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# Promotion of Breast-Feeding, Health, and Growth among Hospital-Born Neonates, and among Infants of a Rural Area of Costa Rica

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## INTRODUCTION

A decline in the incidence of breast-feeding in many developing nations has been recorded in recent years, often in conjunction with (a) rapid changes in way of life, (b) migration from rural to urban centers, (c) incorporation of women into the labor force (especially in industry), and (d) increase in stress, anxiety, and violence in transitional and modern societies. The marked decline in incidence and duration of breast-feeding throughout the world is a matter of international concern. The importance of breast-feeding, particularly in developing societies, stems from its health-promoting effect, as it provides the best food known for infants, protects the child against a variety of debilitating infectious

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processes, and encourages attachment between mother and infant.[1–6] Furthermore, successful breast-feeding indirectly reduces the ills of bottle-feeding, especially in developing nations, as epidemiological observation in many countries has revealed that early weaning is often associated with severe infant malnutrition, neglect, child abuse, abandonment, and premature death.[7–9]

Latin American countries in transition from traditional to modern societies have experienced a rapid decline in breast-feeding according to surveys conducted in the period 1975 to 1978 (Table I).[10–15] The causes for the decline have not been investigated thoroughly, but they are expected to be similar to those detected in other societies where the same phenor enon has been recorded.[7] However, in nations like Costa Rica, where the trend toward hospital childbirth has occurred so rapidly, separation of mothers and infants after delivery may play a more important role than currently realized. If this proves to be the case, a new approach different from that emphasizing routine educational aspects must be tried to promote breast-feeding.

A survey conducted in Costa Rica in 1978 showed that as many as 24% of infants from the rural areas were not breast-fed or were weaned in the first days of life; by 3 to 6 months, approximately one-half had been weaned onto cow's and formula milks. Furthermore, breast-fed infants were given supplements (mainly cow's milk) at an early age and only 19% were exclusively at the breast by age 4 months (Table II).[16]

Such a situation undoubtedly resulted from a combination of factors in our transitional society, such as (a) many years of practicing drastic separation of mothers and infants immediately after delivery, and formula-feeding in hospitals and clinics, (b) many years of intense promotion of processed cow's milk for infants by the medical and commercial establishments, (c) a powdered milk distribution program by the govern-

*Table I.* Percentage of Women Who Nursed Last Child, 1976–1979[a]

| | Urban | Rural |
|---|---|---|
| Honduras (East) | 97 | 96 |
| Peru | 87 | 95 |
| Colombia | 88 | 92 |
| Panama | 70 | 88 |
| Nicaragua | 72 | 85 |
| Costa Rica | 60 | 76 |

[a]Source: references 10–14, 16.

*Table II.* Prevalence of Breast-Feeding, Costa Rica 1978 and Puriscal 1979–1981

| | % Prevalence | | | |
|---|---|---|---|---|
| | | Puriscal subcohorts | | |
| Age (months) | Costa Rica $N = 286$ | 1.1 $N = 114$ | 1.2 $N = 219$ | 1.3 $N = 218$ |
| 1 | 76 | 95 | 95 | 86 |
| 3 | 52 | 82 | 79 | 71 |
| 6 | 57 | 66 | 59 | 46 |
| 9 | 31 | 62 | 47 | 36 |
| Total breast-fed[a] | 74 | 95 | 98 | 95 |

[a]One week or longer.

ment to all new mothers in effect for several years, and (d) cultural distortion of the role of the breasts and breast-feeding.

Although no account of the sequence of events leading to the situation uncovered by the surveys was available, the decline in breast-feeding probably began several decades ago. Early weaning was already common in the 1950s and probably contributed to the exceedingly high rates of diarrheal disease, malnutrition, infant death, and demographic change recorded in that decade. In spite of this, a sustained emphasis by governments on social development and improved nutrition and health resulted in consistent reduction in infant deaths, particularly in the 1970s.[17]

While Costa Rica coped with some of the ill effects of an increasing rate of premature weaning, incidence and duration of breast-feeding continued their decline. By the middle of the 1970s, measures intended to promote breast-feeding emanated from the Social Security and the Ministry of Health, with collaboration of the Costa Rican Association of Demography. They promoted educational programs through the radio, television, and press, but, according to the 1978 nutrition survey, the effect of such programs on breast-feeding was judged to be limited, as no significant changes were detected in the years since the preceding surveys (Table II). In fact, a further decline in breast-feeding was noted in 1978 compared to 1975.[10,16]

The present paper is a preliminary report of a collaborative study permitting implementation of certain hospital and field interventions and an assessment of their possible impact on maternal behavior, the practice of breast-feeding, and infant nutrition and health. The report summarizes findings of interventions affecting neonates at the San Juan

de Dios Hospital in San José, as well as results of a long-term, prospective field observation of mothers in Puriscal, most of whom deliver their infants in that hospital. The municipal seat of Puriscal, Santiago, is just 45 kilometers by paved road from San José, the capital of Costa Rica, but the study region extends to the Pacific Coast, comprising about 800 square kilometers, with approximately 24,000 inhabitants in eight districts containing about 170 localities of a very sparsely distributed rural population (Figure 1). The region is in rapid transition and its population enjoys a better standard of living than most traditional societies in Latin America. Most children have access to schools and health services, and


*Figure 1.* Region of Puriscal in the Republic of Costa Rica. Numerals 1 represent, from left to right, districts of Grifo Alto, Barbacoas, and Candelarita, or subcohort 1.1; numerals 2 are, from left to right, districts of Mercedes Sur, Desamparaditos, San Antonio, and San Rafael, or subcohort 1.2; and numeral 3 is the central district of Santiago, or subcohort 1.3 (see Table III).

about 70% of the homes are connected to piped water supplies. The population lives mainly on agricultural production and sales of food crops, complemented with cash crops such as tobacco.

The Puriscal study was planned simultaneously with several interventions in the Gynecology and Obstetrics Service of the San Juan de Dios Hospital. While planning began in 1976, hospital interventions started in September 1977, and the recruitment of mothers and infants for the study was initiated in September 1979.[15,18]

## Hospital Interventions

The San Juan de Dios Hospital is the oldest and one of the largest and most prestigious institutions in the country. Up to August 1977, the norm in the hospital obstetrics facility (total births: 7,500 to 9,000 per year) was to separate mothers and infants completely for the whole period of hospitalization (Table III). After delivery, neonates were examined, bathed, clothed, and placed in the neonatal ward, where they were fed glucose solution and formula milk; mothers and infants were reunited upon hospital discharge, usually 1 to 2 days after delivery.

In 1977 a series of innovations were initiated, as indicated in Table III. A partial rooming-in system was progressively developed after September 1977, with an ensuing increase in breast-feeding. The measure consisted of leaving the approximately 95% of normal infants with their mothers during the day (Figure 2). Infants born at night stay apart from their mothers until a neonatologist examines them. If they are found normal, they stay with their mothers during the day for the remainder of the hospitalization. Preterm, high-risk, and other very ill neonates (about 5%) are separated from their mothers and kept in an adjoining ward under supervision.

A milk bank was established in December 1977 and January 1978 adjacent to the rooming-in ward. Mothers and staff are very appreciative of the Syster Majas and Schuco breast pumps (Figure 3). The machines often serve to demonstrate the obvious to mothers: that they do produce colostrum and milk. Since most women do not undergo nipple massage before delivery, the pump may be of help in nipple formation and lactation stimulation. We believe the pumps have been important in assuring certain mothers of their capacity to lactate.[18] Donation of colostrum is carried out before or after the mother has breast-fed her own infant for the first time. However, emphasis is on suction of colostrum by the infant itself, and this often occurs on the delivery table, or soon after rooming-in is effected. The program has also encouraged feeding hos-

*Table III.* Interventions in the Gynecology and Obstetrics Service, San Juan De Dios Hospital, 1977–1980

| Intervention | Date of onset | Description | Approximate percent of population exposed |
|---|---|---|---|
| A. Mother–infant separation; formula-feeding | 1969–1976 | a. Brief visual contact at delivery; total separation during hospitalization | 100% |
| | | b. Infants fed glucose solution and milk formulae | |
| B. Rooming-in | September 1977 | a. Infants stayed with mothers for about 8 hours per day; infants separated at night | 66% (in 1977) 95% (in 1978+) |
| C. Colostrum; promotion of breast-feeding | January 1978 | a. Colostrum and milk given to preterm and high-risk neonates | 50% (mid-1978) 95% (in 1979+) |
| | | b. Education of nurses and mothers on lactation practices | |
| D. Early stimulation | July 1979 | a. Skin-to-skin contact | 50% (end 1979) 75% (in 1980+) |
| | | b. Suction of nipple shortly after birth | |
| | | c. Physical contact of mothers and preterm and high-risk neonates | |

pitalized infants their own mothers' milk; nursing mothers from the hospital staff use the pumps to extract their own milk during working hours. Some of these women have donated milk and some have breast-fed infants other than their own under special circumstances. This intervention has been very successful. Mothers transfer breast-feeding techniques to newcomers; the hospital environment has improved, and a relaxed and optimistic atmosphere prevails.

In 1978 a colostrum program for all neonates was initiated. For high-risk neonates who had hyaline membrane disease (HMD), congenital abnormalities, birth trauma, infections, or other pathology, and remained in the hospital for varying lengths of time, pooled fresh colostrum and milk were obtained by breast-pump extraction from donating postpartum women and mothers of hospitalized infants and fed to neonates in varying amounts of about 5 ml per kg of body weight per day.

Colostrum is administered by tube or bottle as soon as 4 hours after birth; some very ill infants may receive colostrum at a later time. Normal neonates (about 95% of the total population) suckle colostrum from their own mothers, a situation favored by the partial rooming-in system established the preceding year and availability of breast-pumps. By the middle of 1978, breast-feeding in this hospital had become almost universal.

A program of early stimulation of mother–infant bonding was started in 1979 and covered about one-half of the mother–infant pairs by the end of the year. Newborns are given to their mothers in the delivery room, although in many instances the infants are already clothed. Eye-to-eye contact, and stimulation of the infant's mouth and maternal nipple are emphasized by nurses attending in the delivery room, but this is not universally practiced. The program has not been wholly successful due, in great part, to the firmly established tradition of separation of mother and infant immediately after delivery, lack of knowledge on the importance of mother–infant interaction, alleged limitations to space and time by the nursing staff, and similar reasons. In 1979 a professional member from INISA commenced interviews of mothers and provided assistance

*Figure 2.* Rooming-in at the San Juan de Dios Hospital.

*Figure 3.* Colostrum is extracted with a mechanical breast pump at the San Juan de Dios Hospital.

in breast-feeding techniques. The activities of this professional focused mainly on the mothers of Puriscal.

Other interventions were effected during the same period, as Costa Rica is a country in rapid transition and continuously tries to improve its health care delivery system. An increasing number of physicians and greater availability of qualified personnel in the hospital have probably resulted in some increase in survival for high-risk neonates. The possible effect of improved health care and sophisticated medical technology on infant mortality and other health indicators cannot be quantified, but it would not be expected to be large in the short period of observation (1977–1981).

Concordant with the evolution of the country, a significant improvement in fetal growth was documented, as the prevalence of low birth weight fell from 9.2 to 7.5% in the period 1970 to 1975.[19] However, only a slight further improvement in fetal growth has been recorded since then (unpublished data).

## The Puriscal Study

The planning of the study began in 1976; recruitment of cases in the hospital and in the field began in September 1979 and paralleled and inspired some of the hospital interventions mentioned above. The Puriscal study is a long-term, prospective observation of mothers and infants predominantly of Spanish and, to a lesser extent, Spanish-Amerindian descent. The population lives partly in the district centers, partly dispersed in valleys and hills surrounding the centers. The localities are "rural dispersed" if they have fewer than 500 people, or "rural concentrated" if they have 500 to 2000 people. The population yields from 600 to 650 newborns per year, and the aim of the study is to include at least two complete yearly cohorts. Although traditionalism and ruralism are still prevalent, the social development of Puriscal and most of rural Costa Rica is significantly high if compared with populations where long-term studies have also been conducted—i.e., in Tezonteopan and Tláltizapán, Mexico,[20,21] Santa María Cauqué, Guatemala,[22] Khanna and Narangwal in India,[23,24] and Matlab, in Bangladesh.[25] However, ruralism in Puriscal is more marked than in the Guatemalan and Mexican villages, and distances between houses may require several hours of walking through forests and fields, while some houses may be more than 2 km from the nearest school.

Many Puriscal mothers are included in the study through prenatal clinics; others are included in connection with delivery; a few are entered at a later date. About 84% of deliveries occur in the San Juan de Dios Hospital, 13% occur in other maternity units and clinics in San José, and 3% occur in the home, a situation contrasting with that of traditional villages in which most births occur at home.

Adequate coordination between our office at the hospital and other hospitals and clinics allows the staff of the field station to know about most deliveries in Puriscal. Inevitably, our personnel at the hospital pay more attention to these women, and stimulation of mothers and infants by a neonatologist, a social scientist, and a nurse should favor bonding and breast-feeding.

Because Puriscal women are harder to reach in their widely dispersed homes, mothers are interviewed while in the hospital. This contact also serves to further stimulate mothers to breast-feed. The base of operations for the medical officer, nurses, health workers, dietary technicians, and other staff is the INISA Field Station in Santiago de Puriscal. Coordination with health workers from the Ministry of Health for coverage of the highly scattered population has been required. Rural motor

*Table IV.* Subcohorts of the Puriscal Study, 1979–1981

| Subcohort | districts[b] | Type of population | Field intervention[c] |
|---|---|---|---|
| 1.1 (114)[a] | Grifo Alto<br>Barbacoas<br>Candelarita | Rural dispersed | a. Visit by INISA's field worker within 10 days postpartum<br>b. Contact with INISA's physician<br>c. Monthly visits by INISA's field workers |
| 1.2 (308) | Mercedes Sur<br>Desamparaditos<br>San Antonio<br>San Rafael | Rural dispersed | a. Monthly visits by health workers from Ministry of Health<br>b. Occasional contact with INISA's physician |
| 1.3 (190) | Santiago | Rural concentrated, rural dispersed | a. Occasional contact with health personnel from Social Security, Ministry of Health, and INISA |

[a]Number of infants born into subcohort.
[b]See text and Figure 1.
[c]Infants in all subcohorts were equally stimulated in the hospital (see text).

vehicles, motorcycles, and horses are used, but surveillance still includes foot travel in each instance.

The cohort comprised 612 infants 1 year after the study began, distributed in three subcohorts according to the type and intensity of intervention and prospective observation (Table IV and Figure 1). All mother–infant pairs were similarly treated in the hospital (Table III). Those of the rural dispersed districts of Grifo Alto, Barbacoas, and Candelarita (subcohort 1.1) were visited within the first 10 days postpartum and then were studied by the physician and health nurses through monthly consultations. Visits served to collect data on physical growth, breast-feeding, food intake, and morbidity.

Mother–infant pairs of four other districts (Mercedes Sur, Desamparaditos, San Antonio, and San Rafael, constituting subcohort 1.2), equally rural and dispersed, were visited monthly by the staff of the Ministry of Health, coordinated by INISA, to collect information on breast-feeding and physical growth. Contact with INISA's physician and field staff was less than for subcohort 1.1. Mother–infant pairs of Santiago, the central district of Puriscal (subcohort 1.3), both rural dispersed and concentrated, attended the health services of the locality and had more access to resources of the region and the capital city. They could consult with INISA's personnel, but monthly visits were primarily coordinated through the staffs of the Social Security and Ministry of Health.

Standard forms and procedures were used to collect data in all districts within the epidemiologic framework of a long-term prospective study.

## RESULTS

*Incidence of Breast-Feeding in the Hospital.* Prior to the interventions at the San Juan de Dios Hospital, most infants did not receive colostrum and were not breast-fed while in the hospital. About 20 to 30% of infants did not breast-feed, a figure in accord with the 24% of rural infants who were not breast-fed at all in Costa Rica in 1978 (Table II). This apparently resulted from the drastic separation of mother and infant and the lack of support of the mother during hospitalization. The current interventions resulted in about 95% of infants being given the breast to receive colostrum soon after birth, in agreement with the theory of bonding and lactation induction.[2,4,7]

*Postpartum Breast-Feeding in Puriscal.* Rates of breast-feeding after hospital discharge were computed for the population of Puriscal newborns delivered in the San Juan de Dios Hospital. Extreme differences in the rate of breast-feeding in all Puriscal subcohorts, as compared with rural Costa Rica in 1978, became evident (Table II and Figure 4). The Puriscal data in Figure 4 represent prevalences of monthly observations for all

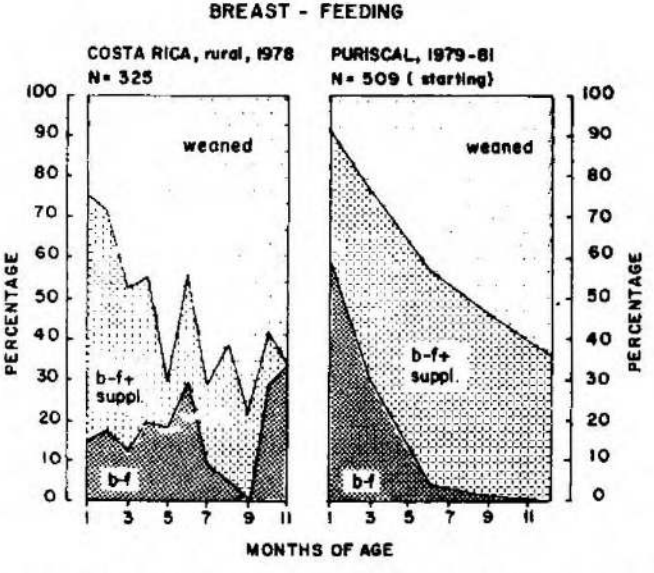


*Figure 4.* At left is the prevalence of breast-feeding in rural Costa Rica, 1978. Data from the national nutrition survey[16] were derived from a representative sample that included the region of Puriscal. At the right is the cumulative prevalence of breast-feeding among the subcohorts of the Puriscal study.

infants of the three subcohorts combined, consisting of 509 newborns 1 month old, 513 3 months old, 454 6 months old, 294 9 months old, and 86 infants 1 year old—a natural attrition because the subcohorts were growing older. In the first months of life, breast-fed infants in Puriscal may receive small amounts of orange juice and fluid and semisolid foods, and this could account for the low rate of exclusive breast-feeding, as illustrated in Figure 4. Significant food supplementation (ablactation) begins at 3 to 4 months for many infants. This also includes cow's milk or other formula milks. Our criteria to define exclusive breast-feeding are more stringent than those used in the 1978 survey. The important consideration is that only 9% of infants did not breast-feed as compared with a 24% weaning rate in rural Costa Rica in 1978 (Figure 4).

A contrast is noted when the prevalence of breast-feeding in rural Costa Rica in 1978 is compared with that of subcohort 1.1 (stimulated by INISA's personnel, as indicated above). Only 7% of infants in this subcohort were weaned by 1 month of age, while at 6 months, more than 60% were still at the breast (Figure 5). The prevalence of exclusive breast-feeding was also greater in subcohort 1.1 than in the others.

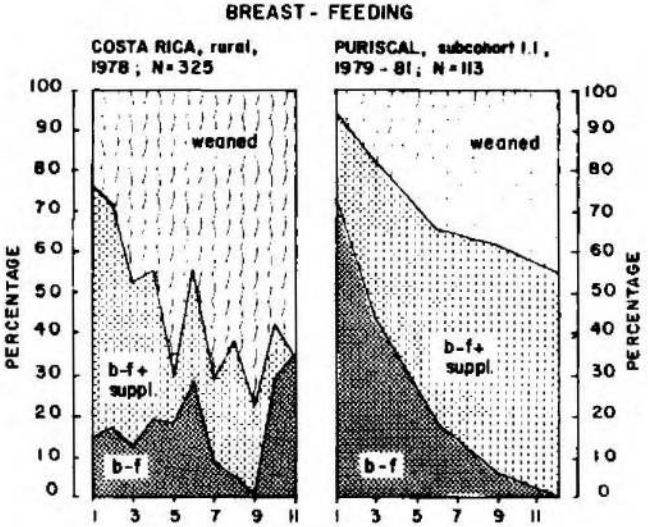


*Figure 5.* At left is the prevalence of breast-feeding in rural Costa Rica, 1978, as in Figure 4. At right is the prevalence of breast-feeding in subcohort 1.1, where a postpartum prospective observation is made by INISA's field workers. Note that a significantly greater number of infants were breast-fed in this subcohort as compared with the total cohort population (see Figure 4).

Although there should not have been any reason for the Puriscal population to adopt improved lactation practices before our intervention began compared to the rest of the rural Costa Rican area, a retrospective survey of the siblings of cohort infants was undertaken. The survey included siblings under 6 years of age, and therefore the data correspond to the period 1975 to 1979, that is, before the Puriscal study was established. The prevalence of breast-feeding in all subcohorts (data corresponding to 1, 3, 6, 9, and 12 months were used for all children who were at least 1 year old) was significantly greater than that of their siblings (Figure 6). A more stringent criterion of defining exclusive breast-feeding in the current study may have accounted for the lower prevalence in the cohort infants than in the siblings.

Since subcohort 1.1 exhibited the greatest prevalence of breast-feeding, a comparison was made with the siblings of infants in this group (Figure 7). All siblings of subcohort 1.1 infants were surveyed. Again, the prevalence was significantly greater for cohort infants than for the corresponding siblings.

Subcohort 1.3 is the least rural of the three and received less stimu-

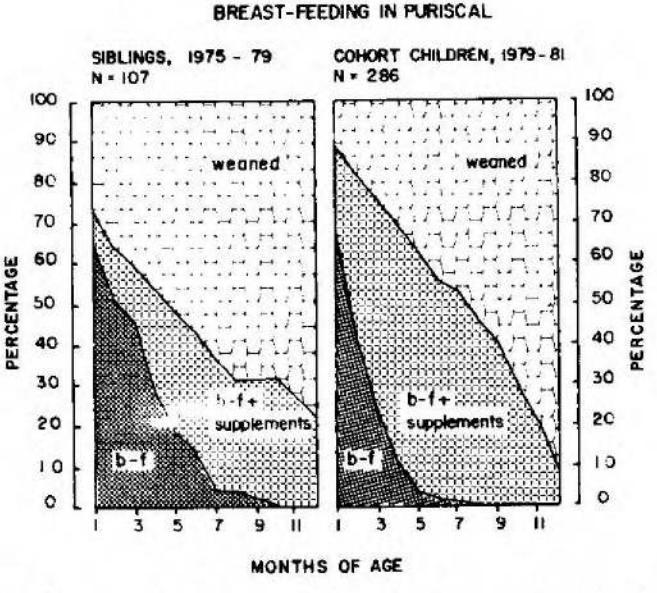


*Figure 6.* At right is the prevalence of breast-feeding in all cohort infants, and at left is that of their siblings under 6 years of age. Note the increase in breast-feeding among infants of the Puriscal study.

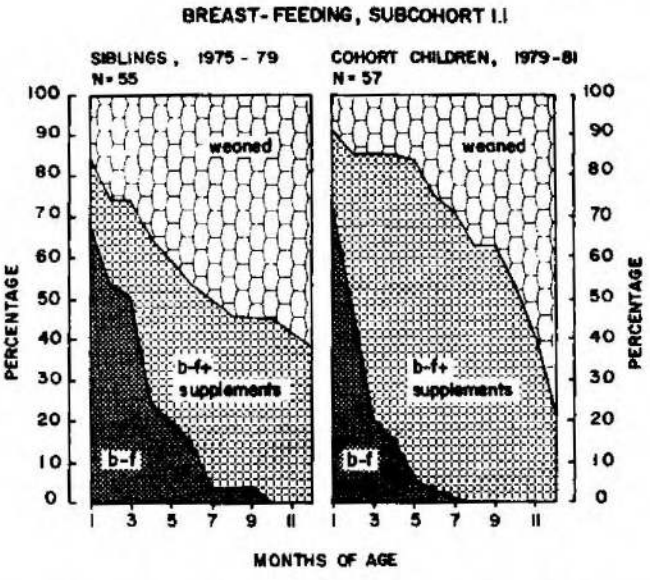


*Figure 7.* At right is the prevalence of breast-feeding for infants of subcohort 1.1 only, and at left is the prevalence in the corresponding siblings under 6 years of age.

lation from INISA's personnel, according to the study design. The prevalence of breast-feeding in this subcohort again showed an improved situation in the current study population compared with the siblings (Figure 8), although the difference was less than that in the other subcohorts.

It is evident that there is significantly more breast-feeding in Puriscal now compared to levels detected for the rural Costa Rican population as a whole in 1978. The difference becomes more noteworthy for subcohort 1.1, which was further stimulated by periodic visits of field workers interested in breast-feeding. The comparison of prevalences in the subcohorts with those of corresponding siblings does indicate an improvement over the preceding period. This evidence strongly suggests an effect of rooming-in and other hospital interventions, strengthened by periodic surveillance by field personnel.[2,3,7]

*Breast-Feeding and Rooming-In.* In order to check further the relation of bonding to improved breast-feeding practices, a prevalence survey was made in two rural regions similar to Puriscal. One (Acosta, Aserri, and Mora) is adjacent to Puriscal, but outside the influence of the field intervention of INISA; most women of this region deliver at the San Juan de Dios Hospital, and therefore mothers and infants are affected by the

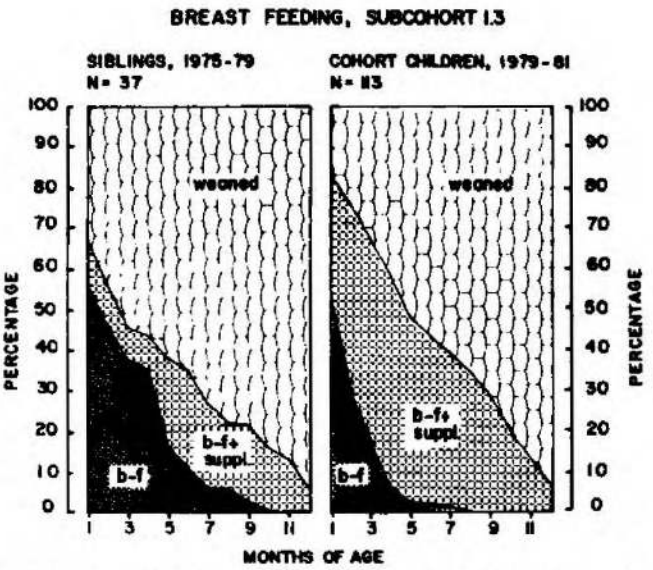


*Figure 8.* At right is the prevalence of breast-feeding for infants of subcohort 1.3 only, and at left is that of their siblings under 6 years of age.

ongoing interventions. The other (Moravia, Santo Domingo) is about 60 kilometers from Puriscal and is not influenced by INISA's field intervention either; women of this region deliver at the Calderón Guardia Hospital, where separation of mothers and infants and formula feeding of neonates is the norm.[18] The community survey results in Table V clearly show a high rate of early weaning among all infants separated from their mothers soon after birth. Furthermore, most infants had been completely weaned by 9 months of age. This finding is in support of observations on the effect of bonding on breast-feeding.[9,26]

*Neonatal Morbidity.* A significant reduction in neonatal morbidity of infectious origin was recorded in the population of live-borns during the observation period (Table VI).[27] Data were from clinical records corresponding to the first few days of life and covered all newborns at the San Juan de Dios Hospital, including those of Puriscal. The decline in morbidity was more striking for diarrheal disease and meningitis. Such a reduction was probably not influenced by improved medical attention, but rather by the colostrum program and promotion of bonding, as shown by Larguía's group in Argentina.[28,29]

A decline in the incidence of hyaline membrane disease (HMD) was also noted (Table VII). HMD appeared at a rate similar to that reported

*Table V.* Breast-Feeding by Hospital Practice, Two Rural Areas of Costa Rica, 1980

| Age (months) | Acosta-Aserri-Mora (incomplete rooming-in[a]) | | Moravia-Sto. Domingo (no rooming-in[b]) | |
|---|---|---|---|---|
| | Number | % at breast | Number | % at breast |
| 0–3 | 43 | 86 | 31 | 77 |
| 4–7 | 40 | 78 | 49 | 35 |
| 8–11 | 25 | 52 | 40 | 10 |

[a]San Juan de Dios Hospital and Carit Institute.
[b]Dr. Calderón Guardia Hospital.

in the medical literature and in accord with the 7.7% rate of prematurity (less than 37 weeks of gestation) before the hospital interventions began. While the frequency of prematurity had declined to 5.1% (a 34% reduction from 1976 to 1979), this does not seem to explain the 56% decrease in the incidence of HMD in the period. Administration of cortisol to high-risk pregnant women is not practiced for all women; it would not have accounted for the total reduction recorded. It appears possible that colostrum has a maturing effect on preterm infants that may help prevent HMD. Colostrum and breast milk might promote or support maturation phenomena, especially because the newborn is an immature, exterogestate fetus.[1] This possibility, currently under investigation, would help explain excess rates of HMD where newborns are customarily deprived of colostrum.

*Table VI.* Neonatal Morbidity Attributed to Infection, San Juan de Dios Hospital

| Year | Intervention[a] | Number of live births | Cases per 1000 live births | | | |
|---|---|---|---|---|---|---|
| | | | Diarrheal disease | Sepsis | Lower respiratory infection | Meningitis |
| 1976 | A | 7629 | 135(17.7) | 41(5.4) | 32(4.2) | 10(1.3) |
| 1977 | B | 8582 | 71(8.3) | 52(6.1) | 35(4.1) | 5(0.6) |
| 1978 | B + C | 8931 | 62(6.9) | 29(3.2) | 27(3.0) | 12(1.3) |
| 1979 | B + C + D | 8638 | 55(6.4) | 28(3.2) | 18(4.9) | 0 |
| 1980 | B + C + D | 8963 | 14(1.6) | NA[b] | 22(2.4) | 1(0.1) |
| % reduction in rates 1976–1979 | | | 91 | | 43 | 92 |

[a]See Table III and text.
[b]NA = not yet available

*Table VII.* Hyaline Membrane Disease (HMD), San Juan de Dios Hospital

| | | | | Hyaline membrane disease | | |
|---|---|---|---|---|---|---|
| Year[a] | Intervention[b] | Number of live births | Number (%) of infants < 37-week gestation | Observed cases (%) | Observed deaths (%) | Observed minus expected case rates as %[d] |
| 1976 | A | 7629 | 589(7.7) | 154(2.0)[c] | 47(0.62)[c] | 0 |
| 1977 | B | 8582 | 618(7.2) | 161(1.9) | 37(0.43) | −5.0 |
| 1978 | B + C | 8931 | 597(6.7) | 133(1.5) | 32(0.36) | −25.0 |
| 1979 | B + C + D | 8638 | 437(5.1) | 85(1.0) | 31(0.36) | −50.0 |
| % reduction in rates 1976–1979 | | | 33.8 | 50.0 | 41.9 | |

[a]In 1978 most moderate and severe cases were transferred to the National Children's Hospital; they are excluded from these statistics.
[b]See Table III and test for description and timing of interventions.
[c]In parentheses, percent cases or deaths among total infants.
[d]Arbitrarily, the 1976 rate (2.0%) was assumed to be the expected value for the following years.

*Neonatal Mortality.* Expectedly, a decrease in neonatal mortality of infectious origin should also have occurred (Table VIII). This was computed only from deaths in the hospital. Most neonatal deaths occur in the first few hours or days of life, and since many high-risk and preterm babies remain hospitalized, the figures should be close to accurate.[27] No deaths from diarrhea, lower respiratory tract infection, or meningitis have been recorded since 1979, in accord with the known antiinfectious protection afforded by colostrum.[1,2,5–7,28–30]

Other causes of neonatal death remained relatively unaltered, as

*Table VIII.* Neonatal Mortality Attributed to Infection, San Juan de Dios Hospital

| Year | Intervention[a] | Diarrheal disease | Sepsis | Lower respiratory infection | Meningitis | Total |
|---|---|---|---|---|---|---|
| 1976 | A | 3(3.9)[b] | 7(9.2) | 4(5.2) | 2(2.6) | 16(20.9) |
| 1977 | B | 1(1.2) | 9(10.5) | 6(7.0) | 2(2.3) | 18(20.9) |
| 1978 | B + C | 0 | 4(4.5) | 1(1.1) | 4(4.5) | 9(10.1) |
| 1979 | B + C + D | 0 | 4(4.6) | 0 | 0 | 4(4.6) |
| 1980 | B + C + D | 0 | 4(4.5) | 0 | 0 | 4(4.5) |
| % reduction in rates 1976–1980 | | 100 | 51 | 100 | 100 | 78 |

[a]See Table III and text.
[b]Deaths (rate per 10,000 live births), number of live-borns as in Table VI.

shown in Table IX for congenital defects. Deaths associated with immaturity decreased by 38%, in accord with the gradual reduction in the incidence of low-birth-weight infants in the country.[19] In this regard, the percent incidence of HMD decreased as a cause of death by 71%, in agreement with the 50% reduction in incidence of HMD (see above). Since better systems to cope with the high-risk mother and with the disease would not likely be solely responsible for this marked decline, other explanations must be sought; for instance, the possibility that colostrum has a maturing capacity that prevents HMD in some infants and ameliorates it in others.

*Infant Mortality in Puriscal.* The evolution of infant mortality in Puriscal is shown in Table X, next to the interventions that might have affected it, and in comparison with the national figures. Only two deaths of cohort infants, both occurring in the first week of life, were recorded. Monitoring survival was by monthly visits of all cohort infants. Furthermore, the records of hospitals and clinics where infants might have been taken to die were examined. More than one-half of infants were 1 year old (cohorts recruited from September 19, 1979, through September 18, 1980), and the remaining were older than 6 months at the time of the present analysis. No additional deaths were likely to occur. An infant mortality rate of 4 per 1000 live births for Puriscal is 82% less than the national figure and 50% less than the Puriscal rate before the Puriscal study began. Before the rooming-in, colostrum, and early stimulation interventions, the difference between the national infant mortality and that of Puriscal had remained rather constant.

*Table IX.* Main Attributed Causes of Neonatal Deaths, San Juan de Dios Hospital

| | | Deaths per 1000 live births | | | | |
|---|---|---|---|---|---|---|
| Year | Intervention[a] | Acute infections | Immaturity | Congenital defects | Asphyxia | Hyaline membrane disease |
| 1976 | A | 16(2.1)[b] | 30(3.9) | 9(1.2) | 14(1.8) | 46(6.0) |
| 1977 | B | 18(2.1) | 51(2.9) | 13(1.5) | 25(2.9) | 37(4.3) |
| 1978 | B + C | 9(1.0) | 29(3.2) | 10(1.1) | 33(3.7) | 32(3.6) |
| 1979 | B + C + D | 7(0.8) | 31(3.6) | 12(1.4) | 39(4.5) | 31(3.6) |
| 1980 | B + C + D | 8(0.9) | 22(2.4) | 15(1.7) | 26(2.9) | 16(1.8) |
| % reduction in rates 1976–1980 | | 57.1 | 38 | | | 71[c] |

[a]See Table III and text.
[b]Deaths (rate per 1000 live births), number of live-borns as in Table VI.
[c]Percent reduction in rates 1976–1979, because severe cases of HMD after 1979 were quickly referred to the National Children's Hospital.

*Table X.* Infant Mortality Per 1000 Live Births

| Year | Rate per 1000 live births | | Percent difference | Intervention[b] |
|---|---|---|---|---|
| | Costa Rica | Puriscal | C.R.-Puriscal | |
| 1970 | 61 | 49 | 20 | |
| 1973 | 45 | 30 | 33 | Rural health (RH) |
| 1975 | 37 | 28 | 24 | RH + supplementary feeding (SF) |
| 1977 | 27 | 15 | 44 | RH + SF + rooming-in (B) |
| 1980 | 22[a] | 4 | 82 | RH + SF + B + colostrum + early stimulation[c] |

[a]Estimated.
[b]For description of interventions see Table III and text.
[c]Affects about 95% of Puriscal infants, or about 13% of infants nationwide.

It is worth noting here that several social, economic, and health measures have been under way in Costa Rica for several years, and they have influenced, and are still influencing, the decline in infant deaths in the country. Among the health interventions, the Rural Health Program and the Nutrition Program (feeding centers) cover more than 80% of the dispersed rural population. The Rural Health Program emphasizes primary health care[31] and should not have strongly affected survival in the neonatal period. The Feeding Program emphasizes food distribution for preschool children,[32] but evidently infants have not been a target. Thus, the rooming-in, colostrum and breast-feeding, and early stimulation interventions are most probably responsible for a considerable part of the remarkable increase in survival, as infant mortality in Puriscal is now considerably below the national figure, and even below that of developed urban areas of Costa Rica (unpublished data).

*Child Abandonment.* Since there appears to be a relationship between bonding and breast-feeding and an increased capacity of the mother to protect the infant, the rate of abandonment was investigated. A significant reduction in abandonment of normal term infants was demonstrated,[33] correlated with rooming-in, skin-to-skin proximity, and breast-feeding interventions (Table XI). The decline in abandonment of hospitalized infants with some form of pathology was less, but nevertheless significant, and in accord with the theory of bonding.[2,9,26,34] A reduction in abandoned children prevents malnutrition and premature death, as well as the complications stemming from the social pathology that often surrounds abandoned children.

*Resistance to Infection.* The significant increase in prevalence of breast-feeding in Puriscal, especially in subcohort 1.1, should have been

*Table XI.* Nosocomial Interventions and Child Abandonment,[a] San Juan de Dios Hospital

| Period (October–September) | Intervention | Condition of infant | | |
|---|---|---|---|---|
| | | Term | Ill[d] | Total |
| 1976–1977 $N$ = 8988[b] | A | 9(10.0)[c] | 10(11.1) | 19(21.1) |
| 1977–1978 $N$ = 9143 | B | 3 (3.3) | 7 (7.7) | 10(10.9) |
| 1978–1979 $N$ = 8737 | B + C | 1 (1.1) | 5 (5.7) | 6 (6.9) |
| 1979–1980 $N$ = 8972 | B + C + D | 1 (1.1) | 5 (5.6) | 6 (6.7) |
| % reduction in rates 1976-1980 | | 89 | 50 | 68 |

[a]Seven infants were abandoned because of maternal death, mental illness, or mental retardation; they were excluded from table.
[b]Number of infants varied from those in preceding tables because they were computed for the period October–September.
[c]Infants abandoned (rate per 10,000 live births).
[d]Hospitalized, preterm, or with various pathologies.

accompanied by an increased protection against enteric infection, an improved capacity to recover from diarrhea and dehydration, better nutrition, and a better state of health derived from the direct benefits of breast milk,[1,5,6] as well as indirect effects, such as increased sharing of time with the infant and a greater degree of parental affection and care.[7] In fact, weight gain in Puriscal infants with rotavirus diarrhea varied according to feeding regimens.[18] Among infants with similar birth weights, the weaned tended to exhibit a larger negative response to rotavirus diarrhea than the supplemented, and in turn had a greater negative response than the exclusively breast-fed, taking age into account. Furthermore, the incidence of diarrhea for subcohort 1.1, which received the benefit of support from our health personnel, was significantly smaller than that of subcohort 1.2, which did not.[18]

*Physical Growth.* The relationship of feeding pattern and weight gain was explored for all infants of subcohorts 1.1 and 1.3 who were at least 1 year old and who had rather complete anthropometric data at birth and at 3, 6, 9, and 12 months. Low-birth-weight infants (less than 2.5 kg) were not included in the analysis. Mean weights were contrasted for breast-fed (including those receiving supplements) and weaned infants with the 25th and 50th percentiles of the NCHS-CDC (Fels Research Institute) curves[35] (Tables XII and XIII). Supplementation in this society often begins at 3 months; by 6 months most infants already receive supplements to breast milk. The weight of breast-fed infants was slightly better, as a group, than that of non-breast-fed infants at 3 and 6 months. At 12

*Table XII.* Weight of Infants from Birth to 12 Months, by Type of Feeding, Puriscal (Subcohort 1.1), 1979–1981

| Age (months) | At the breast* ($N$) $\bar{x}$ weight, kg | Weaned ($N$) $\bar{x}$ weight, kg | Breast-weaned difference, kg | Fels Research Institute 25th P | Fels Research Institute 50th P |
|---|---|---|---|---|---|
| Boys | | | | | |
| Birth | (21)3.19 | | | 3.06 | 3.40 |
| 3 | (18)6.43 | (3)5.75 | +0.68 | 5.35 | 6.01 |
| 6 | (15)7.94 | (6)7.52 | +0.42 | 7.17 | 8.50 |
| 9 | (12)8.71 | (9)9.04 | −0.33 | 8.59 | 9.28 |
| 12 | (11)9.35 | (6)10.15 | −0.80 | 9.51 | 10.10 |
| Girls | | | | | |
| Birth | (14)3.15 | | | 2.89 | 3.25 |
| 3 | (14)5.86 | | | 4.86 | 5.41 |
| 6 | (13)7.47 | (1)7.80 | −0.33 | 6.61 | 7.20 |
| 9 | (11)8.40 | (2)8.70 | −0.30 | 7.89 | 8.54 |
| 12 | (6)9.32 | (4)9.30 | +0.02 | 8.81 | 9.57 |

*Supplementation generally was started at 3 months.

*Table XIII.* Weight of Infants from Birth to 12 Months, by Type of Feeding, Puriscal (Subcohort 1.3), 1979–1981

| Age (months) | At the breast ($N$) $\bar{x}$ weight, kg | Weaned ($N$) $\bar{x}$ weight, kg | Breast-weaned difference, kg | Fels Research Institute 25th P | Fels Research Institute 50th P |
|---|---|---|---|---|---|
| Boys | | | | | |
| Birth | (18)3.15 | | | 3.06 | 3.40 |
| 3 | (10)6.55 | (9)6.02 | +0.53 | 5.35 | 6.01 |
| 6 | (4)8.01 | (14)7.80 | +0.21 | 7.17 | 8.50 |
| 9 | (4)8.81 | (13)9.13 | −0.32 | 8.59 | 9.28 |
| 12 | (3)9.93 | (14)9.83 | +0.10 | 9.51 | 10.10 |
| Girls | | | | | |
| Birth | (34)3.24 | | | 2.89 | 3.25 |
| 3 | (26)5.83 | (6)5.53 | +0.30 | 4.86 | 5.41 |
| 6 | (21)7.61 | (13)7.31 | +0.30 | 6.61 | 7.20 |
| 9 | (11)8.63 | (23)8.55 | +0.08 | 7.89 | 8.54 |
| 12 | (8)9.39 | (21)9.55 | −0.16 | 8.81 | 9.57 |

*Supplementation generally was started a 3 months.

months, the weight for the weaned was, as a group, similar to that of the breast-fed group, except weaned boys of subcohort 1.1, who, at 12 months, were slightly heavier than breast-fed boys. These differences were not significant. It should be kept in mind that breast-fed infants shifted to the weaned group as they got older. The important consideration is that, during the critical first 6 months of life, breast-fed infants fared better compared with the reference standard than did weaned children.

## Comment

Rural infants in Puriscal and many other localities of Costa Rica live under much better socioeconomic conditions than those in other developing areas of the world. Central and local governments have promoted construction of water supplies and latrines and have developed health education programs and an adequate infrastructure of health services.[27,36,37]

Puriscal, like most of rural Costa Rica, had experienced a decline in breast-feeding, revealed by recent surveys.[10,16] With this background, interventions were started to promote breast-feeding in an attempt to diminish morbidity and mortality caused by diarrhea. The reason to intervene in the maternity ward stems from the known effect of early mother–infant interaction on breast-feeding and bonding that influences child growth, performance, and survival.[2,4,7,9] Most Puriscal infants are delivered at the San Juan de Dios Hospital. The interventions effected in hospital cannot be considered optimal, since complete skin-to-skin contact and complete rooming-in were not attained; however, they seemed capable of inducing an increased incidence of breast-feeding, and an apparently related reduction in perinatal morbidity and mortality and child abandonment. A significant reduction in the rate of diarrhea had already been demonstrated by Larguía and co-workers[28,29] after administration of colostrum to neonates.

A decrease in incidence of HMD suggests that colostrum and human milk may have an effect on maturation that prevents or ameliorates this disease. This hypothesis could explain the relatively high rate of lethal HMD in nations where neonates do not receive colostrum.

The influence of early mother–infant stimulation apparently was effective for several months postpartum. While a control was not established beforehand, mainly because such striking changes were not anticipated, prevalence surveys conducted in other localities showed similar

results if mothers delivered infants in the hospital where the interventions were effected. Furthermore, prevalence surveys in similar rural localities served by another hospital, where separation of mothers and infants is the norm, revealed a high incidence of early weaning, a much deteriorated situation as compared with Puriscal, and as bad as or worse than that of rural Costa Rica 1 year prior to the interventions and the beginning of the Puriscal study. Stimulation by field workers also seems important, since differences were noted in the incidence of breast-feeding within the cohort population of Puriscal, in that breast-feeding was more prevalent in subcohort 1.1, where mothers were in closer contact with our field staff. It should be stressed that information on feeding practices was obtained on a monthly basis, employing the same procedure for interview and data-recording for all populations studied.

In addition to improved breast-feeding, there was a lower rate of diarrheal disease in breast-fed than in weaned infants. Furthermore, diarrhea had a greater negative effect on growth in weaned than in breast-fed infants,[18] and the incidence of diarrhea was in general low in the population of breast-fed infants.

The two deaths observed were neonatal, accounting for the very low infant mortality. Puriscal has enjoyed a marked improvement in health, as have other rural areas of Costa Rica[31,36,37] and may be deriving further gains from its distinct ruralism.[38] Nevertheless, the virtual absence of postneonatal infant deaths among 1000 consecutive newborns in about 18 months of prospective observation strongly suggests an effect of interventions in the hospital and in the Puriscal study. Survival has been carefully monitored, including all infants in emigrating families. Additional infant deaths might occur, but even if they double, the infant mortality would still be below the expected rate.

The hospital interventions are not expensive, except for the breast pumps, but two pumps can serve an obstetrics service attending 8000 deliveries per year. The field intervention is expensive because it is part of an ongoing, long-term, prospective field study. The intervention could become incorporated into the duties of existing health personnel.

The significant improvement in breast-feeding in this transitional society, the lower attack rate of diarrheal diseases, diminished rate of abandonment, and increased survival are findings that should prompt implementation of measures to promote bonding, breast-feeding, and nutrition, especially in developing nations undergoing transition and experiencing an increase in institutionalized childbirth, consumption of formula milk, and other ills disruptive of mother–infant health and well-being.

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