

Promotion of Breast Feeding, Health, and Survival of Infants Through Hospital and Field Interventions

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Most authorities agree that the decline in the rate and duration of breast feeding in urban areas in many developing countries has been the result of urbanization and influences of Western culture. Two sequelae have been the transition from extended to nuclear families and the exposure of young mothers to influences affecting their attitudes and working patterns [Jelliffe and Jelliffe, 1978; Elliott and Fitzsimons, 1976]. Experimental studies have demonstrated that early mother-infant stimulation has a marked promoting effect on breast-feeding and bonding. It has become quite obvious that man is not so different from certain animal species in the kind of mechanisms leading to successful nursing and infant-rearing behavior [Bowlby, 1969; Klaus and Kennell, 1976].

A similar decline in breast feeding is also becoming apparent in rural areas, partly owing to a profusion of advertisements of infant formulas and partly to "Westernization" of ways of life [Jelliffe and Jelliffe, 1978; Greiner et al, 1979]. It was not obvious to many, however, that many failures to breast-feed in urban and rural areas have an origin in the inadequacies of medical support during pregnancy and particularly during childbirth and its aftermath [Jelliffe and Jelliffe, 1978]. Such inadequacies have proliferated as institutionalized delivery increases and is expanded to rural populations throughout developing countries. To illustrate, only 50% of births were attended in maternity centers and clinics in Costa Rica in 1960, but in 1970 the rate rose to 71% and in 1980 to 91% [Mata, 1983]. The increment in hospital delivery has not necessarily

been accompanied by practices to promote early mother-infant stimulation, bonding, and nursing. Strict separation of mothers and infants after delivery, and feeding neonates with artificial formulas are common practices in the developing world.

This report summarizes observations recorded during 1976-1982 in the population of newborns delivered in the San Juan de Dios Hospital, one of the largest and most prestigious Costa Rican institutions [Mata et al, 1982a, 1983]. Observations were extended to neonates of one particular mountainous rural region, Puriscal, who were born during the period September 1979-September 1980 primarily in the San Juan de Dios Hospital [Mata et al, 1981; Mata, 1982]. The early neonatal morbidity and mortality were calculated across the 7-year period for the 61,478 live births during the observation period. Furthermore, possible effects of hospital practice were evaluated in terms of differentials in rate and duration of breast feeding, health, and growth among Puriscal neonates born from September 1979 to September 1980. Since this effort was part of a long-term prospective observation on nutrition, health, and growth of mothers and infants in a typical rural area, field interventions were also evaluated accordingly.

PROCEDURE

Population

Observations were made of 61,478 live newborns during the period 1976-1982 in the San Juan de Dios Hospital. These newborns belonged to a large sector of the metropolitan population of Costa Rica and to several counties of the southern mountainous rural area that includes Puriscal [Mata, 1982]. The Puriscal region extends to the Pacific Coast and it comprises about 800 square kilometers and approximately 26,000 inhabitants in localities of very sparsely distributed rural population [Mata, 1982]. The region is in rapid transition; most children have access to schools and health services, and about 70% of homes have an indoor piped water supply. The population subsists mainly on agricultural products and sales of food crops, complemented with cash crops such as tobacco; many hold white-collar jobs. The population is predominantly Spanish and, to a lesser extent, Spanish-Amerindian descent; they live in eight district centers and in 146 localities dispersed in valleys and hills. Localities are "rural dispersed" if they have fewer than 500 people, or "rural concentrated" if they have 500-2,000 people. The social development of Puriscal, as in most of rural Costa Rica, is significantly higher than that of traditional Mexico or Guatemala. However, ruralism in Puriscal is more marked than in these countries, and travel between houses may require several hours of walking in the field; some houses may be more than 2 kilometers from the nearest school [Mata, 1982]. Most Puriscal deliveries occur in the San Juan de Dios

Hospital. Adequate coordination between INISA headquarters and the hospitals and clinics allowed the staff of INISA's Field Station to know about most Puriscal deliveries.

Interventions in the Hospital

From 1976 until August 1977, mothers and newborns were completely separated after delivery and during the period of internment. Furthermore, preterm and high-risk neonates were fed glucose solution and infant formulas. Mothers and infants were reunited at the time of discharge, generally 1-3 days after delivery, or after a longer stay due to maternal infection or cesarean birth. Preterm and high-risk neonates remained separated for weeks. In September 1977, a series of innovations were initiated by two of the authors (M.A.A. and J.R.A.; Table I [Mata et al, 1982a, 1983]).

TABLE I. Interventions in the Gynecology and Obstetrics Service, San Juan de Dios Hospital, 1977-1980

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

*Interventions have been maintained to the present.

Complete and partial rooming-in, initiated in September 1977, consisted of leaving all healthy infants with their mothers during the day. Infants born at night stayed apart from their mothers until a neonatologist examined them the following morning; if neonates were found to be normal, they were given to their mothers during the day. Preterm, high-risk, and other ill neonates (about 5% of the total) were separated from their mothers and kept in an adjoining ward under supervision by neonatologists.

A colostrum feeding program for all neonates, initiated in 1978, was favored by a *milk bank* established in December 1977–January 1978, adjacent to the rooming-in area. Mothers and staff became enthusiastic about the breast pumps. Since most women do not undergo nipple massage before delivery, the pumps helped nipple formation and stimulated lactation [Mata et al, 1983]. Donation of colostrum and milk was carried out before or after mothers breast-fed their own infants. However, emphasis was on suckling of colostrum by the infant itself, and this often occurred on the delivery table after July 1979, when *early mother-infant stimulation* was started, or soon after rooming-in was effected. The program encouraged the nursing of hospitalized infants by their own mothers. For ill neonates who had hyaline membrane disease, congenital abnormalities, birth trauma, infections, or other pathology, pooled fresh colostrum and milk were given in amounts of about 5 ml/kg body weight per day. The pool was collected in sterile plastic bottles, kept under refrigeration, and used not later than 18 hr after collection. Colostrum was administered by tube or bottle as early as 4 hr after birth and generally at 8 hr, but some very ill infants received colostrum at a later date. Healthy neonates (about 95% of the total population) suckled colostrum from their own mothers.

Early mother-infant stimulation was started in 1979, covering about one-half of the mother-infant pairs by the end of the year. Most newborns were given naked to their mothers in the delivery room, although in many instances infants were given clothed. Eye-to-eye contact, and stimulation of the infant's mouth and maternal nipple were emphasized by nurses in the delivery room, although this was not universally practiced. The program has not been wholly successful owing to the firmly established tradition of mother-infant separation immediately after delivery, lack of knowledge about the importance of mother-infant interaction, and alleged limitations of space and time by the nursing staff. In 1979 a professional provided assistance in breast-feeding techniques, focusing mainly on the Puriscal mothers. Rooming-in and other interventions have been very successful; the hospital environment has improved and a relaxed and optimistic atmosphere prevails in the rooming-in wards [Mata et al, 1983]. Interventions remained once they were developed and an additive effect was expected. Other lasting improvements were effected in the hospital by the medical staff. These consisted of an increase in the num-

ber of pediatricians, improved diagnostic and therapeutic procedures, and enlarged physical facilities. The possible effect of these changes on neonatal morbidity and mortality could not be quantified during the observation period (1977-1982). A significant improvement in fetal growth was documented in the country as a whole as the prevalence of low birth weight fell from 9.2% to 7.5% in the period 1970-1975 [Mata et al, 1978]. However, no significant further improvement in fetal growth has been recorded after 1975 (unpublished data).

Analyses of Hospital Data

The complete hospital records for the period 1976-1982 were examined by three pediatricians who accurately determined the number of deliveries, characteristics of newborns, and morbidity and mortality during internment. Neonates with illness or defects were transferred at increasing rates, especially after 1979, to the neighboring National Children's Hospital. Care was taken to record the outcome, including deaths, of neonates that were transferred.

The following classifications and definitions were used: *Infection* (acute) comprised diarrhea, sepsis, bronchopneumonia, and meningitis. *Diarrhea* was defined as an increased frequency of watery stools and/or the presence of blood and mucus in the stools; diarrhea could occur in the first 48 hr after birth, but most cases appeared after 48 hr; all cases occurring during internment were considered in the tabulation. *Sepsis* was a state accompanied by pallor, impaired sucking, hypothermia, hypotension, shock, hepatosplenomegaly, and altered platelet and leukocyte profile; most cases were diagnosed in the first 48 hr. *Bronchopneumonia* was characterized by respiratory distress and was confirmed by chest radiography; almost all bronchopneumonia occurred in the first week of life; neonates with aspiration pneumonia were excluded. *Meningitis* was accompanied by pallor, weak sucking, hypothermia, hypotension, tense fontanel with separation of sutures, convulsions, and a pathognomonic cerebrospinal fluid profile; meningitis was diagnosed during the first week of life; deaths also were observed in the first week. *Hyaline membrane disease* (HMD) was a state of lung immaturity generally beginning at birth with intercostal retraction, nasal flarings, hypoventilation, and expiratory grunting; diagnosis was generally by chest radiography; death due to HMD occurred in the first 48 hr of life; doubtful cases without chest plate were excluded from the analysis. Early morbidity and mortality rates were expressed as cases or deaths observed in the first week of life, per 1,000 live births, the denominator being either all live births or only live births after less than 38 weeks of gestation.

Breast feeding in the hospital was defined as successful suckling several times during internment such as to make it unnecessary to administer infant formula. Incidence of breast feeding was expressed as percentage. *Abandon-*

ment of the newborn was the act of giving the child away, generally in the hospital or upon discharge. Infants abandoned were classified as *well*, meaning healthy with adequate gestation and birth weight, or *ill*, meaning that they were preterm, had low birth weight, defects, infections, or other pathology. Rates of abandonment were computed per 10,000 live births.

Interventions in the Field

Several interventions were effected by INISA with the aim of influencing mothers and infants in Puriscal. Because Puriscal women were hard to reach in their widely dispersed homes, most mothers were interviewed while in the hospital. Information collected in precoded forms included antenatal and pregnancy data, delivery characteristics, and description of the newborn and its condition. Upon discharge, mother-infant dyads were monitored from the base of operations, INISA's Field Station in Santiago de Puriscal. Coordination with health workers from the Ministry of Health for coverage of the highly scattered population was required. Rural motor vehicles, motorcycles, and horses were used, but surveillance included foot travel in each instance.

The first yearly cohort comprised 605 infants, distributed in three subcohorts according to the type and intensity of intervention and prospective observation [Mata et al, 1983]. All mother-infant pairs were similarly treated in the hospital (see Table I), but those of the rural dispersed districts of Grifo Alto, Barbacoas, and Candelarita (subcohort 1.1) were visited within the first 10 days postpartum by a field worker, and by the physician and health nurse through monthly consultations. Visits served to collect data on physical growth, breast feeding, food intake, and morbidity (Table II). Mother-infant

TABLE II. Subcohorts of the Puriscal Study, 1979-1983

Subcohort	Subcohort districts	Type of population	Field interventions
1.1 (115) ^a	Grifo Alto Barbacoas Candelarita	Rural dispersed	a. Visit by INISA's field worker within 10 days postpartum b. Contact with INISA's physician c. Monthly visits by INISA's field workers
1.2 (270) ^a	Mercedes Sur Desamparaditos San Antonio San Rafael	Rural dispersed	a. Monthly visits by health workers from Ministry of Health b. Occasional contact with INISA's physician
1.3 (220) ^a	Santiago	Rural concentrated and dispersed	a. Occasional contact with health personnel from Social Security Bureau, Ministry of Health, and INISA

^aNumber of infants born into subcohort.

Infants in all subcohorts were equally stimulated in the hospital (see text).

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 in coordination with 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, which is the central district of Puriscal (subcohort 1.3) with rural dispersed and concentrated population, had more access to health 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 Bureau and the Ministry of Health.

Breast feeding was evaluated until complete weaning was effected, requiring prospective observation for 3 years. *Duration of breast-feeding*, whether the child was or was not receiving supplements, was expressed in months. *Age of weaning* was the month in which the child was definitely separated from the breast. Standard forms and procedures were used to collect data in all districts within the epidemiologic framework of a long-term prospective study [Mata, 1982].

RESULTS

Breast Feeding in the Hospital

The incidence of breast feeding in *well* (healthy) neonates was 95%; exceptions were imposed by complications requiring cesarean section or by illness in the mother. Some preterm and high-risk (*ill*) neonates who were separated from the mother were also breast-fed. All ill neonates received colostrum and milk during internment from the mother or from donors (pooled).

Abandonment of Newborns

A significant decline in the rate of abandoned infants was noted shortly after effecting rooming-in and other interventions (Fig. 1). The reduction was more marked for *well* than for *ill* infants, but the decrease in rate of abandonment of the latter was clear.

Early Neonatal Morbidity Attributed to Infection

Early morbidity (measured in the first week of life) declined abruptly after the interventions (Fig. 2), particularly for diarrhea and bronchopneumonia. Acute necrotizing enterocolitis did not appear after rooming-in, and human colostrum and milk were routinely administered to preterm and high-risk neonates. Evidently, the use of antibiotics significantly decreased. Changes in early neonatal morbidity attributable to infection were not matched by a comparable decrease in congenital defects. Immaturity and asphyxia declined, although not significantly.

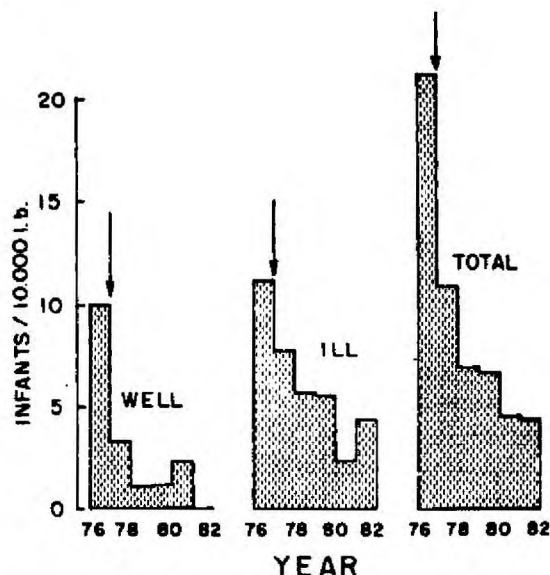


Fig. 1. Abandonment of newborns in the hospital during the period 1976-1982. The arrows indicate the year in which rooming-in was started. Note the drastic reduction in abandonment of newborns, especially if they were healthy.

Early Neonatal Mortality Attributed to Infection

While the number of deaths attributed to infection was already low before the interventions were effected, a marked decline was nevertheless observed (Fig. 3). The most noticeable change was the disappearance of deaths due to diarrhea and meningitis.

Decline in Hyaline Membrane Disease (HMD)

A significant decrease in cases and deaths due to HMD was noted during the study period, especially during the years in which all interventions (rooming-in, colostrum, and early mother-infant stimulation) were operating simultaneously, that is, from 1979 onwards (Table III).

Duration of Breast Feeding After Hospital Discharge

This was evaluated in the cohort of Puriscal infants described. Data on the whole cohort (excluding infants whose families emigrated from the area) are compared in Table IV with data from the World Fertility Survey (WFS) for Costa Rica for 1976 [Ferry and Smith, 1983]. A significant increase in the mean (from 5 to 8.7 months) and median (from 1.8 to 6.9 months) duration of

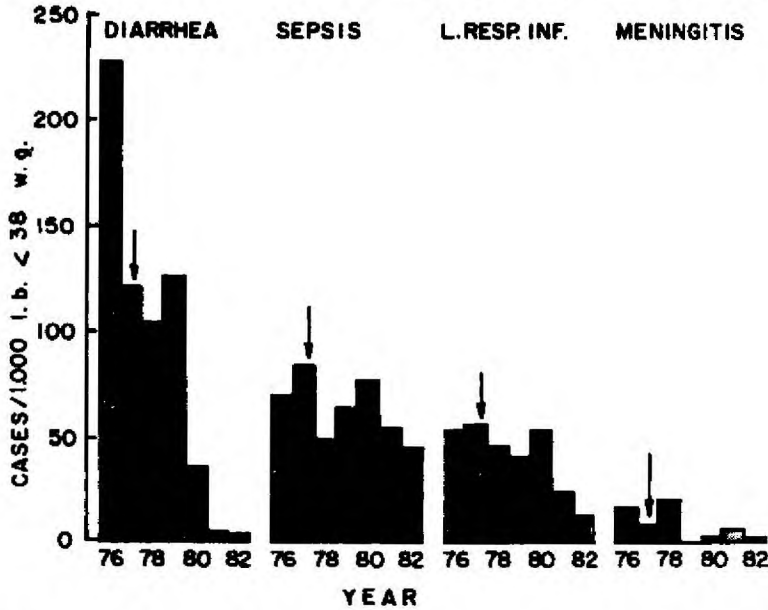


Fig. 2. Neonatal morbidity attributed to infection in the first week of life, as recorded in the hospital during the period 1976-1982. The arrows indicate the date (September 1976) at which rooming-in began. Note the marked decline in diarrheal disease, leading to its virtual disappearance.

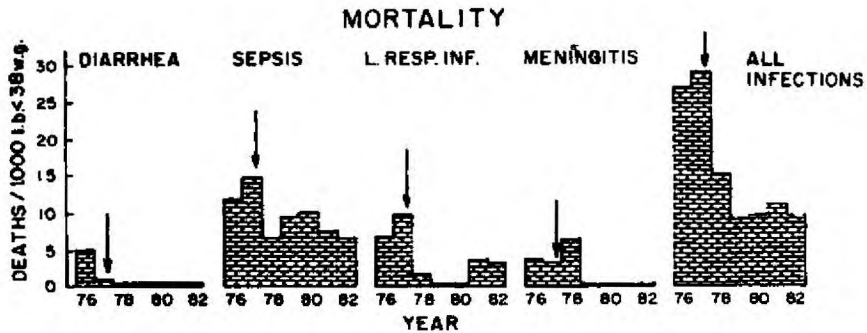


Fig. 3. Neonatal mortality attributed to infection in the first week of life, recorded in the hospital during the period 1976-1982. The arrows indicate the time in which rooming-in started. Note the disappearance of diarrhea as a cause of death.

TABLE III. Hyaline Membrane Disease (HMD) and Interventions, San Juan de Dios Hospital, Costa Rica

Year	Intervention ^a	Number of live births	Number of preterm infants (< 38 wk gestation)	HMD, cases (rate per 1,000 preterm infants)			
				Observed cases	Observed minus expected ^b as %	Observed deaths	Observed minus expected ^b death rate, as %
1976	A	7,629	589(7.7)	154(261.5)		47(79.8)	
1977	B	8,582	618(7.2)	161(260.5)	-0.4	37(59.9)	-24.9
1978	B+C	8,931	597(6.7)	133(222.8)	-14.8	33(55.3)	-30.7
1979	B+C+D	8,638	437(5.1)	85(194.5)	-34.5	41(93.8)	+17.5
1980	B+C+D	8,978	412(4.6)	67(162.6)	-60.8	16(38.8)	-51.4
1981	B+C+D	8,879	541(6.1)	36(66.5)	-74.6	8(14.8)	-81.4
1982	B+C+D	9,271	620(6.7)	62(100)	-61.7	13(20.9)	-73.8
% Change in rates 1976-1982			-13	-62		-74	
Significance ^c			> 0.05	< 0.01		< 0.01	

^aInterventions as in Table I.

^bThe 1976 rates (261.5 and 79.8 per 1,000 live births) were assumed to be the expected values for 1977-1982.

^cTest of equality, 1976 vs 1982.

breast feeding was evident in Puriscal infants in respect to the 1976 WFS data. Furthermore, differences were noted in the duration of breast feeding among the three subcohorts (Table IV): The more stimulated subcohort 1.1 showed the longest duration of breast feeding; duration was less in a similar rural dispersed population that had much less stimulation^{*} (subcohort 1.2). The rural concentrated or urban-rural subcohort 1.3 exhibited the shortest duration of breast feeding of the three groups, but still this was significantly greater than the preintervention figure. The bimodal frequency distribution of subcohort 1.1 probably resulted from exacerbation of breast-feeding efforts related to sustained emphasis and stimulus by the field staff.

Prevalence of Breast Feeding by Type of Delivery

Monthly prevalence rates of breast feeding by the type of delivery (four cases of *induced* delivery were excluded) revealed that the highest rates corresponded to *spontaneous* delivery, and the poorest to infants born by *cesarean* section (Table V). *Induced* deliveries were associated with some negative effect on the incidence of breast feeding.

TABLE IV. Duration of Breast Feeding (months) After Interventions, Puriscal, Costa Rica, 1976-1983

Population	Mean	Median
Costa Rica, WFS, 1972 ^a	5.0	1.8
Puriscal, 1979-1983 ^b		
Subcohort 1.1, RD more stimulated	12.6	11.4
Subcohort 1.2, RD less stimulated	7.8	7.9
Subcohort 1.3, RC, UR	7.6	5.9
Total cohort	8.7	6.9

^aWorld Fertility Survey [Ferry and Smith, 1983].

^bRD = rural dispersed; RC = rural concentrated; UR = urban-rural.

TABLE V. Percentage of Breast Feeding, by Type of Delivery and Age of Infant, Puriscal Cohort, 1979-1981

Age in months	Spontaneous (N = 189)	Induced (N = 245)	Cesarean (N = 80)
1	98.4	96.0	90.0
3	88.3	82.5	69.6
5	78.7	73.1	55.7
7	63.8	60.5	44.7
9	55.9	52.8	32.9
11	48.4	43.1	26.6

DISCUSSION

Premature weaning was already common in Costa Rica in the 1950s and undoubtedly contributed to the high rates of diarrheal disease, malnutrition, infant death, and demographic explosion recorded in that decade [Mata, 1981]. In spite of this situation, a sustained emphasis by governments on social development and improved nutrition and health had resulted in significant gains in the control of infectious diseases and infant deaths, particularly in the 1970s [Mohs, 1982].

Breast feeding continued its decline, and by the middle of the 1970s, measures to promote breast feeding through educational programs by the radio, television, and press emanated from the Social Security Bureau and the Ministry of Health, with collaboration of the Costa Rican Association of Demography. However, according to the World Fertility Survey (WFS), around 1976

26% of infants were never breast-fed [Ferry and Smith, 1983]. Furthermore, the 1978 nutrition survey [Ministerio de Salud, Costa Rica, 1978] revealed no significant changes since the preceding nutrition surveys of 1966 and 1975 [INCAP-OIR-MS, 1969; Díaz et al, 1975]. In fact, a decline in breast feeding was noted between 1975 and 1978, which raised questions about the effectiveness of such programs. According to the 1978 survey, 24% of infants from the rural areas were not breast fed or were weaned in the first days of life; by 3-6 months, about one-half had been weaned onto cow's and formula milks [Ministerio de Salud, Costa Rico, 1978].

Such a deterioration in infant feeding practices likely was the result of a) several years of drastic separation of mothers and infants immediately after delivery; b) formula-feeding in hospitals and clinics; c) many years of intense promotion of processed cow's milk for infants by the medical and commercial establishments; d) several years of governmental distribution of powdered milk to delivering mothers; and e) cultural distortion of the role of the breasts and breast feeding.

Other Latin American nations evolving from traditional to modern lifestyles also experienced a decline in breast feeding, according to surveys conducted in the period 1975-1978 [Ferry and Smith, 1983]. The causes of the decline, as expected, are common to all nations; equivocal medical and hospital practices [Winikoff and Baer, 1980] have played a large role.

It is evident from the studies herein described that rapid transition that results in a significant increase in institutional delivery without the benefit of nontraumatic birth, rooming-in, and promotion of breast feeding undoubtedly has a deleterious effect on breast feeding and infant health. The Costa Rican case illustrates that the phenomenon is no longer urban, since the same is occurring in rural areas as institutional delivery becomes universal.

Therefore, another approach to curtailing the decline in breast feeding must aim at drastic changes in the conditions under which women give birth [Winikoff and Baer, 1980]. The significant gains with interventions in a large general hospital of Costa Rica leave no doubt that they were justified not only in terms of improved benefit to the incidence of breast feeding and the health of suckling neonates, but also in terms of benefits to preterm and high-risk neonates that are derived from maternal stimuli and the provision of fresh human colostrum and milk.

A follow-up of neonates born in two Costa Rican hospitals with contrasting hospital practices showed that all infants separated at birth had been weaned by 9 months, whereas more than one-half of those exposed to rooming-in remained at the breast at 9 months of age [Mata et al, 1981]. The experience in this Costa Rican hospital linked rooming-in, breast feeding, and early mother-infant stimulation with a sharp decline in the rate of abandoned newborns,

whether ill or healthy, but especially the latter, an observation of public health significance.

Field observations in a traditional village in the Guatemalan highlands demonstrated that almost all newborns received human milk from foster mothers shortly after birth. Weak neonates may be given drops of colostrum squeezed into their mouths. The survival rate of rural neonates that were able to suck within the first 24 hr was very high [Mata, 1978]. Furthermore, preterm and small-for-gestational-age rural infants grew adequately under extreme poverty in a microbially contaminated environment, provided they were breast-fed after birth and exclusively breast-fed for several months.

In the Costa Rican experience, the separation of preterm and high-risk neonates for medical reasons was partially compensated by maternal stimulation and the nutritional and anti-infection benefits of human colostrum and milk. The beneficial effect of early consumption of fresh human colostrum and milk rests on its unique anti-infection and nutritional components [Jelliffe and Jelliffe, 1978]. The theoretical and practical implications of feeding human milk to preterm infants have been discussed [Fomon et al, 1976] even though field experience has reiterated the desirability of giving human milk [Mata, 1978]. The administration of fresh human colostrum and milk had no side effects even if given as early as 1 hr after birth [Mata et al, 1982a, 1983].

Feeding of pooled human colostrum to neonates in an institutional setting has been done extensively by Larguía et al [1974, 1977] in Argentina, with striking reduction in diarrheal disease. Similarly, changes in medical practice leading to rooming-in in a Philippines hospital resulted in a reduction in morbidity and mortality of magnitude similar to that observed in Costa Rica [Relucio-Clavano, 1981].

The reduction in incidence and mortality due to hyaline membrane disease suggests a possible relationship with colostrum, particularly because the rate of cesareans did not increase and an improved detection of high-risk pregnancy was not established. It is possible that growth factors [Carpenter and Cohen, 1979; Klagsbrun, 1978] or substances like phospholipids in human colostrum and milk [Bracco et al, 1972] are required for synthesis of surfactant [Farrell and Hamosh, 1978], which plays a role in lung maturation.

The effect of hospital interventions in terms of prolongation of breast feeding and therefore in overall nutrition and health throughout infancy was outstanding [Mata et al, 1982c]. For instance, breast-fed Puriscal infants had a much lower rate of diarrheal disease and rotavirus infection than did artificially fed infants [Mata et al, 1981]. The protective role of breast feeding against diarrhea has been well proven, in industrial [Cunningham, 1979], transitional [Plank and Milanesi, 1973], and traditional societies [Lepage et al, 1981]. It was not surprising that Puriscal infants, who enjoyed a relatively

clean environment, grew according to the WHO-recommended NCHS growth charts, whether they were normal at birth, preterm, or small for gestational age [Mata et al, 1982b]. Furthermore, virtually no stunting or wasting were diagnosed in the first two cohorts of infants, whereas infant mortality was very low in these cohorts [Mata et al, 1982c].

The hospital interventions apparently had a lasting effect in a cohort of rural mothers and infants that had close contact with the field team after hospital discharge (subcohort 1.1). The stimulus provided by field workers interested in breast feeding resulted in further gains in duration. Retrospective analysis showed that the prevalence of breast feeding of cohort infants was greater than that of the corresponding older siblings [Mata et al, 1982b, 1983].

While the rate and duration of breast feeding improved as a result of stimulation from field workers, it became quite evident that the most important health action consisted of early mother-infant stimulation and promotion of breast feeding immediately after birth. Indeed, the dramatic changes observed in a subcohort of mothers who received little stimulation, and in another subcohort living under rural-urban conditions, revealed how important it is to foster breast feeding in the hospital. Furthermore, the marked differentials in breast feeding with regard to the type of delivery attest to the need to reduce cesarean sections, anesthesia, and other interventions to a minimum compatible with good medical practice [Jelliffe and Jelliffe, 1978].

In the light of the present observations, change in hospital practice in Latin America is mandatory and has a higher priority than the orthodox approach of intervening after hospital discharge when the damage has already been done or may not be easily corrected. However, health interventions prior to delivery and after discharge by means of the communication media and the health infrastructure should not be neglected.

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REFERENCES

1. Bowlby J (1969): "Attachment and Loss." New York: Basic Books, Vol 1.
2. Bracco U, Hidaigo J, Bohren H (1972): Lipid composition of the fat globule membrane of human and bovine milk. *J Dairy Sci* 55:1375-1387.
3. Carpenter G, Cohen S (1979): Epidermal growth factor. *Annu Rev Biochem* 48:193-216.

4. Cunningham AS (1979): Morbidity in breast-fed and artificially fed infants. II. *J Pediatr* 95:685-689.
5. Díaz C, Brenes H, Córdoba M, García P, Quirós J (1975): "Encuesta Nacional Antropométrica y de Hábitos Alimentarios en Costa Rica." San José: Ministerio de Salud, Departamento de Nutrición.
6. Elliott K, Fitzsimmons DW (1976): "Breast-Feeding and the Mother." *Ciba Found Symp*, No. 46 (New Series). Amsterdam: Elsevier/Excerpta.
7. Farrell PM, Hamosh M (1978): The biochemistry of fetal lung development. *Clin Perinatol* 5:197-229.
8. Ferry B, Smith DP (1983): "Breast-feeding Differentials, WFS. Comparative Studies," No. 23. Voorburg: International Statistical Institute.
9. Fomon SJ, Avery GB, Beer AE, et al (1976): Human milk in premature infant feeding: summary of a workshop. *Pediatrics* 57:741-743.
10. Greiner T, Almroth S, Latham M (1979): "The Economic Value of Breast-Feeding." Monograph Series, No. 6. Ithaca: Cornell University.
11. INCAP-OIR-MS (1969): "Evaluación nutricional de la población de Centro América y Panamá. Costa Rica." Guatemala City: INCAP/PAHO/WHO.
12. Jelliffe DB, Jelliffe EFP (1978): "Human Milk in the Modern World: Psychosocial, Nutritional and Economic Significance." New York: Oxford University Press.
13. Klagsbrun M (1978): Human milk stimulates DNA synthesis and cellular proliferation in cultured fibroblasts. *Proc Natl Acad Sci USA* 75:5057-5061.
14. Klaus MH, Kennell JH (1976): "Maternal-Infant Bonding." St. Louis: C.V. Mosby.
15. Largaúa M, Urman J, Ceriani JM, O'Donnell A, Stoliaro B, Martínez JC, Buscaglia JC, Weils S, Quiroga A, Irazu M (1974): Inmunidad local en el recién nacido. Primera experiencia con la administración de calostro humano a recién nacidos pre-término. *Arch Argent Pediatr* 72:109-125.
16. Largaúa M, Urman J, Stoliar OA, Ceriani JM, O'Donnell A, Buscaglia JC, Martínez JC (1977): Fresh human colostrum for the prevention of *E. coli* diarrhea—a clinical experience. *Environ Child Health* 23:289-290.
17. Lepage P, Munyakazi C, Hennart P (1981): Breast-feeding and hospital mortality in children in Rwanda. *Lancet* 2:409-411.
18. Mata LJ (1978): "The Children of Santa María Cauqué. A Prospective Field Study of Health and Growth." Cambridge: MIT Press.
19. Mata L (1981): Epidemiologic perspective of diarrheal disease in Costa Rica, and current efforts in control, prevention, and research. *Rev Latinoam Microbiol* 23:109-119.
20. Mata L (1982): Estudio de Puriscal. I. Bases filosóficas, desarrollo y estado actual de la investigación aplicada en nutrición. *Rev Méd Hosp Nac Niños (Costa Rica)* 17:1-20.
21. Mata L (1983): Trends of diarrheal diseases, malnutrition and mortality in Costa Rica and role of interventions. *Assignment Children* 59/60:195-224.
22. Mata L, Jiménez P, Allen MA, Vargas W, García ME, Urrutia JJ, Wyatt RG (1981): Diarrhea and malnutrition: Breast-feeding intervention in a transitional population. In Holme T, Holmgren J, Merson MH (eds): "Acute Enteric Infections in Children: New Prospects for Treatment and Prevention." Amsterdam: Elsevier/North-Holland, pp 233-251.
23. Mata L, Allen MA, Araya JR, Carvajal JJ, Rodríguez ME, Vives M (1982a): Estudio de Puriscal. VIII. Efecto de intervenciones hospitalarias sobre la lactancia y la salud en el período neonatal. *Rev Méd Hosp Nac Niños (Costa Rica)* 17:99-116.
24. Mata L, García ME, Jiménez P, Sibaja A, Solís VJ, Vargas AC, Jiménez MM (1982b): Estudio de Puriscal. II. Crecimiento fetal y su influencia sobre el crecimiento físico posnatal. *Rev Méd Hosp Nac Niños (Costa Rica)* 17:21-36.
25. Mata L, Jiménez P, Castro B, García ME, Vives M, Jiménez S, Sánchez F (1982c): Estudio de Puriscal. IX. Estado nutricional y supervivencia del niño lactante. *Rev Méd Hosp Nac Niños (Costa Rica)* 17:117-139.

26. Mata L, Allen MA, Jiménez P, García ME, Vargas W, Rodríguez ME, Valerín C (1983): Promotion of breast-feeding, health, and growth among hospital-born neonates, and among infants of a rural area of Costa Rica. In Chen LC, Scrimshaw NS (eds): "Diarrhea and Malnutrition. Interactions, Mechanisms and Interventions." New York: Plenum, pp 177-202.
27. Mata L, Villegas H, Albertazzi C, Mohs E (1978): Crecimiento fetal humano en Costa Rica. *Rev Biol Trop* 26:431-450.
28. Ministerio de Salud, Costa Rica (1978): "Encuesta Nacional de Nutrición 1978." San José: Ministerio de Salud, Departamento de Nutrición.
29. Mohs E (1982): Infectious diseases and health in Costa Rica: The development of a new paradigm. *Pediatr Infect Dis* 1:212-216.
30. Plank SJ, Milanesi C (1973): Infant feeding and infant mortality in rural Chile. *Bull WHO* 48:203-210.
31. Relucio-Clavano N (1981): The results of a change in hospital practices. A paediatrician's campaign for breast-feeding in the Philippines. *Assignment Children* 55/56:139-165.
32. Winikoff B, Baer EC (1980): The obstetrician's opportunity: Translating "breast is best" from theory to practice. *Am J Obstet Gynecol* 138:405-412.