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Health Care Costs of Formula-feeding in the First Year of Life

Thomas M. Ball, MD, MPH, and Anne L. Wright, PhD

Abstract. Objective. To determine the excess cost of health care services for three illnesses in formula-fed infants in the first year of life, after adjusting for potential confounders.

Methods. Frequency of health service utilization for three illnesses (lower respiratory tract illnesses, otitis media, and gastrointestinal illness) in the first year of life was assessed in relation to duration of exclusive breastfeeding in the Tucson Children's Respiratory Study ($n = 944$) and the Dundee Community Study (Scottish study, $n = 644$). Infants in both studies were healthy at birth and represented nonselected, population-based samples. Children were classified as never breastfed, partially breastfed, or exclusively breastfed, based on their feeding status during the first 3 months of life. Frequency of office visits and hospitalizations for the three illnesses was adjusted for maternal education and maternal smoking, using analysis of variance. Cost estimates, from the perspective of the health care provider/payer, were based on the direct medical costs during 1995 within a large managed care health care system.

Results. In the first year of life, after adjusting for confounders, there were 2033 excess office visits, 212 excess days of hospitalization, and 609 excess prescriptions for these three illnesses per 1000 never-breastfed infants compared with 1000 infants exclusively breastfed for at least 3 months. These additional health care services cost the managed care health system between \$331 and \$475 per never-breastfed infant during the first year of life.

Conclusions. In addition to having more illnesses, formula-fed infants cost the health care system money. Health care plans will likely realize substantial savings, as well as providing improved care, by supporting and promoting exclusive breastfeeding. *Pediatrics* 1999;103:870-876; *infant feeding, cost analysis, breastfeeding, otitis media, lower respiratory tract illness, gastrointestinal illness, managed care plan, health maintenance organization.*

ABBREVIATIONS. HMO, health maintenance organization; OM, otitis media; LRI, lower respiratory tract illness; CRS, [Tucson] Children's Respiratory Study; TDMC, Thomas-Davis Medical Centers; WIC, Women, Infant and Children's Supplemental Food Program; GE, gastroenteritis.

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A major force in the provision of health care today is the desire to improve the quality of medical services offered to patients while containing costs. Health maintenance organizations (HMOs), which have increased their market share of the health care insurance industry in the United States, contract for services using capitated agreements that fix costs regardless of the patients' utilization of services. This approach has led to an emphasis on evaluating the cost-effectiveness of therapies and services and the provision of programs to improve health-related behaviors, such as smoking cessation and birth preparation classes. Accrediting agencies, such as the National Committee for Quality Assurance and the Accreditation Association for Ambulatory Health Care, acknowledge the importance of such activities by requiring them of HMOs and health centers.^{1,2}

Among children, infectious illness is a major reason for medical consultation. For children younger than 15 years of age, otitis media (OM) is the most frequent diagnosis in physician office practices. US children experienced ~24.5 million visits in 1990 for OM.³ Lower respiratory tract illness (LRI) such as bronchiolitis, croup, bronchitis, and pneumonia also are common, affecting one third of infants in a large US cohort.⁴ In addition, LRI frequently leads to hospitalization; 33 698 infants between 1 and 11 months of age were hospitalized with LRI in fiscal year 1992, with an average stay of 3.0 days.⁵ Greater than 50% of infants see a physician for at least one episode of gastrointestinal illness.⁶ The hospitalization rate for diarrheal illness among children, 97 per 10 000 children for an average length of stay of 3.9 days, was found to be relatively constant between 1979 and 1992.⁷ Each of these illnesses can result in utilization of other services, including telephone advice, visits to emergency departments, radiographic procedures, and prescriptions for medications.

Breastfeeding is associated with lower rates of infant illness in both developing^{8,9} and industrialized^{6,10-13} countries. In addition to ensuring optimal nutrition, breast milk provides a number of elements¹⁴ such as immunoglobins and growth factors not present in formula that appear to facilitate the development of immunologic response and growth of infant tissues such as the brain. More recently, breastfeeding has been associated with long-term protective effects, including lower rates of diabetes mellitus,¹⁵ recurrent wheeze at age 6,^{16,17} and higher intelligence quotients^{18,19} later in childhood. The American Academy of Pediatrics has recommended

that infants be breastfed exclusively during the first 6 months of life and that breastfeeding continue for at least 1 year.²⁰ Unfortunately, <60% of infants born in the United States are breastfed at all, and a minority are breastfed exclusively for the recommended period.²¹

Because breastfed infants have lower rates of illness, formula-feeding should result in higher costs to the health care system. We conducted this study to estimate the actual costs of care for formula-fed infants attributable to three outcomes: LRI, OM, and gastrointestinal illness. Estimates of frequency of illness were adjusted for confounders. We considered only costs accrued in the first year of life for two reasons: 1) the potential protective effects of breastfeeding are best documented for the first year of life, and 2) the current medical market demands a short-term return on each investment, such as perinatal breastfeeding promotion might require.

METHODS

Data regarding physician visits in the first year of life came from two studies: the Tucson Children's Respiratory Study (CRS), and the Dundee Community Study (Scottish study).⁶ Dr Howie graciously provided additional data from the Scottish study in a format compatible with the CRS data, to permit comparable analyses. The populations were similar in that they reflected community-based samples from small cities, where most participants were middle class. Both studies enrolled a large number of infants, with data collected on both the number of illness episodes and the exclusivity of breastfeeding. The Scottish study met the methodologic criteria for assessing the relationship between feeding status and infant illness outlined by Bauchner and associates.²² The CRS also met the same methodologic criteria except that children were followed passively by their pediatricians rather than actively by study nurses. Although results from studies conducted in the United States might be preferable from the standpoint of comparability of patterns of health care utilization, to our knowledge no recent publication has provided information regarding frequency of use of health care services for gastrointestinal illness in a large, nonselected US population.

LRI and OM: The CRS

Healthy infants using the pediatricians of a large local HMO were eligible to participate in the CRS. Of the 1760 families approached for the study, 350 refused participation and 165 were considered ineligible. Infants were considered ineligible if they had used oxygen and/or ventilator after 6 hours of life or had had major congenital anomalies, any congenital problems of the chest or lung, symptomatic congenital heart disease, or any severe systemic disease. Families also were considered ineligible if they did not plan to continue their infant's care at the same clinic or did not speak English. This enrollment strategy left a total of 1246 infants and their families, representing 78% of those eligible, who were enrolled between 1980 and 1984. Most of the population (80%) was white, and the majority of enrolled families had at least one employed member; more detailed descriptions are published elsewhere.^{4,23} Only children who were followed by the HMO physicians for the entire first year of life have been included in these analyses ($n = 1022$).

Data on infant feeding practices came from two sources. At each well-child visit in the first year of life, the HMO physicians recorded on a standardized form whether the child was currently breastfed and/or receiving formula, foods, or milk. When the child was 12 to 15 months of age, parents completed a questionnaire that assessed whether the child had been breastfed and, if so, for how long. Data obtained prospectively (from the well-child visits) were given priority and used in classifying 74% of subjects; however, concordance between the two sources was very high (>90%). Feeding data were available for 944 (92.4%) of the 1022 infants followed the entire first year of life.

Information on maternal education (≤ 12 years, 13 to 15 years,

or ≥ 16 years) was obtained at enrollment. Maternal smoking in the first year of life (nonsmoking or ≤ 1 pack/day vs ≥ 1 pack/d) was characterized based on a questionnaire completed when the child was 15 to 18 months old.

Data regarding occurrence of LRI in the first 3 years of life were obtained from forms completed by the physician at the time of an acute episode. Physicians provided information on signs and symptoms present, diagnosis, concurrent illnesses, medication prescribed, and hospitalization.⁴

The medical records of children in the study were reviewed when children were 3 years old for episodes of OM diagnosed during well-child and sick-child visits in the pediatricians' office (86%), at the HMO's urgent care center (9%), by physicians not in the HMO (3%), or by doctors whose signature was missing or illegible (1%). Medical records were reviewed for the assessment of OM for 1013 (99.1%) of the 1022 children followed the entire first year of life. No data regarding medication prescriptions for OM were obtained.

The study was approved by the University of Arizona Institutional Review Board, and informed consent was obtained from parents.

Gastrointestinal Illness: The Scottish Study

Howie and co-workers⁶ studied the relation between breastfeeding and gastrointestinal illness in the first 2 years of life among infants in Dundee, Scotland; here we use only data collected in the first year. Women with singleton pregnancies close to 36 weeks' gestation who lived in Dundee and were in a stable relationship were approached for participation. Enrollment continued until 750 mothers (86% of those eligible) enrolled. However, subsequent exclusion of 70 infants who delivered before 37 weeks, were <2500 g, or stayed in the special care unit >48 hours, plus six infants whose mothers withdrew, left 674 infants available for study, of whom 617 were followed the entire first year of life.

During home visits, health visitors observed both infant feeding and illness, at 2 weeks, and 1, 2, 3, 4, 5, 6, 9, and 12 months of age. The Scottish investigators categorized infants by breastfeeding status and whether they were breastfed exclusively <13 or ≥ 13 weeks. Health visitors reported new episodes of gastrointestinal illness, including vomiting and/or diarrhea, lasting as a discrete illness for 48 hours or more, as well as whether a general practitioner was consulted. A medical record review was conducted to confirm illnesses for which care was obtained.

Data regarding maternal education (some college versus no college) and maternal smoking (0 to 19 cigarettes vs ≤ 20 cigarettes/day) were obtained at enrollment. The study was approved by the Dundee District Medical Ethical Committee, and consent obtained from parents.

Calculations of Costs of Care

The perspective of the payer and/or provider within a managed care system was used for cost analyses. Direct medical costs were estimated based on the experience of the largest clinic of one HMO headquartered in Tucson, Thomas-Davis Medical Centers (TDMC), a large multispecialty clinic which cared for over 200 000 patients within Arizona. TDMC was an integrated health care system that contracted with local hospital systems for inpatient care. Greater than 90% of the clinic's business was contracted with managed care capitated agreements. The actual costs cited here generally were less than the clinic's regular fee-for-service charges.

Figures were obtained from TDMC administrators for the direct costs in 1995 of pediatric services provided. The total departmental costs included such items as personnel salaries and benefits, recruiting, malpractice insurance, medical equipment and supplies, equipment repair, office supplies, drugs and medicines, printing, postage, telephone, and building and occupancy expenses. The cost of immunizations was not included in the calculated cost because this would not be attributable to sick-child visits. Because co-payments paid by the patients varied by health plan, no co-payment has been deducted from the estimated cost.

The contracted daily rate paid by TDMC for hospitalization was proprietary information; therefore, the average contracted hospital rate charged per day to HMOs by one hospital in the community was used. The estimated cost for a posterior/anterior

and lateral chest radiograph with interpretation was based on contracted fees between the insurer and TDMC for these services. Costs for ventilatory tube placement were not considered because this procedure is rarely performed in the first year of life.

Data were not obtained regarding the antibiotics used to treat OM. Therefore, we made the assumption that each episode of OM was treated with an antibiotic and that 50% of the OM episodes resulted in a second follow-up visit. Medication costs for OM were determined by reviewing 1995 TDMC pharmacy records for frequency of use of antibiotics commonly ordered by TDMC pediatricians for a 10-day treatment of OM. A weighted average cost for an episode of OM was calculated based on the proportion of episodes for which each drug was prescribed, multiplied by the cost of the drug for the pharmacy. Amoxicillin was prescribed most frequently (for 60% of episodes at a cost of \$3.22/10-day course); followed by cefaclor (18%, \$26.65); cefixime (8%, \$29.49); loracarbef (8%, \$36.51); clarithromycin (3%, \$24.39); trimethoprim/sulfasoxazole (2%, \$3.76); azithromycin (0.5%, \$23.32); and erythromycin/sulfisoxazole (0.5%, \$23.34). Albuterol was the drug of choice in treating LRI. The pharmacy also provided the cost of a 10-day course of albuterol syrup. It was assumed that no medication costs were associated with episodes of gastroenteritis (GE). Again, prescription co-payments were not deducted from these estimated costs.

Costs of medical services for payers and providers vary depending on a variety of circumstances, eg, type of HMO, geographic location, and specific contractual arrangements. Therefore, cost data also were obtained from the regional health plan database of a large group model HMO in another state in the West to assist with sensitivity analysis and improve generalizability. The database, which tracks the costs of services, breaks down all costs including regional and local administrative overhead to unit costs for services provided at the patient level.

Analysis

Infants from both data sets were classified into three feeding categories based on the duration of exclusive breastfeeding: never breastfed, breastfed but introduced formula in the first 3 months ("partially breastfed"), and breastfed exclusively for ≥ 3 months. We used these categories to make the Scottish data, which were already categorized with reference to breastfeeding at 13 weeks, comparable with data obtained in the CRS.

Relations between feeding status and each illness outcome were assessed first. The χ^2 test was used to assess the significance of these relationships. Subsequently, health care utilization for a range of services for each illness outcome was calculated by feeding status, and the difference between utilization for never-breastfed children compared with children breastfed exclusively for ≥ 3 months. These mean differences were adjusted for covariates, maternal education level, and maternal smoking in the first year of life, using analysis of variance. Analysis was completed with Statistical Package for the Social Sciences for UNIX, version 4.0. This adjusted mean difference was multiplied by 1000 to determine the adjusted number of services per thousand never-breastfed infants that might be reduced through exclusive breastfeeding.

RESULTS

Relation of Illness Outcomes With Feeding Practices

The CRS population ($n = 944$) had a high rate of breastfeeding, with 34% breastfed exclusively for ≥ 3 months, 49% partially breastfed (breastfeeding supplemented with formula) in the first 3 months, and 16% never breastfed. In contrast, 14% of Dundee subjects ($n = 644$) were breastfed exclusively for ≥ 3 months, 46% partially breastfed, and 40% never breastfed. In both studies, women who breastfed were significantly better educated and less likely to smoke (data not shown).

Of the 1022 children followed for the entire first year in the CRS, 339 (33.2%) had LRI, most of which (69.5%) resulted in wheezing. The majority

of the children with LRI ($n = 251$) had only one episode, but 73 children had two LRI episodes, 10 had three, 3 children had four, and 2 children had five episodes, for a total of 449 LRI episodes in the first year. Acute OM was diagnosed 1679 times during the first year of life in the 1013 CRS children for whom data were available. Of the 617 children followed in Scotland, 313 (50.7%) saw their health care provider for gastrointestinal illness at some point in the first year.

Table 1 presents the relation between each illness outcome in the first year of life and feeding status. Infants breastfed exclusively for ≥ 3 months were significantly less likely to have had OM and gastrointestinal illness than were those who never breastfed. Breastfed infants also tended to be less likely to have had LRI in the first year of life, although the difference was not significant.

Utilization of Health Care Services in Relation to Feeding Status

Table 2 presents the frequency of use of health care services for each illness outcome by feeding status after adjusting for maternal education and maternal smoking. The mean number of episodes of LRI, OM, and GE per child in the first year of life is calculated for each feeding status. Estimates also are given per child for each illness for the number of follow-up visits, medications prescribed, chest radiographs, and hospitalizations.

Table 2 also presents the adjusted mean difference in use of services for 1000 never-breastfed children. Compared with 1000 infants who were breastfed exclusively for ≥ 3 months, the never-breastfed group experienced 60 more episodes of LRI and 580 more episodes of OM after adjusting for maternal education and smoking. These children also experienced 1053 more episodes of gastrointestinal illness. For 1000 never-breastfed infants, there were >609 excess prescriptions and 80 excess hospitalizations, relative to 1000 infants breastfed exclusively for 3 months.

Costs for Health Care Services

The cost estimates for each of the services were as follows: pediatric visit of limited duration for an established patient, \$65.75; course of antibiotics

TABLE 1. Percent With Illness in the First Year of Life, by Feeding Status

	Never Breastfed	Partially Breastfed	Exclusively Breastfed ≥ 3 mo
Tucson Study:	($n = 155$)	($n = 464$)	($n = 325$)
% Any LRI	36.1	33.6	29.8
% With OM*	67.1	67.5	55.7
Scottish Study:	($n = 246$)	($n = 282$)	($n = 89$)
% Gastrointestinal illness†	63.8	48.2	22.5

* $\chi^2 = 5.7$; $P < .02$ when % with OM is compared for those who never breastfed with those who breastfed exclusively ≥ 3 months.

† $\chi^2 = 44.8$; $P < .00001$ between never breastfed and exclusively breastfed. Adjusted for parental smoking and social class.

TABLE 2. Adjusted* Frequency of Health Care Utilization per Child in the First Year of Life, by Feeding Status, and Excess Utilization per 1000 Never-breastfed Infants

	Mean Frequency of Use per Child			Mean Difference/ 1000 Never Breastfed†
	Never Breastfed	Partially Breastfed	Exclusively Breastfed ≥3 Mo	
LRI				
Mean no. office visits	0.46	0.44	0.40	60
Follow-up visits‡	0.066	0.01	0.0165	50
Medications§	0.219	0.209	0.19	29
Chest radiography¶	0.065	0.021	0.014	51
Hospitalization	0.018	0.015	0.008	10
OM				
Mean number office visits	2.04	1.88	1.51	580
Follow-up visits#	1.02	1.44	0.755	290
Antibiotics**	2.04	1.88	1.51	580
Gastroenteritis				
Mean number office visits	1.50	0.94	0.45	1053
Hospitalizations	0.106	0.106	0.036	70

* Adjusted for maternal education and maternal smoking.

† Calculated by subtracting the frequency of use of each service per infant never breastfed from that of an infant breastfed exclusively >3 mo, and multiplying by 1000.

‡ For LRI in the absence of OM, follow-up visits were requested only for children with pneumonia, which was diagnosed for 14.3%, 3.2%, and 4.12% of LRI in the infants never-breastfed, partially breastfed, and exclusively breastfed, respectively.

§ Medication was prescribed for 47.5% of LRI for which OM was not diagnosed simultaneously.

¶ Chest radiography was performed for 14.2%, 4.7%, and 3.4% of LRI in the group that were never-breastfed, partially breastfed, and exclusively breastfed, respectively.

It was assumed that a followup visit was requested and that this visit was not done in conjunction with a well-child visit 50% of the time.

** Although data were not collected specifically regarding prescription of medication for OM, it was standard practice to prescribe an antibiotic among pediatricians in Tucson.

(weighted average), \$13.05; albuterol syrup, \$3.80; chest radiograph, \$36.00; and day of hospitalization (physician visit and hospital fee), \$886.16. Cost estimates obtained from the other large western HMO were comparable, although generally higher than those incurred by TDMC. Costs for office visits ranged from \$69 for a 10-minute “urgent” pediatric visit to \$132 for a 20-minute visit with an established pediatric patient. However, in this practice, chest radiographs cost \$60, whereas one day of hospitalization cost \$1025.

Table 3 calculates the total costs of additional services during the first year of life for a population of 1000 never-breastfed infants based on the cost of health services at TDMC. The difference of costs for office visits, including follow-up visits, was almost \$134 000 per 1000 never-breastfed infants, or \$134 per infant. Although relatively few infants were hospitalized for these illnesses, the difference in

frequency of hospitalization and in the magnitude of expense between never-breastfed and exclusively breastfed infants was substantial, being \$187 866 per 1000 never-breastfed infants. We estimated total expenses for care of 1000 never-breastfed infants as \$331 051 greater than expenses for the care of 1000 infants who were breastfed exclusively for ≥3 months.

When total costs were calculated using the cost data from the other HMO (while assuming similar pharmacy costs), they varied from \$151 per infant assuming 10-minute visits to \$258 per infant assuming 20-minute initial visits for office-based care and \$217 per infant for hospital-based care. Therefore, the excess total direct medical costs incurred by never-breastfed infants during the first year of life for these three illnesses alone was between \$331 and \$475 per infant *more than* the costs incurred by breastfed infants.

TABLE 3. Estimated Costs Associated With Never Breastfeeding Compared With Exclusive Breastfeeding For at Least 3 Months

Type of Service	# Services/1000 Never Breastfed	Cost/Service	Total Cost
Office visits	1693	\$ 65.75	\$111 315
Follow-up visits	340	\$ 65.75	\$ 22 355
Medications:			
LRI	29	\$ 3.80	\$ 110
OM*	580	\$ 13.05	\$ 7 569
Chest radiography	51	\$ 36.00	\$ 1 836
Days of hospitalization†			
LRI	30	\$886.16	\$ 26 585
GE	182	\$886.16	\$161 281
Total			\$331 051

* Cost is a weighted average based on actual prescribing practices by TDMC pediatricians in 1995.

† Uses national estimates of 3.0 and 2.6 days of hospitalization for LRI and gastrointestinal illness, applied to 10 and 70 episodes, respectively.

DISCUSSION

Exclusive use of formula is associated with substantial costs to the health care system solely in terms of the three most common illness outcomes in the first year of life. For each 1000 infants never breastfed, there is an excess of 2033 office visits, >200 days of hospitalization, and >600 prescriptions, compared with infants breastfed exclusively for at least 3 months. Differences between mothers who breastfed and those who did not are unlikely to account for this excess use of health services, because figures have been adjusted for maternal education and smoking. This excess use of health care services attributable to inadequate breastfeeding costs between \$331 and \$475 per infant never breastfed.

Medical costs within managed care systems can vary greatly depending on contractual arrangements and the system's structure. For example, TDMC did not have a hospital within its health care system, preferring to contract with community hospitals to provide inpatient care. The hospital providing pediatric care for TDMC patients contracted with local HMOs at an average rate of \$800 per day. This same hospital calculated its actual daily cost of hospitalization (by breaking down all costs to standard unit of costs for services at the patient level) for infants with bronchiolitis to be \$946. After adding the cost of a physician hospital visit, this figure is quite close to the calculated cost of \$1025 quoted by the other HMO used for comparison that does have a hospital within its system. These differences might explain why costs of hospitalization varied between the two systems whereas the costs of ambulatory care were quite similar.

The substantial cost savings found using cost data from these two western HMOs corroborates the finding in a pilot study completed in a southeastern HMO.²⁴ Actual savings credited to exclusive breastfeeding might differ depending on geographic location, the type of HMO, and characteristics of the population, including rates of illness (which generally are higher in lower income populations), and existing rates of breastfeeding. Because rates of breastfeeding differ widely across the country, the calculation of mean difference in health service utilization between 1000 infants never breastfed and 1000 infants breastfed exclusively permits estimates of costs for a particular HMO as well as comparisons of savings among populations.

We believe that our estimates of excess cost for care of never-breastfed infants are conservative, given that some costs associated with these illnesses were not included. For example, some episodes of all three illnesses would be seen at more costly sites, such as urgent care centers or emergency rooms during hours when the pediatric offices were closed, which cost the plan more than a visit to the pediatric offices. Treatment costs also are increasing, given increases in the prevalence of resistant bacteria in OM that require more expensive medications, as well as the trend to use small-

volume nebulizers in outpatient treatment of infants with LRI. Costs for hospitalization also would be higher if the infant was admitted for intensive care or if the plan is responsible for reimbursing the hospital for such ancillary fees as medications and procedures. Additionally, costs associated with other outcomes less common in breastfed infants in the first year, such as necrotizing enterocolitis²⁵ and meningitis,²⁶ also have not been considered. Finally, health care costs in Arizona have been found recently to be below the national average in both urban and rural settings.²⁷

It might be argued that although exclusive breastfeeding of ≥ 3 months could reduce use of services for the illnesses discussed here, other outcomes associated with breastfeeding might increase costs. Some studies have shown that bilirubin levels are higher in breastfed infants, which might lead to increased hospitalization for jaundice. However, many of these studies included infants who were not breastfed adequately, and proper breastfeeding techniques have been shown to reduce jaundice substantially.²⁸ Although dehydration among breastfed infants has received substantial publicity, this condition occurs more often as the result of diarrhea to which formula-fed infants are predisposed. In a large study of illness visits and hospitalizations among 1829 Navajo infants born over a 2-year period, hospitalization for both dehydration and meningitis was significantly more common among never-breastfed infants, and jaundice was not significantly increased among breastfed infants, despite the predisposition among Native American infants to high bilirubin levels.²⁹

Some differences exist between the two studies from which illness data were obtained that may affect their comparability. In the Scottish study, a nurse visited the home on a regular basis to identify episodes of illness, which were confirmed through a medical record review. The CRS ascertained LRI at the acute visit. However, a medical record review conducted as part of the CRS when the children were 3 years old revealed that only 13% of LRI reported were missed at the acute visit. Both studies were prospective starting at birth, thereby minimizing recall bias. Both enrolled only healthy infants, thereby excluding infants with early health problems, and the populations were not selected with reference to preexisting illness or family history.

Nevertheless, estimates of costs attributable to gastrointestinal illness based on the Scottish study seem higher than might be anticipated in the United States, primarily attributable to the high rate of hospitalization. In the United States, hospitalization for GE is approximately 10 times less common than hospitalization for LRI and tends to occur more frequently both in infants whose health is compromised by other factors and in economically disadvantaged infants born into situations of poor sanitation. Rates of GE may have been elevated in part because of the frequent contact with the research nurses or because of the higher rates of formula-feeding in this population. Undoubtedly,

there also are differences in health-seeking behavior, referral patterns, and reasons for hospital admission between the two countries. Despite these differences, estimates of illness attributable to GE are comparable with national statistics for the United States. Finally, even if there were no hospitalizations attributable to GE among never-breastfed infants, adjusted costs for hospitalization from LRI among 1000 never-breastfed infants still would be from \$26 585 to \$30 750 more than for 1000 infants breastfed exclusively.

Studies of the costs associated with formula-feeding are limited by the fact that it is ethically impossible to conduct a randomized, controlled trial of breastfeeding. The best alternative is to carefully select methodologically strong cohort studies that include appropriate data and to adjust the results for significant covariates, as we have done here. It is possible that this analysis has not accounted for a factor or factors that would impact health care utilization significantly. We also have made a number of assumptions regarding the treatment and follow-up of OM and regarding duration of hospital stays associated with hospitalizations for LRI and GE, which may not reflect future practice patterns or practices in certain populations. Future OM-associated costs might be less than we have estimated if pediatricians begin to use antibiotics less frequently to treat OM and do not substitute another medication. The hospital length of stay data we used are from 1992. Since that time, "viral gastroenteritis" has been subdivided into a number of subgroups; however, all the subgroup lengths of stay have remained between 2.0 and 3.0 days.³⁰ In addition, our estimate of 2.6 days is well within the range of hospital stays for diarrhea reported recently in four West Coast HMOs of 2.1 to 3.4 days.³¹ Future studies will need to confirm these findings in other populations and other health care systems.

This analysis, which has considered only direct medical costs, underestimates substantially the burden to society as a whole associated with our low level of exclusive breastfeeding. The family with a formula-fed infant incurs direct costs for care, if uninsured, or for co-payments if insured, as well as nonmedical costs such as family care and transportation to and from the doctor's office. Parental absence from work is expensive for both employee and employer.³² If a parent misses 2 hours of work for the excess illness attributable to formula-feeding, >2000 hours, the equivalent of 1 year of employment, are lost per 1000 never-breastfed infants. Insufficient breastfeeding also is expensive for the federal government through the Women, Infant's and Children's Supplemental Food Program (WIC). In 1991, the cost of formula through WIC was estimated at \$404 million.³³ Costs to support a breastfeeding mother through WIC is ~55% that of a formula-feeding mother.³⁴ Costs borne by families who purchase formula out of their own pockets are substantial, averaging \$855 for the first 6 months of life.³⁴ Other countries, such as Canada, have recognized potential savings to the economy from breastfeeding and provide a subsidy

to low income mothers for each month of breast-feeding.

Fortunately, there is substantial information regarding how a health plan can encourage breast-feeding among patients. Lactation management should be an important part of care for mothers and new infants, including assistance with positioning of the infant, counseling on the prevention and solution of nursing problems, and advice on dealing with particular concerns such as working outside the home, where to obtain an efficient, comfortable breast pump, and how to nurse in public. Office staff should be trained to assess adequacy of nursing routinely, and a range of support options should be available including liaison with lactation consultants, breastfeeding hotlines, support groups, and La Leche League. Insurers might be wise to team with employers to create a breast-feeding conducive-employee environment.³⁵

However, perhaps the most effective way HMOs can contain costs attributable to inadequate breast-feeding is to carefully select the hospital at which their deliveries occur. Numerous practices common to hospitals appear to undermine breastfeeding,³⁶ including delay in getting the infant to breast,³⁷ separation of mother and infant,^{38,39} lack of hands-on assistance with breastfeeding,³⁶ and provision of formula or coupons to breastfeeding mothers.^{40,41} Health care plans should assess potential contracting hospitals' compliance with the "Ten Steps to Successful Breastfeeding," popularized through the international Baby Friendly Hospital Initiative, to determine their commitment to providing a supportive environment for breastfeeding.^{42,43}

This analysis has demonstrated that substantial cost savings can be expected within the first year of life through exclusive breastfeeding. During this period of cost-containment in health care, it is important to invest in areas that will improve patient health outcomes, increase patient satisfaction, and result in cost savings. Health insurance plans would be wise to support breastfeeding initiatives that improve patient care, infant health, and the financial bottom line.

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