BREAST-FEEDING AND RESPIRATORY INFECTION IN INFANCY

by

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CHAPTER I

INTRODUCTION

Respiratory infections are the commonest type of infection in infants today and are a major cause of hospital admissions and death during the first year of life (Bellanti, Smith, Kim, Mills, Gerin, Parrott, & Chanock, 1969; Downham, Scott, Sims, Webb, & Gardner, 1976). Severe respiratory tract infection during infancy can have a prolonged debilitating effect which may extend through childhood and even into adult life. Some researchers report that infants who suffer an episode of acute lower respiratory tract infection tend to have a higher incidence of respiratory symptoms--including cough, wheeze, nasal discharge, hearing difficulties and absence from school--throughout childhood (Eisen & Bacal, 1963; Paradise, 1981; Rooney & Williams, 1971; Zweiman, Schoenwetter, Pappano, Tempest & Hildreth, 1971). Other workers have found abnormalities of lung function in a high proportion of children with histories of bronchiolitis in infancy. These abnormalities have been reported seven (Mok & Simpson, 1982) and ten (Kattan, Keens & Lapierre, 1977) years later and may persist into adulthood (Burrows, Knudson, & Lebowitz, 1977; Mok & Simpson, 1982). Such findings suggest that prevention of respiratory infection during infancy could have long-term

health benefits. This is a matter of particular concern to health professionals who advise parents and supervise the health care of infants and children.

Recent immunologic studies have provided a rationale to explain the findings of older morbidity and mortality studies showing that breast-feeding protects against respiratory tract infections in infancy. Many host resistance factors have been identified in breast milk which appear to protect the infant while his own immune system is maturing, providing a gradual transition from complete fetal dependence to physiologic independence. A major factor in an infant's susceptibility to respiratory tract infection is that his secretory immune system is immeture at birth and develops slowly during the first year of life. There is evidence that breast-feeding is especially suited to protect an infant during this vulnerable period (Gerrard, 1974; Winberg, 1976).

Despite advances in immunology theory, there is still considerable skepticism about the advantages of breast-feeding in a modern industrial society with a high standard of living. There is also little consensus regarding the effects of giving dietary supplements to breast-fed infants. Some investigators report that to be protective, breast-feeding must be exclusive (Brown & Bosworth, 1922; Chandra, 1979; Fallot, Boyd, & Oski, 1980; Gerstly, Howell, & Nagel, 1932; Mata & Urrutia, 1971). Other investigators have not

differentiated infants who receive supplements from those who are exclusively breast-fed (Cunningham, 1977; Downham et al., 1976; Fergusson, Horwood, Shannon & Taylor, 1978; Frank, Taber, Glezen, Kasel, Wells, & Paredes, 1982). A further source of confusion is that many studies have not considered the influence of socioeconomic factors in their analysis of the effects of breast-feeding. Breast-feeding mothers tend to be from a higher income bracket, have a higher level of education, and have fewer other children (Sauls, 1979). These factors would also tend to lower the risk of infection in infancy (Egbuonu & Starfield, 1982).

More information is needed regarding whether breast-feeding protects against respiratory tract infection in the United States today, the effect of the addition of supplements to the diet of a breast-fed infant, and whether the protection of breast-feeding remains statistically significant when other social factors are considered.

LITERATURE REVIEW

This literature review is divided into two major sections. In the first, previous studies addressing the question of whether breast-feeding is protective against respiratory infections are considered. Then the respiratory disease for which protection has been most completely documented, respiratory syncytial virus, is reviewed. A section dealing with breast-feeding and allergy prevention

is also included. Finally, there is a discussion of the problems confounding studies of the protection of breast-feeding. In the second section, a compilation of evidence and theory from immunological studies is presented which indicates that breast milk protects against respiratory infection. In this section, known constituents of breast milk which may afford protection and the special needs of the newborn are considered. This is followed by a presentation of the conceptual framework: immunology of the mammary gland and the theory of immunocyte "homing." The literature review concludes with a short summary and consideration of the relevance for nursing.

Does Breast-feeding Protect Against Respiratory Tract Infection?

Early Studies

The question of whether the breast-fed baby is better protected against infection than the bottle-fed baby is an old one. Three studies done early in the twentieth century indicated that breast-feeding protects against respiratory tract infection. These studies were carried out at a time when little was known about the management of fluid and electrolyte disturbances and when antibiotics were not available. Any increase in the morbidity or mortality of the babies reared on cow's milk, therefore, was likely to be due either to harmful factors derived from cow's milk, or to the deprivation of beneficial factors present in breast

milk, or both. Woodbury (1922) compared the mortality rates of breast and bottle-fed infants during the first year of life in a study of 22,422 American infants. The most common cause of death in his sample was gastrointestinal illness. Next most common were deaths due to respiratory infections. Woodbury found that the probability of any baby dying during each month of the first year of life was closely related to the method of feeding. Breast-fed babies fared better than those partially breast-fed, and both groups fared better than those artificially fed. Furthermore, mode of feeding appeared to have a cumulative effect: the longer the period of previous artificial feeding, the higher the death rate in each following month of the first year of life, and the longer the period of previous breast-feeding, the lower the death rate in subsequent months. This trend persisted up to the seventh month. When the change from breast to partially or exclusively artificial feeding took place in the seventh month or afterwards, the average monthly death rates were slightly less than the corresponding rates among infants who were exclusively breast-fed until the end of the year.

Other factors Woodbury considered which could have influenced mortality rate were nationality and family income. He found that the differences in prevalence of breast-feeding and mortality rate among different nationalities tended to offset one another and the

correction for nationality did not appreciably affect the result. The correction for income tended to slightly raise the relative excess mortality among the artificially fed since, in 1922, the prevalence of artificial feeding appeared to be greater in the high income groups. He also found that the death rate for artificially fed infants from low income families was much higher than that in artificially fed infants from high income families. Woodbury believed that this difference in mortality rate for artificially fed infants from different income levels warranted further investigation. It could have reflected the type of food given, the care taken in its handling and preparation, or other factors not related to feeding (such as housing conditions, exposure to cold, and infection).

Twelve years later, Grulee, Sanford, and Herron (1934) studied 20,061 infants under the care of the Infant Welfare Society of Chicago. This society shared the care of indigent infants and children of Chicago with the city health department and had stations in the poorest sections of the city. Of the study infants, 9,746 were breast-fed for at least 9 months; 8,605 were partially breast-fed, and 1,707 were fed diluted boiled cow's milk. All infants received the same accessory food of orange juice at 4 weeks, cod liver oil at 6 weeks, a cereal at 5 months, and a vegetable at 6 months. Grulee and co-workers found that infections--respiratory, gastrointestinal, and

unclassified--were more common in babies not given breast milk, and so were deaths. The overall mortality rose from 1.5/1,000 live births in babies breast-fed for 9 months to 84.7/1,000 live births in babies brought up on cow's milk. Deaths due to respiratory infections rose more than those due to any other cause, from 0.4/1,000 live births in the breast-fed group to 48/1,000 in those brought up on cow's milk. Another interesting finding was that for the first 5 months of life, the incidence of respiratory tract infection was about the same for the three groups. In the breast-fed group respiratory infections decreased after the sixth month, while in the artificially fed respiratory infections continued to rise steadily through the ninth month.

Robinson (1951) studied 3,266 infants born between 1936 and 1942 who attended an infant-welfare clinic in Liverpool, England. Among these infants the morbidity and mortality due to respiratory infections were higher than for any other type of infection. The rate of respiratory infection fell from a high of 170.9/1,000 in exclusively bottle-fed infants to 102.9/1,000 in the exclusively breast-fed. The mortality rate from respiratory infection declined even more markedly from 31.6/1,000 in the exclusively bottle-fed to 17.9/1,000 in the partly breast-fed to 8.2/1,000 in the exclusively breast-fed. Otitis media was classified separately and

showed a similar decrease from 45.6/1,000 in the exclusively bottle-fed to 26.3/1,000 in the partly breast-fed to 12.3/1,000 in the exclusively breast-fed.

Robinson also considered the effect of family size and social class on morbidity and mortality. She found that as the size of the family increased, the rate of respiratory infection also tended to increase, from 119.0/1,000 in first-born infants to 191.7/1,000 in infants who were fourth to twelfth in the family. Mortality due to respiratory tract infection also rose with family size from 10.0/1,000 in first infants to 31.2/1,000 in fourth to twelfth infants. Social class was determined by the father's occupation: clerk, skilled worker, laborer, or unemployed. Morbidity was found to be slightly lower when the father was a clerk but about the same for the other three groups. Mortality seemed to be more influenced by social class, being highest in the infants of laborers and lowest in infants of clerks and unemployed fathers. Robinson attributed the lower mortality rate in infants of unemployed fathers to the free medical treatment provided for their families.

There are several shortcomings in the Robinson study. First of all, the classification of infants seems to be overly simplified. Infants called "exclusively breast-fed" were exclusively breast-fed for at least 7 months. Those called "partly breast-fed" had had supplements introduced any time before 7 months. Infants called "completely

bottle-fed" had been entirely bottle-fed by the age of one month. These groupings did not permit observation of the cumulative effect of artificial feeding noted by Woodbury and did not permit correlations to be made between feeding mode and the time of onset of illness. A second shortcoming is that though social class and family factors were discussed and found to be significantly related to morbidity and mortality, how they affected the calculated impact of feeding mode on infant health is not determined. A further shortcoming of all three studies above is that no statistical analyses were performed on the data.

Improvement in the "standard of living" in Western countries during the twentieth century meant improvement in water supply, sewage and waste disposal, refrigeration, and the development of scientific dairy farming and food technology. These changes facilitated safer bottle-feeding and, together with the use of antibiotics and immunizations, an overall decrease in infant infection and mortality was observed. Though the dramatic effects of breast-feeding seen in the early studies of Woodbury, Grulee et al., and Robinson became less striking, it was still notable in an investigation reported from Norbotten, Sweden, by Mellander, Vahlquist, and Melbin (1959).

The Norbotten study was carried out in the northernmost county of Sweden from June 1953 to May 1957. It included

402 infants born between June 1, 1953, and December 31, 1954. Infants were given regular frequent examinations from birth to 2 1/2 years including a doctor's visit every 6 weeks and a nurse home-visit every two weeks during the first year and then followed regularly until 30 months old. The four feeding groups were classified as follows: I. Birth to 2 weeks of exclusive breast-feeding; II. 1 to 2 1/2 months of exclusive breast-feeding; III. 3 to 6 months of exclusive breast-feeding; IV. 6 1/2 months or more of exclusive breast-feeding. The four groups were matched for maternal age, social class, and housing facilities. One significant difference between the groups was that group IV had a higher number of siblings of school age and the lowest annual income. The incidence of respiratory infection in group IV, however, was lower than in groups I through III. The investigators observed a general tendency for the early-weaned infants (group I) to have a higher incidence of infection than the late-weaned ones (group IV). The differences were moderate, however, and the degree of significance did not exceed the 5% level of probability.

Recent Studies

The early studies all showed a marked decrease in morbidity and mortality due to respiratory infections in breast-fed infants. Some recent studies have observed the same phenomenon. However, others have found little or no protection attributable to breast-feeding.

Studies Finding Breast-feeding to be Protective

Cunningham (1977) reviewed the medical records of 253 healthy infants born during a one year period (February 1974 through January 1975) in a rural area in New York. The infants were seen regularly at a pediatric clinic during the first year of life. Episodes of significant illness in breast-fed (n = 106) and bottle-fed (n = 147) infants were compared according to feeding mode at the time of onset of illness. He found that there were 64 episodes of otitis media in the artificially-fed infants compared to 10 in the breast-fed infants ($p < 0.10$). There were 56 episodes of lower respiratory tract infection in the artificially-fed while there was only 1 in the breast-fed, a 94% reduction in those breast-fed compared to infants artificially-fed ($p < 0.001$). Cunningham also observed that the proportion of infants suffering any episode of significant illness increased as the duration of breast-feeding declined, a finding similar to that reported by Woodbury (1922). Thirty-four percent (22/64) of infants given prolonged breast-feeding (more than 4.5 months) had one or more episodes during the first year. The figures for limited breast-fed and bottle-fed infants were 48% (20/42) and 53% (78/147) respectively.

To ascertain whether the advantages of breast-feeding were the result of associated factors such as higher

socioeconomic status, feeding groups were subdivided according to educational level of each parent and the frequency of illness for each group was determined. The health advantages of breast-feeding were found to be independent of educational level. Other indicators of socioeconomic status, such as occupation or income, and other factors related to risk of infection, such as size of family, were not accounted for. A further shortcoming of this study is that Cunningham did not distinguish between infants who were exclusively breast-fed and breast-fed infants who were given supplements.

In two prospective studies conducted in rural India and urban Canada, Chandra (1979) investigated the effect of exclusive breast-feeding during the first two months on morbidity in the first one to two years of life. The study population in a rural community in India consisted of two groups. In the first, 35 infants were exclusively breast-fed for at least the first 2 months. The range of exclusive breast-feeding was 2.2 to 8.5 months with a mean of 4.8 months. These infants were matched for socioeconomic status, parental education and family size with a second group of 35 infants fed fresh cow's or buffalo's milk from the first week onwards. A trained auxiliary nurse midwife visited each family once a week to record morbidity data.

In a comparison of the two groups, Chandra found that the number of respiratory infections over a 12 month period

was reduced from 109 in the formula-fed group to 57 in the breast-fed group ($p < 0.001$). The incidence of otitis was 52 in the formula-fed group and 21 in the breast-fed group ($p < 0.001$). The number of pneumonias went from 8 in the formula-fed group to 2 in the breast-fed group.

In the second study in urban Canada, the population was composed of 30 infants who were exclusively breast-fed for at least 2 months (the range of exclusive breast-feeding was 2.5 to 5.8 months and of partial breast-feeding 4 to 14 months) and 30 infants who were fed cow's milk formula from the first day of life onwards. The two groups were matched for socioeconomic status and parental education and were followed for 24 months. The parents were contacted by phone every two weeks for morbidity data and reports of illness were usually confirmed by physical examination.

Chandra found that the incidence of respiratory tract infection was decreased from 98 in the formula-fed group to 42 in the breast-fed group ($p < 0.001$). The incidence of otitis showed a nearly 10-fold decrease from 96 in the formula-fed group to 9 in the breast-fed group ($p < 0.001$).

It is of particular interest to note that the incidence of respiratory illness and otitis was even more markedly decreased from bottle to breast-fed infants in the urban Canadian (57% reduction for respiratory and 89.5% for otitis) than in the rural Indian (48% reduction for

respiratory and 60% reduction for otitis). This difference may be due to the fact that the infants were followed for two years in Canada and one year in India. It also suggests, however, that Western industrialization does not diminish the significance of the protection afforded by breast-feeding. An oversight in this study is that the time period of the births of the sample infants is not stated in either study. It is possible that the differing rates of respiratory infections in the Canadian populations could be related to seasonal epidemics.

Studies Not Finding Breast-feeding Protective

In contrast to the above studies, two recent studies which did not find that breast-feeding significantly protects against respiratory tract infection were reported by Adebonojo (1972) and Fergusson et al. (1978). Adebonojo reported on observations of 113 infants in an affluent suburban residential area (Marin County, California). All infants were members of a pre-paid health plan (Kaiser Foundation) and were seen from birth through the first year with at least four well-checks. Fifty-two infants who were primarily breast-fed for the first 3 months or longer were called "wholly breast-fed." The 61 "bottle-fed" infants included 8 who started on breast and were changed to bottle prior to 3 months of age. Adebonojo found that fever, gastrointestinal, and respiratory disorders occurred with the same minimal frequency in both groups. The sibling

position did not influence the frequency of respiratory symptoms. Other socioeconomic and family factors were unaccounted for, though the author appears to feel that the sample was fairly homogeneous.

There are several problems with the Adebonojo study. Infants who were called "wholly breast-fed" were infants who "fed primarily at breast for the first 3 months of life." It is not stated whether and at what age these infants received formula and/or solid supplements. The "bottle-fed" group included 8 infants (or 13%) who were breast-fed for a period of less than 3 months. Both these factors--failure to distinguish totally breast-fed infants from those receiving formula and/or solid supplements and the inclusion of a number of infants who were breast-fed for a significant period into the bottle-fed group--would tend to minimize the differences between the two groups.

Fergusson et al. (1978) conducted a prospective study of the relationship between breast-feeding and infant health during the first 16 weeks of life in a cohort of 1,210 New Zealand infants. Information was obtained by interview and a "mother's diary" of the child's health and diet. They found no relationship between the risk of mortality or hospitalization and diet during the first 16 weeks of life. There was a small tendency for breast-fed infants to have a lower risk of medical consultation for respiratory

infection. However, this association became non-significant when social background (maternal education, 1 or 2 parents, family living standards) was taken into account. Fergusson et al. conclude that the benefits of breast-feeding are marginal in New Zealand where child health standards are high.

In the Fergusson study, infants were compared for health differences during the first 16 weeks. This is a shorter period of observation than in any other study reviewed. In the present study, the overall health of all infants was best during the first 4 months regardless of feeding mode. The results of other studies (Woodbury, 1922; Grulee et al., 1935; Cunningham, 1977; Chandra, 1979) also suggest that health differences of infants fed in different modes are more distinct when the infants are observed for an entire year.

Another problem with the Fergusson study is that there is no comparison of degrees of illness. The researchers compare the frequencies of deaths, hospitalizations, and "minor illnesses." More health differences may have been observed if the researchers had distinguished illnesses on the basis of severity such as lower respiratory infection, otitis media and/or those requiring antibiotic therapy vs. upper respiratory infection, flu, and/or those infections not requiring antibiotics.

It can be concluded from the above studies that there is currently a division of opinion whether breast-feeding protects against respiratory infections. However, several characteristics distinguish those studies which did find protection from those that did not. Studies with positive results usually (a) reported observations over not less than 6 months, (b) distinguished infants who were exclusively breast-fed from those given formula and/or solid supplements, and (c) compared the frequencies of specific respiratory illnesses (e.g., otitis media, pneumonia, mild upper respiratory illness) rather than lumping all respiratory illnesses together. There appears to be more of a concensus that breast-feeding protects against the development of respiratory symptoms due to allergy and against serious respiratory illness caused by respiratory syncytial virus.

Breast-feeding and Allergy

Some of the protection against respiratory tract infection in totally breast-fed infants may be due to the exclusion from their diet of food antigens. These antigens can, and often do, precipitate respiratory symptoms such as rhinorrhea and bronchitis which are clinically indistinguishable from the same symptoms caused by infection (Gerrard, 1974). Several respiratory syndromes of early childhood which have been associated with milk protein intolerance include some cases of otitis media, rhinitis,

and Heiner's syndrome. Heiner's syndrome is a severe, recurrent, non-infectious bronchopneumonia-like disease with fever and pulmonary infiltrates and poor weight gain (Heiner, Sears, & Kniker, 1962).

The protective effect of breast-feeding in the prevention of allergy has been indicated in a number of studies. Chandra (1979) followed 74 infants with an older sibling diagnosed to have atopic disease. Half of the infants were exclusively breast-fed for the first 6 weeks or longer and half were fed cow's milk formula. All infants were examined at three month intervals during the first year, and then at 6 month intervals until the age of three years. Incidence of recurrent wheezing, eczema, elevated serum IgE and other parameters were noted. He found that six weeks of exclusive breast-feeding was effective in impairing the development of hypersensitivity and lowering the incidence of manifest allergic disease during the study period of 3 years. Another group of investigators (Mellon, Gorrin, Prenner, Incaudo, Bechamn, Giossi, Orgel & Hamburger, 1976, cited in Jelliffe & Jelliffe, 1979) reduced infantile allergy from 41% to 7% in allergic families by exclusive breast-feeding for 6 months or more, screening to eliminate dust and mites, and delaying immunization with triple vaccine (DPT). Several studies have strongly incriminated cow's milk formula in the genesis of

hypersensitivity in susceptible infants (Gerrard, 1974; Heiner et al., 1962; Matthew, Norman, Taylor, Turner, & Soothill, 1977) and found that three quarters of the cases of hypersensitivity develop during the first 2 months of life (Goldman, 1975, in Jelliffe & Jelliffe, 1979). Thus it is often recommended that infants of families with a history of allergy avoid exposure to cow's milk formula during the first 2 months of life.

Breast-feeding and Respiratory Syncytial Virus

The respiratory disease for which the protective role of breast-milk is best documented is that of respiratory syncytial virus (RSV). RSV is the commonest respiratory pathogen and is known to cause particularly severe disease during the first infection, which often occurs in infancy. Subsequent infections, however, usually lead to symptoms no worse than the common cold (Mills, Knopf, Kirk, Chanock, 1969). Downham et al., (1976) found that the incidence of breast-feeding among infants admitted to the hospital with RSV infection was significantly lower than that among control children. In a study of infants hospitalized for RSV infection, Pullan, Toms, Martin, Gardner, Webb, and Appleton (1980) found that 30% of the children had been breast-fed compared with 49% of controls. Further, they found that the reduced risk of admission with RSV infection was the same whether the child was still breast-feeding or

not, indicating a lasting protective effect after breast-feeding had ceased.

Breast-feeding does not give complete protection and breast milk can vary in its anti-RSV activity. In a study of anti-RSV activity in human milk and colostrum, Toms, Pullan, Gardner, Scott, and Scott (1980) found that only four of 16 mothers tested had high levels of IgA specific for RSV and five of 17 had lymphocytes sensitized to RSV in their milk. These differences probably relate to whether the mother had been recently exposed to the virus. Frank et al. (1982) studied a small number of children in whom signs and symptoms of RSV infection were recorded independently of the need for medical care. Through culture, serologic testing, history, and physical examination, they found that the incidence of documented RSV infection was not significantly different in breast and bottle-fed babies. However, they suggest that protection may be from serious morbidity rather than from infection, since more episodes of pneumonia and bronchiolitis were observed in the bottle-fed group. This would agree with other studies comparing hospitalizations for respiratory tract infections between breast and bottle-fed babies (Cunningham, 1977; Fallot et al., 1980; Pullan et al., 1980).

Problems Confounding Studies of the Protection of Breast-feeding

Variables Associated with Choice of Feeding Method

There are a number of problems which arise when attempting to compare populations of breast-fed and bottle-fed infants to determine whether breast-feeding is beneficial to the health of the infant. Sauls (1979) reviewed studies comparing the inherent differences in breast-feeding and bottle-feeding mothers. A mother who chooses to breast-feed and who lactates for a prolonged period of time tends to have the following characteristics: she is socioeconomically advantaged, does not work outside the home, has an education level beyond high school, is not a racial minority, has breast-feeding friends, and receives support to breast-feed from her husband and from health care personnel (Sauls, 1979).

Mothers who choose to bottle-feed tend to have a lower socioeconomic status and a lower education level. In addition, among bottle-feeding mothers there is a higher incidence of young mothers, single women, smokers, women receiving government financial support, or who are gainfully employed, and women with physical or emotional handicaps. The bottle-fed group is also loaded more heavily with potentially less healthy infants whose mothers had complications during pregnancy (e.g., pre eclampsia, diabetes mellitus, etc.) or who were more likely to have

certain detrimental habits (drug or alcohol addiction, cigarette smoking). Among these mothers there would tend to be more premature deliveries and more low birth weight infants (Sauls, 1979).

Personality and attitudinal differences between the two groups of mothers have also been studied. Breast-feeding mothers are reported to have a more positive perception of themselves, place more importance on affection, seem more "infant centered" and more satisfied in their biologic role as mothers than bottle-feeding women (Sauls, 1979).

These demographic, socioeconomic, educational, and emotional factors also influence a mother's access to and utilization of health care, her own infant care behavior, and her effectiveness as a health care provider to her infant.

Variables Associated With Respiratory Illness

Variables associated with respiratory illness rates in previous studies include ages of siblings, parental smoking, and family socioeconomic status. An increase in incidence of respiratory illness has been reported in children with school-age siblings and in children whose parents smoke (Watkins et al., 1979). The relationship between socioeconomic status and respiratory illness is complex and somewhat controversial. Some studies have shown that children from poor families do not have a greater number of

acute respiratory illnesses (Egbuonu et al., 1982) but significant underreporting of conditions may occur as a result of difference in receipt of medical care (Fergusson et al., 1978; Egbuonu et al., 1982). Paradise (1980) reports that all types of otitis media--purulent, serous, and recurrent chronic--are more common among poor children. Children from low socioeconomic status are also more likely to be affected by the sequelae of otitis media: hearing loss (transient and permanent) and the associated language delays, auditory processing deficits and behavioral problems (Zinkus, Gottlieb, & Shapiro, 1978).

Many of the studies cited in the present review have attempted to take the factors associated with choice of feeding method and frequency of respiratory infection into consideration. Watkins, Leeder, and Corkhill (1973) examined the association of breast-feeding with acute lower respiratory illness in infancy when social and family factors known to be associated with lower respiratory illness in infancy were taken into account. After fitting a general linear interactive model to the data with the incidence of bronchitis and pneumonia as the outcome variable, they found that breast-feeding contributed significantly to the model independent of sex, family size, maternal age and smoking habits, and parent and sibling history of respiratory illness. Downham et al. (1976) found that breast-feeding decreased hospital

admissions for RSV infection independently of social class. Pullan et al., (1980) took into consideration an assessment of maternal care and home environment, maternal age, marital status, smoking habits, and family size in their study of breast-feeding and RSV infection in infancy. They found that breast-feeding still appeared to provide protection when these factors were taken into account.

On the other hand, Fergusson et al. (1978) identified three variables--maternal education, marital status and family living standards--as having significant bivariate or multivariate association with both diet (breast versus bottle) and the risk of illness. When a binary multiple regression analysis was used to control for the effects of these variables, they found that the association between the risk of respiratory symptoms and diet became non-significant.

Another complicating factor in the comparison of breast and bottle-fed infants is that there is a one way flow of infants from the breast-fed group to the bottle-fed group. If a breast-fed baby is not thriving, its diet is likely to be changed to partial or complete artificial feeding. Thus, the purely breast-fed group would contain mainly babies who are doing well (Sauls, 1979).

These differences between the breast-fed and bottle-fed groups confound the difficulty of establishing that it is

the breast milk itself which lowers the incidence of respiratory tract infection in breast-fed infants.

Optimum Duration of Exclusive Breast-feeding

A further problem which arises in studies of the benefits of breast-feeding is that of determining when exclusive breast-feeding becomes inadequate to meet the nutritional needs of infants. Problems associated with determining the optimum duration of breast-feeding are thoroughly discussed in a recent review by Seward and Serdula (1984). These problems center around difficulties in making accurate estimations of the actual amount of breast-milk produced, infant's nutritional needs and optimum infant growth rate. Several authors have calculated the age when breast-feeding alone becomes inadequate to meet the theoretical requirements of the infant with normal birth weight. This age varies between 3 and 4 months depending upon the assumptions about breast-milk volume, growth references used and desired percentile for growth, estimated energy content of milk, and estimated infant requirement for protein and calories. The findings of these authors are summarized in Table 1.

Problems With Growth References

All the major available growth references (Iowa references, National Center for Health Statistics (NCHS) reference from Fels Institute growth data, Harvard references) and those used to determine optimum infant

Table 1

Theoretical Calculations: Age When Breast-Milk Provides Inadequate Energy for Infants With Normal Birth Weight

Author	Volume in 24 hr (ml)	Energy Content (kcal/kg)	Growth Reference	Weight/Age When Breast-milk provides inadequate energy
Thompson & Black (1965)	700	70	Average*	5.5 kg/4 mo.
Naismith (1975)	970	71	Normal	4 mo.
Whitehead (1976)	850	78	Average*	5.0 kg/3 mo.
Thompson & Waterlow (1979)	752	70	NCHS 25%ᵀ	5.65 kg/3-4 mo.
			NCHS 50%ᵀ	2 mo.
Zhi-chien (1981)	850	NS	NCHS-normal*	3-4 mo.

*Growth reference not further specified.
ᵀNCHS, National Center for Health Statistics.

From Seward and Serdula, 1984.

growth rate in the above studies were based on predominately formula fed infants and were done prior to 1965--before low-solute infant formulas were available and at a time when solids were introduced early (Whitehead, 1985). These references may not be appropriate for breast-fed infants. Bottle-fed infants who were introduced to solid foods at an average age of 1.9 months doubled their birth weight earlier than breast-fed infants (Neumann & Alpaugh, 1976). When their birth weight had doubled they had gained disproportionately more weight than length compared to breast-fed infants. Bottle-fed babies may be "bigger," but today many question whether this is "better." Growth references based on bottle-fed infants may be too high at 3 to 6 months for breast-fed infants (Seward & Serdula, 1984).

Problems With Estimates of Protein and Calorie Needs

There is evidence that the World Health Organization/Food and Agriculture Organization estimates of infants' protein and calorie requirements used by all authors except Zhi-chien in the above studies are 15% to 20% too high. The WHO/FAO estimates were derived from observed intakes of bottle-fed infants in the United States. Raiha (1985) compared blood urea concentrations and levels and branched-chain amino acids, valine, isoleucine, and leucine in breast and formula fed infants and found the formula fed infants had significantly elevated blood levels. Raiha questions whether an increased protein load could lead to

metabolic imbalance and perhaps irreversible maladaption in the metabolic machinery.

Problems With Measuring Breast-milk Volume

Many studies have measured breast-milk volume (Butte & Calloway, 1981; Lonnerdal, Forsum, & Hambraeus, 1976; Martinez & Chavez, 1971; Wallgren, 1945). The volume of milk measured by different studies varies widely between populations as well as within individuals of the same population. Most studies report mean peak volumes of milk during the first six months between 500 and 900 ml/24 hours although higher and lower volumes have been reported (Seward & Serdula, 1984). Recently, mean volumes of 1212 ml (range 680 to 1637 ml) were recorded among a group of members of the Nursing Mothers Association of Australia who were fully and partially breast-feeding (Rattigan, Ghisalberti, & Hartman, 1981).

The infant's requirements for normal growth and the quantities of human milk produced are topics of continuing investigation. The validity of many assumptions, upon which previous theoretical estimates of when exclusive breast-feeding becomes inadequate have been based, are currently being questioned. Furthermore, since even revised estimates do not take into account population or individual variability, their validity must be confirmed by direct observations of infant growth and health. Chandra (1981)

conducted such a study of infant growth and health on a small number of infants who were exclusively breast-fed (n = 36). He reported that "growth faltering" (i.e., weight for age at or below the tenth percentile NCHS reference) occurred in 3 (8%) infants at 4 months, 5 (13%) at 5 months (p = .24), and 8 (22.5%) at 6 months (p < .01). Growth faltering was considered clinically significant since respiratory illness (p < .01) and otitis media (p < .01) occurred significantly more frequently in infants who fell below the tenth percentile for weight. The growth faltering was thought to predispose to illness rather than vice versa because in the majority of cases the growth failure was stated to have occurred before infection. Chandra concluded that a small proportion of infants who were exclusively breast-fed may not achieve adequate growth and should be given supplements after 4 months of age.

In a study of middle and upper socioeconomic status populations, Ahn and MacLean (1980) report growth in weight and length until 6 months in infants receiving breast-milk alone. They conducted a retrospective longitudinal study of 96 infants of mothers in the La Leche League. Mean weight and length curves of exclusively breast-fed infants remained above the 50th percentile of the NCHS reference through the sixth month. The study population was highly select: infants had a higher birth weight and length than the NCHS

population and mothers were generally white, well-educated, enthusiastic and highly motivated.

The past concensus regarding when breast-feeding alone becomes inadequate for a normal infant's nutritional needs and even of what is "normal" growth was based on assumptions which are currently being questioned and reevaluated. Furthermore, the wide variations--at least twofold--(Whitehead, 1985) in measured 24-hour milk volumes produced by lactating women make generalizations inappropriate. There appears to be a consensus that under conditions in which a mother is motivated, healthy, and relaxed, breast-milk alone is adequate to support infant growth for at least 4 months, and often 6 months (Underwood, 1985). The above studies concede, however, that breast-milk alone cannot be expected to support normal growth during the second half of infancy.

Evidence and Theory From Immunology That Breast Milk Protects Against Respiratory Infection

An infant's oral, nasal, respiratory, and gastrointestinal tracts are sterile before birth but become colonized within minutes of birth primarily by *E. coli*, *Clostridium welchii*, *Bacteroides*, streptococci, and lactobacilli (Hanson & Brandtzaeg, 1980). Some of these are potential pathogens so it is important to understand how the neonate copes with these microorganisms. At birth, many of

the usual adult local defenses against infection such as a functioning secretory immune system and an intact mucosal barrier are immature or absent. Normal infants do not all have secretory IgA (sIgA) in their saliva until about 6 weeks of age (Selner, Merrill, & Claman, 1968). In the nasal secretions, very low levels of sIgA are detectable at the age of 10 days and increase slowly thereafter (Cohen, Goldberg, & London, 1970). Fecal sIgA concentrations and antibody titers are reported to reach a stable level between one and two months, indicating that the intestinal immune system is not mature until then (Haneberg & Aarskog, 1975). During the first month or two of life, therefore, the infant may be especially vulnerable to infection.

The neonate has a unique manner of coping with potential pathogens and breast milk may play a key role. Breast milk, with its diverse constituents offers much more than just nutrition to the newborn. As the constitution of human milk becomes better analyzed, it becomes more apparent that it is ideally suited to: (a) enhance selective colonization, (b) provide host resistance factors, (c) provide antibodies, (d) promote maturation of the mucusol surface in the gastrointestinal tract, and (e) prevent sensitizing reactions and the development of allergies.

Selective Colonization

During the birth process, the infant's oral and nasal passages are intimately exposed to the microbial flora of the maternal vagina and possibly also rectum i.e., to organisms with which the mother is most likely living in healthy co-existence. Following birth, a characteristic behavior of all mammals including man is the kissing or licking of the newborn. Some mammals continually lick their young. This may innoculate the infant with organisms to which the mother has already responded immunologically and against which she is able to deliver immune protection through her colostrum and milk (Waksman, 1979).

Host Resistance Factors in Breast Milk

With the recent explosion of information in the field of immunology there has been considerable interest in enumerating the constituents of breast milk and in attempting to explain their mode of protective action. Some of the host resistance factors which have been identified are summarized by Goldman and Smith, (1973) and Hanson, Carlsson, Ahlstedt, Svanborg, and Kaijser (1975). These include antibodies (IgM, IgG, IgA and IgE), other soluble factors with immunologic or enzymatic functions (complement, interferon, lysozyme, lactoperoxidase, lactoferrin, bifidus factor) and a variety of living cells both specific (T- and B-lymphocytes, plasma cells) and non-specific (macrophage, granulocytes, neutrophils). The protective role of many of

these factors is fairly well understood. Lactoferrin and lysozyme are found in human milk in concentrations higher than any other biological fluid. Lactoferrin is an iron binding protein which inhibits the growth of bacteria such as E. coli and staphylococci by robbing them of iron. It has been suggested by several investigators (Bullen & Willis, 1971; Bullen, Rogers, & Leigh, 1972, 1975) that lactoferrin acts synergistically with secretory IgA (sIgA), perhaps especially against pathogenic strains of E. coli. Lysozyme is an enzyme which kills bacteria by cleaving the peptidoglycans of their cell walls. It is bacteriolytic against enterobacteriacae and gram-positive bacteria and may play a role in protecting against various viruses including Herpes hominis virus (Chandon, Shahami, & Holby, 1964). Lactoperoxidase, a unique peroxidase found in human milk and saliva, works together with hydrogen peroxide and thiocyanate ions to kill streptococci in vitro (Gothefors & Marklund, 1975). The effect upon other microorganisms and upon the resistance of the infant is unknown.

The above factors contribute to the production and maintenance of a low intestinal pH and a microflora in which Lactobacillus bifidus is the predominant microorganism. Gram-negative enteric organisms including E. coli and other potential pathogens are nearly completely excluded (Hanson & Brandtzaeg, 1980). When Mata (1971) cultured the stools of

breast-fed infants in Guatemala, 98.8% of the colonies were identified as L. Bifidus. With the introduction of supplementary formula or solids, Gerstley, Howell, and Nagel (1932) found that the flora becomes relatively indistinguishable from normal adult flora within 24 hours. If breast milk were again given exclusively, it would take from 2 to 4 weeks for the intestinal environment to return again to a state favoring the gram-positive flora (Brown & Bosworth, 1922; Gerstley et al., 1932)

These findings indicate that breast-feeding must be exclusive to achieve full benefit of the protective factors of breast milk and the unique intestinal microflora. A study of hospital admissions for infection in infants (Fallot et al., 1980) supports this. No bacterial morbidity was found in breast-fed infants while 22.3% of the partly and completely bottle-fed infants had proven bacterial infections. Bacterial culture results from the partly and completely bottle-fed include Chlamydia, Diplococcus pneumonia, E. coli, Group B Streptococcus, H. influenzae, H. pertussis, Listeria monocytogenes, Neisseria meningitides, Salmonella sp. and Staphylococcus. This list includes potential systemic and respiratory as well as enteric pathogens. Winberg and Wesner (1971) observed that infants with E. coli neonatal sepsis had consumed significantly less human milk than matched controls. Other investigators have reported that the throats of breast-fed babies are less

often colonized with E. coli (McFarlan, Crone, & Tee, 1949), Pneumococci, or H. influenzae (Hanson, Ahlestedt, Andersson, Carlsson, Fallstrom, Mellander, Porras, Soderstrom, & Svanborg, 1985) than babies who are partly or entirely bottle-fed.

Breast Milk Antibodies

Breast milk contains a number of antibodies (IgM, IgG, IgA, and IgE) and living cells (macrophage, granulocytes, neutrophils, T- and B-lymphocytes and plasma cells). The main immunoglobulin in human breast milk is IgA and 80% of the IgA is secretory IgA (sIgA), identical to the sIgA obtained from other mucus glands (respiratory tract, parotid, lacrimal, and salivary glands). Newcomb and Sutoris (1974) have shown that sIgA is effective in cross-linking antigens and has substantial agglutinating properties. This suggests that its primary function may be to clump and coat bacteria and other antigens, inhibiting their adherence to epithelial cells and reducing their invasive properties. The immunofluorescence studies of Heremans and Crabbe (1967) have shown that sIgA is incorporated into the mucin covering the mucosal surfaces which form a protective mechanical barrier. Antigen aggregates "trapped" in the coat by sIgA are disposed of by the continuous removal of the mucin. Antigen binding could be the major biological function of sIgA, providing a "first

line of defense" on mucosal surfaces. At birth, the human infant has little or no secretory IgA and the ability to produce it develops gradually during the first year of life (Solomon, 1971). Breast milk appears to be especially suited to protect the newborn's mucosal surfaces until sIgA can be produced locally. This role takes on added significance in the light of recent evidence that the mucosal barrier to antigens is not complete but allows for the absorption of macromolecules in small quantities that may be antigenic or biologically active (Walker, 1979). This implies that the intestinal tract is a potential portal of entry for endotoxins, bacterial breakdown products, proteolytic enzymes, or ingested antigens that normally exist in the intestinal lumen. Many of the factors which limit their uptake, such as a competent mucosal barrier containing sIgA and mucosal protein, are underdeveloped in the newborn period. Numerous factors in breast milk can facilitate the maturation of the mucosal barrier and provide secretory antibodies to furnish immune exclusion at its surface (Udall, Colony, Fritze, Pang, Trier, & Walker, 1981).

Addressing the question of how breast milk might enter the respiratory tract to provide local protection there, Frank and Gatewood (1966) and De Carlo, Tramer, and Startzman (1952) used radiological studies to show that infants do inhale milk during feeding and occasionally

regurgitate feed through the nose. Whether this occurs in sufficient quantities to be protective is unclear. Recent research has elucidated other ways that breast-milk may protect the respiratory tract from infection.

Haemophilus influenzae and Pneumococci, which together account for about 70% of cases of otitis media, adhere to human pharyngeal cells. In the presence of human milk, attachment by these bacteria is completely prevented (Hanson et al., 1985). In a preliminary report of their research, Hanson et al. state that prevention of attachment by these bacteria was mediated by 2 milk fractions: (a) an antibody rich high-molecular-weight fraction and (b) a low-molecular-weight fraction without antibodies. This second fraction is rich in oligosaccharides including a disaccharide that has been identified as the specific receptor for pneumococci. Hanson et al. suggest that these analogues of microbial epithelial receptors present in breast-milk are important for the mucosal defense of the infant.

Prevention of Sensitizing Reactions and the Development of Allergy

Atopic persons are characterized by the presence of large quantities of IgE antibodies (reagins or sensitizing antibodies). The IgE antibodies attach to cells throughout the body, especially to mast cells and basophils. When antigen enters the body and combines with the IgE, the mast

cells and basophils rupture and consequently release histamine and other substances which are responsible for the symptoms of allergic reactions (hay fever, asthma, uticaria) (Roitt, 1980).

Recent work on rats (Jarret & Hall, 1979) suggests that factors suppressing IgE responsiveness are transferred from mother to offspring via breast milk. This suppression is antigen specific (i.e., for antigen against which the mother had been immunized) and protects the offspring against deleterious hypersensitivity reactions to the same antigens.

The newborn's period of relative sIgA deficiency at the mucosal surfaces, which in normal children lasts 1 to 2 months, has already been discussed. Investigators (Taylor, Norman, Orgel, Stokes, Turner, & Soothill, 1973) have suggested that this period of sIgA deficiency is prolonged in the infants of allergic parents. During the sIgA deficient period, antigen can penetrate the mucosal surfaces and cause sensitization. Chronic respiratory symptoms observed in children who have had an acute respiratory tract infection in infancy may also be caused by such a process of sensitization. Evidence has been reported which suggests that the IgE response in the respiratory tract following RSV infection may be responsible for the pathogenesis of bronchiolitis (Welliver, Kaul, Riddlesburger, & Ogra, 1980).

It is possible that the protection of breast milk against the development of allergy involves the interplay of

both above mechanisms: furnishing sIgA during the infant's deficiency period and suppression of IgE responsiveness.

Conceptual Framework: The Immunology of the Mammary Gland

In many mammals the transmission of immunity from mother to offspring takes place primarily, and sometimes even solely, after birth by suckling. Ungulates and ruminates, for example, are born virtually agammaglobulinemic and antibodies, which are present in high concentrations in the colostrum, are absorbed across the intestine. However, investigators have not been able to show that antibodies in human milk and colostrum are absorbed across the human infant's intestine in significant quantity. After orally giving diptheria antibodies to newborns and older infants, there was no significant rise in their serum levels (Vahlquist & Hogstedt, 1949). Boorman, Dodd, and Gunther (cited in Loke, 1978) studied 97 mothers who had anti-A, anti-B, and anti-Rh antibodies in their sera and colostra. They were unable to detect any rise in the serum titer of these antibodies in their breast-feeding infants. Initially, these findings led to considerable skepticism regarding the protective role of antibodies and other host resistance factors in breast milk. If these factors were not absorbed into the infant's blood stream, how could they protect against infection?

With the advance in modern protein chemistry, it was shown that sIgA, the major immunoglobulin found in secretions, was immunochemically and physiochemically different from serum IgA (Hanson, 1961; Tomasi, Tan, Solomon, & Prendergast, 1965). Furthermore, there was found to be little correlation between antibody titers in maternal serum and those in colostrum or milk. Goldblum, Ahlstedt, Carlsson, Hanson, Jodal, Lindin-Janson and Sohl-Akerlund (1975) fed live E. coli 083 bacteria to women in the last month of pregnancy and within 3 days they began to produce antibodies against the O-antigen of E. coli 083 in their colostrum. However, there was no increase in their serum antibody production against the O-antigen. These and related studies (Parmley & Beer, 1976; Waksman, 1979) led to the realization that the secretory immune system is distinct and independent of the serum immune system and a theory of "local" immunity was formulated.

Some of the characteristics of the local immune response have already been discussed (the role of sIgA and its apparent antigen-trapping function at the mucosal epithelium). What remains to be considered here is the theory of immunocyte "homing." This theory summarizes current understanding of how the immunocyte-producing glands are linked together.

The Theory of Immunocyte Homing

The epithelium of the gut, respiratory tract, and tonsillar crypts contain "microfold" or "membrane" cells which are specialized for antigen trapping (Owen & Jones, 1974; Olah & Everett, 1975; Richardson, Bouchard, & Fergusson, 1976). Once an antigen is "trapped" it stimulates the production of precursor (blast) cells which then migrate through the lymph nodes and into the thoracic duct where they are emptied into the blood stream. From there they migrate or "home" to all the glandular regions (respiratory tract, mammary, paratoid, lacrimal, and salivary glands). In the glands, the blast cells receive a "second signal" for maturation and differentiation into mature plasma cells producing sIgA against specific antigen (Hanson & Bradzaeg, 1980).

Thus antigen trapped in the mother's respiratory or gastrointestinal tract stimulate the production of specific antibodies in the mammary gland which are then passed to the infant through the milk. They protect the infant against antigens the mother has come into contact with and which the infant is also likely to contact. The antigens and microbes to which the mucus membranes of the gut and respiratory tract have been exposed provide the major stimuli for antibody production in the mammary gland. It is not surprising that the majority of antibodies in colostrum and milk are specific for microorganisms (and their products)

which colonize the gut and respiratory tract. Antibodies to H. pertussis, streptolysin, staphylolysin, pneumococci, O and K strains of E. coli, Salmonella, Shigella, and C. diptheria have been identified in human milk. Antibodies to the bacterial enterotoxins of V. cholerae and E. coli and to poliovirus 1, 2, and 3, coxsachie B1, B2, and B9, ECHO viruses 6 and 9, and influenza viruses have also been found (Goldman, 1973).

The "homing" theory accounts for the migration of cells stimulated in the mother's gut associated lymphoid tissues (GALT) and bronchus associated lymphoid tissue (HALT) to the mammary glands. It provides a beautiful system for passing to the infant protection against organisms he is likely to come in contact with, particularly those which are likely to enter his gastrointestinal and respiratory tracts.

Summary

In summary, it has been seen that early studies clearly showed breast-fed infants had a lower morbidity and mortality from respiratory tract infections than bottle-fed infants. However, currently there is a division of opinion whether the protection afforded infants in Western industrialized countries with a high standard of living is significant. Some studies claim that breast-feeding does not protect against respiratory infection but does prevent serious morbidity. Others claim that the benefits of

breast-feeding are most marked for minor complaints which can be treated at home; still others that the major benefit is the avoidance of food allergens. Additionally, there is evidence that some of the advantages of breast-feeding are delayed and protect against respiratory infections in the second half of the first year.

Studies of the constituents of breast milk are convincing that breast milk provides infants with many factors they are unable to synthesize themselves. Breast milk fosters a unique micro flora in the infant's GI tract which is hostile to potential pathogens and is particularly hospitable to Lactobacillus bifidus. However, with the introduction of any supplements, the balance is upset and the flora quickly becomes indistinguishable from that of an adult.

The production of milk antibodies is linked in a common secretory system so that antigen entering the mothers oral, nasal, respiratory, and GI tracts stimulate the production of specific antibodies in the mammary gland. These antibodies are passed to the infant through the milk. Though it is not completely understood how local protection of the respiratory tract is achieved, there is evidence that breast-milk prevents adherence of Haemophilus influenzae and Pneumococci to pharyngeal cells and it is likely that some regurgitation and inhalation of breast milk does occur.

Current immunology theory supports the concept of "local" protection of an infant's respiratory tract by breast-feeding, though many of the details of how this protection is accomplished are not yet understood. Some of the present-day controversy regarding this protection may be due to the fact that many investigators fail to distinguish infants who are exclusively breast-fed from breast-fed infants who are given supplements. Other researchers fail to distinguish mild and severe respiratory illnesses, fail to observe the infants for an adequate period of time, and fail to account for the many social characteristics which tend to differentiate the breast-feeding and bottle-feeding groups. More studies which adequately account for these variables are needed to establish whether breast-feeding protects against respiratory tract infections in a modern Western culture today.

PROBLEM STATEMENT

One of the fundamental changes in infant nutrition in this century has been the substitution of cow's milk for human milk. Sixty years ago, according to Woodbury (1922), 90% of all American babies were put to breast and a little more than 10% were still receiving breast milk at 12 months of age. Today, about 55% are breast-fed in the hospital and 67% receive prepared formula by 3 months of age (Martinez & Nalezienski, 1981). Bottle-feeding tends to be more prevalent among infants from a lower socioeconomic status

(Martinez & Nalezienski, 1981) who also tend to be more at risk for respiratory infections (Egbuonu & Starfield, 1982). Since severe respiratory tract infection in infancy tends to be associated with respiratory symptoms which persist throughout childhood and perhaps even longer (Mok & Simpson, 1982), prevention of early respiratory infection is a priority for health professionals caring for children.

Clearly there is much evidence from past studies, from the composition of breast milk itself, and from current immunology theory to suggest that breast-feeding protects against respiratory infection. However, more data are needed to firmly establish that this is true in modern industrial society when the influence of other factors which may contribute to either the choice of feeding mode or frequency of respiratory infection are considered. More data are also needed to determine whether protection is compromised by the addition of supplements to the diet of a breast-fed infant.

The results of past studies indicate that health differences between infants fed in different modes (a) may be concurrent (i.e., while breast-feeding) and/or prolonged (becoming salient when the infants are observed over a year), (b) may be most marked when infants are distinguished on both the exclusiveness and duration of breast-feeding, and (c) may show up best when the occurrence of significant

respiratory illness is distinguished from that of minor respiratory illnesses.

HYPOTHESES

There are 5 hypotheses which guide this research: 3 are related to whether breast-feeding protects infants from respiratory illness concurrently (i.e., while they are breast-feeding) and 2 address the question of prolonged protection (i.e., lasting through the first year).

The "incidence" (hypotheses 1 and 2), "number" (hypothesis 3), and "severity" (hypothesis 4) of respiratory infections will be determined by a scale of points assigned to specific respiratory symptoms: infants who have more serious respiratory symptoms will accumulate more points than infants with minor symptoms. A cutoff number of 10 points (described more thoroughly in the methods section) was selected to distinguish minor respiratory illness from "definitive" respiratory illness. The "severity of respiratory symptoms during the first year" (hypothesis 4) will be determined by the overall total number of points for the year.

Concurrent Protection: Infant Respiratory Health While Breast-feeding

1) The incidence of "definitive" respiratory illness is lower in infants while they are being exclusively breast-fed than in infants while they

are being breast-fed with supplementation of formula and/or solids.

2) The incidence of "definitive" respiratory illness is lower in infants while they are being breast-fed with supplementation of formula and/or solids than in infants while they are being entirely bottle-fed.

3) The incidence of "definitive" respiratory illness is lower in infants while they are being exclusively breast-fed than in infants while they are being entirely bottle-fed.

Prolonged Protection: Infant Respiratory Health for the Entire First Year of Life

4) The longer the period of exclusive breast-feeding, the fewer the number of months during which respiratory illnesses occur during the first year.

5) The longer the period of exclusive breast-feeding, the lesser the severity of respiratory infections that occur during the first year.

CHAPTER II

METHODS

In the following section, the research setting and subjects are described. The rationale for including or excluding infants from the study is discussed and the study design, procedure for data collection and coding are presented.

DESIGN

This was a retrospective study designed to explore the relationships between (a) exclusive breast-feeding, (b) breast-feeding supplemented with formula and/or solids, or (c) total bottle feeding, and the incidence and severity of respiratory illness during the first year of life. The retrospective design was selected since it was the only feasible way to examine the feeding and health records of a reasonable sample through their first year of life within the allowed time frame. Studies in the past have indicated that health differences between infants fed in the various modes during the first weeks or months are accentuated with time.

The most serious threat to the validity of a retrospective study is the problem of incomplete information. In the present study, lack of information on variables which have been found in previous studies to be

associated with either the choice of feeding method or the risk of respiratory illness limited the analysis. However, information was sufficiently complete on the variables pivotal to the study--monthly feeding method and respiratory illnesses experienced by the infant subjects--to warrant the use of the retrospective design. How missing information on all variables was managed will be described later.

SETTING

The outpatient clinic used for this study is located in a lower income section of a city (population 450,000) in the northwest region of the United States. Offering complete health services to adults, as well as to children, the clinic is attended by a large proportion of welfare patients, blacks, and Southeast Asians. In the pediatric division, health care is provided by four pediatric nurse practitioners, a third-year medical student, and occasionally a resident. A pediatrician is always present in the clinic for consultation.

SUBJECTS

The study sample is composed of all children born between January 1, 1981, and December 31, 1981, who received health care at the outpatient clinic. The criteria for qualifying as a subject pertain to the completeness of a child's medical record or to factors which tend to increase the risk of respiratory illness. They were as follows:

1) The child's first visit to the outpatient clinic occurred during the first month of life.

2) The child attended the outpatient clinic for the entire first year of life and had at least four clinic contacts during that time.

3) The child was born at term (36 weeks gestation), had a birth weight greater than 2500 grams, was free of major congenital anomalies or severe problems during the neonatal period, and was discharged with his or her mother from the hospital.

Exclusions

Many children born during the study period were not included in the study either because their first visit to the outpatient clinic was after one month of age or because they did not attend the clinic for the entire first year of life. To estimate what proportion of children were excluded for these reasons, an alphabetically consecutive section of 49 children born during the study period was examined. Sixteen (or 33%) qualified as subjects for the study. Of the 33 (or 67%) who did not qualify, 24 were not seen at the clinic during the first month of life and 9 did not attend the clinic through their first birthday.

Other exclusions included 15 infants for low birth weight, 4 for prematurity, and 6 for significant congenital anomalies and problems during the neonatal period. These included spina bifida, pyloric stenosis, lung infiltrate at

birth, 11 days in NICU, meconium aspiration and 5 days in NICU, seizures and on mechanical ventilator for 3 days.

There were 2 infants who met the criteria to qualify as subjects but who were finally excluded from the analyses. Both were breast-fed without supplementation through 8 months of age and became quite ill after 6 months of age. The first was hospitalized for 2 days during month 7 with reactive airway disease and bilateral otitis media. The otitis media persisted through month 8. The second child showed significant growth faltering by 9 months of age, being below the fifth percentile in height for age and far below the fifth percentile in weight for age. This infant contracted an otitis media during month 10 which persisted through month 12. These 2 infants stood out from the rest of the breast-fed group in 2 ways: (a) they were exclusively breast fed longer than the other infants, and (b) they experienced markedly poorer health during the second half of their first year than the other breast-fed infants.

The observed growth and/or health faltering following prolonged exclusive breast-feeding in these 2 infants from the present study closely follows the pattern reported by Chandra (1981). Their growth and/or health faltering is not surprising considering that their mothers probably were not unstressed, highly motivated, well-educated and from higher socio economic backgrounds--factors associated with

successful prolonged lactation in previous studies (Ahn & MacLean, 1980). The present study is concerned with investigating the relationship between breast-feeding and infant health under normal conditions. The observed phenomenon of health failure in the 2 infants exclusively breast-fed for 8 months is of considerable interest and does deserve attention. However, as discussed in the Review of Literature, the present consensus among researchers is that exclusive breast-feeding becomes inadequate to meet an infants nutritional needs when he is between 4 and 6 months of age. If exclusive breast-feeding is continued past 6 months, many additional factors which are not the focus of this paper enter into play. The two infants who were exclusively breast-fed for 8 months, therefore, were not included in any of the analyses.

Description of Study Sample

A total of 109 infants born between January 1, 1981, and December 31, 1981, who attended the outpatient clinic qualified as subjects for the study. Characteristics of the subjects are summarized for the entire sample and for the four feeding groups in Appendix A. The 4 feeding groups are (a) infants exclusively breast-fed for more than 1 month and not more than 6 months (Br > 1 mo), (b) infants exclusively breast-fed during month 1 only and not during month 2 (Br 1 mo); (c) infants breast-fed with supplementation of formula and/or solids beginning during month 1 (Br + Sup);

and (d) infants exclusively bottle-fed beginning during month 1 (Bottle). Since there was much missing information for the characteristics examined, the following discussion is meant only to indicate general trends.

The males (53%) slightly outnumber the females (47%). Blacks were the largest racial group (45%), followed by Caucasians (26.7%), Southeast Asians (21%), and Asians (5%). Single parents were the majority (56%); next most common were married parents (35%). Few parents were separated (5.6%) or divorced (3.7%). Most infants were on welfare (70%), some had private insurance (28%), and a few had no insurance at all (2%). The majority of mothers for whom data were available smoked when pregnant (60%). Most infants had no family history of allergy (58%). The majority did not have a sibling less than 4 years old (61%), and the majority did not have a sibling greater than 4 years old (76%).

Most infants missed 1 (37%) or no (30%) appointments, though there were those who missed 2 (8%), 3 (11%), 4 (7%), and more than 4 (14%). The maximum number of missed appointments was 7. Solids were most commonly introduced at 5 or more months of age (68%), although some infants received solids as early as 1 month of age (2%).

Cross tabulations for the characteristics of sex, race, marital status, insurance, mother's smoking, and family

history of allergy by feeding group and corresponding chi square analyses were computed. None of these chi-square tests was significant at $p < .05$.

A one-way analysis of variance (ANOVA) was employed to compare the 4 feeding groups on number of siblings less than or equal to 4 years of age, number of siblings greater than 4 years of age, month solids were introduced, number of missed appointments, number of well-checks, and number of visits for respiratory illness. Three significant differences between groups were found: the number of siblings greater than 4 years old, the month solids were introduced, and the number of visits for respiratory illness. The group bottle-fed from month 1 had significantly fewer siblings older than 4 years ($M = .15$) than did the group exclusively breast-fed for 1 month [$M = .91$; $t(10.6) = 1.80$, $p < .05$, separate variance estimate]. The direction of this difference is important since siblings of this age are exposed to more respiratory pathogens outside the home and also increase the exposure of their infant brother or sister. Thus the infants bottle-fed from month 1 had the least likelihood of contracting a respiratory infection through the exposure of a school-aged sibling. Results of the ANOVAs finding significant differences between the feeding groups for the month solids were introduced and the number of visits for respiratory

illness will be discussed in a later section of this chapter.

The mean birth weight was 3275 grams with a range from 2509 to 4522 grams. The mean age of mother was 22.8 years with a range from 13 to 44 years. A one way analysis of variance and multiple range test using a Least Significant Difference (LSD) procedure were done for birth weight and maternal age. No two groups were significantly different at the 0.05 level.

Description of Feeding Practices

Feeding Patterns

The feeding practices of the study sample (N = 109) are summarized in Appendix B. There were 26 infants who were exclusively breast-fed for at least 1 month and not more than 6 months (Br > 1 mo). The range of exclusive breast-feeding for this group was 2 to 6 months with a mean duration equal to 3.5 months. Within a month of cessation of complete breast-feeding, two infants were completely bottle fed. However, all others were given breast-milk with supplements for 2 or more additional months with 12 infants continuing to receive some breast-milk through the end of the first year. The mean age of last breast-feeding (age when last feeding of breast-milk was given) calculated from available data was 8.6 months. The actual mean age at last breast-feeding is most certainly higher than that since many

mothers did breast-feed into the second year. Data during the second year were not gathered for this study.

Infants who were exclusively breast-fed during month 1 only (Br 1 mo) numbered 13. Duration of breast-feeding with supplementation for this group ranged from 0 to 12 months. Six infants were completely bottle-fed by month 2 and only 1 continued to receive some breast-milk until the end of the first year. Mean age at last breast-feeding was 3.9 months.

There were 15 infants who were breast-fed with supplements given during month 1 (Br + Sup). One infant in this group continued to receive some breast-milk through month 12. However the majority (n = 8) were completely bottle-fed by month 2. Mean age at last breast-feeding for this group was 3.2 months.

Infants who were entirely formula fed during month 1 (Bottle) numbered 55. As discussed earlier, these infants could have received some breast-milk during the first month of life, however all were entirely weaned from the breast prior to their first clinic visit (which, as designated in the criteria, was during the first month).

Introduction of Solids

A one-way analysis of variance followed by planned comparisons showed that infants exclusively breast-fed more than 1 month received solids significantly later (M = 6.28) than both the group exclusively breast-fed 1 month only [M = 4.17 months; $t(94) = 2.83$, $p < .005$] and the group

entirely bottle-fed during month 1 [M = 5.26 months; $t(94) = 1.94$, $p < .005$]. The age at which solids were started in the group exclusively breast-fed for more than 1 month ranged from 3 to 6 plus months with a mean of 6.28 months (see Appendix B). Infants exclusively breast-fed for 1 month only ranged in age when solids were introduced from 2 to 6 plus months with mean age of 4.2 months. Infants fed breast-milk with supplementation beginning during month 1 ranged in age from 2 to 6 plus months when first given solids. Mean age was 5.3 months. Infants entirely bottle-fed beginning during month 1 first received solids when they were 2 to 6 plus months with a mean age of 5.3 months.

Previous studies have also found an association between early weaning from the breast and early introduction to solids (Riodan & Countryman, 1980; West, 1980; Gulick, 1983).

In summary, the feeding groups were found to vary along a gradient for both age at last breast-feeding and age when solids were introduced. The group exclusively breast-fed more than 1 month tended to receive last breast-feeding later and first solid foods later than the other groups (see Appendix B).

Comparison of Feeding Patterns

How do the feeding habits of this sample compare with feeding trends reported in other studies? Table 2 compares

Table 2

Percentages of Infants Fed Breast or Bottle at Different Ages as Reported in the Literature

Reference	Breast-fed	Bottle-fed	Year of Research
Cunningham			1974
in hospital	50		
≥ 6 weeks	42		
≥ 3 months	33		
≥ 4 1/2 months	25		
≥ 6 months	19		
≥ 9 months	13		
≥ 12 months	4		
Martinez et al.*			1980
in hospital	55.3	50.5	
at 2 months	42.3	64.5	
at 3 and 4 months	33.2	73.6	
at 5 and 6 months	24.9	81.4	
at 8 months	19.1	91.9	
at 10 months	10.4	97.8	
at 12 months	7.5	98.3	
Frank et al.			1982
at 2 weeks	50.9		
at 3 months	34.8		
at 5 months	31.3		
at 6 months	23.2		
at 9 months	12.5		
Study Sample			1981
at 1 month	49.5	50.5	
at 2 months	36.7	63.3	
at 3 months	32.1	67.9	
at 4 months	30.3	69.7	
at 5 months	27.5	72.5	
at 6 months	22.9	77.1	
at 8 months	18.3	81.7	
at 10 months	13.8	86.2	
at 12 months	11.9	88.1	

*Totals exceed 100% due to supplemental feeding.

feeding patterns reported in several previous studies conducted at different times using a variety of sources. These studies did not distinguish infants who received supplements from those entirely breast-fed.

Cunningham (1977) reviewed the medical records of all infants born during 1974 who attended a particular pediatric clinic in rural upstate New York. He found that 50% of infants were breast-fed while in the hospital, half of these, or 25%, were still breast-feeding at 4.5 to 6 months of age, and 4% were still breast-feeding after their first birthday.

The subjects of Frank et al. (1982) were those of the Houston Family study: 112 infants born between May 1975 and June 1980. Half (or 50.9%) were breast-fed at 2 weeks, 23% were still breast-fed at 6 months and 12.5% at 9 months.

The most comprehensive study of feeding patterns was conducted on a national scale by Martinez, Dodd, and Samartgedes (1981) from the Marketing Research Department of Ross Laboratories. National feeding pattern for the first six months was determined from data gathered by questionnaires mailed to a probability sample of 49,821 new mothers (response rate was 56%). Data for months 8 to 12 were gathered through a bi-monthly telephone survey of mothers with 8- to 12-month-old infants. These mothers were selected from a list of 18,000 names representing a probability sample of 70% of the national births and

following county distribution specified in the most current U.S. government data. Response rate for the telephone survey was 78.4%. Data were gathered during 1980.

Martinez et al. found that in the hospital 55.3% of infants surveyed were breast-fed. By 5 to 6 months almost half of that number, or 24.9%, were still breast-feeding. At 12 months of age, 7.5% of infants were breast-feeding.

To facilitate comparison, the study sample was divided into feeding groups and age divisions similar to those used by Martinez et al. The "breast-fed" group in Table 2 includes infants who were given supplements. "Bottle-fed" infants are those who are bottle-fed only. The feeding pattern of the study sample is remarkably similar to that reported by the studies cited, with 49.5% breast-feeding at 1 month, 25.2% continuing to breast-feed at 5 to 6 months, and half of those breast-feeding at 6 months continuing to breast-feed at 12 months.

The similarities of feeding pattern observed in the study sample and that reported by Martinez et al. (1981) in a study conducted on a national scale and by Cunningham (1977) and Frank (1982) in smaller studies help support the reliability of the method used in this study to "estimate" feeding mode for months when feeding method was not documented in an infant's chart. The method used to

estimate feeding mode will be described later in this section.

Reasons For Clinic Visits

The largest number of visits for illness during the first year were made for respiratory illness (n = 350). The number of clinic visits for respiratory illness ranged from 0 to 12 and averaged 3.2 per infant. To find if the feeding groups differed in the number of clinic visits for respiratory illness, a one-way analysis of variance was done (as discussed earlier). After generating a contrast coefficient matrix, a one-tailed t test was performed. Significant differences were found with the group exclusively breast-fed more than 1 month having fewer visits for respiratory illness [M = 1.62 visits] than the group breast-fed with supplements given beginning during month 1 [M = 3.40; t (105) = 2.04, $p < .05$]. The group exclusively breast-fed more than 1 month also had significantly fewer visits for respiratory illness during the first year than did the group entirely bottle-fed during month 1 [M = 4.07; t (105) = 3.83, $p < .001$]. The group breast-fed for 1 month only (M = 2.54) had fewer visits for respiratory illness during the year than did the group entirely bottle-fed during month 1 [M = 4.07; t (105) = 1.84, $p < .05$].

Visits for all other illnesses totalled 172, ranging from 0 to 6 and averaging 1.6 visits per infant. Gastrointestinal symptoms (n = 36) and rashes (n = 24) were

the most common other illnesses. Visits for well-checks totalled 450 with a range from 1 to 7 and an average of 4 per infant (see Table 3).

Table 3

Reasons For Clinic Visits

Purpose of Visit	Total for sample*	Range per Infant	Mean per Infant
Well-check	450 (46.3)	1 - 7	4.1
Respiratory Symptoms	350 (36)	0 - 12	3.2
Other Illnesses	172 (17.7)	0 - 6	1.6

*Numbers in parentheses indicate percentage of total visits.

Previous studies have found that totally breast-fed infants receive more well-child care. This suggests that mothers who choose to breast-feed may be more conscientious, provide a higher standard of infant care and be more compliant with medical advice and treatment (Fergusson et al., 1978; Sauls, 1979). It has been suggested that the health advantages seen in breast-fed infants may be due more to better child care than to the breast-milk itself. It was thus interesting to find that in the present study the feeding groups did not differ in the number of well-checks or in the number of missed appointments (see Table 4). The health differences between feeding groups in the present

study cannot, therefore, be attributed to more well-child care or more compliance with medical advice.

Table 4

Number of Well-checks and Missed Appointments Compared by Feeding Group

	Feeding Groups							
	Br > 1 mo (n = 26)		Br 1 mo (n = 13)		Br + Sup (n = 15)		Bottle (n = 55)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Number of Well-Checks	4.15	1.19	4.38	.87	3.87	1.36	4.13	1.0
Number of Missed Appointments	1.15	1.22	1.54	2.07	1.93	1.71	1.56	1.6

DATA COLLECTION

Instruments

Instruments used in this study include:

1) Data sheet--used to standardize, organize, and focus the information gathered from patient charts on the variables relevant to this study.

2) Respiratory Illness Score--a scale of relative respiratory illness based on points assigned to symptoms. The respiratory illness score was used to determine the incidence and severity of respiratory illness.

3) Infant feeding group designation--as described earlier, 4 feeding groups were created to distinguish infants on the initiation, duration, and exclusiveness of breast-feeding (Br > 1 mo, Br 1 mo, Br + Sup, and Bottle).

Data Sheet

Information was gathered from patient charts onto the data sheet (see Appendix C for sample data sheet). Background information was taken from the "Patient Information" and "Pediatric Questionnaire" forms which were completed by the child's parent at the initial visit, and from the "Patient History" form which was completed by the health care provider at the first visit (see Appendices D, E, and F for examples of these forms). Background information was gathered on variables which:

(a) related to meeting the study criteria (birth weight, full term/premature, problems at birth, congenital anomalies, hospital stay);

(b) were indicators of socio-economic status (insurance/welfare);

(c) have been found in past studies to correlate with frequency of respiratory infection and/or prevalence of breast-feeding (race, caregiver's relationship to child and marital status, whether mother smokes, mother's age, family history of

allergy, number of preschool siblings and school-age siblings).

For each contact with the clinic information was recorded for:

(a) date of contact;

(b) type of contact (telephone call, no show, clinic visit, emergency room visit, hospitalization);

(c) purpose of contact (well-check, immunization, respiratory symptoms, symptoms of illness other than respiratory);

(d) diet (breast-milk only, breast-milk with supplementation, type and amount of supplements given, bottle milk only, solids);

(e) parent's report of respiratory symptoms and their duration (coryza, rhinorrhea, nasal congestion, cough, lower respiratory symptoms e.g., wheezing, elevated temperature, vomiting or diarrhea associated with respiratory symptoms);

(f) health care provider's recorded observation of respiratory symptoms (coryza, rhinorrhea, cough, adventitious upper respiratory sounds, adventitious lower respiratory sounds, injected pharynx, otitis media, bilateral otitis media, serous otitis media, perforated tympanic membrane, temperature, retractions, nasal flaring);

(g) health care provider's diagnosis (virus, URI, flu, bronchitis, bronchiolitis, pneumonia, croup, etc.);

(h) planned intervention and follow-up.

Respiratory Illness Score

A system of points was designed to indicate relative illness. The points assigned to respiratory symptoms were graded so that as the severity of illness indicated by the symptom increased so did the number of points assigned. Thus the sicker infants received a higher respiratory illness score. The point system is given below.

Respiratory Illness Scale

Criteria	Points
Parent's Report of Symptoms	
Each day of reported upper respiratory symptoms (coryza, rhinorrhea, nasal congestion, cough)	1
Each day of reported temperature elevation associated with respiratory symptoms	1
Each day of diarrhea associated with respiratory symptoms	1
Each day of vomiting associated with respiratory symptoms	2
Each day of reported lower respiratory symptoms	2

Criteria	Points
Health Care Provider's Assessment	
Adventitious upper respiratory sounds and/or congestion	2
Symptoms of upper respiratory illness	3
Temperature 100-103° F	3
Pharyngitis	3
Perforated tympanic membrane or PE tubes placed	3
Adventitious lower respiratory sounds	4
Temperature Greater than 103° F	5
Serous otitis media	10
Bronchitis	10
Croup	10
Otitis media	12
Bilateral otitis media	14
Bronchiolitis	16
Reactive airway disease	16
Retractions/nasal flaring/pneumonia	20
Type of Contact	
Phone call or clinic visit for respiratory symptoms	1
Each day hospitalized for respiratory symptoms	30

The point system was submitted to three health care providers (one MD, two PNPs) for evaluation and was

reevaluated after test coding several sample infants until it was felt that the scale accurately reflected an objective rating of illness severity.

A cutoff of 10 points per month on the Respiratory Illness Scale was established to distinguish infants who experienced mild respiratory symptoms from those with a more significant respiratory illness. Though it was an arbitrary cutoff, a Respiratory Illness Score of 10 points or more in 1 month meant that the infant either had a complex of persistent mild symptoms, an otitis, or a lower respiratory illness. In this study, a score of 10 or more points in 1 month was defined as a "definitive" respiratory illness.

Infant Feeding Group Designation

The 4 feeding groups were designated to make possible a comparison of infants based on the initiation, duration,and exclusiveness of breast-feeding. The rationale for using these three criteria to distinguish groups of infants is more thoroughly discussed in the Review of Literature. A summary of these points follows:

Initiation of breast-feeding. Infants who are breast-fed for even a short time may have health advantages over those who do not receive any colostrum or breast-milk. These advantages are related to some of the constituents of breast-milk: (a) immunoglobulins and other host resistance factors (Goldman et al., 1973), (b) factors which promote

maturation of the intestinal mucosal barrier (Udall et al., 1981), and (c) factors which appear to suppress IgE responsiveness and the expression of allergy (Jarett & Hall, 1979).

Duration of breast-feeding. It has been reported (Woodbury, 1922; Cunningham, 1979) that the longer the period of breast-feeding, the lower the rate of respiratory illness in subsequent months.

Exclusiveness of breast-feeding. It appears that if a breast-fed infant is given supplemental feedings of formula or solids, the bacterial flora and pH of the intestine changes and the biological activity of immunoglobulins and host resistant factors may be diminished (Gerstley et al., 1932; Hanson & Brandtzaeg, 1980).

Based on these ideas and evidence, the 4 feeding groups created to compare infants in this study are:

1) Infants who were exclusively breast-fed for at least 1 month but not more than 6 months (Br > 1 mo). Infants in this group did not receive formula or solid supplements during their first 1-plus to 6 months.

2) Infants who were exclusively breast-fed during their first month only (Br 1 mo). These infants did not receive formula or solid supplements during their first month, but did after the first month.

3) Infants who were breast-fed but also had formula and/or solid supplements beginning during the first month of life (Br + Sup).

4) Infants who were entirely bottle fed beginning during their first month of life (Bottle). The infants in this group have no clinic record of receiving breast-milk. Since the first clinic visit was usually around 2 weeks of age, it is possible that the infants in this feeding group could have received breast-milk in the hospital and even for up to 2 to 3 weeks later. However, they were totally weaned from the breast by 1 month of age.

Sources of Error

Incomplete information on infant feeding method. Although feeding method was always recorded for well-child checks, it was not always recorded when a visit was made for illness. In addition, most children did not have a clinic contact every month. Thus it was necessary to "estimate" feeding mode for several months for each child. When there is no record of feeding mode for an even number of months and the feeding mode changes during that time, the "estimates" assigned to the missing months are equally divided between the feeding mode last recorded before the gap and the feeding mode recorded immediately after the gap. If the number of months with missing information is odd,

more months are assigned to the feeding mode with more supplementation or bottle feeding. See example below.

Example:

Month	1	2	3	4	5	6	7	8	9	10	11	12
Feeding mode	Br	Br*	Br*	Br	Br*	Br+*	Br+	Bot*	Bot	Bot*	Bot*	Bot*

Br Breast-fed only and recorded in chart
Br+ Breast plus supplements and recorded in chart
Bot Bottle-fed only and recorded in chart
* Estimated feeding mode

Respiratory illness score. Some parents and health care providers were more thorough than others in how they filled out forms, reported or recorded information and illness symptoms. In addition, there were cultural and language barriers hindering the transfer and recording of information, a problem particularly with the Southeast Asian subjects. Demographic variables were the most affected by incomplete information and will be used only for general descriptive purposes. To minimize error in the respiratory illness score due to missing information, more points were given for the health professional's physical assessment and diagnosis than for the parent's report of illness. When more than one symptom could indicate the same illness, points were given for either one or the other symptom (e.g., retractions or pneumonia 20 points). This helped achieve a uniformity in respiratory illness score. Mild symptoms

which were more likely to vary in how there were reported and recorded were given few respiratory illness points, and if a diagnosis was not given, it was never inferred.

It is theoretically possible that a child could have received treatment for a respiratory illness at another facility with no record of it on the clinic chart. This, according to one clinic health care provider, was probably a rare occurrence since the subjects were mostly poor with few resources available to them.

PROCEDURE

Data Summary

Clinic contacts, feeding method, respiratory illness score, and respiratory illness diagnoses were summarized on a monthly basis (see Appendix G for an example summary sheet). Information from the summary sheet was analyzed as described in the next chapter.

CHAPTER III

ANALYSIS AND RESULTS

In this section the statistical methods used to address each hypothesis are presented first and are followed by the results. The analysis and results of hypotheses 1, 2, and 3 investigating infant respiratory health while breast-feeding are considered first. Next, the analysis and results of hypotheses 4 and 5 regarding prolonged protection through the first year are discussed.

Hypotheses 1, 2 and 3--Concurrent Protection: Infant Respiratory Health While Breast-feeding

This section will include the analysis and results of the first 3 hypotheses:

1. The incidence of "definitive" respiratory illness is lower in infants while they are being exclusively breast-fed than in infants while they are being breast-fed with supplementation of formula and/or solids.
2. The incidence of "definitive" respiratory illness is lower in infants while they are being breast-fed with supplementation of formula and/or solids than in infants while they are being entirely bottle-fed.

3. The incidence of "definitive" respiratory illness is lower in infants while they are being exclusively breast-fed than in infants while they are being entirely bottle-fed.

Analysis of Hypotheses 1, 2, and 3

The independent variable for the hypotheses was feeding method. Because these hypotheses investigated respiratory health while breast-feeding (i.e., the concurrent protection afforded by breast-feeding), it was important to use an analysis which allowed an infant to change feeding groups over time. Infants were identified on a monthly basis as (a) exclusively breast-fed (Br); (b) breast-fed with supplementation (Br + Sup); or (c) completely bottle-fed (Bottle). (These feeding groups differed from those used to analyze hypotheses 4 and 5.)

The dependent variable for the 3 hypotheses in these analyses was absence (0) or presence (1) of "definitive" respiratory illness. As described earlier, "definitive" respiratory illness is defined as a score of 10 points or more for that month on the Respiratory Illness Scale.

An overall examination of hypotheses 1, 2, and 3 was conducted using a 3 x 2 (groups x presence/absence of "definitive" respiratory illness) chi square analysis for each month during the first 6 months. For months 1 through 6, a 2 x 2 chi square analyses was also computed for each month to compare each pair of feeding modes on presence or

absence of "definitive" respiratory illness. Because no infants were exclusively breast-fed after the sixth month, only 2 groups remained and therefore a 2 x 2 chi square analysis was computed for each month for months 7 through 12.

Respiratory illness scores were tabulated for each month and entered into a chi-square analysis according to the feeding method during the month.

Results of Hypothesis 1, 2, and 3

Infants being exclusively breast-fed had significantly fewer "definitive" respiratory illnesses than infants being breast-fed with supplementation of formula and/or solids for month 3 [$\chi^2(1) = 3.10$, $p \leq .05$]. Infants being exclusively breast-fed also had significantly fewer "definitive" respiratory illnesses than infants being entirely bottle-fed for month 1 [$\chi^2(1) = 2.89$, $p \leq .05$] and for month 2 [$\chi^2(1) = 2.89$, $p \leq .05$]. No other significant differences between groups were found. The number and percentage of infants with a "definitive" respiratory illness during each month of the first year and the results of the chi-square analyses are presented in Table 5.

Table 5

Concurrent Protection: Hypotheses 1, 2, and 3. Occurrence of "Definitive"[a] Respiratory Illness While Being Exclusively Breast-fed, Breast-fed With Supplementation of Formula and/or Solids, or Entirely Bottle-fed.

	Feeding Mode												Results of Chi-Square Analyses			
	Exclusively Breast-fed				Breast-fed with Supplements				Entirely Bottle-fed				3 x 2 chi square	2 x 2 chi square		
Mo.	Total n	Well Infants n	Infants with "Definitive" Respiratory Illness n	%	Total n	Well Infants n	Infants with "Definitive" Respiratory Illness n	%	Total n	Well Infants n	Infants with "Definitive" Respiratory Illness n	%		Br. vs. Br + Sup	Br vs. Bottle	Br. + Sup vs. Bottle
1	38	38	0	0	16	16	0	0	55	51	4	7	4.22	0	2.89*	3.29*
2	26	24	2	8	14	12	2	14	69	63	6	9	.60	.44	2.89*	.42
3	17	17	0	0	18	15	3	17	74	69	5	7	3.91	3.10*	1.12	1.79
4	13	11	2	15	20	18	2	10	76	68	8	11	.11	.21	.26	.01
5	7	6	1	14	23	20	3	13	79	57	22	28	3.00	.01	.60	2.10
6	2	2	0	0	23	19	4	17	84	68	16	19	.95	.41	.47	.03
7					22	18	4	18	87	62	25	29				.53
8					20	18	2	9	89	69	20	23				.90
9					17	13	4	24	92	75	17	19				0
10					15	12	3	20	94	74	20	21				.01
11					13	13	0	0	96	80	16	17				.38
12					13	11	2	15	96	70	26	27				.56

[a]"Definitive" respiratory illness score of 10 points or more during that month

* $p \leq .05$

Hypothesis 4--Prolonged Protection: The Relationship Between the Duration of Breast-feeding and the Incidence of Respiratory Infection During the First Year of Life

This section will include the analysis and results of hypothesis 4:

> The longer the period of exclusive breast-feeding, the fewer the number of months during which respiratory illnesses occur during the first year.

Analysis for Hypothesis 4

A one-way analysis of variance was used when the dependent variables were continuous; chi squares were done when the dependent variables were dichotomous. Eight ANOVAs and 5 chi squares were done to investigate hypothesis 4.

In each of the ANOVAs, feeding group was the independent variable. Feeding groups were designed to distinguish the subjects on the initiation and duration of exclusive breast-feeding. One of the underlying assumptions in an analysis of variance is that the subjects do not change groups. Thus the feeding groups used here were not the same as those used in hypotheses 1, 2, and 3. The four feeding groups for hypotheses 4 and 5 were: (a) exclusively breast-fed more than 1 month (Br > 1 mo); (b) exclusively breast-fed during month 1 only (Br 1 mo); (c) breast-fed with formula and/or solids given beginning during month 1

(Br + Sup); and (d) entirely bottle-fed beginning during month 1 (Bottle).

Respiratory illness, the dependent variable, was broken into subcategories to distinguish mild from serious illness and the different kinds of respiratory illnesses. A different subcategory of respiratory illness was used as a dependent variable in each ANOVA. These were: The number of months in the first year during which the subjects had (a) a URI; (b) bronchitis; (c) bronchiolitis; (d) pneumonia; (e) croup; or (f) a lower respiratory infection. ANOVAs were also done for (g) the number of days the subjects were hospitalized for a respiratory infection in the first year and (h) the number of months in the first year during which the subjects had an otitis media.

Planned comparisons congruent with hypotheses 4 and 5 were employed to determine where the means of the feeding groups differed significantly. Prior to computing the planned comparisons, homogeneity of variance was tested using the "Cochran's C" and "Bartlett's-Box F" tests. If a test for homogeneity of variance was significant at $p \leq .01$, the separate variance estimate was used for the one-tailed t test; if alpha > .01, the pooled variance estimate was used for the one-tailed t test.

Chi-square analyses were done to compare the 4 groups on each of five dichotomous dependent variables. These five variables were scored as absence (0) or presence (1) for

each of the following: (a) any URI during the year; (b) early onset of otitis media (onset during the first 6 months of life); (c) any otitis media during the year; (d) recurrent otitis (2 or more episodes of otitis during the year); and (e) persistent otitis media (an otitis lasting more than 2 weeks and requiring more than 1 course of antibiotic therapy).[1]

Results for Hypothesis 4

Upper respiratory infection. The dependent variable for the first ANOVA was calculated by counting chart notations of upper respiratory infection (URI). Feeding groups were compared on the number of months that URI occurred during the first year. The results of this ANOVA indicated that infants exclusively breast-fed for more than 1 month (M = .34) had significantly fewer episodes of URI during the year than infants bottle-fed from month 1 [M = .81; $t(60.4) = 2.65$, $p \leq .005$, separate variance estimate]. It is possible that a small number of infants in the group entirely bottle-fed from month 1 had many recurrences of URI. A small number of infants with many

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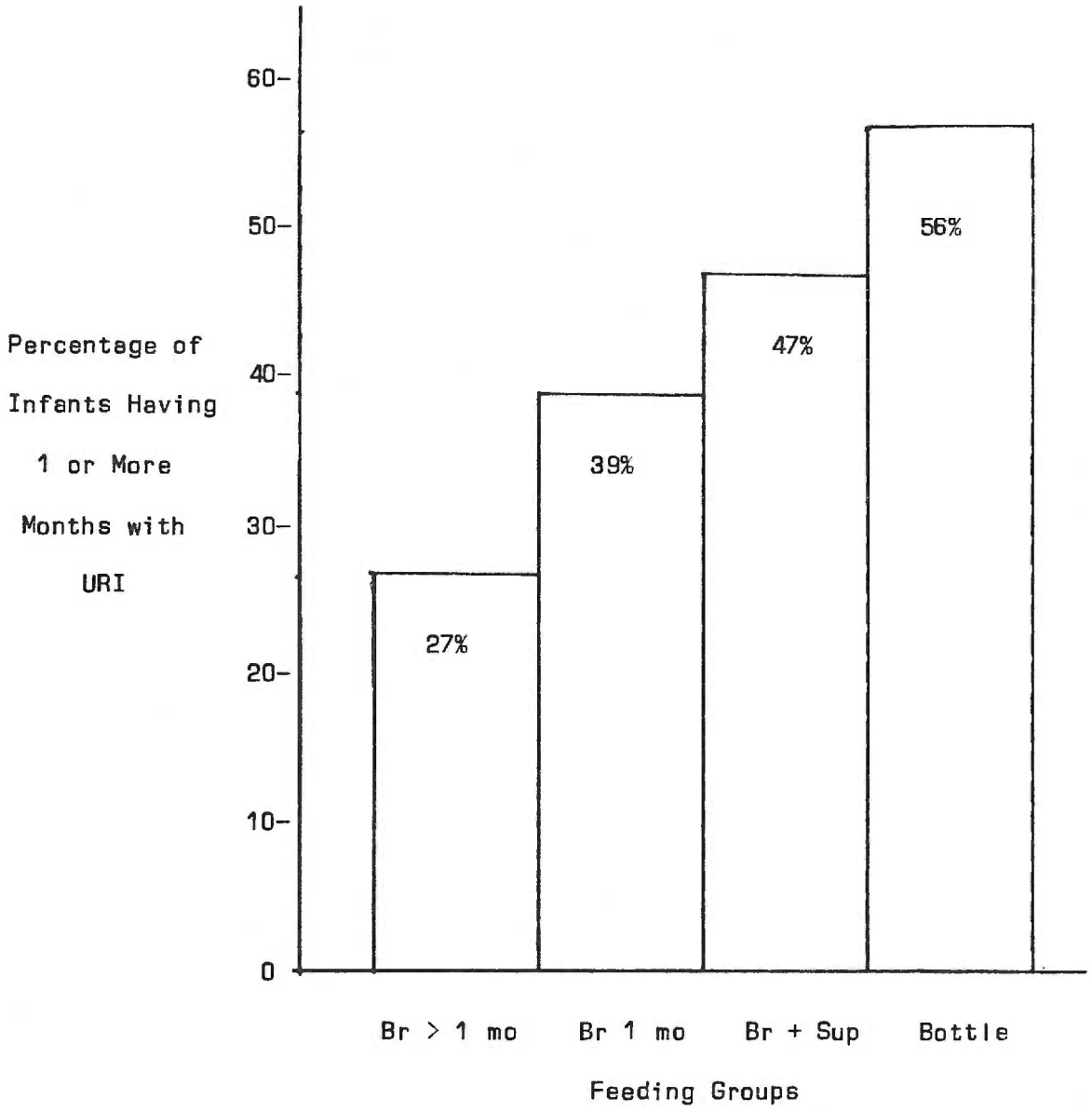
[1]The formulation of this definition was determined by the methods used in this study to summarize data on a monthly basis for computer analysis (as described in the Procedure section). If an otitis occurred in two consecutive months, or occurred twice in one month, and each time was treated with a course of antibiotic therapy, it was considered to be "persistent."

recurrences could account for the differences observed between groups in ANOVA number 1. A chi-square analysis was done to look at the differences between feeding groups in number of infants with no episodes of URI (0) and the number of infants with 1 or more episodes of URI (1). Differences between feeding groups were not significant ($\chi^2(3) = 6.49$, $p = .09$) but were in the hypothesized direction as is depicted in the bar graph in Figure 1. One or more months with URI, virus, or flu were observed in half (57%) of the infants entirely bottle-fed from month 1 and in a quarter (27%) of the infants exclusively breast-fed more than 1 month.

Lower respiratory illness. The dependent variables used in the second through fifth ANOVAs were the number of months in the first year during which the subjects had (a) bronchitis; (b) bronchiolitis; (c) pneumonia; and (d) croup. On these variables, differences between the feeding groups showed a trend with the group exclusively breast-fed more than 1 month having fewer of these illnesses. However, the numbers of each of these respiratory illnesses were small and the significance of differences did not exceed the .05 level. The sixth ANOVA investigated the total number of lower respiratory illnesses. This was defined as the sum of the number of months with bronchitis, bronchiolitis, pneumonia, and croup. The group bottle-fed from month 1 had significantly more



Note: chi-square (3) = 6.49; p = .09.

Figure 1. Occurrence of URI during the first year compared by feeding group.

months with lower respiratory illness (M = .42) than the group exclusively breast-fed more than 1 month [M = .08; $t(73.8) = 2.81$, $p < .005$, separate variance estimate]. The numbers of lower respiratory illnesses are presented in tabular form in Table 6.

Days hospitalized. The seventh ANOVA compared the feeding groups on the number of days hospitalized for respiratory illness during the first year. Infants bottle-fed from month 1 were the only group who had any hospitalizations for respiratory illness. As shown in Table 6, the total number of days hospitalized was small and the differences between the feeding groups on this variable were not significant.

Otitis media. Otitis media was defined as a clinic visit with the diagnosis of otitis media or bilateral otitis media and a prescription for antibiotic therapy noted on the medical record. The results of the eighth ANOVA, using number of months with otitis media as the dependent variable, indicated a significant difference in the predicted direction. The group bottle-fed from month 1 had significantly more months with an otitis (M = 1.78) than did either the group exclusively breast-fed more than 1 month [M = .65; $t(70.5) = 4.46$, $p = 0.000$, separate variance estimate], or the group breast-fed for 1 month only [M = 1.0; $t(26.2) = 2.50$, $p \leq .01$, separate variance estimate]. The

Table 6

Comparison of Feeding Groups on the Total Number of Months With a Lower Respiratory Infection

Lower Respiratory Tract Illness	Feeding Groups			
	Br > 1 mo (n = 26)	Br 1 mo (n = 13)	Br + Sup (n = 15)	Bottle (n = 55)
Bronchitis	0	1 (.08)	0	3 (.05)
Bronchiolitis	0	1 (.08)	1 (.07)	9 (.02)
Pneumonia	2 (.08)	0	2 (.13)	9 (.16)
Croup	0	0	0	2 (.04)
Total	2 (.08)	2 (.15)	3 (.20)	23 (.42)
Total Number of Months With a Hospitalization For Lower Respiratory Illness	0	0	0	4 (.07)

Note: Each entry in Table 6 is the total number of months with a lower respiratory illness for that group. The mean number of months per group is placed in parentheses following the total number.

group breast-fed with supplements given beginning during month 1 also had significantly more months [M = 1.87] with otitis than did the group exclusively breast-fed more than 1 month [M = .65; t(17.2) = 2.19, p ≤ .05, separate variance estimate]. The results of 3 of the 4 chi-squares on (a) early onset of otitis; (b) one or more months with otitis; (c) recurrent otitis; and (d) persistent otitis were significant and are described below.

Early onset of otitis. In the first chi-square, incidence of early otitis was cross-tabulated with feeding method. Results [$\chi^2(3) = 9.39$, $p \leq .05$] indicated that infants who were exclusively breast-fed for at least 1 month had a lower incidence (15%) of early otitis media (during months 1 to 6) than infants who were exclusively bottle-fed from month 1 (42%). The number of infants in each feeding group who had an early otitis is presented in Table 7.

Recurrent otitis. The purpose of the second and third chi squares was to investigate the distribution of otitis episodes within the feeding groups. Do a few infants in the bottle-fed group have many recurrences? If so, that would contribute to the observed difference between groups in the number of months with otitis (ANOVA #8). The second chi square looked at the differences between feeding groups in number of infants with no episodes of otitis versus infants with one or more episodes of otitis. Differences between

Table 7

Number of Months With an Otitis Media Per Infant During the First Half Year and Entire First Year in Reference to Feeding Group*

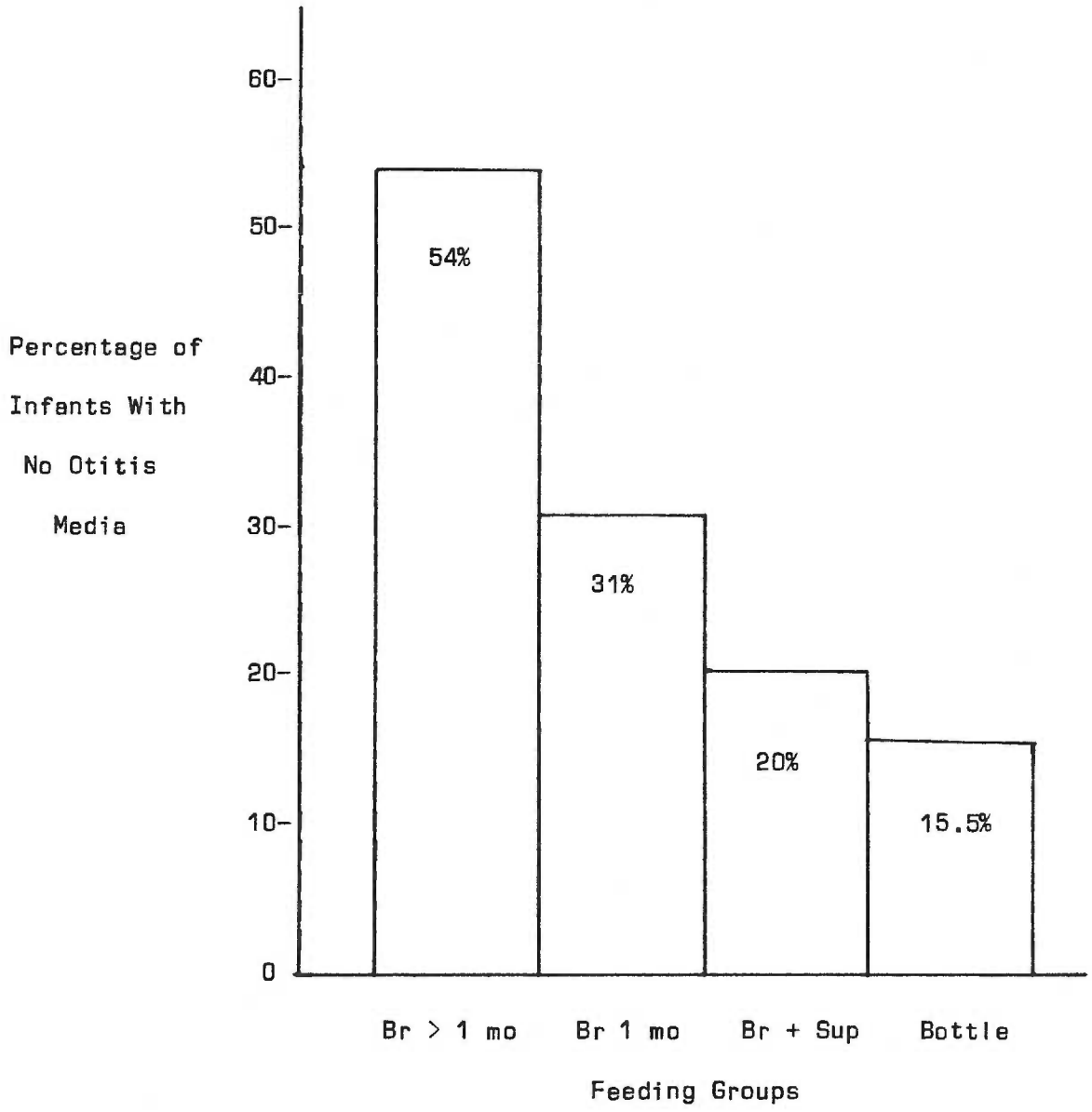
Episodes of Otitis Media Per Infant	Feeding Groups			
	Br > 1 mo (n = 26)	Br 1 mo (n = 13)	Br + Sup (n = 15)	Bottle (n = 55)
	Months 0 - 6			
0	11 (85)	11 (85)	8 (53)	31 (56)
1	3 (12)	2 (15)	5 (33)	14 (25)
2	1 (4)			8 (15)
3				2 (4)
4			1 (7)	
5			1 (7)	
	Months 0 - 12			
0	14 (54)	4 (31)	3 (20)	8 (15)
1	9 (35)	6 (46)	7 (47)	19 (35)
2	1 (4)	2 (15)	1 (6)	10 (18)
3	2 (8)	1 (8)		6 (11)
4			2 (13)	5 (9)
5				4 (7)
6			1 (6)	1 (2)
7				1 (2)
8				
9			1 (6)	1 (2)

*Numbers in parentheses indicate percentage of feeding group.

feeding groups were significant [$\chi^2(3) = 14.43$, $p = .0024$] with the group bottle-fed from month 1 having the greatest number of infants with 1 or more episodes of otitis during the first year. These results are depicted graphically in Figure 2. In the third chi-square, recurrent otitis was cross-tabulated with feeding method. Recurrent otitis is defined as two or more months with an otitis media during the first year. Results indicated that there was a significant difference in recurrent otitis between the feeding groups in the hypothesized direction [$\chi^2(6) = 19.77$, $p = .003$]. The results are presented in tabular form in Table 7 and are depicted graphically in Figure 3.

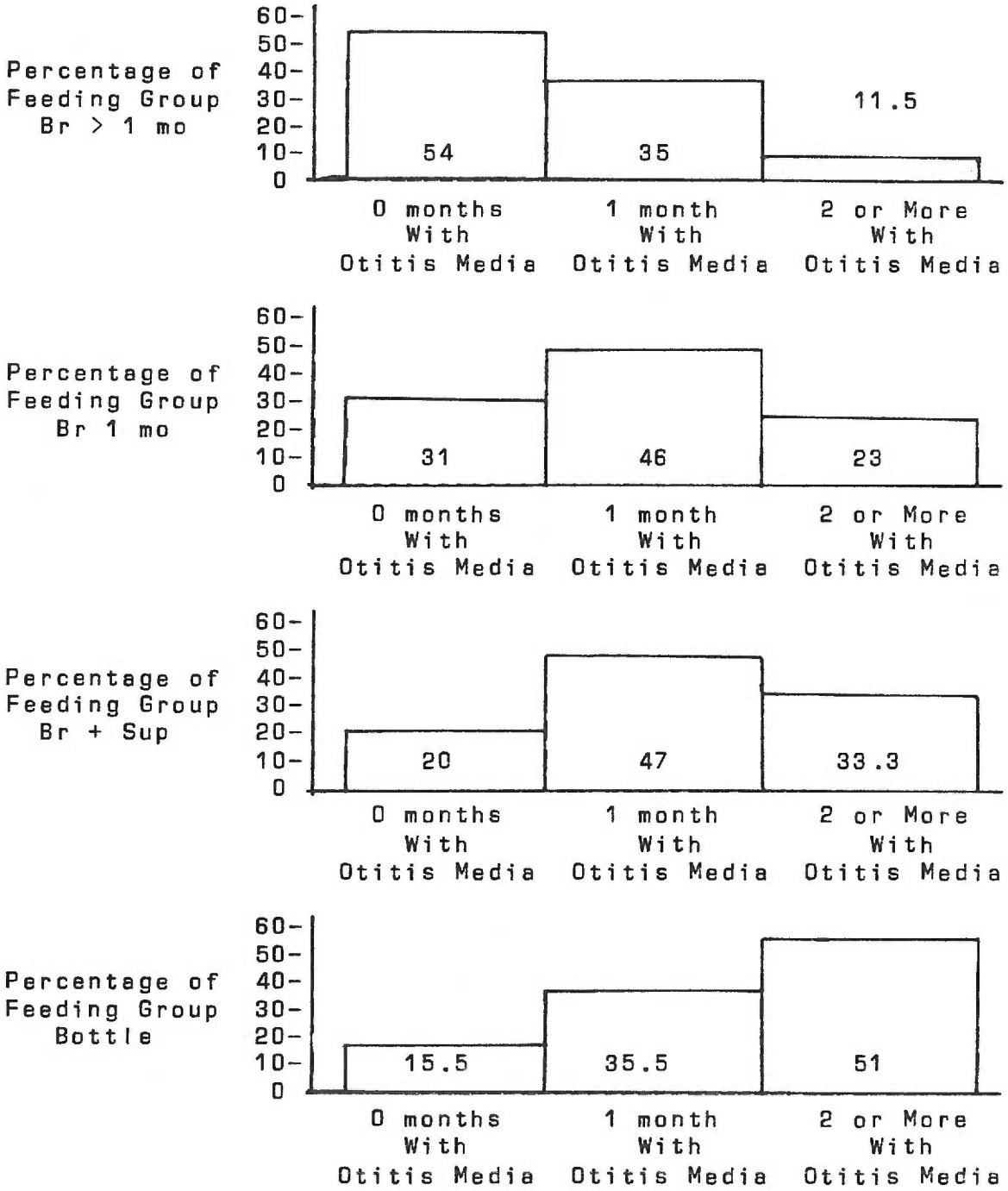
Persistent otitis. Persistent otitis was defined as an episode of otitis media lasting longer than 2 weeks and requiring more than one course of antibiotic therapy. The chi-square done using persistent otitis as the dependent variable indicated differences in the predicted direction. Infants bottle-fed from month 1 had more persistent otitis medias than any other feeding group. These differences approached significance [$\chi^2(3) = 6.70$, $p = .082$], and are presented graphically in Figure 4.

These comparisons of months with URI, lower respiratory illness, and otitis, and of the occurrence of early, recurrent, and persistent otitis media verify hypothesis 4: The longer the period of exclusive breast-feeding, the fewer



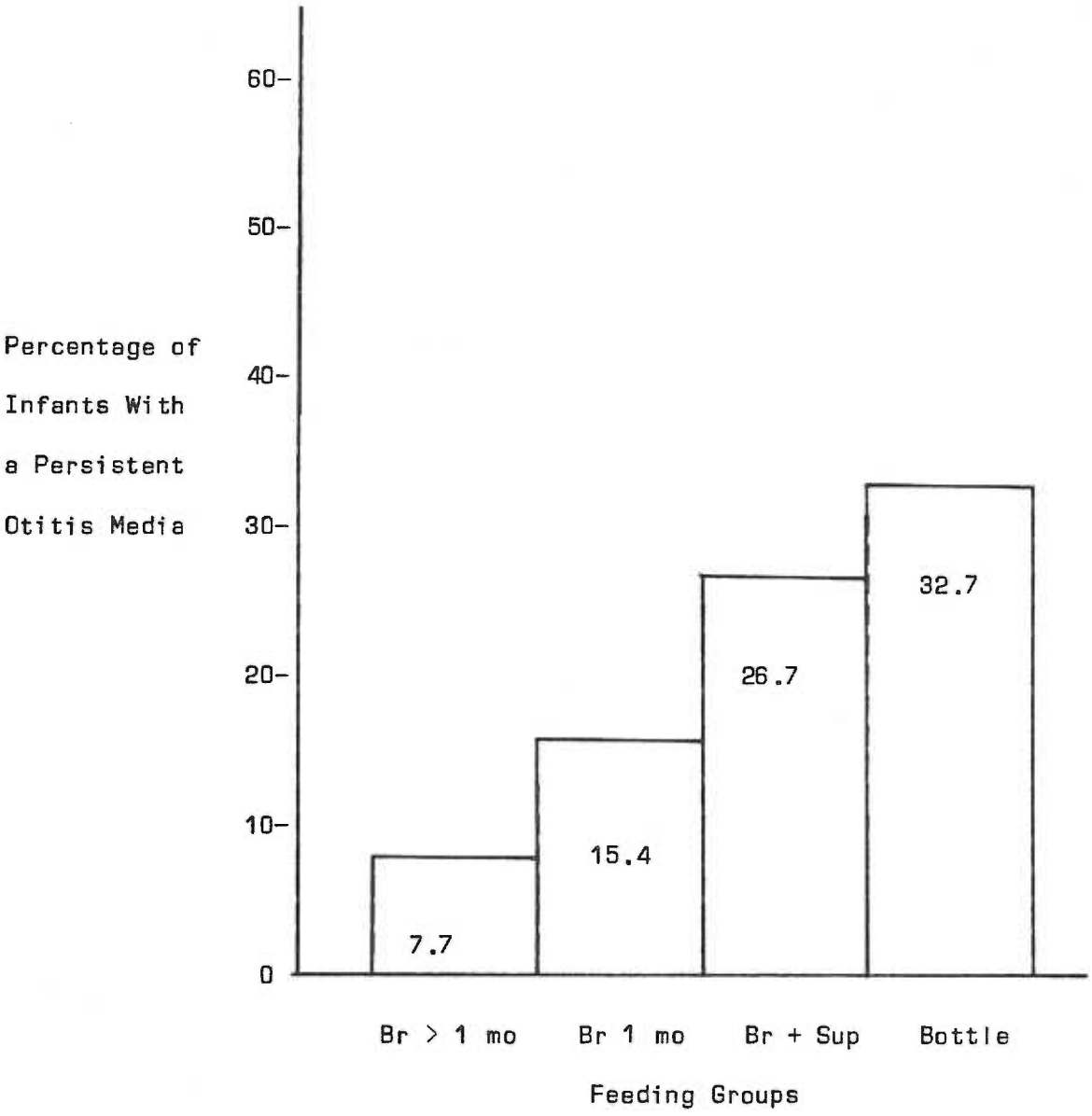
Note: chi-square (3) = 14.43; p = .0059.

Figure 2. Distribution by feeding group of children with no episodes of otitis media during the entire first year of life.



Note: chi square (6) = 19.77, $p \leq .005$.

Figure 3. Comparison of number of months with otitis media during the first year of life by feeding group.



Note: chi-square (3) = 6.70; p = .082.

Figure 4. Distribution by feeding group of children with persistent otitis media. Persistent otitis media (OM) is defined as an episode lasting longer than 2 weeks and requiring more than one course of antibiotic therapy.

the number of months during which respiratory illnesses occur during the first year.

Hypothesis 5--Prolonged Protection: The Relationship Between the Duration of Breast-feeding and the Severity of Respiratory Illness During the First Year of Life

This section will include the analysis and results of the fifth and final hypothesis:

> The longer the period of exclusive breast-feeding, the lesser the severity of respiratory illnesses that occur during the first year.

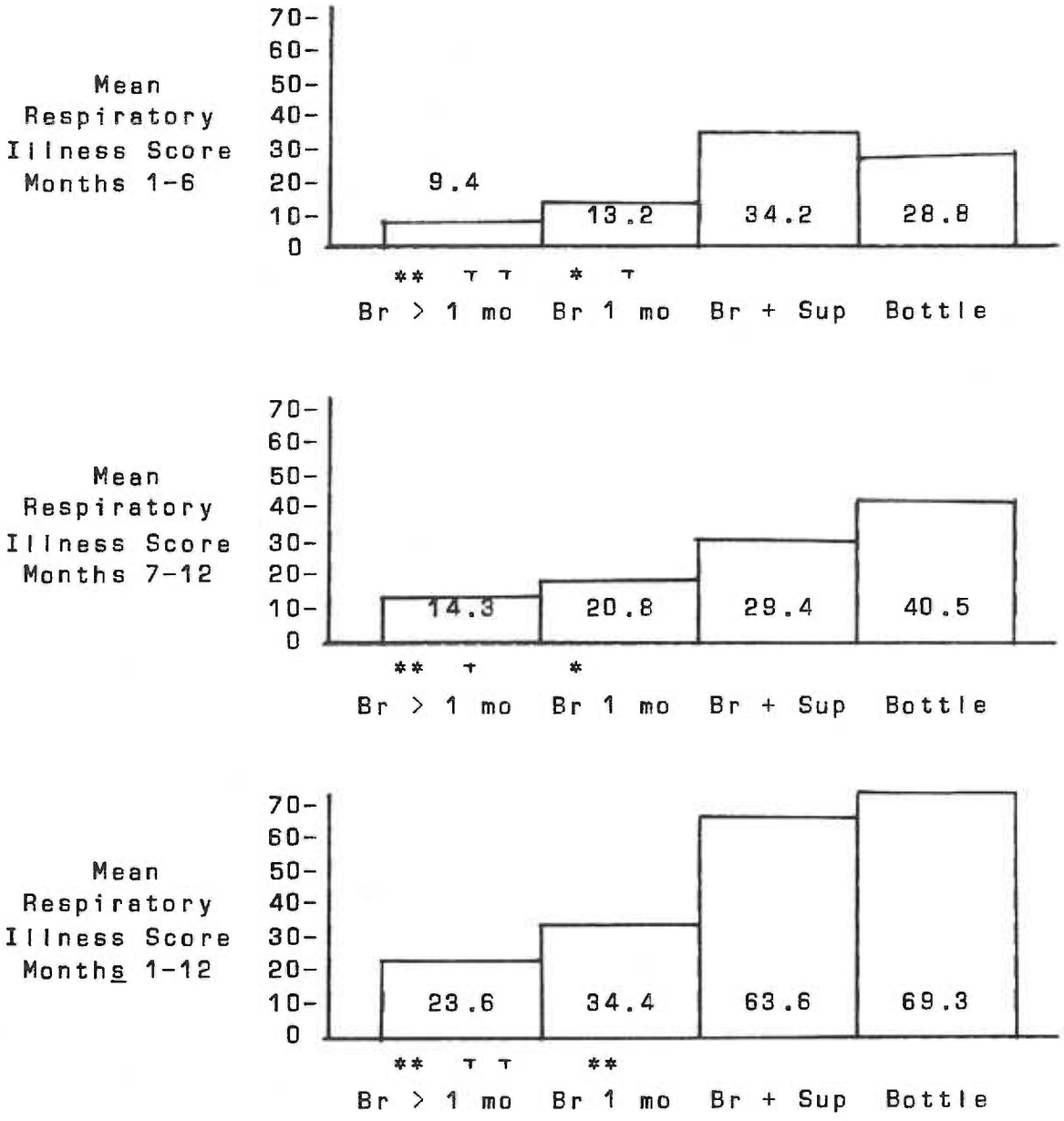
Analysis for Hypothesis 5

This hypothesis was analyzed with three ANOVAs. In each ANOVA, feeding method was used as the independent variable. The dependent variable in the first ANOVA was the total score on the Respiratory Illness Scale for the first six months of life. The dependent variable for the next ANOVA was the total score on the Respiratory Illness Scale for months 7 through 12. For the final ANOVA, the sum of the scores on the Respiratory Illness Scale for all 12 months was used as the dependent variable. Planned comparisons were employed to determine where the feeding groups differed significantly. Homogeneity of variance was tested using the "Cochran's C" and "Bartlett-Box F" tests. Whenever group variances were significantly different at

$p \leq .01$, the separate variance estimate was used for the one-tailed t test.

Results For Hypothesis 5

Significant differences were found in all three ANOVAs in the hypothesized direction. These differences are presented graphically in Figure 5 and are summarized in Table 8. Compared to the group exclusively breast-fed more than 1 month (Br > 1 mo), the Br + Sup group had a significantly higher mean respiratory illness score for months 1 to 6 [$t(15.8) = 2.03$, $p \leq .05$], and for the year [$t(17.8) = 2.27$, $p \leq .05$]. Compared to the group exclusively breast-fed more than 1 month (Br > 1 mo), the Bottle-fed group had a significantly higher mean respiratory illness score for months 1 to 6 [$t(74.9) = 2.30$, $p \leq .005$], months 7 to 12 [$t(78.5) = 4.06$, $p = 0.00$] and for the year [$t(78.9) = 4.36$, $p = 0.00$]. Compared to the group exclusively breast-fed for 1 month only (Br 1 mo), the Bottle-fed group had a higher mean respiratory illness score for months 7 to 12 [$t(45.2) = 2.83$, $p \leq .005$], and for the year [$t(32.3) = 2.75$, $p \leq .005$]. The bar graph in Figure 5 depicts these relationships. These findings verify hypothesis 5: The longer the period of exclusive breast-feeding, the lesser the severity of respiratory illnesses that occur during the first year.



Note: Significant mean differences by one-tailed "t" tests in comparison with the bottle group are indicated by asterisks: ** $p \leq .005$.; * $p \leq .01$; in comparison with the Breast + Sup. group are indicated by crosses ⊤⊤ $p \leq .05$; ⊤ $p \leq .1$.

Figure 5. Mean respiratory illness score compared by feeding groups for months 1 to 6, months 7 to 12, and for the entire year, months 1 to 12.

Table 8

Summary of Results of ANOVAS With Significant Findings, Means, Standard Deviations and Significance Tests For Differences Between Means For the Four Feeding Groups

Variable	Means and Standard Deviations For Each Feeding Group: Br < 1 mo (n = 26)	Br 1 mo (n = 13)	Br + Sup (n = 15)	Bottle (n = 55)	Overall "F" from ANOVA	Significant Pair-wise Mean Differences: Br > 1 mo vs Bottle	Br 1 mo vs Bottle	Br + Sup vs Bottle	Br > 1 mo vs Br 1 mo	Br>1 mo vs Br. + Sup	Br 1 mo vs Br + Sup	Variance Used
Demographic Variables:												
Number of sibs > 4 yr. old	.41 (.71)	.9 (14)	.8 (1.8)	.15 (.43)	3.05*	Br>1 mo>Bottle t = 1.39[a]	Br 1 mo>Bottle t = 1.80*	Br+Sup>Bottle t = 1.41[a]				separate
Months solids introduced	5.28 (1.9)	4.17 (1.6)	5.29 (2.8)	5.26 (2.2)	2.85*	Br>1 mo>Bottle t = 1.94*	Br 1 mo>Bottle t = 1.58[a]		Br>1 mo>Br 1 mo t = 2.83***	Br>1 mo>Br+Sup t = 1.39[a]	Br 1 mo>Br+Sup t = 1.34[a]	pooled
Number of Visits for Respiratory Illness	1.6 (2.0)	2.5 (2.4)	3.4 (3.5)	4.1 (2.8)	5.19***	Bottle>Br>1 mo t = 3.83****	Bottle>Br 1 mo t = 1.84*			Br+Sup>Br>1 mo t = 2.04*		pooled
Hypothesis 4:												
Number of Months with URI, Virus, Flu	.34 (.69)	.92 (1.7)	.73 (.96)	.81 (.86)	1.64	Bottle>Br>1 mo t = 2.64***				Br+Sup>Br>1 mo t = 1.37[a]		separate
Number of Months with Lower Respiratory Infection	.08 (.27)	.15 (.55)	.20 (.41)	.42 (.81)	1.96	Bottle>Br>1 mo t = 2.8***	Bottle>Br 1 mo t = 1.4[a]	Bottle>Br+Sup t = 1.4[a]				separate
Number of months with Otitis Media	.55 (.89)	1.00 (.91)	1.87 (2.0)	1.78 (1.36)	5.19***	Bottle>Br>1 mo t = 4.46****	Bottle>Br 1 mo t = 2.5**			Br+Sup>Br>1 mo t = 2.19*		separate
Hypothesis 5:												
Respiratory Illness Score Months 1-6	9.35 (15.1)	13.17 (28.6)	34.2 (46.11)	28.76 (42.9)	2.34[a]	Bottle>Br>1 mo t = 2.99***	Bottle>Br 1 mo t = 1.55[a]			Br+Sup>Br>1 mo t = 2.03*	Br+Sup>Br 1 mo t = 1.45[a]	separate
Respiratory Illness Score Months 7-12	14.27 (19.6)	20.77 (16.7)	29.40 (34.3)	40.49 (38.5)	4.33**	Bottle>Br>1 mo t = 4.06****	Bottle>Br 1 mo t = 2.83**			Br+Sup>Br>1 mo t = 1.57[a]		separate
Respiratory Illness Score Months 1-12	23.6 (3.08)	34.4 (32.5)	63.6 (64.2)	69.3 (53.4)	4.78***	Bottle>Br>1 mo t = 4.36****	Bottle>Br 1 mo t = 2.75**			Br+Sup>Br>1 mo t = 2.27*		separate

Note: Standard deviations are enclosed in parentheses.

[a] $p \leq .1$ * $p \leq .05$ ** $p \leq .01$ *** $p \leq .005$ **** $p \leq .001$

CHAPTER IV

DISCUSSION, SUMMARY AND CONCLUSION

Purpose of the Study

This study addressed the question whether, when compared to bottle-fed infants, breast-fed infants have fewer respiratory infections (a) while they are breast-feeding, or (b) during the first year after breast-feeding has ceased. Is the health of infants who are exclusively breast-fed different from breast-fed infants who are given supplements? Do infants who exclusively breast-feed for a longer period of time fare better than those who exclusively breast-feed for a shorter period? Do breast-fed infants have milder respiratory illnesses than bottle-fed infants?

Study Design

The investigation was a retrospective chart review conducted in an out-patient clinic frequented by a large proportion of Black (45%) and Southeast Asian (21%) infants. Many of the subjects were on welfare (70%) or had single parents (56%) Five hypotheses guided the research. Hypotheses 1, 2, and 3 addressed the question of infant respiratory health while breast-feeding (concurrent protection), and hypotheses 4 and 5 were concerned with a prolonged effect lasting through the first year.

Concurrent Protection

Hypotheses 1, 2, and 3 were investigated using chi-square tests to compare infants of the same age (in months) on the occurrence of a "definitive" respiratory illness while being (a) exclusively breast-fed, (b) breast-fed with supplementation of formula and/or solids, or (c) entirely bottle-fed.

Results for hypotheses 1, 2, and 3. The results of these analyses (presented in Table 5) were generally in the hypothesized direction but only reached a level of significance (exceeding a probability of .05) for the first three months. During months 1 and 2, exclusively breast-fed infants had fewer "definitive" respiratory illnesses than infants who were entirely bottle-fed and during month 3, exclusively breast-fed infants had fewer respiratory infections than infants being fed breast-milk with supplements.

Problems with the analyses of hypotheses 1, 2, and 3. Several problems may have contributed to the lack of additional significant findings: (a) the number of exclusively breast-fed infants declines every month (n = 13 in month 4; n = 8 in month 5) while the number of bottle-fed infants increases each month (n = 76 in month 4; n = 84 in month 6). Statistical comparisons between these divergent groups become less and less likely to find significant differences; (b) appropriate statistical analyses for

comparing their respiratory health were limited because the infants kept changing feeding modes (and comparison groups) during the observation period. Because the infants changed feeding groups during the year, one also wonders whether the intended question--that of concurrent respiratory health while feeding in a certain mode--is really being addressed. As the infant changes from exclusive breast-feeding to entire bottle feeding, is not his "current" respiratory health while bottle-feeding also influenced by his past 1 or 2 months of breast-feeding? Awareness of these problems and the strengths and weaknesses of previous studies led to the formulation of the four feeding groups in which the infants did not change groups over time. These 4 feeding groups were used to analyze hypotheses 4 and 5 and the demographic and social variables. The 4 feeding groups were: (a) exclusively breast-fed more than 1 month (Br > 1 mo); (b) exclusively breast-fed during month 1 with formula and/or solid supplements given during month 2 (Br 1 mo); (c) breast-fed with formula and/or solid supplements given beginning during month 1 (Br + Sup); and (d) entirely bottle-fed beginning during month 1 (Bottle).

Demographic and Social Variables

The demographic and social variables considered here were limited by the retrospective design and reliance on the medical records for information.

Significant differences between groups were found on 3 variables: (a) the number of siblings greater than 4 years old, (b) the month solids were introduced, and (c) the number of visits for respiratory illness.

Ages of siblings. The Bottle group had fewer siblings more than 4 years of age than did the group Br 1 mo ($p \leq .05$). Findings in the Norbotten Study (Mellander et al., 1959) were in a similar direction with the group exclusively breast-fed longest having the greatest number of school-age siblings. Since school-age siblings tend to be exposed to, and bring home, more respiratory pathogens, the direction of observed differences between feeding groups on this variable would tend to favor better respiratory health in the bottle-fed group.

Feeding habits. The results of the analysis of feeding habits indicated that infants who were exclusively breast-fed longer also tended to receive their last breast-feed later and solids later (see Appendix B). Other studies have also found an association between early weaning from the breast and early introduction to solids (Gulick, 1983; Riodan & Countryman, 1980; West, 1980).

Number of clinic visits for respiratory illness. Infants had more clinic visits for respiratory illness than for any other kind of illness. Visits for respiratory illness accounted for 36% of all clinic visits during the first year of life. The Bottle group made more clinic

visits for respiratory illness than either the group Br > 1 mo ($p \leq .001$) or the group Br 1 mo ($p \leq .05$). The group Br + Sup also had more clinic visits for respiratory illness than did the group Br > 1 mo ($p \leq .05$).

Number of well-checks or missed appointments and ethnicity. The number of well-checks and number of missed appointments were included in the study as indicators of the quality of care that the infants received at home. Past studies (Fergusson et al., 1978) have found that breast-fed infants receive more well-child care and that their mothers are more conscientious and compliant with medical advice. If improved health is observed in breast-fed infants, these researchers claim, it may be due to the better child-care these infants receive rather than to the breast-milk itself. Since the feeding groups in the present study did not differ in the number of well-checks or missed appointments, the health differences observed cannot be attributed to the better care-giving practices of the mother, as inferred in the study of Fergusson.

There are reports in the recent literature (Rassin et al., 1984) that breast-feeding is less practiced among Blacks and Hispanics. It was expected that the feeding groups in the present study would differ in racial composition. Even though Blacks were the largest racial

group, accounting for 39% of the total sample, the feeding groups did not differ significantly in ethnicity.

Prolonged Protection: Incidence of Respiratory Infection

Hypothesis 4 proposes an inverse relationship between the duration of exclusive breast-feeding and the number of respiratory illnesses during the first year. To analyze hypothesis 4, ANOVAs were used to compare the feeding groups for the number of months in the first year during which the infants had: (a) URI; (b) bronchitis; (c) bronchiolitis; (d) pneumonia; (e) croup, (f) a lower respiratory illness (the sum of b, c, d, and e); (g) days hospitalized, (h) an otitis media. Means, standard deviations, and significant pair-wise mean differences for the ANOVAs with significant findings are summarized in Table 8.

URI. The group Br > 1 mo had a mean of .34 months during the year with a URI. This was nearly a 3-fold reduction from that observed in the Bottle group ($p \leq .005$) who had a mean of 1.6 months with a URI. This marked difference between groups was not due to a few infants in the Bottle group having many recurrences of these upper respiratory illnesses. Nearly twice as many infants in the Bottle group (56%) had one or more episodes of URI (compared to 27% of the group Br > 1 mo).

Lower respiratory infections. A 5-fold reduction was seen in the number of months with a lower respiratory

illness from .42 months in the Bottle group to .08 in the group Br > 1 mo ($p \leq .005$).

Otitis media. Infants in this study had more months with otitis media than with any other respiratory illness and more differences between feeding groups were found for this variable than for any other variable. These differences are presented graphically in figures 2, 3, and 4 and are summarized in Table 8. The group Br > 1 mo differed from the Bottle group in having fewer infants with an early onset of otitis ($p \leq .05$), fewer recurrent otitises ($p \leq .005$) and fewer months with an otitis during the year ($p \leq .005$). The group Br > 1 mo also had fewer months with an otitis than did the group Br + Sup ($p \leq .01$).

These findings are similar to those of Saarinen (1982) who reported that infants for whom breast-milk was the only source of milk had fewer episodes of otitis during months 1 to 6 ($p \leq .05$) and months 1 to 36 ($p \leq .05$) than formula-fed infants. Saarinen suggests that early onset of otitis may induce metaplastic mucosal changes in the tympanic membrane which predisposes to recurrences and may lead to chronic secretory otitis. These tympanic mucosal changes could also explain the trend observed in the present study of a higher incidence of persistent otitis media in the bottle group (see Figure 4).

Even a short period of exclusive breast-feeding appeared to offer infants in the present study some

protection from otitis. Infants in the group Br 1 mo had significantly fewer ($p \leq .01$) months with otitis than infants in the Bottle group.

Otitis media was by far the most common respiratory illness recorded on infants' charts during the first year, and more differences between feeding groups were seen for otitis than for any other variable. The large number of differences seen between feeding groups for otitis could mean that breast-feeding is more effective in preventing otitis infections than in preventing other respiratory infections (URI or lower respiratory tract infections). However, the many differences between feeding groups for otitis also suggests that with a larger sample size and a larger number of illness episodes to compare, more distinctive differences between feeding groups would be seen for these other illnesses as well.

Prolonged Protection: Severity of Respiratory Illness

Hypothesis 5 proposed an inverse relationship between the duration of breast-feeding and the severity of respiratory illness during the first year. The total respiratory illness scores for months 1 to 6, 7 to 12, and 1 to 12 were compared by feeding group using three ANOVAs. The group Br > 1 mo had a lower respiratory illness score than the Bottle group for months 1 to 6 ($p \leq .005$), 7 to 12 ($p \leq .001$), and 1 to 12 ($p \leq .001$). The group Br > 1 mo had

a lower respiratory illness score than the Br + Sup group for months 1 to 6 ($p \leq .05$), and 1 to 12 ($P \leq .05$). The Group Br 1 mo had a lower respiratory illness score than the bottle group for months 7 to 12 ($p \leq .05$) and 1 to 12 ($p \leq .05$). Thus all group differences on the severity of respiratory illness were in the predicted direction. The results for severity of respiratory illness (hypothesis 5) parallel those for incidence of respiratory illness (hypothesis 4): a longer period of exclusive breast-feeding is better than a shorter period, but even a shorter period of exclusive breast-feeding is better than receiving supplements from month 1. There were no significant differences between infants who received breast-milk with supplements from month 1 and infants who were entirely bottle-fed.

Summary of Results

The greatest differences in respiratory health were observed between infants who were exclusively breast-fed for a longer period and infants who were entirely bottle-fed from the first month. Those breast-fed had significantly fewer clinic visits for respiratory illness, fewer months with URI, fewer months with lower respiratory illness, fewer months with otitis media, fewer otitis medias of early onset, and fewer recurrent otitis medias. The severity of respiratory illness, as reflected in the respiratory illness score, was lower for the infants exclusively breast-fed for

the longest period. These infants had a lower respiratory illness score for the first 6 months, second 6 months, and entire first year than infants who were entirely bottle-fed.

Infants who were exclusively breast-fed for a shorter period (1 month) also showed significant differences from the bottle-fed group in the indices examined: significantly fewer clinic visits for respiratory illness, fewer months with otitis media, a lower respiratory illness score for the second 6 months, and lower total respiratory illness score for the year.

The differences in respiratory health between breast and bottle-fed infants could not be attributed to social or demographic characteristics, or to a few infants in the bottle-fed group with many recurrent illnesses.

The finding which would perhaps surprise many health care practitioners is that there were no differences in respiratory health between infants who were breast-fed with supplements given beginning in month 1 and infants who were entirely bottle-fed from month 1. In addition, infants who were exclusively breast-fed for the longer period had significantly better respiratory health than breast-fed infants who were given supplements in several parameters: fewer clinic visits for respiratory illness, fewer months with otitis media, and a lower respiratory illness score for the first 6 months and the entire year.

Limitations of this Study

The question of whether breast-feeding protects infants while breast-feeding (concurrent protection) could not be answered adequately. This was in part due to an insufficient sample size. Though the total sample size was reasonable (N = 109), the number of exclusively breast-fed infants declined each month and statistical comparisons with the ever increasing bottle-fed group became more difficult after 2 months.

The retrospective design was the only feasible way to conduct this study within the allowed time frame. Because of this design, however, information was not available on some variables which have been found in past studies to be related to either the choice of feeding method or rate of respiratory illness. These variables which could not be investigated include family living standards, family income, parents' education, and whether mother is employed outside the home.

Suggestions for Future Studies

The following recommendations for further study were developed as a result of this investigation:

1) Design a prospective study to include accurate information on (a) infant feeding practices during the first month of life; (b) exact age when supplements of formula and/or solids are first

introduced into the diet of breast-fed infants; (c) exact age at last breast-feed; (d) family income, family living standards, and mother's employment status.

2) Repeat the study using a larger sample size so that better comparisons of infant respiratory health while being breast-fed, breast-fed with supplementation, or bottle-fed can be made.

3) Do a similar study over a longer time period (e.g. 3 years) to see if early feeding methods have a lasting influence on the child's respiratory health.

Conclusion

As the intricate interrelationships of immune system components become better understood, it becomes more obvious that breast-milk is uniquely suited to protect as well as nourish the infant during his first months. It is well accepted that breast-milk is effective in protecting the infant against certain common enteric pathogens. The theory of immunocyte "homing" (also called the enteromammeric link) joins the mother's mammary gland with the infant's gut and respiratory tract in a common secretory immune system. This theory suggests that the protective qualities of breast-milk witnessed in the infant's intestine also extend to the respiratory tract. How breast-milk is able to provide "local" protection in the respiratory tract is still

somewhat of a mystery. There is some evidence that young infants do inhale milk during feeding and that breast-milk prevents the adherence of pathogens to the infant's pharynx.

Studies of large numbers of infants early in this century reported that compared to bottle-fed infants, breast-fed infants did have fewer illnesses and deaths due to respiratory tract infections. Today, however, the concept that breast-feeding may protect infants from respiratory infection is foreign to many of the practitioners who provide their health care. Perhaps because protection is prolonged, the connection between early feeding methods and later health or illness goes unrecognized by many health practitioners as well as by many investigators studying the health benefits of breast-feeding. Formula and solid supplements are often quite casually recommended and given to breast-fed infants. In an equally casual manner, breast-fed infants who are given supplements are grouped with exclusively breast-fed infants by those studying the health benefits of breast-feeding. It is not surprising that many studies of this sort have found few health differences between groups of breast and bottle-fed infants.

The infant's own secretory immune system and mucous membrane barrier are immature at birth. Thus during the first few months he is particularly vulnerable to gastrointestinal and respiratory infections, to

hypersensitivity reactions, and to the long-term alterations in the mucous membrane structure and function which early infection can cause. The period of vulnerability corresponds to the period of exclusive breast-feeding which was found in this study to provide a lasting protective effect on the infants' respiratory health during the entire first year. The present study has found that the health benefits of exclusive breast-feeding do not end for the infant with the last breast-feed. Breast-feeding somehow contributes to the infant's long-term self-defense capabilities.

Implications for Practice

Nurses play a central role in determining the success or failure to establish breast-feeding. Their influence in this regard appears to be growing as they become more involved in patient teaching, give "birthing" classes, encourage expectant parents to make "birth plans," and inform parents of their options during and after the birth process. For example, a mother may wish to have skin-to-skin contact with her newborn, breast-feed on the delivery table, and a father may enjoy being involved with giving the first bath. All of these activities may be as important in establishing successful lactation as in the initial innoculation and immunological protection of the newborn.

Since parents may find the hospital environment hostile and strange, it is the nurse who acts as the patient advocate to be certain their plans are carried out.

In the past, many hospital nursing routines have hindered rather than promoted breast-feeding. These include taking the baby away soon after birth for weighing, measuring, shots, and bath; giving supplemental feedings in the nursery; limiting contact between mother, father, and infant; administration of excessive or unnecessary pain medication; inadequate patient education and assistance; and the distribution of "free" samples, literature, and other materials advertising infant formula. These and other aspects of stereotyped Western maternity care (Jelliffe & Jelliffe, 1978) are likely to make the initiation and maintenance of lactation more difficult by interfering with the let-down reflex by increasing the mother's anxiety and pain and/or the prolactin reflex by diminishing the amount of infant sucking (Jelliffe & Jelliffe, 1978).

During and after the neonatal period, nurses continue to play a crucial role in the maintenance of successful lactation. Parents often need encouragement to continue breast-feeding and seek advice regarding when to supplement breast-feeding with formula or solids and how long to continue breast-feeding.

The findings of the present study indicate that breast-fed infants who are not given any supplements for at least

the first 1 to 2 months have better respiratory health over the course of the first year. Supplements should not be given to breast-fed infants without good reason during the first few months.

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APPENDIX A

CHARACTERISTICS OF FAMILIES AND INFANTS

Characteristics of Families and Infants

Variable	Total (n = 109) No.	%	Br > 1 mo (n = 26) No.	%	Br 1 mo (n = 13) No.	%	Br + Sup (n = 15) No.	%	Bottle (n = 55) No.	%
Sex										
Male	57	53.3	12	46.2	6	46.2	9	64.3	30	55.6
Female	50	46.7	14	53.8	7	58.8	5	35.7	24	44.4
(missing = 2)										
Race										
Black	39	45.3	7	33.3	5	50.0	3	27.3	24	54.8
White	23	26.7	8	38.1	3	30.0	4	36.4	8	18.2
Asian	4	4.7	3	14.3	1	10.0	0	0	0	0
SE Asian	18	20.9	3	14.3	1	10.0	4	36.4	10	22.7
Chicano	1	1.2	0	0	0	0	0	0	1	2.3
Am. Indian	1	1.2	0	0	0	0	0	0	1	2.3
(missing = 23)										
Parental Marital Status										
Married	19	35.2	4	44.4	4	50.0	3	33.3	8	28.6
Single	30	55.6	5	55.6	4	50.0	5	56.6	16	57.1
Separated	3	5.6	0	0	0	0	1	11.1	2	7.1
Divorced	2	3.7	0	0	0	0	0	0	2	7.1
(missing = 55)										
Insurance										
None	2	2.2	0	0	1	12.5	0	0	1	2.2
Private	25	27.5	9	37.5	3	37.5	3	21.4	10	22.2
Welfare	64	70.3	15	62.5	4	50.5	11	78.6	34	75.6
(missing = 18)										
Mother Smoked When Pregnant										
No	19	40.4	4	66.7	2	28.6	1	16.7	12	42.9
Yes	28	59.6	2	33.3	5	71.4	5	83.3	16	57.1
(missing = 62)										
Family History of Allergy										
No	42	58.3	7	50.0	5	55.6	6	60.0	24	61.5
Yes	30	41.7	7	50.0	4	44.4	4	40.0	15	38.5
(missing = 37)										

Characteristics of Families and Infants

Variable	Total (n = 109) No. %	Br > 1 mo (n = 26) No. %	Br 1 mo (n = 13) No. %	Br + Sup (n = 15) No. %	Bottle (n = 55) No. %
Number of Sibs ≤ 4 years old					
0	49 61.3	8 47.1	8 72.7	7 53.8	49 61.3
1	27 33.8	9 52.9	3 27.3	5 38.5	27 33.8
2	4 5.0	0 0	0 0	1 7.7	4 5.0
Mean	.44	.53	.27	.54	.41
SD	.59	.52	.47	.66	.64
	(missing = 29)				
Number of Sibs > 4 years old					
0	59 75.6	12 70.6	7 63.6	6 54.5	34 81.2
1	12 15.4	3 17.6	1 9.1	4 36.4	4 10.3
2	3 3.8	2 11.8	0 0	0 0	1 2.6
3	3 3.8	0 0	3 27.3	0 0	0 0
6	1 1.3	0 0	0 0	1 9.1	0 0
Mean	.42	.41	.91	.91	.15
SD	.97	.71	.37	1.76	.43
	(missing = 31)				
Number of Missed Appointments					
0	33 30.3	8	5 30.5	3 20.0	17 30.9
1	40 36.7	12	4 30.8	5 33.3	19 34.5
2	9 8.3	2	1 7.7	1 6.7	5 9.1
3	12 11.0	3	1 7.7	4 26.7	4 7.3
4	8 7.3	0	1 7.7	1 6.7	6 10.9
5 or more	7 6.4	1	1 7.7	1 6.7	4 7.3
Mean	1.51	1.15	1.54	1.93	1.56
SD	1.62	1.22	2.07	1.70	1.65
	(missing = 0)				
Month Solids Introduced					
1	2 2.0	0 0	0 0	0 0	2 4.3
2	10 10.2	0 0	3 25.0	2 14.3	5 10.6
3	5 5.1	0 0	1 8.3	2 14.3	5 4.3
4	14 14.3	4 16.0	2 16.7	3 21.4	5 10.6
5	20 20.4	5 20.0	3 25.0	0 0	12 25.5
6 or later	46 47.8	16 64.0	3 25.0	6 42.8	21 44.7
Mean	5.39	6.28	4.17	8.29	5.26
SD	2.19	1.88	1.59	2.79	2.15
	(missing = 11)				

Characteristics of Families and Infants

Variable	Total (n = 109) No. %	Br > 1 mo (n = 26) No. %	Br 1 mo (n = 13) No. %	Br + Sup (n = 15) No. %	Bottle (n = 55) No. %
Birth Weight (grams)					
Mean	3279	3239	3356	3345	3252
Range	2509-4522	2509-3830	2550-4522	2807-4026	2537-4153
Age of Mother (years)					
Mean	22.8	23.9	22.5	22.3	22.5
Range	13 - 44	16 - 40	18 - 31	16 - 35	13 - 44

APPENDIX B

INFANT FEEDING PRACTICES

Duration of Exclusive Breast-feeding, Infant Age at Last Breast-feed and Age When Solids Were Introduced With Reference to Feeding Groups

Feeding Groups	Number of Infants Exclusively Breast-Fed During Given Month of Life						Number of Infants Receiving Last Breast-feed at the Given Age (in months)												Mean Age at Last Breast-feed (in months)	Number of Infants First Receiving Solids at Given Age (in months)[a]					
	Months						Months													Months					
	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12		1	2	3	4	5	6+
Br > 1 mo (n = 26)	–	9	5	5	5	2	–	1	1	3	2	1	2	1	1	1	0	12	8.6[b]	0	0	0	4	5	16
Br 1 mo (n = 13)	13	–	–	–	–	–	6	1	0	0	2	0	0	2	0	1	0	1	3.9	0	3	1	2	3	3
Br + Sup (n = 15)	–	–	–	–	–	–	8	2	1	0	0	2	0	0	1	0	0	1	3.2	0	2	2	3	0	7
Bottle (n = 55)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	5	2	5	12	21

[a] Number of observations do not equal "n" in feeding group due to missing data.

[b] Actual Mean is higher than that given but data not available for second year. See text. Significance of differences for age solids introduced is $p \leq .001$ by chi square analysis.

APPENDIX C

DATA SHEET

Preliminary Data

No. _____ included

birth date _____ hospital stay _____

sex 1) M 2) F mother's age _____

race 1) bl 2) wh 3) as responsible party's relation to child:

Birth wt _____ 1) mother 2) father 3) other relation

full term / premature 4) foster 5) other _____

severe problems at birth responsible party's marital status: 1) M 2) S

congenital anomaly insurance: 1) private 2) welfare

Additional Data

where delivered _____ sibs ≤ 4 yr. _____

mother smoked when pregnant 1) Y 2) N sibs > 4 yr. _____

family H/O allergy 1) Y 2) N # adults in houshold ___ # children ___

Health Data

date of contact _____ age _____

mode of contact: 1) phone 2) no show 3) visit clinic 4) visit ER day

5) visit ER night 6) hospitalized _____ days

purpose of contact: 1) well-check 2) immunization 3) respir. symptoms

diet: 1) breast only 2) breast & suppl. _____ 3) bottle only 4) solids

when suppl. introduced _____ when breast-feeding ceased _____

report of respiratory sympt.: 1) coryza days ___ 2) rhinorrhea days ___

3) vomitting days ___ 4) diarrhea days ___ 5) cough days ___

6) nasal congestion days ___ 7) temp. days ___ 8) ear pain days ___

health professional's assessment: 1) coryza 2) rhinorrhea 3) OM

4) BOM 5) SOM 6) cough 7) wheezing 8) adventitious UR sounds

9) adventitious LR sounds 10) throat 11) temp 12) retraction

diagnosis: _____

treatment: 1) antibiotics 2) ch. x-ray 3) referred for respir. sympt.

follow up visit scheduled 1) yes 2) no

APPENDIX D

PATIENT INFORMATION

Account # _____

Resident Outpatient Clinic

PATIENT INFORMATION
PLEASE COMPLETE ALL SECTIONS

Date _____

Patient Name _____

Patient Address _____

City _____ State _____ Zip Code _____

Patient Telephone _____ Patient's S.S. # _____

Patient Birthdate _____ Patient Sex _____ M _____ F

Patient Marital Status _____ Patient Race _____

Responsible Party (Person Paying Bill) _____

Responsible Party Address _____

City _____ State _____ Zip Code _____

Responsible Party Telephone _____ Responsible Party S.S. # _____

Responsible Party Marital Status _____

Responsible Party's Employer _____

Responsible Party's Work Telephone _____

Insurance Plan Name _____

Group Number _____ Agreement Number _____ Eff. Date _____

Accident Yes _____ No _____ Date _____ Time _____ Place _____

How Did Accident Happen _____

Who Referred You To This Clinic _____

Name of Friend or Relative _____ Telephone _____

I will make payment: 1) Cash at time of visit _____ 2) Need to arrange payments _____

The patient is responsible for all fees, regardless of insurance coverage. A variety of financial assistance programs are available.

INSURANCE AUTHORIZATION AND ASSIGNMENT (please read and sign)

I hereby authorize this clinic to furnish the insured's Insurance Company all information which said Insurance Company may request concerning my present claim. I hereby assign to the doctor all money to which I am entitled for expense relative to the services performed from time to time but not to exceed my indebtedness to said clinic. It is understood that any money received from the above named Insurance Company over and above my indebtedness will be refunded to me when my bill is paid in full. I understand I am financially responsible to said clinic for charges not covered by this assignment.

_____ RESPONSIBLE PARTY'S SIGNATURE

_____ PATIENT'S SIGNATURE

_____ DATE

AUTHORIZATION FOR MINORS (please read and sign)

I hereby authorize this clinic to provide such medical services including surgery, if necessary, either regular or emergency as may be determined to be in the best interest of those members of my immediate family, as listed above, who are minors. This authorization shall continue and be in full force and effect until revoked in writing.

PARENT OR GUARDIAN SIGNATURE _____

APPENDIX E

PEDIATRIC QUESTIONNAIRE

PEDIATRIC QUESTIONNAIRE

This questionnaire will provide the clinic with necessary background information to assure good health for your child. The information in this form is confidential and will become a part of the medical record. Please fill out all information appropriate for your child's age.

CHILD'S NAME _____ BIRTHDATE _____

DATE _____ CHART NUMBER _____

_____

FAMILY HISTORY:

Mother's age:_____ Father's age:_____

Names of other children and ages:

1. _____ 4. _____
2. _____ 5. _____
3. _____ 6. _____

Miscarriages, stillbirths, or abortions: No Yes

PAST HISTORY:

Mother's pregnancy

Prenatal care received at _____

Problems, illness or injury	No	Yes
Smoked cigarettes	No	Yes
Medications or drugs	No	Yes
Alcohol	No	Yes
Special tests (ultrasound, etc.)	No	Yes

Baby's Delivery

Delivered at _____

Type of delivery: (circle) Spontaneous vaginal Forceps C-section

Full term infant _____ Premature infant _____

Birth weight _____ Length _____ Head _____

Apgars _____

Problems at birth	No	Yes
Jaundice	No	Yes

Hospital stay _____ days

DO RELATIVES OF YOUR CHILD HAVE:

Allergies (asthma, hay fever, eczema)?	No	Yes	Who?_____
Heart attacks before the age 50 years?	No	Yes	Who?_____
Thyroid disease?	No	Yes	Who?_____
Tuberculosis?	No	Yes	Who?_____
Kidney disease?	No	Yes	Who?_____
Mental illness?	No	Yes	Who?_____
Convulsions?	No	Yes	Who?_____
Cancer?	No	Yes	Who?_____
Deafness or Blindness?	No	Yes	Who?_____

How many people live in your home Adults _____ Children _____

With whom does the child live (circle) Parents Mother Father Legal Guardian

APPENDIX F

PATIENT HISTORY

NAME

BIRTHDATE

BIRTH HISTORY

PRENATAL CARE _____ GRAVIDA ___ PARA ___ AB ___

PRENATAL MEDICATIONS & COURSE

_____

LABOR & DELIVERY _____

NEONATAL COURSE: GESTATION _____ LENGTH _____ WEIGHT _____

_____

PAST MEDICAL HISTORY

PREVIOUS MEDICAL CARE BY : _____

MAJOR ILLNESSES, INJURIES, HOSPITALIZATIONS, SURGERY (AGE, PLACE):

PREVIOUS IMMUNIZATIONS: DPT, TOPV
MMR
TB

FAMILY HISTORY

	CONG. DEFECTS	HEART DISEASE	DIABETES	SEIZURES	CANCER	ALLERGIES, ASTHMA	TB
FATHER							
MOTHER							
SIBS							
GRANDPARENTS							

SOCIAL HISTORY

HEALTH HISTORY SUMMARY

APPENDIX G

SUMMARY SHEET

Summary Sheet

Birthday
Sex
Race
Birth-wt (gms)
Mo. age
Marital status
Insurance
Smoked w. preg.
Fam. H.O. allergy
sibs $\leq$ 4 y.o.
sibs > 4 y.o.
no shows
mo. intro. solids

	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Feeding mode												
# WCC												
# immuniz.												
# visits resp. ill.												
resp. ill. score												
# visits other ill												
OM												
BOM												
SOM												
PE Tubes												
URI/Virus/Flu												
bronchitis												
bronchiolitis												
croup												
pneumonia												
meningitis												
sepsis												
reactive airway												
dehydration												
# days hospitalized												

AN ABSTRACT OF THE THESIS OF

JOANNA C. PICCHI, B.S.N., P.N.P.

FOR THE MASTERS OF NURSING

DATE OF RECEIVING THIS DEGREE: JUNE 1986

TITLE: BREAST-FEEDING AND RESPIRATORY INFECTION IN INFANCY

APPROVED: _____
MARIE SCOTT BROWN, R.N., Ph.D. THESIS ADVISOR

Respiratory infections are the most common cause of morbidity in infancy and childhood. Theory and evidence from immunology suggest that breast-feeding may protect infants against respiratory infections. This study investigated whether infants who were fed in different modes in early infancy differed in the number and severity of respiratory illnesses experienced while breast or bottle-feeding, and during the entire first year of life. All information was gathered from the medical records of infants born during 1981 who attended a particular pediatric outpatient clinic. The sample (N = 109) was composed of a large proportion of minority and Welfare patients.

To investigate whether breast-fed infants have a lower incidence of respiratory illness while breast-feeding (concurrent protection), infants feeding in three different modes (exclusively breast-fed, breast-fed with supplements, or entirely bottle-fed) were compared monthly on the incidence of any respiratory illness. The results showed

that infants exclusively breast-fed had a lower incidence of respiratory illness than entirely bottle-fed infants for months 1 and 2. During month 3, exclusively breast-fed infants had a lower incidence of respiratory illness than those breast-fed with supplements.

To determine whether infant feeding method influenced the incidence of specific respiratory illnesses during the entire first year of life (prolonged protection), four feeding groups were defined: exclusively breast-fed more than 1 month (Br > 1 mo); exclusively breast-fed during month 1 only (Br 1 mo); breast-fed with supplements of formula and/or solids given beginning during month 1 (Br + Sup); entirely bottle-fed beginning during month 1 (Bottle). The greatest differences were observed between the group Br >1 mo and the Bottle group: the group Br > 1 mo had fewer clinic visits during the year for respiratory illness; fewer months with a URI, lower respiratory infection, or otitis media; fewer otitis medias of early onset; fewer persistent otitis medias; and a lower Respiratory Illness Score for months 1 through 6, 6 through 12, and 1 through 12.

Significant differences were also observed between the groups Br > 1 mo and Br + Sup, and the groups Br 1 mo and Bottle. In each comparison, the groups receiving longer exclusive breast-feeding had fewer respiratory illnesses than those receiving little or no exclusive breast-feeding.

No differences were seen between the groups Br + Sup and Bottle.

The results of the present study indicate that breast-fed infants who are not given any supplements for at least the first 1 to 2 months have better respiratory health for the entire first year of life. This implies that supplements should not be given to a breast-fed infant without good reason during the first few months.