in neonatal and maternal mortality.³⁴

2. Child Health

Current international programs such as the IMCI do not cover the neonatal period,⁶ yet that is where the maximum risk of death is

concentrated. The clinic-based approach of IMCI is inappropriate for neonatal care because the family is usually unwilling to take a sick newborn out of the home for medical care. The HBNC approach overcomes these two gaps.

There are several other potentially synergistic points between a child health program and HBNC: (i) Both can be delivered in the community by the same worker. (ii) Many skills required for the treatment of a sick child and a neonate are common (weighing, measurement of respiratory rate and temperature, breast-feeding, health education and use of antibiotics). (iii) The gains of HBNC may not be completely retained if the saved neonates subsequently die during later years of childhood because of other infections such as pneumonia, diarrhea.³⁵ An IMCI or child health program can prevent these deaths. In the Gadchiroli trial, the post-neonatal mortality did not increase.²⁶ The reduction in the NMR by 44 points was almost completely reflected in the reduction in the IMR by 43 points. This was probably because the HBNC was introduced in the intervention area over and above an already existing community-based management of childhood pneumonia and diarrhea.^{11,12}

Such an incremental effect of pneumonia case management since 1988, followed by the HBNC since 1995 in the 39 intervention villages in Gadchiroli, is seen in Figure 10. The IMR in the last reported year (2002 to 2003) had decreased to 26.5. Thus, the IMR decreased by six points per year during 15 years.

3. Millennium Development Goal and the National Goal:

It is meaningful that the resultant IMR in Gadchiroli is less than

30, which is precisely one of the goals of the National Health Policy and the Population Policy of India,²⁷ to be achieved by the year 2010. HBNC offers a possible approach to achieve that goal. The Millennium Development Goals also include reducing child mortality by two-thirds by 2015.³⁶ The feasibility and applicability of the HBNC approach can be tested in other developing countries for achieving this ambitious goal.

4. Health Services: Driven by the needs of the individual disease control programs, health services have been overstretched, creating a void of care at the community level. There are multiple vertical programs vying with each other for priority, without any health worker in the community to deliver them. A gross shortage of trained manpower for delivering health programs in developing countries, and the need to strengthen the health systems, has been recently identified as high priority.^{37,38} Developing a new VHW or CHW for delivering the HBNC can meet the needs of many programs such as IMCI, polio immunization, AIDS control, DOTS, malaria control — to name a few.

The daily workload of providing HBNC for a unipurpose worker in Gadchiroli was approximately one-and-a-half hours, and, for a multi-purpose worker, it was estimated to be approximately 1 hour. Community-based delivery of various health programs through one CHW may improve the coverage and the compliance of many health interventions, reduce costs by sharing them and will strengthen the health services by providing the currently missing presence in community. The gains of integrating two health interventions into one at the community level have been earlier

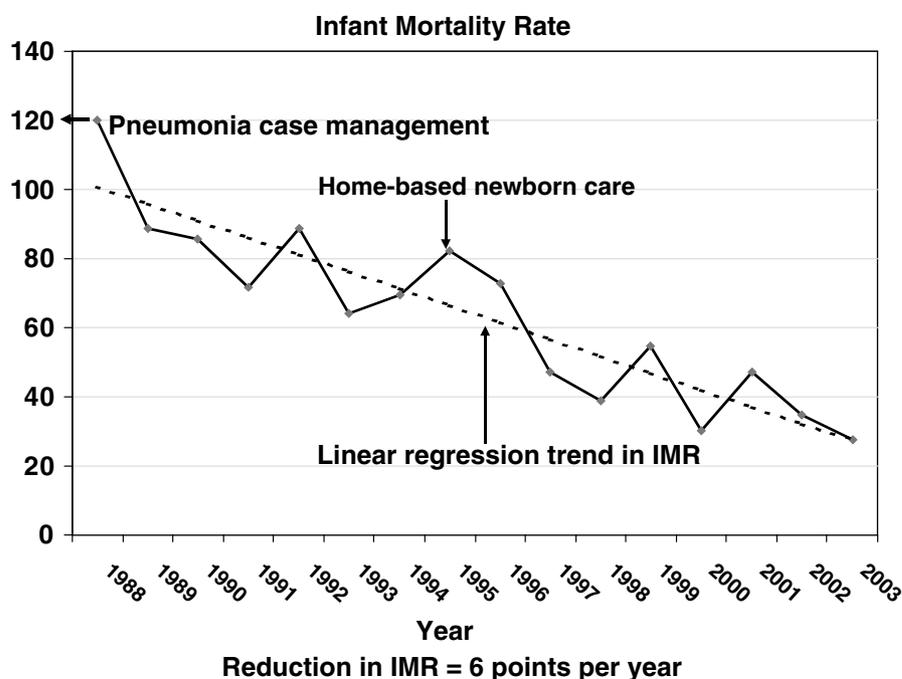


Figure 10. The infant mortality rate in Gadchiroli. Effect of pneumonia case management and the home-based neonatal care in the 39 intervention villages (1988 to 2003).

shown by the field trials of health care and nutrition, and of health care and family planning in Narangwal, India.³⁹

However, a lot of groundwork and operations research will be necessary before this potential of integrating the HBNC into health services is realized.

ESSENTIAL INGREDIENTS FOR SUCCESSFUL REPLICATION

The coverage, quality and effectiveness of HBNC in the Gadchiroli trial were high. On looking back, the following ingredients are considered crucial for this achievement:

1. **Community Consultation:** Neonatal care was not a high priority for the adult males who usually articulate community needs. Moreover, due to their past experience, families had a fatalistic outlook towards the survival of newborns. Hence, a wider consultation with community members, including women, to sensitize them to the need and the possibilities of the new intervention of HBNC, was necessary.

2. **Selection of VHWs:** This was probably the single most important decision for ensuring success at the community level. A nationwide CHW program in India failed nearly two decades ago and was finally stopped. The major causes were selection of inappropriate persons as CHWs (mostly males) and poor training. The method of selecting VHWs in Gadchiroli involved setting eligibility criteria, wide publicity and community involvement to get the maximum number of eligible candidates, personality testing of the candidates, objective evaluation and, finally, testing in the field. This intensive method of recruiting yielded satisfactory results — high performance of VHWs and a <10% dropout rate in 8 years.

3. **Training:** In the training strategy and the curriculum that we developed, a new, literate woman from a village required a minimum 36 days of training, spread over a period of 12 months. This gave her the opportunity to learn in small doses (3 days in each month) and to practice the incrementally learned new skills in community (in which about two births occur every month) under the guidance of a visiting field supervisor. This ensured a good quality of training; moreover, she was trained in the setting where she would be working. The community became the ground for learning clinical and communication skills.

4. **Supervision:** Intensive field supervision (once in 15 days in this trial) was essential for onsite training and ensuring quality performance. Supervision was viewed as an extension of training and support.

5. **Performance-linked remuneration:** Families, at least for now, were unwilling to pay for the services to the newborn. Hence, the VHW had to be financially supported. Her remuneration was kept marginally more than the wages she might earn as an agricultural laborer in the same number of hours. This ensured that the rural elites did not vie for the job, but at the same

time, ordinary village women found it attractive to take up this new job.

We divided her total expected remuneration into approximately one-third as a fixed monthly payment (retention price) and two-thirds linked to her performance. A scale of payment using the work output and the quality of work was developed. We found this to be very effective in providing motivation as well as in ensuring good performance.

6. **Motivation:** Apart from the remuneration, the new skills and a new role, the recognition that these give her in her community, the respect which she gets from her supervisors and her program managers and, finally, the emotional gratification she gets by helping other mothers and newborns in her own community are powerful motivators.

7. **Acceptance and utilization:** HBNC covered 93% of neonates in the intervention area in Gadchiroli. The VHW could be present for 84% of the home deliveries. Most families were willing for management of sick neonates, including of LBW, preterm neonates and those with sepsis, to take place at home. The crucial elements for high acceptance were:

- (i) An unserved area in which 95% of deliveries occurred at home. (However, even in the areas with a higher proportion of hospital deliveries, most of the post-partum/neonatal period is spent at home. Therefore, HBNC might be needed even in such areas.)
- (ii) Selection as the VHW of a woman acceptable to the community.
- (iii) 24-hour availability of the VHW.
- (iv) Cooperation of the TBA who was made to feel not threatened but supported by the arrival of an *additional* hand.
- (v) The curative role of the VHW, and the reduced CF. Treatment of minor illnesses in adults, management of pneumonia and diarrhoea in children, management of birth asphyxia with bag and mask, administration of injection vitamin K to neonates and management of neonatal sepsis, LBW or preterm babies and other problems gave the VHWs good credibility. Without these, she would be powerless.

REPLICATION AND IMPROVIZATION INITIATIVES IN SOUTH ASIA

- (i) In two national workshops (1999 and 2003), the national leadership of pediatricians and neonatologists in India endorsed the HBNC approach and recommended its wider application.^{40,41}
- (ii) Replication through NGOs at seven sites in Maharashtra — the project ANKUR. This trial is testing two operational questions. First, is HBNC acceptable and effective in different types of settings such as the rural, tribal and urban slums, including areas with higher proportions of hospital deliveries and lower levels of the IMR? Second, can

HBNC be delivered through the NGO sector? After the baseline study for 2 years, the training has been completed, and interventions introduced in 2003. The early results are promising.

- (iii) Development of the training curriculum, manuals and health education material for training in HBNC has been completed by SEARCH, Gadchiroli. The evaluation of the training in seven different field sites showed that 92% of the trained CHWs scored >70%. As a result, the training has been now standardized.

These two projects (ii and iii) are supported by the Saving Newborn Lives Initiative, Save the Children, USA and the Bill & Melinda Gates Foundation.

- (iv) Replication through government health services is a major research issue. A field trial (2003 to 2007) by the Indian Council of Medical Research at the behest of the Ministry of Health and Family Welfare, Government of India, is field testing the HBNC approach in five states in India, using the intervention package and training developed in the Gadchiroli trial.
- (v) The new 5-year national project, Reproductive and Child Health (RCH-II) of the Government of India (2005 to 2010) includes introducing the HBNC approach in a substantial part of the country.
- (vi) The IMCI program in India is being modified to include a HBNC component using a similar approach and has become an “IMNCI” that is, Integrated Management of Newborn and Child Illnesses.⁴²
- (vii) New field trials have been launched to test the feasibility, replicability, and sustainability of HBNC in communities in Bangladesh, Malawi, Nepal and Pakistan.

BEYOND THE OLD BOUNDARIES, A NEW ROLE

Management of a high-risk or sick neonate is usually considered a difficult and specialized job. Though theoretically sound and well meaning, this position may result in a “touch-not a neonate” mindset among health workers. The Gadchiroli trial shows that by using the method of task analysis, the complex job of neonatal care can be broken down into a series of smaller, simpler tasks and the VHWs can be trained to successfully undertake these tasks.

This new role involves some unconventional tasks, such as the management of birth asphyxia with bag and mask, administering injection vitamin K, management of LBW babies, clinical diagnosis of sepsis using specific criteria and managing sepsis with two antibiotics, including the administration of gentamicin. With proper training and supervision, these tasks can be done well in home settings by a VHW as demonstrated in this trial.

A trained VHW is not a skilled birth attendant, but she is also not an illiterate traditional attendant. She may be called “a semi-

skilled attendant”. The evidence in this trial shows that by teaming up with TBA, mother and family, the VHW can provide neonatal care, improve neonatal survival, and, as described earlier, also improve maternal health in unserved areas.

THE TALISMAN FOR EQUITY IN HEALTH CARE

We began this chapter with a quote, “the talisman”, by Mahatma Gandhi. A neonate in developing countries undoubtedly is that weakest human being, its care the ultimate test of equity, human justice and health care.

Four million neonates die every year, most of them at home. If they cannot reach health services, the health services must reach out to them. The evidence from the Gadchiroli field trial suggests that such reaching out is possible.

References

1. Save the children, State of the World's Newborns. Save the Children. Washington, DC; 2001.
2. Bale JR, Stoll BJ, Lucas AO. The Executive Summary: Improving Birth Outcomes — Meeting the Challenge in the Developing World. Washington DC: Institute of Medicine, The National Academy Press; 2001. p. 3–16.
3. World Health Organization. Post-Partum Care for the Mother and the Newborn: A Practical Guide. Geneva: WHO; 1998.
4. World Health Organization. Report of the Fourth Meeting of the Technical Advisory Group, Programme of Acute Respiratory Infections. Geneva: WHO; 1989 (document no. WHO/ARI/89.4).
5. World Health Organization. Supervisory Skills: Management of the Young Child with an Acute Respiratory Infection. Geneva: WHO; 1990.
6. Gove S, The WHO Working Group on Guidelines of Integrated Management of the Sick Child. Integrated management of childhood illness by outpatient health workers: technical basis and overview. Bull World Health Org 1997;75(Suppl):7–24.
7. Bang AT, Bang RA, Mornkar VP, Sontakke PG, Solanki JM. Pneumonia in neonates: can it be managed in the community? Arch Dis Childhood 1993;68:550–6.
8. Sutrisna B, Reingold A, Kresno S, et al. Care-seeking for fatal illness in young children in Indramayu, West Java, Indonesia. Lancet 1993;342:887–9.
9. Bhandari N, Bahl R, Bhatnagar V, Bahn MK. Treating sick young infants in urban slum setting. Lancet 1996;347:1174–5.
10. Stoll BJ. Neonatal infections: a global perspective In: Remington JS, Klein JO, editors. Infectious Diseases of the Fetus and Newborn Infant. 6th ed. Philadelphia: WB Saunders Company (in press).
11. Bang AT, Bang RA. Background of the field trial of home-based neonatal care in Gadchiroli, India. J Perinatol 2005;25:S3–10.
12. Bang AT, Bang RA, Tale O, et al. Reduction in pneumonia mortality and total childhood mortality by means of community-based intervention trial in Gadchiroli, India. Lancet 1990;336:201–6.
13. Bang AT, Rani RA, Reddy HM, Deshmukh M. Methods and the baseline situation in the field trial of home-based neonatal care in Gadchiroli, India. J Perinatol 2005;25:S11–7.
14. Bang AT, Reddy HM, Baitule SB, Deshmukh M, Bang RA. The incidence of morbidities in a cohort of neonates in rural Gadchiroli, India: seasonal and

- temporal variation and a hypotheses about prevention. *J Perinatol* 2005;25:S18–28.
15. Bang AT, Paul VK, Reddy HM, Baitule SB. Why do neonates die in rural Gadchiroli, India? (Part I): Primary causes of death assigned by neonatologist based on prospectively observed records. *J Perinatol* 2005;25: S29–34.
 16. Bang AT, Reddy HM, Bang RA, Deshmukh M. Why do neonates die in rural Gadchiroli, India? (Part II): Estimating population attributable risks and contribution of multiple morbidities for identifying a strategy to prevent deaths. *J Perinatol* 2005;25:S35–43.
 17. Greenland S, Rothman K. Measures of effect and measures of association In: Rothman K, Greenland S, editors. *Modern Epidemiology*. 2nd ed. Philadelphia: Lippincott-Raven Publ.; 1998. p. 47–65.
 18. Rowe AK, Powel KE, Flanders WD. Why population attributable fractions can sum to more than one. *Am J Prev Med* 2004;26(30):243–9.
 19. Reddy HM, Bang AT. How to identify neonates at risk of death in rural India: clinical criteria for the risk approach. *J Perinatol* 2005;25: S44–S50.
 20. Bang AT, Bang RA, Reddy HM, Baitule SB, Paul VK, Marshal T. Simple clinical criteria to identify sepsis or pneumonia in neonates in the community needing treatment or referral. *Ped Inf Dis J* (in press).
 21. Bang AT, Baitule SB, Reddy HM, Deshmukh M, Bang RA. Low Birth Weight and Preterm Neonates: Can they be managed at home by mother and a trained village health worker? *J Perinatol* 2005;25:S72–81.
 22. Bang AT, Bang RA, Stoll BJ, Baitule SB, Reddy HM, Deshmukh M. Is home-based diagnosis and treatment of neonatal sepsis feasible and effective? Seven years of intervention in the Gadchiroli field trial (1996–2003). *J Perinatol* 2005;25:S62–71.
 23. Bang AT, Baitule SB, Reddy HM, Deshmukh M. Management of birth asphyxia in home deliveries in rural Gadchiroli: the effect of two types of birth attendants and of resuscitating with mouth-to-mouth, tube-mask or bag-mask. *J Perinatol* 2005;25:S82–91.
 24. Bang AT, Bang RA, Reddy HM, Deshmukh M, Baitule SB. Reduced incidence of neonatal morbidities: Effect of home-based neonatal care in rural Gadchiroli, India. *J Perinatol* 2005;25:S51–61.
 25. Bang AT, Bang RA, Baitule S, Reddy MH, Deshmukh M. Effect of home-based neonatal care and management of sepsis on neonatal mortality: field trial in rural India. *Lancet* 1999;354:1955–61.
 26. Bang AT, Reddy HM, Deshmukh M, Baitule SB, Bang RA. Neonatal and infant mortality in the ten years (1993–2003) of the Gadchiroli Field Trial: effect of home-based neonatal care. *J Perinatol* 2005;25:S92–107.
 27. Government of India. *The National Population Policy (2000)*. New Delhi: Ministry of Health and Family Welfare, Government of India; 2001.
 28. Murry CJL. Qualifying the burden of disease: the technical basis for disability-adjusted life years. In: Murry CJL, Lopez AD, editors. *Global Comparative Assessments in the Health Sector: Disease Burden, Expenditures and Intervention Packages*. Geneva: World Health Organization; 1994.
 29. Harendra de Silva DG. Perinatal Care in Sri Lanka: secrets of success in a low-income country. *Sem Neonatology* 1999;3(4):201–8.
 30. Bang RA, Bang AT, Baitule SB, Choudhary Y, et al. High prevalence of gynecological diseases in rural Indian women. *Lancet* 1989;i:85–8.
 31. Bang RA, Bang AT, Reddy MH, Deshmukh MD, et al. Maternal morbidity during labour and the puerperium in rural homes and the need for medical attention: a prospective observational study in Gadchiroli, India. *BJOG* 2004;111:231–8.
 32. Bang RA, Bang AT and SEARCH team. Commentary on a community-based approach to reproductive health care. *Int J Gynecol Obstet* 1989;3:125–9.
 33. Li F, Fortney JA, Kotelchuck M, Glover LH. The post-partum care: the key to maternal mortality. *Int J Gy-OB* 1996;54:1–10.
 34. Manandhar DS, Osrin D, Shreshtha BP, et al. Effect of a participatory intervention with women's groups on birth outcome in Nepal: cluster-randomized controlled trial. *Lancet* 2004;364:970–9.
 35. Mosley WH, Becker S. Demographic models for child survival and implications for health intervention programs. *Health Policy Plann* 1991; 6(3):218–33.
 36. United Nations General Assembly. *United Nations Millenium Declaration; Resolution 55/2 September 18, 2000*. Available at <http://www.un.org/millennium/declaration/ares552e.pdf>(accessed April 23, 2004).
 37. Task force on Health Systems Research. Informed choices for attaining the Millennium Development Goals: towards an international cooperative agenda for health-systems research. *Lancet* 2004;364:997–1003.
 38. Hongoro Charles, McPake Barbara. How to bridge the gap in human resources for health. *Lancet* 2004;364:1451–6.
 39. Taylor CE, Kielmann AA, DeSweemer C, Chernchovsky D. The Narangwal nutrition experiment: background and summary of findings In: Kielmann AA, Taylor CE, DeSweemer C et al., editors. *Child and Maternal Health Services in Rural India*. Vol I. Baltimore: The Johns Hopkins University Press; 1983. p. 3–30.
 40. Consensus Statement of the National Workshop on Home-based Neonatal Care jointly organized by the Indian Academy of Pediatrics, National Neonatology Forum of India, UNICEF and SEARCH. SEARCH, Gadchiroli, India, 1999.
 41. Consensus Statement of the National Workshop on 'How to Reduce the IMR to 30', 31 March–1 April 2003, SEARCH, Gadchiroli, India.
 42. Save the Children. *State of India's Newborns*. National Neonatology Forum of India and Save the Children, US. New Delhi; 2004. p. 92–4.