ORIGINAL ARTICLE

# The management of sick young infants at primary health centres in a rural developing country

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**Aims:** To investigate the epidemiology of illness among young infants at remote health clinics in a rural developing country, and to determine risk factors for mortality that might be used as triggers for emergency treatment or referral.

**Methods:** Multi-site 12 month observational study of consecutive presentations of infants less than 2 months, and an investigation of neonates who died in one district without accessing health care.

**Results:** Forty per cent of 511 young infant presentations occurred in the first week of life and most of these in the first 24 hours. Twenty five deaths were recorded: 18 in the health facilities and seven in villages. In addition there were eight stillbirths. Clinical signs predicting death were: not able to feed, fast respiratory rate, apnoea, cyanosis, ''too small'', ''skin-cold'', and severe abdominal distension. Signs indicating severe respiratory compromise were present in 25% of young infants; failure to give oxygen therapy was a modifiable factor in 27% of deaths within health facilities. A high proportion of seriously ill young infants were discharged from health facilities early without adequate follow up. A common reason for not seeking care for fatally ill neonates was the perception by parents that health staff would respond negatively to their social circumstances.

**Conclusions:** Clinical signs with moderate positive predictive value for death may be useful triggers for emergency treatment and longer observation or urgent referral. The results of this study may be useful in planning strategies to address high neonatal mortality rates in developing countries.

About 40% of the estimated 10.8 million annual child deaths worldwide occur in the first two months of life, and perinatal conditions cause approximately 2 million of these.[1] More than 95% of child deaths occur in developing countries. In addition to mortality, neonatal conditions cause considerable long term morbidity, including neurological impairment, and perhaps the origins of some late childhood or adult chronic diseases.[2]

This study was part of a programme to design a management strategy for sick neonates and young infants in primary health facilities and district hospitals in Papua New Guinea (PNG), a developing country of about 5 million people in the Western Pacific Region. For more than a decade Papua New Guinea (PNG) has had a clinical checklist that has been taught to health workers for use when they are seeing sick children. This is similar to the World Health Organisation (WHO) Integrated Management of Childhood Illness (IMCI), a strategy that has now been implemented to varying stages in over 93 countries. In May 2000, WHO sponsored a process of adaptation of the IMCI strategy into the PNG 10-Step Checklist. The generic WHO IMCI programme has two age components: a young infant component covers illness *after* the first week of life up to 2 months, and the other covers illness in children 2 months to 5 years (pneumonia, gastroenteritis, anaemia, measles, malnutrition). Perinatal conditions such as prematurity, low birth weight, birth asphyxia, conjunctivitis, and congenital syphilis[3] are not well covered, nor are they mentioned in the WHO strategy for management of children at district hospitals.[4]

This study was conducted to better understand the epidemiology of young infants presenting to rural health centres, to identify the clinical signs that can be recognised by primary health workers, the management currently given, and the outcomes for these babies. We hoped to determine modifiable factors in the management of young infants in remote primary health centres, to define clinical predictors of mortality that might be used as triggers for referral and emergency treatment, and to determine the reasons why young infants die in villages without being brought to health care.

In Papua New Guinea the infant mortality rate is at least 56 per 1000 live births, and may be as high as 70 per 1000 live births.[5] In a previous study in the highlands,[6] 21% of infant deaths occurred in the first week of life, and 36% in the neonatal period. Neonatal mortality in rural areas was up to seven times higher than in urban areas. Only 40% of child deaths occurred in a health facility; however, between 73% and 96% of rural and urban dwelling children respectively who died received some treatment in a health facility during their final illness.

## METHODS

We studied all presentations of sick young infants to seven health centres in rural PNG between 1 December 2001 and 31 January 2002. Participating health centres were selected because they represented the range of sizes of rural health facilities and the geography of PNG, and because the staff agreed to be involved; they were not randomly chosen. Four health facilities were selected from two districts in a remote and poorly serviced part of the East Sepik Province (a coastal and inland malaria endemic area); three health facilities were selected from three large districts in the Eastern Highlands Province (a low malaria area, where pneumonia is the commonest cause of hospitalisation and mortality in older infants and children). A data recording form was designed in consultation with the Paediatric Society of PNG and health workers in the participating health centres. Health workers piloted the recording form over one month, and further amendments were made. The recording form was printed in

**Abbreviations:** IMCI, Integrated Management of Childhood Illness; PNG, Papua New Guinea; WHO, World Health Organisation

**Table 1** Diagnoses made by health workers of 511 infants less than 2 months of age presenting to remote health facilities (more than one diagnosis was recorded where appropriate)

| Diagnosis | No. |
|---|---|
| Neonatal infection or neonatal sepsis | 191 |
| Pneumonia | 89 |
| Malaria | 64 |
| Simple cough/URTI | 46 |
| Premature or low birth weight | 35 |
| Bronchiolitis/bronchitis | 21 |
| Meconium aspiration | 19 |
| Conjunctivitis | 17 |
| Skin sores/skin sepsis/pustules | 17 |
| Birth asphyxia | 13 |
| Umbilical cord infection | 9 |
| Stillbirth | 8 |
| Birth trauma/birth injury | 6 |
| Congenital syphilis | 6 |
| Scabies | 5 |
| Thrush | 5 |
| Meningitis | 4 |
| Diarrhoea | 3 |
| Heart failure | 3 |
| Pertussis | 3 |
| Cellulitis | 2 |
| Congenital anomaly | 2 |
| Hypoglycaemia | 2 |
| Jaundice | 2 |
| Abscess | 1 |
| Bowel obstruction | 1 |
| Measles | 1 |
| Orchitis | 1 |
| Pyomyositis | 1 |
| Respiratory depression | 1 |

English and *Tok Pisin*, the lingua franca of PNG. Data included the date and place of birth, sex, weight, home village, where the baby presented from, clinical signs at the time of birth and at the time of presentation to the health centre, the diagnoses made by the health workers, a full list of the treatments given, whether the baby was admitted, sent home, or referred, and the outcome. Details of the maternal history were also recorded; these included attendance at antenatal clinics, the duration of labour, timing of membrane rupture, presenting part, and occurrence of complications including bleeding, fever, seizures, and death. Health workers recorded whether there was a plan for review at a later date, and the outcome of that review if it took place.

In the Wosera district of the East Sepik Province an epidemiological field site has been maintained for more than a decade by the Papua New Guinea Institute of Medical Research. A detailed demographic health survey is done every three months on the 12 000 people in the catchment area. This enabled us to carry out verbal autopsies on some young infant deaths occurring outside the health centres that service the district, to understand the epidemiology of young infant mortality in the community. This involved interviews with parents regarding dates and times of death, signs of illness, and health seeking behaviour. The interview questionnaire was partly structured and partly open. There was a section in which the parents were invited to tell the story of their infant's death in their own words, and to describe how they died, or reasons why they did not seek care.

The PNG Department of Health, the PNG Medical Research Advisory Committee, and the provincial health authorities in the participating provinces approved the study, and the health workers in charge of the district health centres agreed to be involved.

Data were entered into an Excel spreadsheet and analysed using Stata 7 (Stata Corporation, Texas). Logistic regression was used to determine clinical signs predicting death. We first did univariable logistic regression to identify predictive variables, then developed a multivariable regression model using independent risk factors that were present in one third or more of the deaths.

## RESULTS

Data were received on 691 infants less than 2 months of age. A total of 511 infants were diagnosed to have some clinical problem; of these, 301 were admitted to the health centres for treatment, 139 were sent home with treatment, 53 were given single dose treatment and sent home without further treatment, and 22 were referred (either at the time of presentation or after a period of health centre admission) (fig 1). The data on these 511 sick babies and the seven verbal autopsies of babies dying in the villages were analysed further, and form the major parts of this report.

### Characteristics of young infants presenting to rural health centres

The median age was 10 days (IQR 1–25 days). A total of 146 (29%) presented in the first 24 hours, and 210 (41%) presented in the first 7 days of life. The mean weight was 3121 g (SD 840 g). Excluding those over 7 days, in an effort to determine birth weight, the mean weight of infants was 2727 g (SD 740 g). Of the 511 infants, 13 (2.5%) had very low weight (1000–1500 g), and five (1%) had extremely low weight (<1000 g). Health workers were asked to classify babies as being ''too small'' or not. The mean weight of infants considered ''too small'', and those who proved to be at high risk of death if they were managed in the health centres (table 2) was 1841 g (95% CI 1664–2019 g), compared to the mean weight of those babies considered to be of adequate size: 3299 g (95% CI 3231–3366 g).

A total of 296 infants were born in villages, and 206 in health centres. Only 24 were referred from an aid post or by a village based health worker: the remainder of babies arrived directly from their home villages (338) or became unwell after being born in the health facilities.

Signs of severe respiratory compromise occurred in 25% (128 of 511) infants at presentation: ''fast respiratory rate'' (n = 102), severe chest indrawing (74), cyanosis (35), or apnoea (32). These were associated with a significantly increased risk of death (table 2). Health workers were asked to classify babies as having fast breathing or not, and then to record the respiratory rate, counted by observation over one minute. The mean respiratory rate of the infants classified by health workers as having fast respiratory rate was 60 (IQR 49–68) breaths per minute, and the mean for infants not classified as having a fast respiratory rate was 48 (IQR 40–60) breaths per minute.

### Treatment given

Of the 511 infants, 364 (71%) were treated with antibiotics, predominantly intramuscular penicillin and gentamicin (135 infants, 26%), intramuscular penicillin alone (86, 16.8%), oral amoxicillin (76, 14.9%), intramuscular penicillin and streptomycin (43, 8.4%), and chloramphenicol (22: 4.3%).

Antimalarials were given to 158 infants (31%); 153 of these received only oral amodiaquine and only three received quinine; two were unspecified. Fever was the predominant indication for antimalarial administration; however, antimalarials were given to 44 of 208 infants (21%) with a temperature in the normal range (36–37.2℃ per axilla), and 13 of 109 infants who did not have their temperature taken. No blood slides to confirm malarial parasitaemia were done.

Forty four infants were treated with oxygen, including 38 of 128 infants (12%) with severe respiratory distress (tachypnoea, severe chest in-drawing, cyanosis, or apnoea).

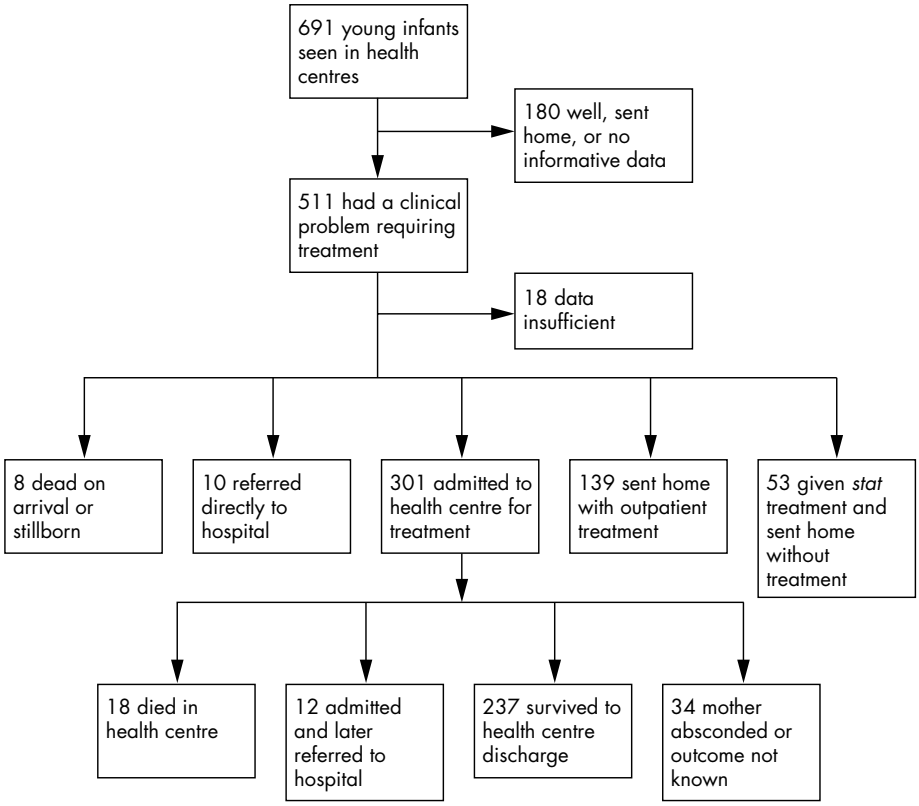


**Figure 1** Outcome for young infants presenting to eight remote health centres.

Twenty three of 49 infants (47%) who presented with cyanosis and/or apnoea did not receive oxygen: of these, five died.

Twenty seven infants with serious illnesses (including 13 sepsis, four pneumonia, three meconium aspiration/birth asphyxia, and three very low birth weight) were discharged without any plan for follow up. Although they were said to be well at discharge, the longer term outcome is not certain for these infants.

## Complications of pregnancy

The mothers of 105 infants (20.5%) reported that their pregnancies ended early. For 59 (11.5%) the membranes had ruptured more than 24 hours, and in 99 (19.4%) of cases the duration of labour was more than 24 hours. In 28 cases (5.5%) the presenting part was non-cephalic: either breech or limb presentation. There were no recorded maternal deaths.

## Mortality

### Deaths within health centres

Among the 301 young infants who were admitted there were 18 deaths (case fatality rate of 6.0%, 95% CI 3.3–8.7%), excluding stillbirths (see below). The clinical symptoms and signs at the time of presentation of babies who died are described in table 2. Inability to feed was present in all babies who subsequently died, but also present in 27% of infants who survived (positive predictive value = 18%). Other signs had comparable positive predictive value for a fatal outcome: apnoea (PPV = 25%), cyanosis (23%), "skin-cold" (33%), severe abdominal distension (25%), and "too small" (14.5%). A multivariable logistic regression model that included four independently predictive signs—inability to feed, apnoea, skin-cold, and severe abdominal distension—had an area under the ROC curve of 0.76 (table 3).

**Table 2** Univariable logistic regression of risk factors for death among 301 babies admitted to health centre

| Risk factor | No. recorded | No. with sign who died | No. with sign who survived | Odds ratio | p>z |
|---|---|---|---|---|---|
| Not feeding | 299 | 17/17 | 77/282 | | <0.001 |
| Fast breathing | 299 | 9/17 | 72/282 | 3.3 (1.2–8.8) | 0.019 |
| Chest in-drawing | 299 | 8/17 | 55/282 | 3.7 (1.4–9.9) | 0.011 |
| Apnoea | 299 | 7/17 | 21/282 | 8.7 (3.0–25.2) | <0.001 |
| Cyanosis | 299 | 7/17 | 23/282 | 7.9 (2.7–22.7) | <0.001 |
| Too small | 299 | 7/17 | 41/282 | 4.1 (1.5–11.4) | 0.007 |
| "Skin-cold" | 299 | 6/17 | 12/282 | 12.3 (3.9–38.8) | <0.001 |
| Severe abdominal distension | 299 | 6/17 | 18/282 | 8 (2.7–24.1) | <0.001 |
| Pale | 299 | 2/17 | 1/282 | 37.5 (3.2–436.8) | 0.004 |
| Bulging fontanelle | 299 | 2/17 | 2/282 | 18.7 (2.5–141.8) | 0.005 |
| Malformation | 301 | 2/18 | 3/283 | 11.7 (1.8–74.9) | 0.010 |
| Hypothermia (axillary temp <36°C) | 226 | 4/14 | 15/212 | 5.3 (1.5–18.8) | 0.011 |

**Table 3** Multivariable model for signs (measured at presentation) independently predicting death in 301 babies admitted to health centres

| Risk factor | Odds ratio | p>z |
|---|---|---|
| Not feeding | | <0.001 |
| Apnoea | 4.2 (1.1–15.4) | 0.03 |
| ''Skin-cold'' | 6.2 (1.5–26.6) | 0.01 |
| Severe abdominal distension | 3.6 (0.94–13.9) | 0.06 |

### Stillbirths

There were eight stillbirths out of the 357 infants delivered in health centres: the health facility still birth rate was 2.2% (95% CI 1.0–4.3%).

### Village deaths

Interviews were carried out with the parents of a further seven babies who died in the villages within the demographic survey area in the East Sepik Province. Five of the deceased were male. All babies dying in the villages were considered by parents to be ''too small'', but birth weights were not available. The median time the babies had been sick before death was three days (IQR 2–6 days), and the median age at the time of death was 3 days (IQR 3–7 days). Only one of the seven babies who died in villages had accessed a health centre during the final illness. The median distance from the home village to the closest health centre was 7 km, with a range of 1–10 km. The median estimated walking time to the closest health centre was 3 hours (IQR 1.5–6 hours). Reasons given by parents for not taking their infant to the health centre included that mothers were afraid of the nurses' reaction, fearing criticism because the baby was delivered at home. Other mothers said they were too upset or ashamed to take their baby to the clinic because of their social or marital circumstances. Some parents perceived that staff at clinics were not friendly, or did not give the right treatment.

## DISCUSSION

This study was done to better understand the causes, clinical signs, management, and outcome for young infants presenting to remote primary health facilities in Papua New Guinea. Forty per cent of young infant presentations occurred in the first week of life and most of these were in the first 24 hours. Based on this study a series of recommendations have been made (see box).

### Case fatality proportions and areas where there is scope for improvement

Case fatality rates for young infants in developing countries depend partly on the level of health facility, ranging from 5.4% among 4552 infants attending hospital outpatient clinics in the WHO young infant study[7] to 18%[8 9] among those admitted to district or provincial hospitals. Higher rates of mortality might be expected in referral hospitals because in general sicker infants will be referred; however, in primary health clinics where referral is difficult, higher rates of mortality might occur because of inadequacies in the most basic of resources and skills. The health facility mortality of 6% suggests that in general clinical care was good; however, deficits identified were failure to use oxygen appropriately, lack of follow up, and inadequate care of low and very low birth weight babies.

Failure to give oxygen therapy to infants with severe respiratory compromise was present in 27% of deaths. Signs of severe respiratory distress are common in young infants (25% of presentations of sick young infants). Although not all neonates with respiratory distress will have primary respiratory disease, the frequency of apnoea and cyanosis suggests hypoxaemia was present in at least 10% of sick young infants. This contrasts to a 30–40% rate of hypoxaemia among neonates requiring admission to referral hospitals in developing countries, established using pulse oximetry.[10 11] The 10% probability from our study will be an underestimate as apnoea and cyanosis are late signs of hypoxaemia. However, even one in ten young infants represents a very substantial burden of neonatal hypoxaemia in rural health centres, and better oxygen availability in primary health centres is vital.[12] Barriers to oxygen use must be overcome; these may include availability, technical competence, or fear of the therapy among staff or parents. Following this study, as part of the IMCI strategy for young infants, it has been recommended that any infant with a danger sign (see table 2) should be given oxygen, where this is available, and a study of oxygen concentrator use in rural district hospitals is planned. Ideally all very low birth weight (VLBW) babies and those with danger signs should be managed at an inpatient facility where nasogastric feeding, temperature stabilisation, oxygen, and regular weighing and prolonged observation are available.

The implications for mortality and morbidity from failure to follow up seriously ill neonates and VLBW babies was not completely demonstrated in our study as the investigators relied on health service follow up to determine longer term

### Summary and recommendations

- The following signs are associated with an increased risk of death, and are indications for emergency care and inpatient treatment: inability to feed, fast breathing, severe chest in-drawing, apnoea, cyanosis, ''too small'', ''skin-cold'', and severe abdominal distension
- Four clinical signs that had high positive predictive power for death (apnoea, cyanosis, ''skin-cold'', and severe abdominal distension) could be taught to health workers as indications for urgent referral to a hospital that can provide neonatal care, where referral is safe
- Young infants with any of the above danger signs should receive oxygen
- Appropriate systems for oxygen delivery should be established at district hospitals, and at primary health centres from where referral is difficult
- All VLBW babies and infants with the above danger signs should have access to nasogastric feeding, temperature stabilisation, oxygen, regular weighing and prolonged observation time
- Greater emphasis should be placed on completion of treatment and follow up of seriously ill and low birth weight infants
- Use of antimalarial drugs could be reduced if blood slides or rapid testing were used, and if antimalarials was restricted to infants with fever
- Antenatal and intrapartum care in health facilities should be actively promoted in the community
- The community perception that very low birth weight babies cannot survive should be addressed
- Perceptions by some within the community that health staff are unfriendly or unhelpful should be addressed
- The systems of transport and communication between primary health facilities and provincial hospitals urgently need improvement

outcome. It is possible that a number of infants died after discharge from the health centres. The importance of follow up for infants with serious infections or low birth weight should be emphasised by management strategies such as IMCI.

The excess mortality among VLBW babies, as well as the high rate of maternal complications (particularly prolonged rupture of membranes and prolonged labour) reinforces the importance of antenatal and intrapartum care and maternal education.

An antimalarial drug was given to a third of all infants. There were only four deaths among those treated with an antimalarial drug (mostly amodiaquine), and conditions other than malaria are likely to account for the deaths. Three of these infants were given antibiotic treatment of short duration (2 days) or not treated with oxygen despite having cyanosis. As has been shown previously, despite high levels of chloroquine resistance in PNG,[13] there was little evidence of failure of treatment with amodiaquine.[14] However, without a diagnostic test it is likely that many infants were treated with amodiaquine when they did not have malaria. Use of amodiaquine alone, as occurred for the majority of infants in this study, will increase the development of resistance.[14] Pyrimethamine-sulfadoxine (Fansidar) is recommended in PNG as adjunctive treatment, but this was rarely given. Use of antimalarial drugs could be reduced if blood slides were done or rapid testing was introduced. Although the empirical use of antimalarials in children with fever is common worldwide, there is scope for reducing antimalarial use in this population as more than 20% of afebrile infants were also treated for malaria.

### Clinical signs identifying infants at high risk of dying

The multi-country WHO Young Infant Study identified clinical signs that predict severe infection in infants presenting to hospitals and primary health facilities.[15] These included fever, hypothermia, inability to suck, crepitations, cyanosis, history of convulsions, lower chest indrawing, failure to arouse with minimal stimulation, history of change in activity, RR, age, weight for age. Risk factors for death included inability to feed, low or high temperature, low white blood cell count, and positive blood or CSF culture.[7] Because of recruitment methods this series of studies did not include some perinatal conditions that have some of the highest risk of mortality (case fatality rates ranging up to 50% for very low birth weight and up to 44% for birth asphyxia, for example).[8 9 16] In a study in Kenya, which included infants in the perinatal period, the following were predictive of bacterial sepsis: omphalitis, ''prostration'', hypoxaemia (haemoglobin oxygen saturation <90%), weak or absent movements, abnormally irritable or sleepy, abnormal feeding, inability to console the infant, and bulging fontanelle. Risk factors for neonatal death were hypoxaemia, inability to feed, hypoglycaemia, hypercarbia, and metabolic acidosis.[9] Many of these signs require laboratory services or monitoring equipment that will not be available at most primary health clinics. Our study examined clinical signs predicting death in young infants with all diagnoses. These signs were recognisable by health workers and did not require laboratory tests. The signs with moderately high positive predictive value: apnoea, cyanosis, ''too small'', ''skin-cold'', and severe abdominal distension could be used as indications for urgent referral to a hospital that can provide neonatal care[8] under circumstances where referral is safe, or emergency treatment and prolonged observation when referral is not possible. Safe referral of these babies will require basic pre-referral and during referral treatment, which should always include warming, oxygen, antibiotics, and monitoring and treatment of apnoea. Others have found that even moderate hypothermia on arrival at a referral hospital is a strong independent predictor of death.[17] Where referral is not possible, primary health workers need to be equipped and empowered to care for these babies in their health centre.

### Community perceptions and care seeking behaviour

The stated reasons why parents did not access health clinics, even when their infant was fatally ill, suggest a community perception that health workers can be judgemental about behaviour or social circumstances; however, the sample was small, perceptions may be modified by fatal outcomes, and may not be representative of widespread community perceptions or experience. For six of the seven babies the time from becoming ill to the time of death was several days longer than the time it would have taken walk to the nearest health facility, suggesting that geographical barriers to health service access were not the most important. That all the babies who died in villages were considered to be of low weight suggests a perception among some parents that babies of low birth weight cannot survive. With basic but good quality neonatal care, such as can be provided in provincial hospitals in developing countries, up to two thirds of babies with weights 1–1.5 g can survive.[8] Perceptions of unfriendly or judgemental health staff and futility of treating low birth weight will need to be addressed if overall neonatal mortality is to fall. Training of traditional birth attendants (TBAs) to provide safe village deliveries, linking TBAs with conventional health facilities, and ensuring health facilities are adequately resourced to provide necessary neonatal care, would support timely referral and care seeking and improve community confidence in the health system.

## Conclusions

This study has enabled the development of an IMCI strategy for the management of young infants in PNG that is consistent with WHO recommendations but based on locally validated clinical signs, and emphasising locally relevant problems. The study has also identified gaps in the system of communication and referral from primary health centres to provincial hospitals, and critical areas of community perception that need to be addressed.

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