npg

Original Article

The Incidence of Morbidities in a Cohort of Neonates in Rural Gadchiroli, India: Seasonal and Temporal Variation and a Hypothesis About Prevention

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

BACKGROUND:

The incidence of morbidities among home-cared neonates in rural areas has not been studied.

OBJECTIVES:

1. To estimate the incidence of various neonatal morbidities and the associated risk of death in home-cared neonates in rural setting.
2. To estimate the variation in the incidence of neonatal morbidities by season and by day of life.
3. To identify the scope for prevention of morbidities and suggest a hypothesis.

STUDY DESIGN:

A prospective observational study nested in the first year of the field trial in rural Gadchiroli, India. Trained village health workers in 39 villages observed neonates at the time of birth and in subsequent eight home visits up to 28 days. We diagnosed 20 neonatal morbidities by using clinical definitions. The data were analyzed for the incidence, case fatality, and relative risk of death and for the seasonal and day-wise variation in the incidence of morbidities.

RESULTS:

We observed total 763 neonates in 1 year. The incidence of morbidities was a mean of 2.2 morbidities per neonate. The case fatality in 13 morbidities was >10%. Only 2.6% neonates were seen or treated by a physician, and 0.4% were hospitalized. Hypothermia, fever, upper respiratory symptoms, umbilical and skin infections, and conjunctivitis showed statistically significant seasonal variation. Although the morbidities were concentrated in the first week of life, new cases continued to appear throughout the neonatal period. Various morbidities showed different distribution of incidence during 1 to 28 days.

CONCLUSIONS:

A large burden of disease occurs in rural home-cared neonates, and many morbidities are associated with high case fatality. Some morbidities show strong seasonal and day-wise variation in incidence, indicating poor care at home. We hypothesize that changes in practices and better home-based care will prevent the seasonal and temporal increase in morbidities. Some morbidities may not be preventable and will need early detection and treatment. Therefore, frequent home visits by a health worker are necessary to identify sick neonates.

Journal of Perinatology (2005) **25,** S18–S28. doi:10.1038/sj.jp.7211271

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

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

Address correspondence and reprint requests to Abhay T. Bang, MD, MPH, SEARCH, Gadchiroli 442-605, India. Email: search@satyam.net.in

INTRODUCTION

Very little is known about the natural history of neonates born in rural areas in developing countries because most of them are never seen by a physician. We have earlier reported the findings of the first prospective observational study of home-cared neonates in rural Gadchiroli.[1] We found a 48.2% incidence of high-risk morbidities (those associated with >10% case fatality (CF) in the observed neonatal population) and a 72% incidence of low-risk morbidities (CF<10%).

The occurrence of neonatal morbidities is largely determined by maternal health and the postnatal environment — both of which are influenced by seasons. Previous studies have reported on seasonal variation of birth weight,[2–8] pre-term deliveries[9–11] and hypothermia.[12] The possibility of seasonal variation in the incidence of other neonatal morbidities such as asphyxia, sepsis, breast feeding problems, diarrhea, fever, skin and umbilical infections, and upper respiratory infections has not been evaluated or reported. This occurs because modern life and hospital care shield neonates from the harsh effects of seasons. Standard textbooks of pediatrics or neonatology do not describe the seasonality of neonatal diseases.[13–15] Neonates in communities in developing countries are cared for at home mostly in rural settings and often in inadequately protected environments.[16,17] Study of the

effect of seasons on neonatal diseases in developing countries may help in identifying the gaps in home care.

Many morbidities such as preterm birth, low birth weight (LBW), or asphyxia ''occur'' at the time of birth. The remaining morbidities appear at different times during days 1 to 28. Except for neonatal jaundice, tetanus, and early- and late-onset sepsis, we found no description in the literature about how the incidence of different moribidities is distributed during different days and weeks of the neonatal period. Study of that will help in understanding their epidemiology and might throw light on the causative mechanisms.

In addition, such description about the timing of morbidities will facilitate making informed decisions about the needed days of visit to neonates by the care providers.

This article has three objectives:

1. To estimate the incidence of various neonatal morbidities and the associated risk of death in home-cared neonates in rural setting.
2. To estimate the variation in the incidence of neonatal morbidities by season and by day of life.
3. To identify the scope for prevention of morbidities and suggest a hypothesis.

We tried to get answers by analyzing the data collected on the neonates in 39 intervention villages in the first year (1995 to 1996) of the intervention phase of the field trial in Gadchiroli.

METHODS

The area, the study design, and the methods of data collection have already been described.[1,16,17] In the first year of the intervention (April 1995 to March 1996), the main role of the village health worker (VHW) was to observe and record maternal and newborn health with few interventions. The VHW was present at the time of home delivery — usually conducted by traditional birth attendants (TBAs) with the help of relatives. The VHW examined and recorded observations on the day of birth (called the first day) at 1 minute, 5 minutes, and within 6 hours after birth, and on days 2, 3, 5, 7, 15, 21, and 28. She instructed parents to call her immediately if the baby developed any problem on other days. Her data were checked by a physician who visited each village once in 15 days.

The VHW was trained in the first year of the intervention phase to treat minor illnesses in older children and adults, but not in neonates — except pneumonia, which was treated with co-trimoxazole in the intervention villages in all children, including neonates.[18,19] The other treatments that newborns received were tetracycline eye ointment, applied at birth routinely by TBAs, and home remedies. A few neonates were seen by doctors or hospitalized. We have earlier described the traditional beliefs and practices of neonatal care in the study area.[17]

We developed simple clinical definitions of neonatal morbidities, applicable in a field setting, from those recommended by the National Neonatolgy Forum of India.[20,1] These are reproduced in Appendix A1. We estimated the incidence of various morbidities by applying these definitions to the field data. We grouped the morbidities into ''high risk'' and ''low risk'' by arbitrarily using 10% CF as the cutoff.

Based on the local climate, we divided the year into the following seasons: summer (March – June), rainy season (July – October), and winter (November – February). The local temperature reached its maximum in summer, especially mid-April to mid-June, reaching as high as 117°F (47°C) in May, and its minimum in winter, going as low as 41°F (5°C). Average rainfall during the rainy season was usually 150 cm. During summer and rainy season, especially during April – August, collection of forest produce and paddy cultivation were the major activities, involving strenuous work mainly by women. This was also the lean period for food availability. The new crop was usually harvested in November, so food availability was better from November to March. Housing and clothing being poor, people were exposed to both high and low temperatures without much protection. Neonates were not well protected with warm clothes because of poverty and traditional beliefs. They were often not put to breast for 1 to 3 days after birth.[17] The home delivery room was kept warm in winter with the help of a fire and burning cow dung, which emitted a lot of smoke. Most houses had neither toilets nor running tap water. The mother and the newborn were strictly isolated for the first 7 days. Social contact increased after a small ceremony, *baj kadhane*, usually performed on the 7th day.

From the 20 types of morbidities diagnosed and earlier reported,[1] (Tables 1 and 2), we selected 15 for which the number of reported neonates was at least 25 or more, for seasonal analysis. We also analyzed the incidence of these morbidities by day of occurrence, that is, the day it was first recorded by VHWs. Depending on the fixed days of visit by VHWs, the 28-day neonatal period was divided into the following unequal intervals: days 1, 2, 3, 4 to 5, 6 to 7, 8 to 15, 16 to 21, and 22 to 28.

Since asphyxia, preterm birth, LBW, or delay in the initiation of breast feeding occurred only on the day of birth, we excluded them from the day-wise variation.

Although we made effort to study all neonates born in 39 villages, VHWs could not study some neonates because they were unaware of the birth. The independent vital statistics system of the study recorded all births and child deaths in the area.[17] Neonates observed by VHWs and not observed were estimated by comparing with these data.

Consent and ethical clearance have already been described.[1,17]

RESULTS

A total of 1016 neonates were born in 39 villages in year one (1995 to 1996), out of which 763 (75.1%) were studied. A total of 95%

Table 1 Incidence of High-Risk Health Problems, Associated Fatality, and Relative Risk of Death in Home-Cared Neonates ($n = 763$)

	Sick neonates (1–28 days)		Deaths‡		Relative risk of death
High-risk* health problems†	No.	Incidence (%)	No.	CF (%)	
Congenital anomaly	10	1.3	2	20.0	4.0
Multiple pregnancy	22	2.9	8	36.4	8.4
Birth asphyxia					
Severe	26/570§	4.6	10	38.5	8.0
Indirect asphyxia	3/193	1.6	2	66.7	13.9
Preterm	75	9.8	25	33.3	15.3
Birth weight <2000 g	74	9.7	27	36.5	19.3
Neonatal sepsis (clinical)	130¶	17.0	24	18.5	7.3
Only pneumonia‖	8	1.0	0	—	—
Delayed breast feeding	71	9.3	8	11.3	2.4
Problems in breast feeding					
Total	124	16.3	28	22.6	12.0
As part of sepsis	61	8.0	22	36.1	14.1
Independent morbidity	63	8.3	6	9.5	2.0
Meconium aspiration	4	0.5	4	100.0	21.1
Hyaline membrane disease	4	0.5	4	100.0	21.1
Hypothermia (<95°F)					
Total	130	17.0	20	15.4	4.9
As part of sepsis	24	3.1	11	45.8	11.7
Independent morbidity	106	13.9	9	8.5	1.8
Hemorrhage	11	1.4	8	72.7	17.1
Abnormal jaundice	15	2.0	3	20.0	4.0
Neonates with any one of the high-risk health problems (95 % CI)	370	48.5 (45.0 – 52.0)	38	10.3 (7.2 – 13.4)	20.2 (4.9 – 83.1)

*High risk = CF >10%.
†For diagnostic criteria, see Appendix A1.
‡Most deaths occurred in neonates with multiple problems. Such deaths were included with more than one health problem. Thus, associated % CF shown here does not imply that death was entirely attributable to that problem.
§Actual observations at birth were made by VHWs on 570 neonates.
¶A total of 54 cases out of 130 were treated with co-trimoxazole, because they fulfilled the criteria of pneumonia as well.
‖Respiratory rate ≥60, but no other sign of sepsis present. All the cases received treatment with co-trimoxazole, hence included in high-risk category in spite of no fatality.

were born by home delivery and only 5% in the hospital. As many as 81% of deliveries were conducted by TBAs.

We have earlier reported the incidence of the 20 types of neonatal morbidities and associated case fatalities.[1] These are reproduced here with some minor revision in estimates (Tables 1 and 2). Almost half (48%) of neonates suffered from high-risk morbidities (i.e. those with associated CF >10%) and nearly 72% suffered from low-risk morbidities (CF<10%). Some 42% of neonates were born with LBW, and 9.8% were preterm. The mean number of morbidities per neonate was 2.2. Nearly 18% neonates gained <300 g weight during neonatal period. Only 2.6% of neonates were seen and treated by a doctor, most often private, and 0.4% were hospitalized.

Table 3 presents the incidence by season of 15 morbidities. Hypothermia, unexplained fever, upper respiratory symptoms, skin infection, umbilical infection, and conjunctivitis show a statistically significant variation seasonally, and feeding problems, LBW, and preterm birth show a nonsignificant, but substantial, seasonal variation.

Asphyxia (mild and severe), preterm birth, LBW, or delay in the initiation of breast feeding occur only on the first day of life. The distribution of the incident cases of the remaining nine morbidities during 1 to 28 days of life is presented in Figures 1–3.

While the ''incidence'' represents the occurrence of new cases, the total number of cases, old and new, at any given point of time is represented by the ''point prevalence''. Point prevalence of feeding problems on various days is shown in Figure 4a and that of hypothermia in Figure 4b. Their prevalence markedly decreases during 2 to 4 weeks. On the contrary, the prevalence of upper

Table 2 Incidence of Low-Risk Health Problems, Associated Fatality in Home-Cared Neonates ($n = 763$)

	Sick neonates (1–28 days)		Deaths‡	
Low-risk* health problems†	No.	Incidence (%)	No.	CF (%)
Birth weight 2000 – 2499 g	246	32.2	9	3.7
Birth asphyxia — mild§	81/570	14.2	3	3.7
Upper respiratory symptoms	153	20.1	1	0.7
Diarrhea	42	5.5	0	0.0
Unexplained fever	87	11.4	2	2.3
Umbilical infection	151	19.8	4	2.6
Bacterial skin infection	88	11.5	2	2.3
Conjunctivitis	94	12.3	1	1.1
Neonates with any one of the low-risk health problems (95% CI)	548	71.8 (68.6–75.0)	19	3.5 (1.9–5.0)

*Low risk = CF <10%.
†For diagnostic criteria, see Appendix A1.
‡Most deaths occurred in neonates with multiple problems. Such deaths were included with more one health problem. Thus, associated % CF shown here does not imply that death was entirely attributable to that problem.
§Actual observations at birth were made by VHWs on 570 neonates.

Table 3 Seasional Variation in the Incidence of Neonatal Morbidities in Gadchiroli: 1995-96 ($n = 763$)

	Percent incidence by season			
Type of morbidity	Rainy ($n = 330$)	Winter ($n = 274$)	Summer ($n = 159$)	p*
Preterm	10.7	10.3	7.9	NS
Birth weight <2000 g	11.7	8.2	9.9	NS
Birth weight 2000 – 2499 g	35.4	34.6	27.0	<0.15
Mild asphyxia	15.2[a]	13.5[b]	13.6[c]	NS
Severe asphyxia	4.6[a]	2.7[b]	8.7[c]	<0.06
Delay in breast feeding	10.6	8.0	8.8	NS
Feeding problems (total)	18.2	12.4	18.9	<0.10
Hypothermia	14.8	21.5	13.8	<0.05
Neonatal sepsis	17.6	17.2	15.7	NS
Upper respiratory symptoms	16.1	29.9	11.3	<0.001
Diarrhea	5.2	5.8	5.7	NS
Unexplained fever	10.3	5.5	23.9	<0.001
Umbilical infection	20.3	26.3	7.5	<0.001
Bacterial skin infection	9.7	17.2	5.7	<0.001
Conjunctivitis	13.9	13.9	6.3	<0.04

*χ^2 test 2×3.
VHW did not attend all deliveries. Hence, asphyxia was observed in total 570 out of 763 neonates: a, 244; b, 223; c, 103. NS: nonsignificant.

respiratory symptoms (Figure 4c) remarkably increases during 2 to 4 weeks. A comparison with the reported incidence of the upper respiratory symptoms (Figure 2a) shows a much higher prevalence than incidence.

The neonatal mortality rate (NMR) in the observed neonates was 40/763 or 52.4/1000, and in the unobserved group it was 12/253 or 47.4/1000 ($P = 0.88$). The respective still-birth rates per 1000 births were 24 and 25 ($P = 0.55$).

DISCUSSION

We found a high incidence of neonatal morbidities in this cohort of home-cared neonates; many of these morbidities

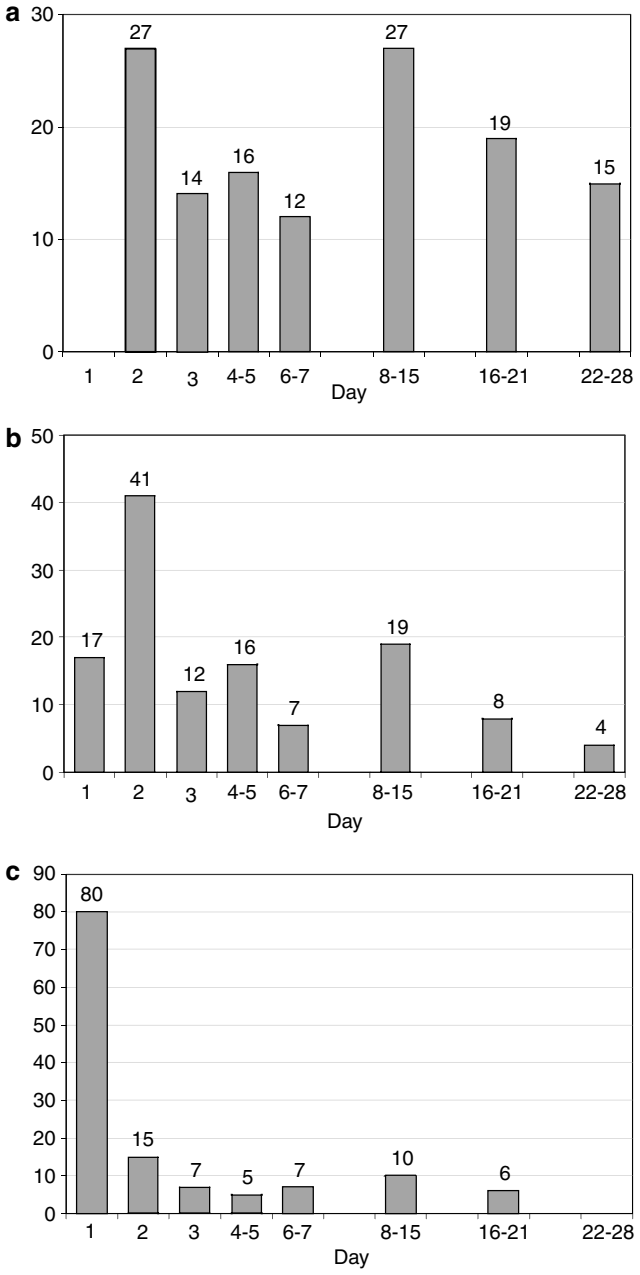

Figure 1. Distribution of incident cases of neonatal morbidities by day and week of life (Gadchiroli, 1995 to 1996) ($n = 763$).
(**a**) neonatal sepsis; (**b**) feeding problems; (**c**) hypothermia.

were associated with high CF. The incidence of hypothermia, fever, upper respiratory symptoms, skin and umbilical infections, and conjunctivitis showed a significant seasonal variation. Nonsignificant seasonal variation was also observed in the incidence of preterm birth, LBW, severe asphyxia, and feeding problems. Sepsis and diarrhea did not vary seasonally.

The incidence of most morbidities showed a marked variation by the day of life. Some morbidities were concentrated in the first week of life (hypothermia, feeding problems), while others — most infections — were distributed in different weeks of neonatal life, suggesting an acquired mode of transmission. Nearly 30% cases of neonatal sepsis occurred on days 1 to 3, probably of maternal origin.

To our knowledge, this is the first report of a large cohort of neonates in a community in a developing country setting followed from birth to the 28th day for morbidities by day of life and compared by season. Some of the seasonal variations or the

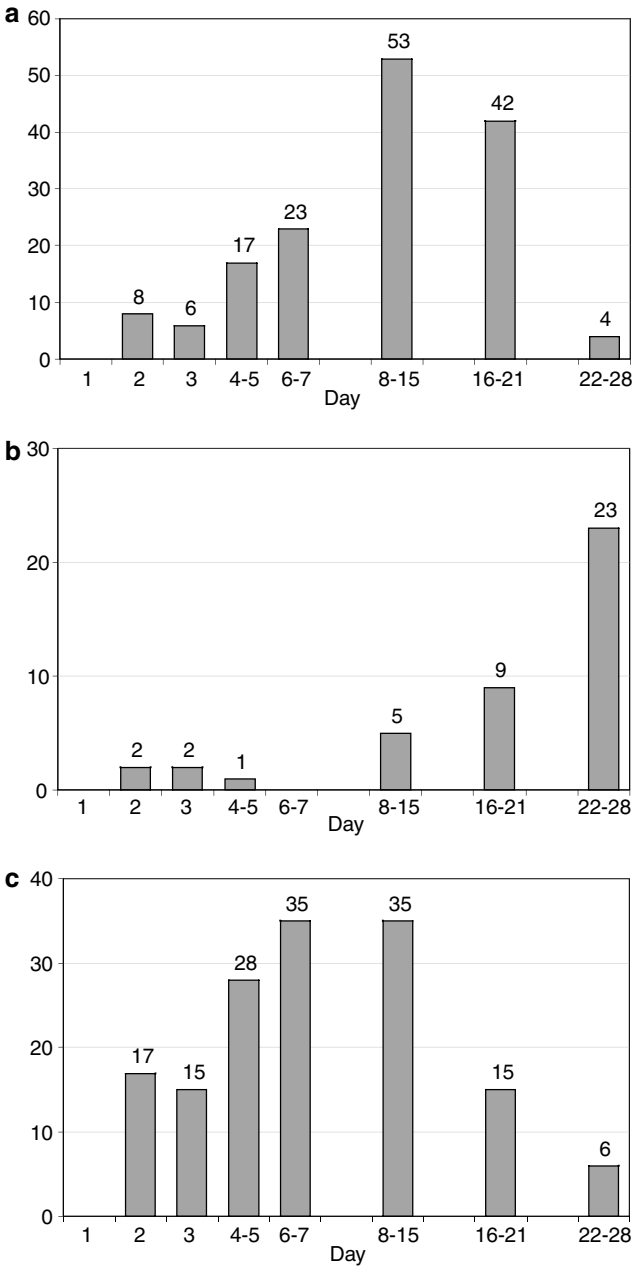

Figure 2. Distribution of incident cases of neonatal morbidities by day and week of life (Gadchiroli, 1995 to 1996) ($n = 763$):
(**a**) upper respiratory symptoms; (**b**) diarrhea; (**c**) umbilical infection.

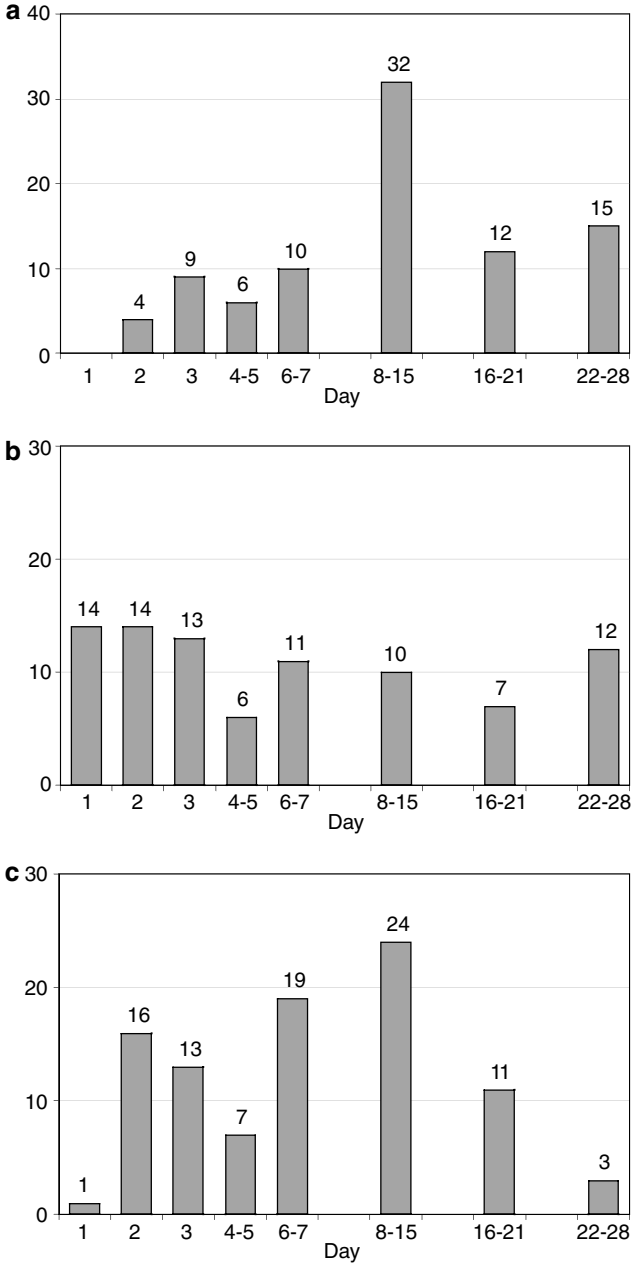

Figure 3. Distribution of incident cases of neonatal morbidities by day and week of life (Gadchiroli, 1995 to 1996) ($n = 763$):
(**a**) bacterial skin infection; (**b**) unexplained fever; (**c**) conjunctivitis.

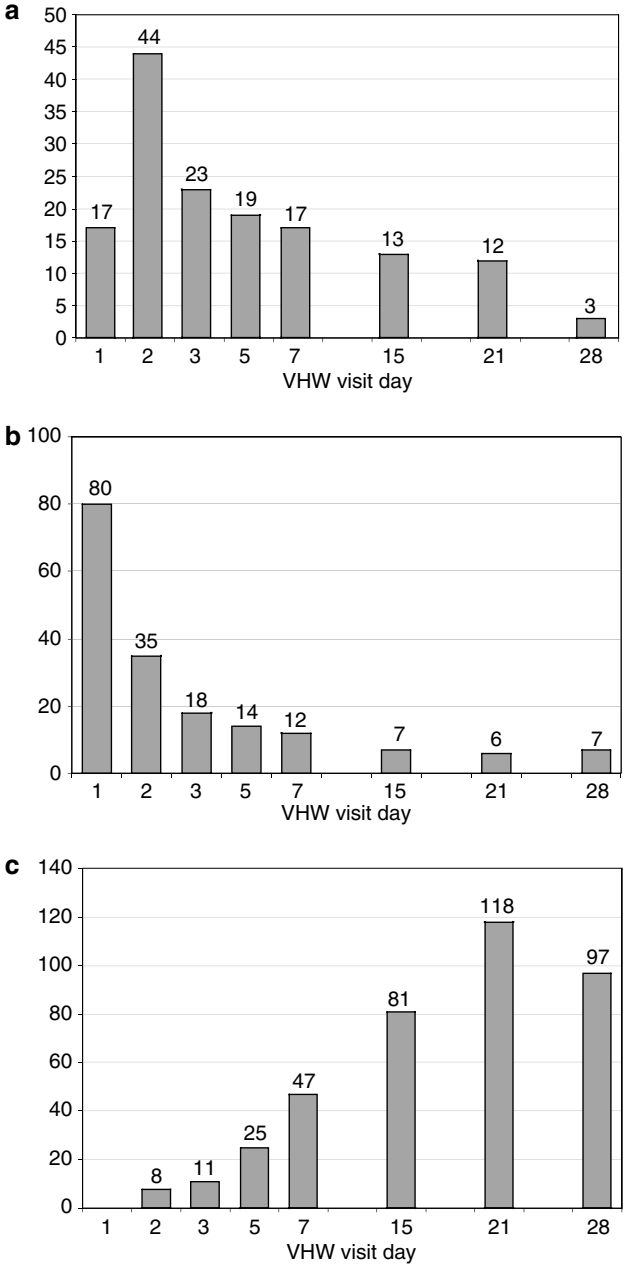

Figure 4. Prevalence of feeding problems, hypothermia and upper respiratory symptoms by day and week of life (Gadchiroli, 1995 to 1996) ($n = 763$):
(**a**) feeding problems; (**b**) hypothermia; (**c**) upper respiratory symptoms.

infections acquired after birth may point to inadequate protection from the influence of environment and infections (Figure 5), and therefore, likely to be amenable to interventions. We hypothesize that a proportion of the morbidities with varying seasonal and temporal incidence can be prevented by better home care and change in practices.

The findings should be interpreted with the understanding of the limitations of the methods. The diagnoses were based on data collected by trained VHWs to which clinical definitions (Appendix A1) were applied by a computer program. No laboratory investigations were possible. Hence, there was scope for imprecision in diagnosis. However, the quality of the data was checked by a physician in the field. The clinical definitions used were developed by an expert group (National Neonatology Forum Nomenclature),[20] and the use of a computer program eliminated subjective judgment.

We studied 75% of all babies born in 39 villages. This may have introduced a selection bias, as an unstudied group is often different from the one studied. However, the close similarity of the NMR (52 vs 47) and SBR (24 vs 25) does not suggest a significant bias.

Figure 5. Poor thermal protection and hygiene in the home care of rural neonates in Gadchiroli (note the house-flies on the neonates).

These limitations are inherent in the subject of study. Home-delivered neonates in rural area are difficult to access and are scattered geographically and temporally, and hence, surveillance is difficult. Taking blood or other specimens from such neonates and conducting laboratory investigations in the field was not possible. Within these circumstantial limitations, our methods were the available practical alternative.

The observed seasonal variations, significant or of borderline significance, have possible explanations (Table 4), which lead to potential interventions.

Severe climatic changes in temperature can be countered by good housing with devices for thermal control. Socio-economic factors determine availability of housing, heating, warm clothes, toilets, and time. Neonates in rural community get inadequate protection due to lack of those facilities. Although immediate changes in housing or socio-economic conditions may not be possible, neonatal care practices offer more opportunities to change and thereby to reduce the incidence of many morbidities.

A closer look at the incidence of morbidities by day of life reveals several interesting features.

Sepsis (Figure 1a): The diagnosis was entirely clinical and presumptive. By our definition, sepsis was usually not diagnosed on

Table 4 Possible explanations of the seasonal variations

Morbidity	Observed variation	Possible factors			
		Climatic	Housing/ delivery room	Socio-economic	Maternal and newborn care beliefs and practices
Hypothermia	↑ in winter	+	+	+	Neglect at birth No early breast feeding Early and exposed bathing No clothing up to 7th day
Fever	↑ in summer	+	+	+	Keeping the delivery room unventilated Restricted fluid intake by mother during first 7 days may result in reduced breast milk and poor hydration of neonates
Upper respiratory symptoms	↑ in winter		+		Crowding and indoor smoke increased in winter
Umbilical infection	↑ in winter and rainy season			+	Reduced hygiene, bathing, and skin care in winter and rainy season due to inadequate hot water or dry clothes
Skin infections	↑ in winter			+	Reduced hygiene, bathing, and skin care in winter
Conjunctivitis	↑ in winter and rainy season		+	+	Reduced cleanliness and increased indoor smoke in winter and rainy season due to lack of running/hot water and the cold climate
LBW	↑ in rainy season			+	Lower maternal food availability and increased hours of work during summer and rainy season
Feeding problems	↓ in winter				Mother spends more time and has more skin contact with baby

the first day. Over half of the sepsis cases (69/130) occurred in the first week of life. Nearly 40 cases (30%) on days 2 and 3 indicate the importance of early onset of sepsis in which the infection is maternal in origin. We have earlier reported a high prevalence of gynecological infections in this rural area.[21] New cases of sepsis continued to occur up to the fourth week, but in decreasing numbers. A total of 89 cases (70%) of late-onset sepsis (4 to 28 days) point toward environmentally acquired infection. Possible factors involved could be poor hygiene in the delivery room and in neonatal care, not feeding colostrum, umbilical or skin infections during the late neonatal period, and high rates of LBW and prematurity — all contribute to an increased risk of sepsis.

Continued occurrence of new cases after the first week (61 cases during days 8 to 28) indicates the need for repeated home visits during the late neonatal period as well. Even if these were babies born by hospital deliveries, the mothers would be usually discharged on the second day. Hence, 103 cases of presumptive sepsis would occur at home, pointing to the need for home-based care even in institutionally delivered neonates.

Feeding problems: Figure 1b reveals the importance of the first week, especially the second day when the largest number of mothers or babies had difficulty with breast feeding. Occurrence of new cases in weeks 2 to 4 was relatively low. Figure 4a shows the point prevalence of breast feeding problems during days 1 to 28. The problem persisted in fewer than 2% of babies as observed by the VHWs on the day of visit during 8–28 days. Most of these problems were resolved by the 28 day. Overall, this points to successful breast feeding in most neonates in a traditional rural area.

However, this is an incomplete picture, based on the difficulty reported by mothers. Weight gain <300 g during the neonatal period was observed in 17.9% of neonates on the 28th day. This points to a much larger prevalence of the problem of inadequate feeding in home-cared neonates. Some of this could also be associated with the occurrence of other morbidities such as infections. As we have reported earlier, postnatal infant mortality was significantly higher in those neonates who gained weight <300 g.[1]

Hypothermia (Figure 1c and 4b): The new cases of hypothermia occurred mainly on the first day. Few new cases occurred subsequently — although some of those diagnosed on the first day persisted on subsequent days, as seen in the point prevalence on subsequent days in Figure 4b. These figures underscore the crucial role of newborn care on the first day and the first week of life and a large scope for improvement in thermal protection. This need is also seen in the increased hypothermia in winter (Table 1). Hypothermia in winter has been reported from other developing countries as well.[12]

Upper Respiratory Symptoms (Figures 2a and 4c): Their incidence increased progressively, with the peak in the second and third weeks. The increased incidence observed in winter (Table 1) and the variation in the incidence by day of life suggest that these symptoms (cough or nasal discharge for >3 days) may be occurring due to two main factors: (1) infection transmitted to newborns through increased human contact after the first week when the isolation period ended (see traditional care);[17] and (2) increased crowding and indoor smoke inhalation from the fire in the delivery room. Not feeding colostrum would further decrease the neonate's immunological protection.

Comparison of the incidence (Figure 2a) with the prevalence (Figure 4c) of upper respiratory symptoms reveals a disturbing feature. Although the incidence seems to have markedly decreased on day 28, this is deceptive. Due to our definition — persistence of these symptoms >3 days — the new symptoms appearing on days 27 and 28 are not included as new cases because they were not observed for the required 3 days before the observation ceased on the 28th day. On the contrary, in spite of the low incidence, prevalence is high in the third and fourth weeks. Prevalence is a product of incidence and duration of illness. Hence, low incidence but high prevalence suggests prolonged duration of upper respiratory symptoms in home-cared neonates.

Diarrhea (Figure 2b): The incidence of diarrhea increased between the second and fourth weeks. It did not show seasonal variation (Table 3), and the total number of cases was small. Incidence of diarrhea did not follow the incidence of breast feeding problems. Breast feeding problems (Figure 1b) showed a decreasing trend from the early to the later part of neonate life, opposite to that of diarrhea. Moreover, there is no practice of giving complementary feeds beyond the first 3 days. Hence, the cases of diarrhea were probably due to poor hygiene, especially related to hand washing and cleanliness of breasts (see traditional care).[17] More persons handling the baby may also be a contributory factor.

Umbilical infection (Figure 2c): A sizable number of babies developed umbilical infection, peaking on the seventh day and into the second week. The maximum number occurred in week 1 (95), followed by week 2 (35), but new infections continued to occur during weeks 3 and 4 as well. The picture suggests a need for improving the traditional method of cord care.

Skin infections (Figure 3a): This included the cases of intertrigo and pyoderma. It showed distributions similar to umbilical infection, with the peak in the second week. The peak in winter (Table 3), when bathing, hand washing, and washing of clothes may diminish due to severe cold, suggests that the skin infections probably were due to lack of hygiene and skin care.

Unexplained fever (Figure 3b): Fever not accompanied by other clinical manifestations such as cough, diarrhea, sepsis, etc.,

was called unexplained fever. A total of 58 cases occurred in the first week, as compared to 7 to 12 during weeks 2 to 4. This may be explained by the neonate's inability to cope with the environmental temperature in the early neonatal period, and by delayed initiation of breast feeding and mothers restricting their fluid intake in the first week.[17] Both can result in diminished breast feeding, causing dehydration of the baby. Fever showed a higher incidence in summer (Table 3) when the environmental temperature reached high (up to 47°C). Thus, the fever seems to be related to both environmental temperature and breast feeding practices.

Conjunctivitis (Figure 3c): The cases peaked in the first week (56), and then progressively decreased. The presence of only one case on day 1, 19 cases on days 6 to 7, and 24 during days 8 to 15 suggests that these were not cases of gonoccocal ophthalmia neonatrum. We have earlier reported low prevalence of gonococcal infection in women in this area,[21] and tetracycline eye ointment was routinely put in eyes at birth by the TBAs. Hence, probably these were cases of bacterial conjunctivitis acquired postnatally due to poor hygiene or due to indoor smoke.

We did not find significant seasonal variation in the incidence of LBW or preterm birth as others have reported.[2–10] This probably was due to smaller sample size, because seasonal variation in the incidence of these two problems is apparent in Table 3, but it does not reach a significant level. This effect may become significant as data from more years accumulate.

Near-significant seasonal variation in the incidence of asphyxia (Table 3), especially the increase in summer, is a surprising and unexplained finding. It should be evaluated further as data from more years accumulate.

CONCLUSIONS

To summarize, three striking points emerge from the distribution by day of life: (1) the importance of the first week of the neonatal period wherein many of the discussed morbidities were concentrated (and not discussed morbidities such as preterm, LWB, and asphyxia), (2) the problem of infections most probably acquired postnatally from the environment, and (3) the important role of neonatal care practices as an explanation of the seasonal and temporal variation in the incidence of many morbidities.

Based on these findings, we suggest that a large proportion of morbidities such as hypothermia, fever, feeding problems, and various infections, such as of upper respiratory tract, skin, conjunctiva, and to some extent sepsis, can be prevented by (1) repeated visits by the health worker, especially in the first week, and (2) changes in neonatal care practices at home.

To prevent these morbidities, neonatal care at home should include (1) improved cleanliness and hygiene, (2) reduced contact of neonates, especially with infected persons, (3) early and exclusive breast feeding, (4) proper thermal protection, beginning on the first day, (5) cord care and (6) early detection and treatment of infections such as sepsis, skin infections, umbilical infection, and conjunctivitis.

We hypothesize that health education and repeated home visits by a trained health worker will reduce a substantial proportion of these neonatal morbidities by helping to substitute improved neonatal care at home for some traditional beliefs and practices. We shall test this in the intervention phase (see ''The reduced incidence of neonatal morbidities'', J Perinatol 2005;25:S51–S61).

References

1. Bang AT, Bang RA, Baitule SB, Deshmukh MD, Reddy HM. 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.
2. Murray LJ, O'Reilly DP, Betts N, Patterson CC, Davey Smith G, Evans AE. Sesaon and outdoor ambient temperature: effect on birth weight. Obstet Gynecol 2000;96:689–95.
3. Matsuda S, Sone T, Doi T, Kahyo H. Seasonality of mean birth weight and mean gestational period in Japan. Hum Biol 1993;65: 481–501.
4. Van Hnswijck de Jonge L, Waller G, Stettler N. Ethnicity modifies seasonal variations in birth weight and weight gain of infants. J Nut 2003;133:1415–8.
5. Bantje H. Seasonality of births and birthweights in Tanzania. Soc Sci Med 1987;24:733–9.
6. Hort KP. Seasonal variation of birthweight in Bangladesh. Ann Trop Paediatr 1987;7:66–71.
7. Fallis G, Hilditch J. A comparison of seasonal variation in birthweights between rural Zaire and Ontario. Can J Public Health. Rev Can Sante Publique 1989;80:205–8.
8. Matsuda S, Hiroshige Y, Furuta M, Doi T, Sone T, Kahyo H. Geographic differences in seasonal variation of mean birth weight in Japan. Hum Biol 1995;67:641–56.
9. Cooperstock M, Wolfe RA. Seasonality of pre-term birth in the Collaborative Perinatal Project: demographic factors. Am J Epidemiol 1986;124:234–41.
10. Keller CA, Nugent RP. Seasonal patterns in perinatal mortality and preterm delivery. Am J Epidemiol 1983;118:689–98.
11. Lajinian S, Hudson S, Applewhite L, Feldman J, Minkoff HL. An association between the heat–humidity index and preterm labor and delivery: a preliminary analysis. Am J Public Health 1997;87:1205–7.
12. Costello A. New methods for monitoring neonatal hypothermia and cold stress In: Costello A, Manandhar D, editors. Improving Newborn Infant Health in Developing Countries. London: Imperial College Press; 2000. p. 221–32.

13. Behrman RE, Kliegman RM, Arvin AM. Textbook of Pediatrics. Philadelphia: WB Sauders Company; 1996.
14. Taeusch HW, Ballard RA, Avery ME. Schaffer and Avery's Diseases of the Newborn. Philadelphia: WB Saunders Company; 1991.
15. Remington JS, Klein JO. Infectious Diseases of the Fetus and Newborn Infant. Philadelphia: WB Saunders Company; 2001.
16. Bang AT, Bang RA, Baitule SB, Reddy HM, Deshmukh MD. Effect of home-based neonatal care and management of sepsis on neonatal mortality: field trial in rural India. Lancet 1999;354:1955–61.
17. Bang AT, Bang RA, Reddy HM, Deshmukh MD. Methods and the baseline situation in the field trial of home-based neonatal care in Gadchiroli, India. J Perinatol 2005;25:S11–7.
18. Bang AT, Bang RA, Morankar VP, Sontakke PG, Solanki, JM. Pneumonia in neonates: can it be managed in the community? Arch Dis Childhood 1993;68:550–6.
19. Bang AT, 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.
20. Singh M, Paul VK, Bhakoo ON. Neonatal Nomenclature and Data Collection. New Delhi: National Neonatology Forum; 1989. p. 63–74.
21. Bang RA, Bang AT, Baitule MB. High prevalence of gynaecological diseases in rural Indian women. Lancet 1989;i:85–8.

Appendix A1

Diagnostic Definitions of the Neonatal Health Problems

1. Birth asphyxia
   (i) Mild: At 1 minute after birth, no cry, or the breath was absent or slow, weak or gasping.
   (ii) Severe: At 5 minutes after birth, the breath was absent or slow, weak or gasping.
   (iii) Indirect: In the absence of direct observations by VHWs about newborn's condition at 1 and 5 minutes, presence of the following:
      (a) baby did not cry on its own, so the care provider had to make efforts to make the baby cry; and
      (b) color of the umbilical cord was green or yellow.
2. Preterm: Less than 8 months and 14 days (37 weeks) of gestation counted from the onset of the last menstrual period as per the history given by the mother.
3. LBW: Weight less than 2500 g.
4. Delayed breast feeding: Due to traditional practice, breast feeding not started in first 24 hours after birth, but baby licked/sucked the sweetened water.
5. Problems in breast feeding: Presence of any one of the following:
   (i) Baby did not suck breast for more than continuous 8 hours even when offered.
   (ii)
   - Mother unable to breast feed, or
   - baby fed on extracted breast milk, goat, or cow milk, or by bottle, or on sweetened water beyond 3 days, or
   - inadequate breast milk evidenced by continuous crying of baby and failure to gain weight.
6. Diarrhea: Watery, liquid motions three or more, or >9 motions of normal consistency in 24 hours, or mucus or blood in liquid stool.
7. Neonatal sepsis (septicemia, meningitis, or pneumonia diagnosed clinically): Simultaneous presence of any two of the following six criteria any time during 0 to 28 days:
   (i) Baby which cried well at birth, its cry became weak or abnormal, or stopped crying; or baby who earlier sucked or licked well stopped sucking, or mother feels that sucking became weak or reduced; or baby who was earlier conscious and alert became drowsy or unconscious.
   (ii) Skin temperature >99 or <95°F.
   (iii) Sepsis in skin or umbilicus.
   (iv) Diarrhea or persistent vomiting or distention of abdomen.
   (v) Grunt or sever chest indrawing.
   (vi) Respiratory rate (RR) 60 or more per minute even on counting twice.
8. Hemorrhage: bleeding from mouth, anus, eyes, nose, or in skin or in urine any time or vaginal bleeding after first week.
9. Conjunctivitis: Mother complained of excessive discharge from the eyes of baby, and on examination, eyes were red and with purulent discharge or dried pus.
10. Skin infection:
    (i) Pyoderma: Pus, ulcer, boil, pustule in skin.
    (ii) Intertigo: Excoriation with moist, cracked skin at skin folds.
11. Abnormal jaundice: Skin or eyes yellow on the first day or yellowness persisted at 3 weeks, or when yellowness associated with sepsis.
12. Meconium aspiration: History of difficult delivery or presence of birth asphyxia and respiratory distress (RR 60 or more; or severe indrawing of lower chest) started in first 24 hours after birth.
13. Hyaline membrane disease: Respiratory distress started within 6 hours after birth in preterms baby.
14. Pneumonia: RR 60 or more, persistent even when counted twice (Increased RR when associated with other signs symptoms of sepsis was included in neonatal sepsis).
15. Upper respiratory symptoms: Cough or nasal discharge present for 3 days or more without respiratory distress or increased RR.

16. Hypothermia: Axillary temperature <95°F.
17. Umbilical infection: Pus discharge from umbilicus.
18. Tetanus: Baby which earlier sucked well, stopped taking feeds from fourth day or more; and appearance of seizures, spasm and trismus.
19. Convulsive Disorder: Seizures but baby conscious, alert and feeds well between seizures (excludes tetanus, asphyxia, sepsis).
20. Unexplained fever: Axillary temperature >99°F without any attributable cause.
21. Failure to gain weight: Total weight gain during 0 to 28 days <300 g.