npg

Original Article

Reduced Incidence of Neonatal Morbidities: Effect of Home-Based Neonatal Care in Rural Gadchiroli, India

Abhay T. Bang, MD, MPH
Rani A. Bang, MD, MPH
Hanimi M. Reddy, PhD
Mahesh D. Deshmukh, MSc
Sanjay B. Baitule, DHMS

OBJECTIVE:

We found a high burden of morbidities in a cohort of neonates observed in rural Gadchiroli, India. We hypothesised that interventions would reduce the incidence of neonatal morbidities, including the seasonal increase observed in many of them. This article reports the effect of home-based neonatal care on neonatal morbidities in the intervention arm of the field trial by comparing the early vs late periods, and the possible explanation for this effect.

METHODS:

During 3 years (1995 to 1998), trained village-health-workers (VHWs) in 39 villages prospectively collected data by making home visits during pregnancy, home-delivery and during neonatal period. We estimated the incidence and burden of neonatal morbidities over the 3 years from these data. In the first year, the VHWs made home visits only to observe. From the second year, they assisted mothers in neonatal care and managed the sick neonates at home. Health education of mothers and family members, individually and in group, was added in the third year. We measured the coverage of interventions over the 3 years and evaluated maternal knowledge and practices on 21 indicators in the third year. The effect on 17 morbidities was estimated by comparing the incidence in the first year with the third year.

RESULTS:

The VHWs observed 763 neonates in the first year, 685 in the second and 913 in the third year. The change in the percent incidence of morbidities was (i) infections, from 61.6 to 27.5 (−55%; $p<0.001$), (ii) care-related morbidities (asphyxia, hypothermia, feeding problems) from 48.2 to 26.3 (−45%; $p<0.001$); (iii) low birth weight from 41.9 to 35.2 (−16%; $p<0.05$); (iv) preterm birth and congenital anomalies remained unchanged. The mean number of morbidities/100 neonates in the 3 years was 228, 170 and 115 (a reduction of 49.6%; $p<0.001$). These reductions accompanied an increasing percent score of interventions during 3 years: 37.9, 58.4 and 81.3, thus showing a dose–response relationship. In the third year, the proportion of correct maternal knowledge was 78.7% and behaviours was 69.7%. The significant seasonal increase earlier observed in the incidence of five morbidities reduced in the third year.

CONCLUSION:

The home-based care and health education reduced the incidence and burden of neonatal morbidities by nearly half. The effect was broad, but was especially pronounced on infections, care-related morbidities and on the seasonal increase in morbidities.

Journal of Perinatology (2005) **25,** S51–S61. doi:10.1038/sj.jp.7211274

INTRODUCTION

Diseases during the perinatal period rank as the third leading cause of the global burden of disease.[1] Four million neonates die each year, 98% of them in developing countries.[2] The global burden of neonatal morbidities has been estimated to be: 4 to 7 million cases of birth asphyxia,[3] 20 million low birth weight (LBW) babies[2] and 30 million bacterial infections.[4] However, the lack of community-based data on neonatal morbidities in developing countries makes such an estimation difficult.

We prospectively observed neonates in 39 villages in Gadchiroli, India, during 1 year (1995 to 1996) in order to estimate the burden of neonatal morbidity. A total of 48.2% neonates had high-risk morbidities, which was nearly 10 times the neonatal mortality rate (NMR) of 52 per 1000, and 72% neonates had low-risk morbidities.[5] These morbidities can cause death or long-term consequences in childhood and adulthood, making huge demands on family and on the health-care system. To compound the problem, most neonates in developing countries are born and cared for at home and cannot be taken for medical care even if sick.[6,7] Hence, providing health care to neonates in rural homes is an enormous challenge in developing countries.

Based on the observed variations in the incidence of neonatal morbidities by season and day of life,[5] and the gaps in the traditional beliefs and practices of neonatal care that we observed

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

This work was financially supported by The John D. Catherine T. MacArthur Foundation, The Ford Foundation, Saving Newborn Lives, Save the Children, USA, The Bill and Melinda Gates Foundation and The Rockfeller Foundation.

Address correspondence and reprint requests to Abbay T. Bang, SEARCH, Gadchiroli 442-605, India.
E-mail: search@satyam.net.in

in the preintervention period, we hypothesised that improved neonatal care would reduce morbidities that showed significant variation by season and by the day of life.[8]

We have reported earlier a field trial of ''Home-based Neonatal Care'' (HBNC) in rural Gadchiroli (1993 to 1998), in which the neonatal and perinatal mortality rates declined by 62 and 71%, respectively ($p<0.001$).[9] Although it reduced mortality, did HBNC affect the larger problem of neonatal morbidity? To answer this question, we further analysed the data from the Gadchiroli field trial, with the following objectives:

1. To evaluate the effect of HBNC on (a) the incidence of 17 neonatal morbidities; (b) the burden of morbidity, measured as the mean number of morbidities per 100 neonates; and (c) the proportion of morbidity-free neonates.
2. To assess whether the effect can be explained by (a) the percent coverage of mothers and neonates by different interventions in HBNC, and (b) the resultant maternal knowledge and behaviours.
3. To test whether the seasonal variations in the incidence of neonatal morbidities observed in the first year changed as a result of HBNC.

METHODS

Study Design

It would have been ethically wrong and practically difficult to closely observe the neonates in the control area for morbidities without making interventions. Hence, we observed neonatal morbidities only in the 39 intervention villages, without much intervention in the first year and with increasing interventions in the second and the third years. The effect was estimated by comparing the first year with the third year and noting the trend.

We have earlier reported the study area, subjects, methods of observing, the definitions and the incidence of the 'baseline' morbidities during 1995 to 1996, subsequent interventions, and the effect on the mortality rates.[5,8,9] Here we describe only the relevant background and the additional information.

Gadchiroli is the most underdeveloped and remote district in Maharashtra state. The HBNC field trial area consisted of 39 intervention villages (population 38,998) and 47 control villages (population 42,149). A well-established surveillance system collected vital statistics during 1993 to 1998. At baseline the two types of villages had similar socioeconomic characteristics, birth rates, and neonatal and infant mortality rates.[9] In the intervention villages, traditional birth attendants (TBAs), trained by our organisation (SEARCH), provided basic maternal and childcare from 1988 onwards.[10,11] Antenatal care was provided by government nurses (1:3000 population) and at a women's clinic of SEARCH located outside the field area. Emergency care was available at the government district hospital in the adjacent town.

All neonates who spent the whole or a part of the neonatal period in the intervention villages during 1995 to 1998 were eligible for inclusion in the study. These included neonates (i) home-delivered in intervention villages; (ii) born outside but brought into the intervention villages for home-care during days 1 to 28; or (iii) born in the intervention villages but moved out before day 28.

Data Collection

During the preintervention period (1993 to 1995), we did a qualitative study of the traditional beliefs and practices about pregnancy, delivery and neonatal care. In 1995, 39 female village health workers (VHWs) were selected, trained and introduced into the intervention villages. They interviewed the mothers thrice during pregnancy, attended and observed home deliveries (most often conducted by TBAs), and subsequently made eight home visits to observe the neonates up to the 28th day, with little intervention during the first year (1995 to 1996). We estimated the baseline incidence of neonatal morbidities from these data using simplified clinical criteria.[5,8]

To ensure quality, a physician made home visits once every 2 weeks to all neonates and checked the data. Moreover, on-site training and economic incentives/disincentives were used to ensure the completeness and quality of the observations. To evaluate the quality, the physician independently recorded parallel observations on 119 consecutive neonates.

Interventions

Based on this information, we trained the female VHWs in 1996 to advise, demonstrate and help mothers in neonatal care at home, identify neonatal morbidities such as asphyxia, prematurity, birth weight <2000 g, sepsis, hypothermia, breast feeding problems, conjunctivitis, skin infections, umbilical sepsis, fever and treat these illnesses appropriately[9] (Figure 1). Although VHWs advised hospitalisation for every serious illness, families rarely followed this advice. Hospital care was not a part of our intervention package, but when the baby was hospitalised, it was recorded.

Recording of various observations about mother, delivery and neonates by the VHWs, and the supervision by the physician continued during 1996 to 1998 with the same frequency and methods as during the first year.

Health Education

We introduced intensive health education in the third year (1997 to 1998). The messages were based on the observations made about the traditional beliefs and practices and the barriers to better care experienced during 1996 to 1997. The health education was delivered by three methods.

1. TBAs who were earlier trained by SEARCH continued their advice to mothers.
2. Group meetings of pregnant women and grandmothers were organised every 4 months in each village. The supervisor and

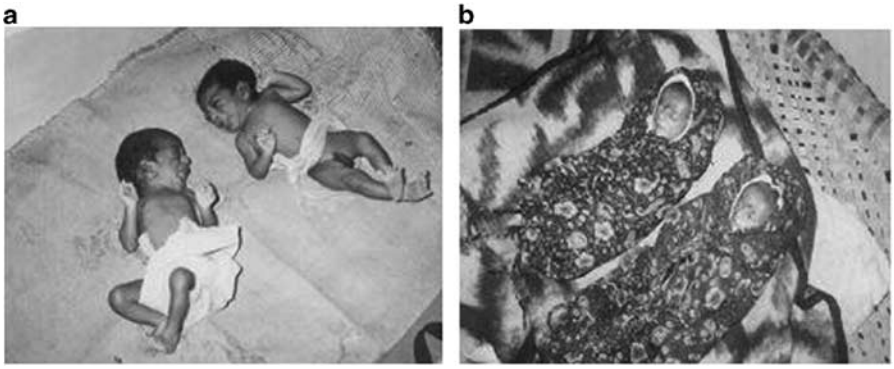


Figure 1. Thermal care in home. (**a**) The traditional practice. (**b**) Keeping the LBW twins warm at home by covering loosely in a warm bag.

the female VHW gave information and demonstrations about nutrition and weight gain during pregnancy, antenatal care, preparation for delivery and the baby, breast feeding, keeping the baby warm, cleanliness, danger signals in the baby and seeking early care from the VHW. Songs, role-plays, games, slide shows, posters, demonstration, case stories and experience sharing were used during these sessions. The retention of information and effect on the beliefs was assessed by way of a questionnaire completed by VHWs by home visits to the mothers 2 weeks after the group meeting.

3. The VHW gave health education to the mother and the family during her home visits using a flip chart. During the eighth and ninth months of pregnancy, she gave 10 messages and a printed pamphlet about mother and baby care. On the first day after delivery she repeated these messages, weighed the baby and demonstrated how to keep the baby clean and warm and how to breastfeed. She also described nine danger signals requiring early care. If, on day 1, the VHW identified the baby as high risk, she gave additional messages and help. During the subsequent home visits, seven by the VHWs and one or two by the supervisory physician, they persuaded the mothers to follow the advice. TBAs, the mainstay of traditional care, also reinforced the messages and practices.

We assessed the interventions on an ongoing basis by the coverage (percent of mothers/neonates covered) and quality. The supervising physician verified this information. The births and child deaths were independently recorded by an ongoing system of SEARCH with the help of the male VHWs and their supervisors. The coverage of the neonates attended by the female VHWs was evaluated against these data. We also assessed the beliefs and behaviours of mothers and the quality of home-based care by introducing an evaluation form in 1997 to 1998, completed by the supervising physician for each baby based on the observations made during home visits. Antenatal care and government health services were not part of the package, so these were not recorded, nor were TBAs interventions measured.

Analysis

For measuring the effect of interventions on the incidence of neonatal morbidities, we compared the incidence in the first vs the third year of interventions. Information about various components in the intervention package and about the effect on behaviour could be analysed for selected indicators in all 3 years. Mothers' knowledge and practices were evaluated only in the third year (1997 to 1998). The data were analysed by SPSS-PC and FOXPRO packages. The significance was tested by the χ^2 test.

Consent, Quality and Ethical Clearance

Written community consent for conducting the study and subsequent interventions was obtained from all intervention villages. An external group of paediatricians and epidemiologists reviewed the technical guidelines, quality of data collection and gave the ethical clearance.[5,8,9]

RESULTS

We have earlier reported the population characteristics and the maternal health indicators in the 39 study villages.[5,9,12] Female literacy was 37.9% and mean maternal height was 149.6 cm. During the baseline years (1993 to 1995), the birth rate was 25.4/1000 population, the NMR was 62.0/1000, the infant mortality rate was 75.5/1000 and the perinatal mortality rate was 68.3/1000 births.

In the first year, out of the total 1016 live births in the study villages, 763 (75.1%) neonates were observed by VHWs and 253 were not observed. The NMRs in the observed neonates (52.4/1000) and in the unobserved neonates (47.5/1000) were similar ($p > 0.5$). The proportion of the observed newborns in the subsequent years was 85.2% (685/804) in 1996 to 1997, and 93.3% (913/979) in 1997 to 1998.

The data collected by VHWs and the parallel data collected by physician in 119 neonates showed mean 92.7% agreement (SD 6.7), the range being 70.2 to 100%. The traditional beliefs and practices reported elsewhere[12] are summarised in Panel 1.

Panel 1 Traditional Beliefs and Practices.

(i) Women underfed themselves during pregnancy to ensure a small baby for easy delivery.
(ii) The babies were often not breast-fed on the first three days and were given sweetened water.
(iii) The babies were not covered properly immediately after birth; baby-clothes were not used until a ceremony (*baj kadhane*) performed on the seventh day.
(iv) Mothers could not leave the delivery room until *baj kadhane*. To minimize the toilet needs during this period, they severely restricted their intake of fluids and food.
(v) Mothers did not wash hands properly, their clothes and linens were often dirty, and the delivery rooms were poorly ventilated.
(vi) Newborns were usually not named until they had lived one month because of the uncertainty about their survival.
(vii) The usual explanations for the sicknesses in neonates were '' the evil eye,'' ''witchcraft'' or the mother's body humours or indiscretions in eating.
(viii) Newborn babies, even if sick, were not moved out of the home.
(ix) Families believed that nurses or doctors could not effectively treat the sick newborn or change the course of the events.
(x) Neonatal death was stoically accepted.

The incidence of various neonatal morbidities in the 3 years is presented in Table 1. Most infections and the care-related morbidities showed progressive reduction. Except for the LBW, morbidities related to maternal factors did not decline significantly. The proportion of neonates with any morbidity also declined.

The mean birth weight was 2471 g (SD 427) in 1995 to 1996; and 2539 g (SD 420) in 1997 to 1998 ($p<0.001$) with a mean net increase of 68 g.

The effect on the burden of morbidities, estimated as the mean number of morbidities per 100 neonates, is presented at the end of Table 1. In Figure 2a, we present the change in the burden in three categories. Infections declined by 66.6% (from 98.7 morbidities to 33 morbidities per 100 neonates; $p<0.001$), care-related morbidities by 53.6% (from 72.0 to 33.4; $p<0.001$) and maternal-factor-related morbidities by 13% (from 53.1 to 46.2, $p<0.05$).

Figure 2b presents the effect on the incidence of neonatal morbidities categorised into high-risk (case fatality >10%) and the low-risk (case fatality <10%).[5] The main high-risk morbidities were preterm, birthweight <2000 g, sepsis, pneumonia, hypothermia, breast-feeding problems and severe asphyxia. The proportion of morbidity-free neonates increased from 12.8 to 36.3% (+184%, $p<0.001$).

The effect on the primary outcome measure of the HBNC field trial, the NMR, is presented in Figure 2c.

The phased manner of introducing interventions and their coverage during different years is presented in Table 2. The coverage of some pre-existing interventions and of most new interventions progressively increased, with the highest levels reached in 1997 to 1998. The mean percent score of interventions on 12 indicators (Table 2, bottom) rose from 37.9 in year 1, to 58.4 in year 2 and to 81.1 in year 3. ($p<0.001$).

The effect of HBNC on breastfeeding is presented in Figure 3. Significant increase occurred in the proportion of newborns breastfed early and exclusively and in the number of feeds per day.

The mean weight gained during days 0 to 28 increased by only 9 g (not significant), but the proportion of neonates with inadequate weight gain (<300 g) during days 0 to 28 declined from 17.9 to 12.4% ($p<0.05$).

The knowledge and behaviour of mothers, assessed in 1997 to 1998 on 21 indicators (Table 3) shows high levels reached for all but two indicators. We did not measure the baseline levels, except for the qualitative data on the beliefs and behaviours (Panel 1).

The seasonal variation observed in the first vs the third year of interventions is presented in Table 4. It shows that the significant seasonal variation present in 1995 to 1996 in the incidence of many morbidities was no longer significant in 1997 to 1998; however, fever in summer, though at reduced incidence, continued to be significant.

The VHWs missed collecting some information. For example, VHWs were not present at the time of some deliveries though they observed these neonates on subsequent days. To ascertain the selection bias, we compared the stillbirth rate in two groups in the observed neonates in 1995 to 1996. It was 24/1000 (14/584) in the deliveries attended by VHWs, and 25/1000 (5/198) in the unattended deliveries ($p>0.5$).

The proportion of hospital deliveries or hospitalisation of sick neonates in the intervention villages (Table 2) remained practically the same during the period of measurement, as did the NMR in the control area (Figure 2c).

DISCUSSION

In this field trial of HBNC, the incidence of a broad range of neonatal morbidities declined in the intervention villages. The burden of morbidities per 100 neonates declined by 49.6%, from 227.9 to 114.8% ($p<0.001$) and the proportion of morbidity-free neonates increased by 184%, from 12.8 to 36.3% ($p<0.001$). The effect on morbidities shows a dose–response relationship with the multiple interventions in HBNC, their increasing coverage and the resultant high levels of knowledge and correct practices in mothers. Hence the observed reduction in morbidities can be attributed to the interventions. The hypothesis that the incidence of morbidities and the seasonal variation will decrease with HBNC was proved.

Table 1 Incidence of Neonatal Morbidities During Different Years of Intervention Phase in Gadchiroli (1995–1998)

Morbidity*	Incidence (%)				*p* (for trend)
	1995–1996 ($n=763$)	1996–1997 ($n=685$)	1997–1998 ($n=913$)	% reduction from 1995–1996 to 1997–1998	
(A) *Infections*					
(1) Umbilical sepsis	19.8	6.6	2.0	−89.9	<0.001
(2) Skin infection	11.5	7.0	2.7	−76.5	<0.001
(3) Conjuctivitis	12.3	4.2	1.2	−90.2	<0.001
(4) Neonatal sepsis	17.0	9.6	8.2	−51.8	<0.001
(5) Pneumonia only	1.0	1.0	1.0	0.0	NS
(6) Unexplained fever	11.4	10.8	5.0	−56.1	<0.001
(7) Diarrhoea	5.5	3.5	2.1	−61.8	<0.001
(8) Upper respiratory infection	20.1	18.1	11.2	−44.3	<0.001
Any of the above infections	61.6	46.1	27.5	−55.3	<0.001
(B) *Care-related morbidities*					
(9) Mild asphyxia	14.2[a]	9.1[b]	7.9[c]	−44.4	<0.001
(10) Severe asphyxia	4.6[a]	2.4[b]	2.5[c]	−45.7	NS
(11) Breast feeding problems (Total)	22.8	16.8	10.0	−56.1	<0.001
Delayed breast feeding (cultural)	9.3	1.0	0.0	−100.0	<0.001
Breast feeding problems	16.3	16.4	10.0	−38.7	<0.001
(12) Hypothermia (total)	17.0	8.6	3.6	−75.8	<0.001
Hypothermia ≤92°F	4.2	1.0	0.5	−88.1	<0.001
Hypothermia 92.1–94.9°F	12.8	7.6	3.1	−75.8	<0.001
(13) Weight gain in 0–28 days <300 g	17.9[d]	19.0[e]	12.4[f]	−30.3	<0.05
Any of the care-related morbidities	48.2	38.1	26.3	−45.4	<0.001
(C) *Morbidities due to maternal factors*					
(14) Pre-term	9.8	11.2	10.2	+4.1	NS
(15) Low birth weight (total)	41.9	44.2	35.2	−16.0	<0.05
Weight <2000 g	9.7	8.7	6.9	−28.9	<0.04
Weight 2000–2499 g	32.2	35.5	28.3	−12.1	NS
(16) Congenital anomalies	1.3	1.0	0.9	−30.8	NS
Any morbidity due to maternal factors	44.0	49.8	39.8	−9.5	NS
(D) *Other problems*	3.7	2.3	2.1	−43.2	NS
Total incidence of any of the above 17 morbidities	87.2	82.8	63.7	−26.9	<0.001
Mean number of morbidities per 100 neonates	227.9	170.1	114.8	−49.6	<0.001

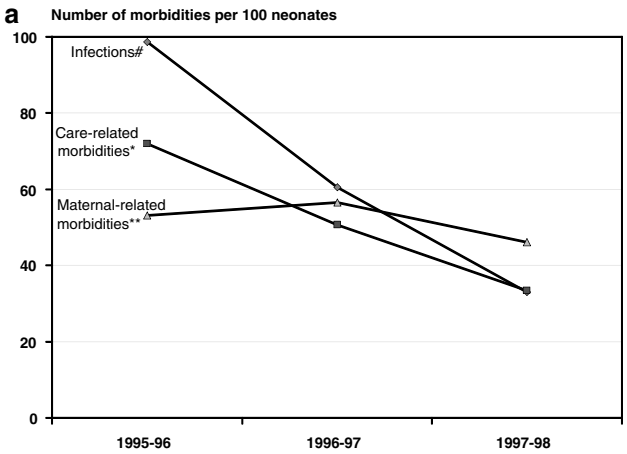
*Clinical definitions of morbidities — Bang AT et al., 2005;25:S18–28.[8]
Observations were recorded in neonates: a = 570, b = 508, c = 772, d = 654, e = 573, f = 814.
NS = nonsignificant.

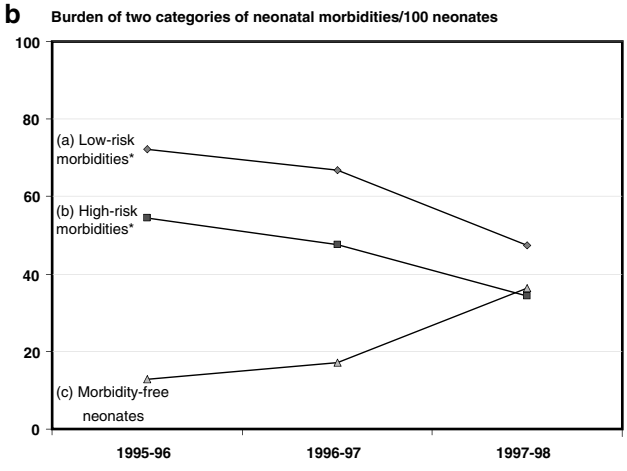
Is the Observed Effect on Morbidities True?

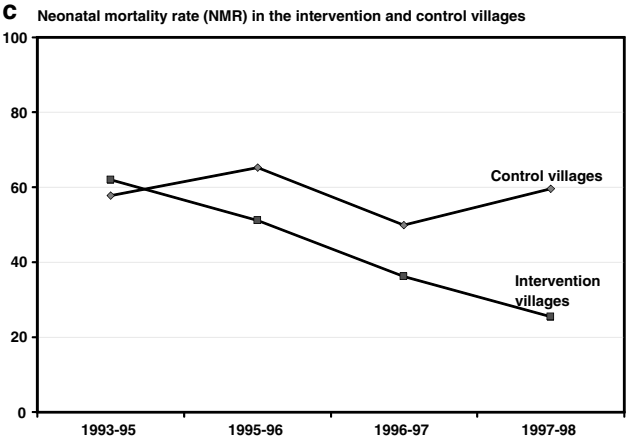
A limitation of the study is the absence of a control group for ethical reasons. Hence, we have compared early vs late intervention years. However, the field trial included monitoring of mortality in a control area, and there, the NMR remained at around 60 during these years except a transient and insignificant reduction in 1996 to 1997 (Figure 2c). Similarly, the IMR and the NMR in India remained practically unchanged during these years.[13] Hence, it can be assumed that the neonatal morbidities in the control area did not change substantially during this period and that, therefore, the observed change in the intervention villages was not due to a background change.

By comparing the first year (1995 to 1996) with the third year (1997 to 1998) of intervention, we may, in fact, have

underestimated the effect. The activities of the female VHWs in 1995 to 1996 (Table 2) may have caused a change in the behaviour of mothers and TBAs, and hence in neonatal health. Evidence of this is seen in Figure 2c, wherein the NMR in the intervention villages declined from the baseline (1993 to 1995) level of 62.0, to 51.2 in the first year (1995 to 1996).[9] Hence, by comparing the first and third years, the effect was underestimated.







Was There a Selection Bias?

Some neonates were not observed by VHWs. The comparison of NMR in the neonates observed vs unobserved (52.4 vs 47.5) ($p>0.5$) or of stillbirth rate in the deliveries attended vs unattended (24 vs 25) do not suggest such selection bias.

Was the Observed Effect Due to Imprecise Measurement?

Diagnoses of neonatal morbidities were based on clear definitions, applied objectively to the data. Validity of the methods has been discussed elsewhere.[5] Since the definitions were entirely clinical, an imprecision in the diagnosis is very likely. However, since these definitions remained uniform during 1995 to 1998, the observed effect cannot be attributed to them. In addition, the quality of data collected by VHWs was validated by the 92% agreement with the parallel data collected by the physician.

Can the Observed Effect be Attributed to the Interventions?

The effect on the incidence of morbidities was broad, occurred on multiple morbidities and increased progressively (Table 1 and Figure 2a). The number of interventions, their coverage and effect show similar features (Tables 2 and 3). Three aspects in particular are relevant: (i) the progressive increase in the elements of interventions as well as their percent coverage, (ii) intensive health education, with good coverage (66 to 76%), (iii) the resultant high scores of correct knowledge and behaviour of mothers (Table 3). These dose–response relationships between the interventions and the reduced morbidities suggest a cause and effect relationship.

Seasonal variation observed in some morbidities disappeared or decreased (Table 4), proving our hypothesis that the seasonal variation was suggestive of lack of adequate protection from the effects of environment, and that the HBNC shall decrease this variation.[8]

However, the magnitude of the effect on morbidities varied. A pronounced reduction occurred in almost all infections (Table 1), suggesting an improved immunity or decreased exposure to

Figure 2. Effect of HBNC on neonatal morbidities and mortality. (**a**) Burden of three categories of neonatal morbidities/100 neonates. #Eight types of infections (see Table 1) *Includes hypothermia, breast feeding problems and asphyxia. **Includes pre-term, low birth weight, congenital anomalies. (**b**) Incidence of high-risk and low-risk morbidities, and the morbidity free neonates. Bang AT et al., 2005; 25:S18–28.[8] (a) Low-risk morbidities (morbidities with natural case fatality <10%*) (b) High-risk morbidities (morbidities with natural case fatality >10%*) (c) Proportion of morbidity-free neonates. (**c**) Neonatal mortality rate (NMR) in the intervention and the control villages.

Table 2 Elements of Interventions and Percent Coverage of the Target Population (Mothers or Neonates): 1995–1998

	1993–1995 Preintervention	1995–1996 ($n=763$)	1996–1997 ($n=685$)	1997–1998 (n = 913)	p (for trend)
Phased Interventions					
(A) Pre-existing interventions (Home delivery conducted by trained TBA, ANC care)	+	+	+	+	
(B) Home visits by VHW during pregnancy, delivery and neonatal period	–	+	+	+	
(C) Home-based care of neonates assisted by VHWs and sickness management	–	–	+	+	
(D) Intensive health education	–	–	–	+	
Selected indicators of the interventions					
(A) 1. Tetanus toxoid received during pregnancy	NR	79.3	95.8	95.4	<0.001
2. Percent deliveries at home, conducted by trained TBA	NR	81.3	94.2	94.6	<0.001
3. Hospital delivery*	NR	5.4	3.5	4.2	NS
4. Caesarian section delivery*	NR	0.5	0.4	1.1	NS
(B) 5. Home visits and observations by VHW	0.0	75.1	85.2	93.3	<0.001
6. VHW present at the time of delivery	0.0	74.7	69.9	81.5	<0.001
7. Ointment put in eyes	NR	16.8	30.7	41.3	<0.001
8. Cord blood milked before cutting the cord	NR	78.8	95.0	94.4	<0.001
(C) 9. Exclusive breast feeding started within 6 hours	NR	47.5	81.9	89.7	<0.001
10. Preterm or LBW babies received added care at home	0.0	0.0	NR	88.1	–
11. Management of neonatal sepsis out of the incident cases	0.0	0.0	27.3 (18/66)	70.7 (53/75)	<0.004
12. Blanket/warm-bag used to keep the at-risk (preterm/LBW < 2000 g/hypothermic) baby warm	NR	1.9 (4/211)	62.7 (94/150)	83.9 (125/149)	<0.001
13. Sick neonate hospitalised*	NR	0.4	0.6	0.5	NS
(D) 14. Health education at home	0.0	0.0	0.0	76.2	–
15. Group health education attended	0.0	0.0	0.0	66.6	–
Mean coverage on the 12 indicators of home-based care (excluding 3, 4 and 13)*	–	37.9	58.4	81.3	<0.001

+, Component operational.
–, Component not operational.
NR, Not recorded; NS, nonsignificant.
*Not a part of the home-based neonatal care.

infections or both. Improved immunity can occur due to increased breastfeeding (Figure 3), especially in the first week when the colostrum is rich in immunoglobulins. A meta-analysis of studies on the protective effect of breastfeeding on infections in children has reported an odds ratio of 5.8 in breastfed infants <2 months of age.[14] In addition, high levels of maternal knowledge and practices about cleanliness and antenatal care seeking for infections (Table 3) can result in reduced exposure of neonates to infections acquired from mother or the environment.

Care-related morbidities of all types declined substantially (Table 1 and Figure 2a). Asphyxia was reduced (by approximately 45%) by the early resuscitation measures of VHWs who were present at birth. Earlier, the TBAs were primarily anxious about the mother and were unable to pay adequate attention to the baby. This experience suggests the need for an additional attendant at the time of birth, besides the TBA.[15]

The incidence of hypothermia showed a more pronounced reduction, 78.8% (Table 1), which can be attributed to the better thermal protection practices, the special care of the preterm/LBW babies (Table 2 and Figure 1) and the early and more frequent breastfeeding (Figure 3). Reduction in hypothermia can contribute to improved neonatal survival and reduced susceptibility to infections.

The incidence of LBW showed a small (16.0%) but significant reduction, especially in birth weight <2000 g. This can contribute to improved survival because the neonatal mortality in 1995 to 1996 was concentrated (27/40 deaths) in the LBW babies of <2000 g.[5,9]

Increased birth weight (by mean 68 g) was an unexpected finding because the HBNC did not include any major intervention to improve birth weight. The traditional practice of restricting food intake during pregnancy (Panel 1) is common in many developing

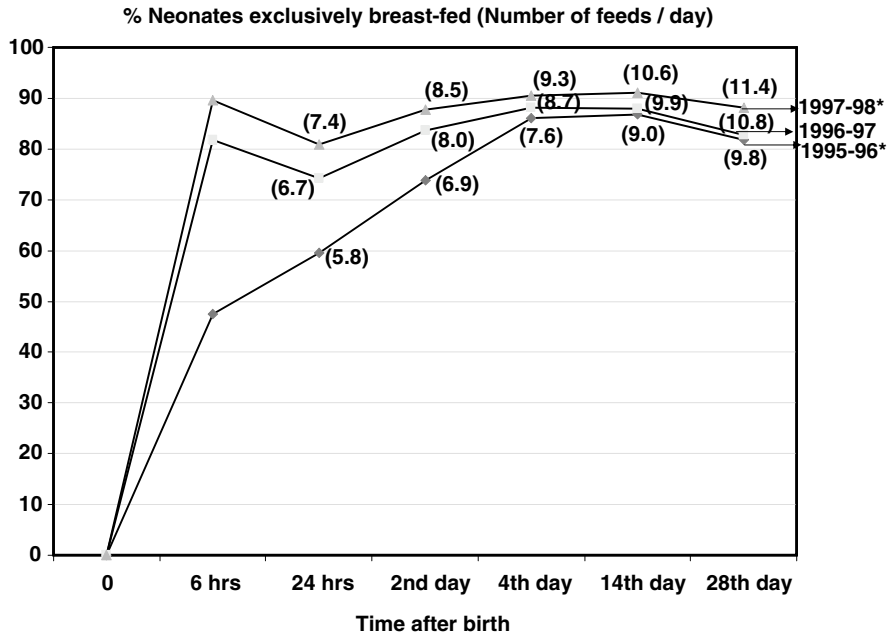


Figure 3. Effect of HBNC on breastfeeding. Proportion of the neonates exclusively breast-fed and (in parantheses) the mean number of feeds/day. *All the differences between 1995 to 1996 and 1997 to 1998 in the proportion exclusively breastfed, $p<0.001$, except on 4th and 14th day $p\leq 0.05$. *All the difference in the number of feeds per day $p<0.001$.

countries.[16] The intensive health education probably changed this practice (Table 3) to some extent and improved birth weight. Since we did not measure dietary intake and there was no control group, the hypothesis cannot be conclusively proved or disproved. However, this finding suggests a modestly effective intervention, cheaper than food supplementation during pregnancy[17] and more relevant in the region of South Asia characterised by cultural restrictions on maternal food intake[16] and a high, 31%, incidence of LBW.[2]

The effect on breastfeeding reveals four striking changes. (i) Early and exclusive breastfeeding increased steeply, with nearly 90% of neonates put to breast within 6 hours of birth in 1997 to 1998 (Figure 3). (ii) The frequency of breastfeeding increased significantly. (iii) The incidence of breast-feeding problems decreased substantially (Table 1). and (iv) The mean weight gain during the neonatal period increased by a small amount (9 g) while the proportion of neonates with weight gain <300 g during neonatal period declined significantly. These changes can improve neonatal health, especially by improving immunity, reducing hypoglycaemia and hypothermia, and increasing weight gain. Evidence of such an effect in the form of reduced incidence of infections and hypothermia was seen in the third year (Table 1).

The increase in breastfeeding most probably occurred due to the effective health education and practicing supervised breastfeeding in the presence of VHW. Active support by the TBA was crucial for this change to occur. Evidence of these changes was seen in the knowledge and behaviour of mothers (Tables 3 and 4).

Table 2 provides data on some interventions that show increased coverage from 1995 to 1998. These might explain some of the observed effect on morbidities. Coverage of some interventions was not recorded, especially those provided by TBAs. Antenatal care at a referral clinic can improve pregnancy outcomes, but information on the coverage of this was not recorded. However, these interventions have been present since 1989 and are unlikely to have made a difference in neonatal morbidities in 1997 to 1998.

In comparison to the traditional beliefs and practices recorded qualitatively at the baseline (Panel 1), a different picture was found in 1997 to 1998 (Table 3): a mean of 78.7% of mothers gave correct answers to the 10 questions asked 2 weeks after the health education in group, indicating a high rate of retention. The proportion of correct practices — either self reported or observed — was high, which can explain some of the decrease in morbidities. Care seeking for sick neonates (87.2%), and correct care of preterm, LBW babies (88.1%) should result in better survival. Health education did not seem to influence the practices of hand washing before feeding and consuming iron–calcium tablets, which remained at low levels.

One would expect that improved maternal knowledge and practices, increased coverage of HBNC interventions and reduction (though modest) in the incidence of LBW suggesting improved dietary intake by mothers — these should cause improvement in maternal health as well. In fact, we did observe a significant reduction in the incidence of maternal morbidities in these mothers, to be reported separately.

Table 3 Evaluation of Mothers' Knowledge and Behaviour in the Last Year of Intervention (1997–98)
(% Mothers with Correct Response, $n = 726$)

Knowledge	(%)
1. Mother should eat adequately	84.4
2. Preparedness for delivery	78.7
3. Hand washing is necessary	84.4
4. Delivery room should be clean	85.0
5. Which neonates are high risk	67.6
6. Danger signals in baby when the VHW should be called	77.3
7. How to keep baby warm	78.0
8. Preterm, LBW babies not to be bathed daily	74.5
9. What is the illness if baby breathes fast or has chest indrawing	80.2
10. What should be done to ensure weight gain in baby	77.3
Total (mean)	78.7
Behaviour	(%)
1. Mother eating full meals during pregnancy*	93.9
2. Mother sought medical/ANC care during pregnancy*	39.1
3. Mother consumed iron/calcium tablets during last trimester of pregnancy*	11.8
4. Mother eating full meals after delivery*	78.9
5. The delivery and baby room was clean†	75.8
6. Proper care taken to keep the baby warm†	96.0
7. Mother washed hands before feeding†	7.7
8. Mother's nails were clipped†	92.4
9. Mother held baby properly for breast feeding†	96.0
10. Mother cared properly for preterm, LBW baby†	88.1
11. VHW was called if baby was sick†	87.2
Total (mean)	69.7

*As reported by mother.
†Observed by VHW/supervisor.

Even after making allowance for the possibility that the baseline beliefs and behaviours may have already departed from the traditional beliefs, the level of correct knowledge and practices recorded in 1997 to 1998 was very high. In view of the known difficulties in changing the traditional beliefs and human behaviours by health education,[18] *what could explain these high levels?* We believe that the following factors may be responsible:

1. The credibility of the providers of education. The therapeutic role of VHWs in treating sick neonates and the support by TBAs who had a decisive power in determining the practices probably played an important role.
2. Health education messages, targeting the specific audience and the local beliefs and practices and containing culturally appropriate appeal (such as, ''Every baby in the womb is Lord Krishna, and you are the Mother Yashoda. Will you starve the Lord Krishna growing in your womb?'').
3. The high coverage of health education, 66 and 76% (Table 2, points 14 and 15) repeated four times (thrice by home visits and once in group).
4. Health education followed by home visits by the VHWs and the physician with demonstration, practice, persuasion and problem solving.
5. Visible results in the form of improved survival[9] and decreased illness.

Our methods of health education match with the ''Social Cognitive Theory'' developed by Bandura and others.[19] Our approach addressed the group as well the individuals, it provided the enabling feeling of self-efficacy to mothers, and it was linked with experience rather than mere information.

How does this study compare with other experiences of reducing neonatal morbidities? Earlier studies have reported reduction in the incidence of a single morbidity such as birth asphyxia, hypothermia or tetanus with the help of TBAs, or tetanus toxoid immunization.[20–22] ''Kangaroo care'' improved the survival of preterm, LBW babies;[23] and breastfeeding improved immunity.[24,25] High-calorie supplementary food to mothers decreased the proportion of LBW.[17] Putting eye ointment at birth decreased the incidence of conjunctivitis.[26] The package of HBNC, as practised in the Gadchiroli trial, and the observed effect on morbidities, is in consonance with the known effect of these interventions. However, *the distinctive feature of the HBNC approach is that it combined multiple interventions in a package and decreased multiple morbidities by a large margin*.

Recently, Manandhar and colleagues reported on a field trial in Makwanpur, Nepal. The interventions included health education and mobilisation of rural women for better practices and care seeking. The authors report improvement in various process indicators, and 30% reduction in the NMR, and 69% reduction in maternal mortality.[27] This report supports our experience in Gadchiroli.

We cannot single out any one intervention in HBNC that reduced the neonatal morbidities. The simultaneous presence of multiple interventions in the package of home-based neonatal care probably had a synergistic effect. Thus, the reported increased food intake by mothers, increased breastfeeding, better thermal care, clean practices or early detection and treatment of infections together produced multiple effects, enhancing the total positive effect. Since almost all interventions in the HBNC were based on standard medical practice and, together, have yielded good results at low cost, individual trials of each component intervention may not be necessary. However, the total approach of HBNC should be repeated to examine its feasibility in different settings and effectiveness when scaled. Success of the HBNC approach in a smaller area is only the first step. Replicating these methods on larger scale without a loss of coverage or quality is a challenge to the program managers.

Table 4 Seasional Variation in the Incidence of Neonatal Morbidities in Gadchiroli: 1995–1996 vs 1997–1998

Type of morbidity	1995–1996 ($n = 763$)				1997–1998 ($n = 913$)			
	Percent incidence by season				Percent incidence by season			
	Rainy ($n = 330$)	Winter ($n = 274$)	Summer ($n = 159$)	p*	Rainy ($n = 419$)	Winter ($n = 299$)	Summer ($n = 195$)	p*
Preterm	10.7	10.3	7.9	NS	11.5	8.0	10.8	NS
Birth weight <2000 g	11.7	8.2	9.9	NS	7.6	5.4	7.7	NS
Birth weight 2000–2499 g	35.4	34.6	27.0	<0.15	26.7	31.8	26.2	NS
Mild asphyxia	15.2[a]	13.5[b]	13.6[c]	NS	6.6[d]	8.1[e]	10.4[f]	NS
Severe asphyxia	4.6[a]	2.7[b]	8.7[c]	<0.06	2.9[d]	1.2[e]	3.7[f]	NS
Delay in breastfeeding	10.6	8.0	8.8	NS	0.0	0.0	0.0	NS
Feeding problems (total)	18.2	12.4	18.9	<0.10	11.0	8.4	10.3	NS
Hypothermia	14.8	21.5	13.8	<0.05	3.3	3.7	4.1	NS
Neonatal sepsis	17.6	17.2	15.7	NS	9.1	7.4	7.2	NS
Upper respiratory symptom	16.1	29.9	11.3	<0.001	9.8	14.4	9.2	NS
Diarrhoea	5.2	5.8	5.7	NS	1.2	2.0	2.6	NS
Unexplained fever	10.3	5.5	23.9	<0.001	3.6	1.0	14.4	<0.001
Umbilical infection	20.3	26.3	7.5	<0.001	1.9	1.7	2.6	NS
Bacterial skin infection	9.7	17.2	5.7	<0.001	2.6	2.7	3.1	NS
Conjuctivitis	13.9	13.9	6.3	<0.04	1.0	1.3	1.5	NS

*χ^2 test 2×3.
VHW did not attend all deliveries. Hence, asphyxia was observed in total 570 out of 763 neonates in 1995–1996 and 772 out of 913 neonates in 1997–1998: a, 244; b, 223; c, 103; d, 350; e, 259; f, 163.

The high baseline level of morbidities (1995 to 1996) enabled the interventions to produce a large effect. However, a high proportion (42%) of LBW neonates, or the traditional nature of the community with low levels of female education and health care, worked in the opposite direction, making any improvement difficult — and that much more remarkable. Hence, we expect this approach to produce favourable results elsewhere as well.

The 62% reduction in the NMR caused by the HBNC may be attributed partly to the reduced incidence of morbidities, and partly to the reduced case fatality due to the treatment of morbidities, as we have reported earlier.[9] In a subsequent paper, we have tried to diaggregate and quantify these two effects on the NMR.[28]

SIGNIFICANCE

Apart from reducing neonatal and perinatal mortality, the HBNC in the Gadchiroli trial reduced a broad range of neonatal morbidities. These outcomes add to the value of the approach. It revealed that health education of mothers, training of VHWs and TBAs, and frequent home visits to identify and care for sick neonates can change neonatal care practices in a traditional community, reduce infections, care-related morbidities and the seasonal increase in morbidities. This approach was found to be feasible and effective in one of the most deprived areas of India. Developing the methods to scale this approach is the next challenge.

References

1. Murrey CJ, Lopez AD. The global burden of disease. Summary. The World Health Organisation, World Bank and The Harvard School of Public Health. Geneva; 1996.
2. Save the Children. The State of the World's Newborn. Save the Children. Washington, DC; 2001.
3. World Health Organisation. World Health Report, 1998: Life in 21st Century — A Vision For All. WHO, Geneva; 1998.
4. Stoll BJ. The global impact of neonatal infection. Clin Perinatol 1997;24(1):1–21.
5. Bang AT, Bang RA, Baitule SB, Deshmukh MD, Reddy MH. Burden of morbidities and the unmet need for health care in rural neonates — a prospective observational study in Gadchiroli, India. Indian Pediatr 2001;38:952–65.
6. Bang AT, Bang RA, Morankar VP, et al. Pneumonia in neonates: can it be managed in the community? Arch Dis Child 1993;68:550–6.
7. 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.
8. Bang AT, Reddy HM, Baitule SB, et al. The incidence of morbidities in a cohort of neonates in rural Gadchiroli, India: seasonal & temporal variation & a hypothesis about prevention. J Perinatol 2005;25:S18–28.

9. Bang AT, Bang RA, Baitule SB, Deshmukh MD, Reddy MH. Effect of home based neonatal care and management of sepsis on neonatal mortality: field trial in rural Gadchiroli. Lancet 1999;354:1955–61.
10. 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.
11. Bang R, Bang A. Commentary on a community-based approach to reproductive health care. Int J Gynecol Obstet 1989;3(Suppl):125–9.
12. Bang AT, Bang RA, Reddy HM, et al. Methods and the baseline situation in the field trial of home-based neonatal care in Gadchiroli, India. J Perinatol 2005;25:S11–7.
13. Registrar General of India. The Report of the Sample Registration System, 1998, The Ministry of Home Affairs, Government of India, New Delhi, 2000.
14. WHO Collaborative Study Team on the Role of Breastfeeding on the Prevention of Infant Mortality. Effect of breastfeeding on infant and child mortality due to infections in less developed countries: a pooled analysis. Lancet 2000;355:451–5.
15. John TJ, Bodhankar U. Birth attendants: one or two? Indian Pediatr 2001;38:327–31.
16. Standing H, Costello A. Social and developmental issues affecting the perinatal health of mothers and their infants In: Costello A, Manandhar D, editors Improving Newborn Infant Health in Developing Countries. London: Imperial College Press; 2000. p. 79–98.
17. Ceesay SM, Prentice AM, Cole TJ, et al. Effects on birth weight and perinatal mortality of maternal dietary supplements in rural Gambia: five-year randomised controlled trial. Br Med J 1997;315:786–90.
18. Bolam A, Tillen D, Costello A. Does health education improve newborn care? In: Costello A, Manandhar D. Improving Newborn Infant Health in Developing Countries. London: Imperial College Press; 2000. p. 393–408.
19. Bandura A. Self-efficacy: towards a unifying theory of behavioural change. Psychol Rev 1997;84:191–225.
20. Kumar R. Training of traditional birth attendants for resuscitation of newborns. Trop Doctor 1995;25:29–30.
21. Daga SR, Daga AS. Reduction in neonatal mortality with simple interventions. J Trop Pediatr 1989;35:191–5.
22. Kamal I. Traditional birth attendants' training: sharing experiences. Int J Obset Gynecol 1992;38(Suppl):S55–58.
23. Bergman NJ, Jurisoo LA. The 'kangaroo method' for treating low birth weight babies in a developing country. Trop Doctor 1994;24:57–60.
24. Narayanan I, Prakash K, Murthy NS, Gujral VV. Randomised controlled trial of effect of raw and holder pasteurised human milk and of formula supplements on incidence of neonatal infections. Lancet 1984;2:1111–3.
25. Victora CG, Vaughan JP, Lombardic, et al. Evidence for protection by breast-feeding against infant deaths from infectious diseases in Brazil. Lancet 1987;2:319–22.
26. Hammerschlag MR, Cummings C, Robin PM, Williams TH, Delke I. Efficacy of neonatal ocular prophylaxis for prevention of chlamydial and gonococcal conjunctivitis. N Engl J Med 1989;320:769–72.
27. Manandhar D, 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.
28. Bang AT, Reddy HM, Deshmukh MD, et al. Effect of home-based neonatal care on neonatal and infant mortality (1993–2003). J Perinatol 2005;25:S92–107.