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April 19, 2013 — Date

Benefits of Exclusive Breastfeeding for 6 months of Life:
A cost analysis in a Medicaid population

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Career MPH

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An abstract of
A Thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Benefits of Exclusive Breastfeeding for 6 months of Life:
A cost analysis in a Medicaid population

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Andrea L. Caplea, M.D.

Objectives: Evidence suggests cost savings if exclusive breastfeeding for 6 months national goals are met. This analysis fills a knowledge gap of inpatient Medicaid cost expenditures due to exclusive breastfeeding percentages under goal. It was hypothesized that in a Medicaid population, exclusive breastfeeding for 6 months is cost effective in comparison to other feeding methods with regards to inpatient hospitalizations averted due to the high prevalence primary diagnoses of lower respiratory tract infections (LRTI) and gastroenteritis.
Methods: A decision analysis model was built. Analysis included determination of the under 1 year of age US population with Medicaid insurance, the percentages of exclusive breastfeeding versus non-breastfeeding within this group, and the incidence of hospitalization for LRTI and gastroenteritis in each cohort. Costs were then calculated for each cohort and diagnosis. This methodology was repeated for the national US exclusive breastfeeding percentage and the Healthy People 2020 goal percentage.
Results: If Medicaid exclusive breastfeeding percentage at 6 months increased from its current level of 10.0% to the current national exclusive breastfeeding percentage at 6 months of 16.3%, more than $14,234,680 could be saved annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis. If Medicaid exclusive breastfeeding percentage at 6 months increased to the Healthy People 2020 exclusive breastfeeding percentage at 6 months goal of 25.5%, more than $35,000,000 could be saved annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis.
Conclusions: Medicaid breastfeeding percentages are below US National breastfeeding percentages and well below Healthy People 2020 goal percentages; this difference is costly in terms of infant morbidity as well as inpatient hospitalization costs. Appropriate cost research may encourage further outreach aimed to increase exclusive breastfeeding in Medicaid recipients.

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Table of Contents

Abbreviations

AAFP- American Academy of Family Physicians
AAP- American Academy of Pediatrics
ACOG- American Congress of Obstetricians and Gynecologists
AHRQ- Agency for Healthcare Research and Quality
CDC –Centers for Disease Control and Prevention
CI- confidence interval
HCUP- Healthcare Cost and Utilization Project
ICD-9-CM- International Classification of Diseases-9th Revision- Clinical Modification
LRTI- lower respiratory tract infection
NIS- National Immunization Survey
NSCH- National Survey of Children's Health
OR- odds ratio
SCHIP- State Children's Health Insurance Program
UNICEF- United Nations International Children's Emergency Fund
USDA- United States Department of Agriculture
WIC- Special Supplemental Food Program for Women, Infants and Children

Introduction

Breast milk is the physiologic form of infant nutrition and contains maternal antibodies that are protective of infant health via passive immunity. Breastfed infants have fewer episodes of many common childhood infections including respiratory infections, gastrointestinal infections, and otitis media.[1-3] The risk of disease including eczema, asthma, obesity, type I diabetes mellitus, and acute lymphocytic and acute myelogenous leukemias is lower in breastfed babies.[2] Reports indicate a decreased risk of type II diabetes mellitus in individuals breastfed as infants.[1,2] Mortality due to sudden infant death syndrome (SIDS) is less prevalent in breastfed infants as well.[1,2]

Puerperal maternal benefits of breastfeeding include decreased blood loss from delivery and decreased risk of delayed postpartum hemorrhage.[4] Exclusive breastfeeding can induce lactational amenorrhea and can therefore assist with birth spacing.[3] Mothers who breastfeed have a lower risk of breast cancer, ovarian cancer, and type 2 diabetes mellitus.[1,2] Psychosocial benefits to mother and child, including a sense of bonding, are often described by women who breastfeed.[1]

Additionally, the social and public health benefits due to breastfeeding are marked. Direct cost savings due to breastfeeding have been demonstrated largely due to a reduction in disease burden. Indirect costs of infant formula feeding (non-breastfeeding) include an increase in parental missed workdays and decreased work productivity. Non-breastfeeding increases the environmental burdens of disposal of infant formula feeding products and energy usage for infant formula production.[4]

Worldwide efforts to increase breastfeeding rates have been underway for decades. UNICEF began “The Baby-Friendly Hospital Initiative” in 1991; this global program remains active

and encourages hospitals to implement specific steps to encourage new mothers to initiate breastfeeding during hospitalization for labor and delivery.[5] The World Health Organization (WHO) began multinational data collection and surveillance on breastfeeding duration in 1991, and reports the transition from breast milk to table food as a fragile time in regards to onset of malnutrition in those nations that experience high rates of under-five mortality.[6,7]

The 2011 Surgeon General's Call to Action to Support Breastfeeding promotes breastfeeding and endorses breast milk as the preeminent form of infant nutrition.[1] This report cites the many psychosocial, health, environmental and economic benefits to both mother and child of infant breastfeeding and encourages an increase in social, workplace, healthcare, and community support for breastfeeding women. The Special Supplemental Food Program for Women, Infants and Children (WIC), the United States (US) federal grant program that provides funding for nutritious foods and nutrition resources, reports promotion of breastfeeding as a major goal, and restructured their food packages in 2009 to increase food resources to exclusively breastfeeding enrollees.[8] Various state health department projects are currently funded by the Centers for Disease Control and Prevention (CDC) with the goal to improve community outreach and support to breastfeeding women, especially in low-income and minority populations that consistently have demonstrated lower prevalence of breastfeeding initiation and maintenance.[9]

Many national health organizations focused on obstetrics and infant care support breastfeeding in their policy and position statements. The expert consensus guideline clinical protocol model breastfeeding policy assumed by the National Guideline Clearinghouse of the United States Department of Health and Human Services Agency for Healthcare Research and Quality (AHRQ) promotes breastfeeding as the optimal nutritional choice for infants, and actively supports education and support of breastfeeding mothers to improve breastfeeding

outcomes for infants and mothers.[10] Further organizations and their respective recommendations include:

- The American Academy of Family Physicians (AAFP) policy statement on breastfeeding reads "breastfeeding is the physiological norm for both mothers and their children."[11]
- The American Academy of Pediatrics' (AAP) position is "breastfeeding ensures the best possible health as well as the best developmental and psychosocial outcomes for the infant."[4]
- American Congress of Obstetricians and Gynecologists (ACOG) committee opinion "strongly supports breastfeeding" and presents breast milk as the preferred form of infant feeding. ACOG calls for support for breastfeeding women in the medical community and in the workplace.[12]
- American Public Health Association (APHA) states "exclusive breastfeeding for 6 months with continued breastfeeding for at least the first 1 to 2 years of life, is the biologic norm and that all alternative feeding methods carry health risks in comparison."[13]
- American College of nurse Midwives "promotes breastfeeding as the optimal method of infant feeding" and addresses the instinctive and learned behaviors that benefit from social and health system support.[14]

The extent and duration of infant breastfeeding is largely determined on an individual basis by the breastfeeding mother and infant pair. There is large variation in the individual practice choices regarding exclusivity of and duration of breastfeeding. This decision is impacted by many factors, including (but not limited to) a desire to provide health benefits to the infant, convenience, comfort of breastfeeding at home or in public spaces, and ease of breastfeeding continuance upon maternal return to work.

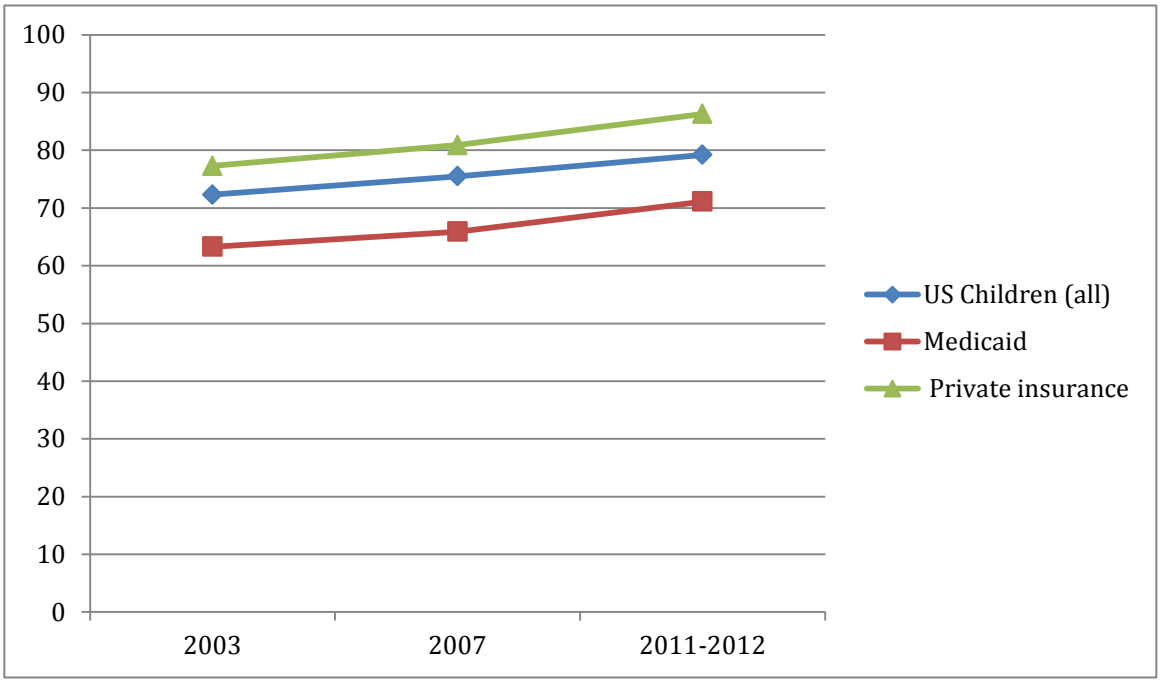
A 2013 study by Odom et al. on more than 2500 new mothers reported 60% of mothers did not continue breastfeeding for as long as they had initially intended.[15] In fact, return to work is often cited as a reason for maternal cessation of breastfeeding.[16] Employed women who spend greater than 30 hours at the workplace are significantly less likely to initiate and sustain

exclusive breast-feeding.[17] Statistically significant indicators for actual breastfeeding duration lower than initial personal goal include multiparity, single parenthood, WIC participation, and education level.[15]

It is common for infants to receive nutrition via a combination of breast milk and infant formula. This practice is referred to as "partial breastfeeding". Exclusive breastfeeding will be defined as the use of breast milk alone for infant nutrition. Exclusive infant breastfeeding until 6 months of age is the current recommendation of the APHA, WHO, AAFP, AAP, and ACOG and many other professional organizations.[4,7,11-14,18,19] These organizations encourage continued breastfeeding during infants' first year of life and for as long as both mother and child mutually desire.

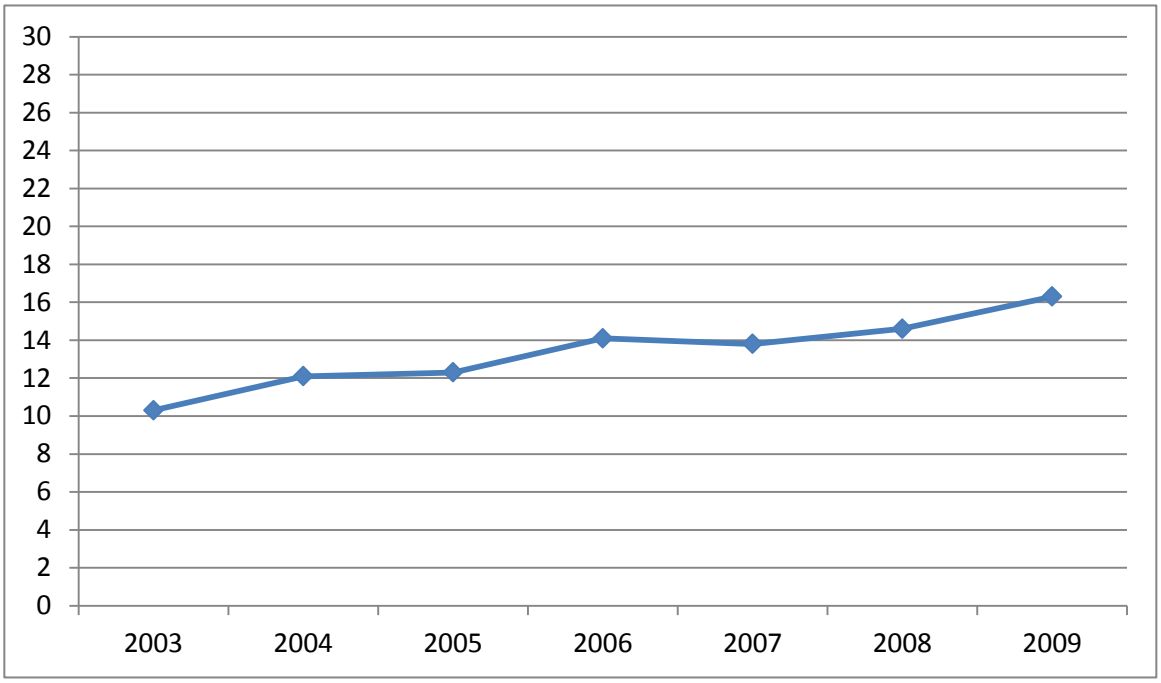
National breastfeeding practices are on the rise. Between 2000-2008, the prevalence of infants ever breastfed in the United States (US) increased from 70.3 to 74.6%.[9] The National Child Health Survey (NCHS) reports increasing rates of ever-breastfed amongst Medicaid recipients since it began collecting this information. In 2003, 63.3% (95% CI: 61.7, 65.0) of US Medicaid recipients under the age of 5 were ever breastfed. In 2007, survey results indicated 75.5% (95% CI: 74.3, 76.7) of infants insured by Medicaid were ever breastfed, and data from the most recent survey covering 2011-2102 indicate an even higher percentage at 79.2% (95% CI: 78.2, 80.2) (see Figure 1).[20]

Figure 1. Percentage of US Children (ages 0-5) ever breastfed, National Survey of Children's Health



These ever-breastfed data are encouraging, but they do not include specifics on breastfeeding duration. As the current recommendation by many public health entities is to exclusively breastfeed for 6 months, data specifically addressing a 6 month duration of exclusive breastfeeding is more indicative of compliance with this recommendation. The NCHS, the survey utilized in this research report to provide distinction between breastfed groups by insurance status, added a question specifically addressing exclusive breastfeeding for 6 months to its survey in 2007. The 2007 data set is the only published data in this survey to date; the most recent survey data from 2011-2012 is not yet reported. The CDC's National Immunization Survey (NIS) began data collection specifically regarding exclusive breastfeeding for 6 months percentages in 2003, and the documented percentages have been steadily increasing (see Figure 1).[21] Provisional 2009 data from the NIS indicate that 16.3% (95% CI: 15.1,17.5) of US infants were exclusively breastfed until 6 months of age.[22] Healthy People 2020 Objectives aim to increase this percentage of exclusive breastfeeding to 25.5% by 2020.[22,23]

Figure 2: Percentage of US Children Exclusively Breastfed for 6 months, National Immunization Survey



Studies suggest significant cost savings if breastfeeding percentages increased. Jon Weimer's USDA report in 2001 calculated a direct and indirect cost savings of 3.6 billion US dollars due to projected reduction of only three diseases with an increase from 29% to 50% breastfeeding (partially and/or exclusively) at 6 months. Of this amount, 3.1 billion dollars was attributed to costs associated with infant fatality due to necrotizing enterocolitis, a disease with reduced incidence in breastfed infants.[24]

It is valid to perform cost analysis of breastfeeding in Medicaid populations as Medicaid devotes significant resources towards prenatal care, infant delivery, breastfeeding promotion and lactation support. According to Medicaid data, 40% of the newborn deliveries in the US are financed via Medicaid insurance, and lactation services commonly begin during prenatal care and continue into maternity hospitalizations.[25] Many states include coverage for lactation services under Medicaid insurance, however, these services are not nationally mandated and

service coverage varies by state.[26]

Total Medicaid spending in fiscal year 2010 was over 389 billion US dollars.[27] 21.2% of that expenditure, or over 82 billion US dollars (FY2010), was directed to inpatient medical costs, excluding physician, laboratory, prescription drug, and x-ray payments.[28] According to the NSCH, 34.7% (C.I. 33.2, 36.2) of US children under the age of 5 have public insurance.[29] Medicaid is the majority payer for US pediatric admissions, and "Medicaid's share of aggregate hospital costs for children increased from 40 percent in 2000 ($10.5 billion, inflation-adjusted) to 49 percent in 2009 ($16.4 billion)."[30] Medicaid is also the major insurance payer for pediatric infectious disease hospitalizations, covering 58.5 +/- 0.8% of these pediatric admissions.[31] Inpatient hospital costs consume a large portion of the Medicaid budget. In addition, small pilot studies have suggested that inpatient hospitalization cost and average medical costs are lower in breastfed infants.[24,32]

Hospitalization implies a high level of disease morbidity. Almost half (42.8%) of pediatric inpatient primary diagnoses cases are of infectious etiology.[31] Between 2000 and 2009, respiratory diseases were the leading diagnoses for inpatient pediatric hospitalizations and accounted for approximately 25% of these admissions.[30,33] Disorders of the digestive tract comprise the second highest rate of pediatric hospital admission categories after respiratory illness between the years 2000 and 2009. Dehydration, a common complication of acute gastroenteritis that can require inpatient care, was the 6th leading inpatient diagnosis in this time period. (The fourth and fifth leading inpatient pediatric diagnoses were mood disorders and appendicitis, respectively).[30] Lower respiratory tract infection (LRTI) and gastroenteritis are frequent causes of inpatient hospitalizations and thus important contributors to Medicaid expenditures.

The objective of this thesis is to demonstrate the potential cost savings due to exclusive

breastfeeding for 6 months in Medicaid recipients, using the outcome of cost of hospitalizations averted. Specifically, inpatient hospitalizations with the primary diagnosis of two diseases of infectious etiology will be analyzed; those due to lower respiratory tract infection (LRTI) and those due to gastroenteritis. The risk ratio in these two disease categories supports breastfeeding for disease reduction, as presented in an AHRQ meta-analysis of breastfeeding outcomes data performed by Ip et al.[2]

Multiple publicly available data sources will be utilized: National Vital Statistics System population data, Medicaid inpatient hospital costs, National Survey of Children's Health (NCHS) breastfeeding data on breastfeeding percentages in the Medicaid population, National Immunization Survey breastfeeding percentages, and Healthcare Cost and Utilization Project (HCUP) cost data.

Research Question

What are the potential cost savings to Medicaid due to LRTI and gastroenteritis hospitalizations averted if percentages of exclusive breastfeeding for 6 months in Medicaid recipients increased to national recommendations?

Population: Medicaid recipients

Outcome: cost savings due to LRTI and gastroenteritis hospitalizations averted

Time Horizon: insurance cost analysis for infants less than 1 year of age

Problem and Purpose Statements

Evidence suggests cost savings if exclusive breastfeeding for 6 months national goals are met. This analysis fills a knowledge gap of inpatient Medicaid cost expenditures due to exclusive

breastfeeding percentages under goal. It was hypothesized that disease incidence and therefore hospitalization reduction associated with exclusive breastfeeding for 6 months is cost saving in comparison to non-breastfeeding with regards to inpatient hospitalizations averted due to the high prevalence primary diagnoses of lower respiratory tract infections and gastroenteritis.

Significance Statement

Appropriate cost analysis may encourage further support and outreach aimed to increase exclusive breastfeeding in Medicaid recipients.

Definitions

Breastfeeding shall be inclusive of direct breastfeeding and the feeding of expressed human breast milk. Exclusive breastfeeding is defined as the use of breast milk as the sole form of infant nutrition. Partial breastfeeding is the use of other forms of nutrition, inclusive of infant formula, solids, table food, water, or other liquids in addition to breast milk. Infant formula feeding is regarded as the use of infant formula for infant nutrition. The term “bottle feeding” does not distinguish between breast milk and infant formula and thus shall not be used in this analysis. For the purpose of this study, those not categorized as exclusively breastfeeding for 6 months duration will be referred to as non-breastfeeding or non-breastfed. The cohorts of partially breastfed infants or infants breastfed exclusively for less than 6 months will not be analyzed.

Literature Review

A 2012 study specifically addressing the cost to the state of Louisiana associated breastfeeding with cost savings. Utilizing AHRQ cost data on 4 disease categories [LRTI,

gastroenteritis, necrotizing enterocolitis (NEC), and sudden infant death syndrome (SIDS)], Ma et al. reported a savings of over 99 million US dollars to the state of Louisiana if compliance with Healthy People 2020 goals of exclusive breastfeeding for 6 months could be achieved (2012 US dollars).[34] Disease incidence for each disease in exclusively breastfed and in non-breastfed infants was estimated by the formula x= s/br +1 –b, wherein x was the particular disease incidence, s was overall disease incidence, b was breastfeeding percentage in Louisiana, and r was the odds ratio in favor of breastfeeding. Disease incidence was obtained from multiple resources, breastfeeding percentages were obtained from previously published studies and via the NIS, odds ratios were obtained from the AHRQ study. Cost savings presented were the products of the difference in cases and the cost per case/death, which was estimated using calculations from the AHRQ and previously published studies. Of note, this study categorized infants as exclusively breastfed or non-breastfed, as they determined categorization and analysis of partially breastfed infants prohibitive.

A 2010 study by Bartick and Reinhold utilized CDC NIS breastfeeding percentages from 2005 to perform a cost analysis on all diseases that the AHRQ presented with risk reductions secondary to breastfeeding. The analysis estimated 2.2 billion US dollars annual savings due to reduction in these 10 conditions if Healthy People 2010 goals of 17 percent of the population exclusively breastfed for the first six months of life. The authors estimated these savings escalated to an estimated 13 billion US dollars saved annually if ninety percent of the population complied with the recommendation for exclusive breastfeeding for 6 months (2007 cost adjustment value). [35]

A 2001 US Department of Agriculture report by Weimer presented the potential cost savings if breastfeeding prevalence increased from actual percentages to percentages recommended by the Surgeon General. Weimer calculated an estimated 3.6 billion dollars of

direct and indirect medical costs to society due to excess expenditures associated with three childhood illnesses. Lower respiratory tract infection, gastroenteritis, and necrotizing enterocolitis costs were analyzed; of note, 3.1 billion dollars was attributed to premature deaths most often associated with necrotizing enterocolitis.

A 1997 prospective trial on over 800 Medicaid recipients in Colorado associated breastfeeding and being enrolled in WIC with reduced Medicaid expenditures. WIC recipients who breastfed during the first 6 months of life were associated with a WIC cost savings of $478 per infant for a period of 6 months, which decreased to a savings of $161 after inclusion of infant formula manufacturers' rebates.[36] The adjusted value are $691.44 and $232.89 US dollars in 2013 [adjusted with CPI Inflation Calculator, US Department of Labor][36,37] The Medicaid cost difference was not significantly different between the cohorts. Of note, this study eliminated those enrolled in Medicaid HMO or FQHC enrollees, two large contributors to healthcare provision in Medicaid populations. This study was performed prior to the amplification of the WIC package for breastfeeding mothers.

A 1996 study by Horton et al. regarded the cost impact of breastfeeding versus infant formula feeding. Implementing breastfeeding promotional campaigns was found to be a cost effective intervention because of an associated decrease in infant formula usage, a decreased morbidity and mortality due to gastroenteritis, and a gain in disability adjusted life years (DALYs). The researchers found that by investing between 30 to 40 cents per birth on successful breastfeeding promotions, the burden of disease would be reduced for approximately 2 to 4 dollars per DALY gained.[38] In 2012, this is equivalent to investing 44 to 58 cents per birth to reduce the burden of disease for approximately $2.90 to $3.80 per DALY [adjusted with CPI Inflation Calculator, US Department of Labor].[37]

LITERATURE REVIEW: BREASTFEEDING AND LOWER RESPIRATORY TRACT INFECTION AND GASTROENTERITIS-

Increased duration of exclusive breastfeeding has been shown to improve health outcomes. A 2006 secondary analysis of NHANES data by Chantry et al. compared a cohort of infants exclusively breastfed for 4 to less than 6 months with a cohort of infants exclusively breastfed for at least 6 months. They reported statistically significant increased odds for respiratory tract infection (specifically, pneumonia) in infants breastfed for less than six months, adjusted odds ratio 4.27 (95% CI: 1.27, 14.35).[39] (OR was adjusted for common respiratory disease confounders.)

A 2003 meta-analysis by Bachrach et al. analyzed the impact of exclusive breastfeeding upon pediatric inpatient hospitalization due to LRTI in developed nations. This study used two mutually exclusive categories for analysis: exclusively breastfed and not breastfed. The number needed to treat (exclusively breastfed for a minimum of 4 months) to prevent one hospitalization for LRTI was 26. The calculated summary relative risk was 0.28 (0.14-0.54), demonstrating a 3.6 fold increase in hospitalizations for LRTI in those who are not exclusively breastfed.[40]

A study of 15,890 term infants born in the United Kingdom between 2000-2002 analyzed the impact of breastfeeding upon LRTI and gastroenteritis hospitalizations. In sum, Quigley et al. reported 27% of LRTI hospitalizations and 53% of gastroenteritis hospitalizations could have been prevented monthly by exclusive breastfeeding. More specifically, the calculated monthly prevalence of LRTI admissions in those not breastfed was 0.49, and in those exclusively breastfed was 0.30. The adjusted odds ratio for LRTI admission in those not breastfed was 1.00, and in those exclusively breastfed was 0.37 (95% CI: 0.18, 0.78). The monthly prevalence of gastroenteritis admissions in those not breastfed was 0.18, and in those exclusively breastfed

was 0.05. The adjusted odds ratio for gastroenteritis admission in those not breastfed was 1.00, and in those exclusively breastfed was 0.66 (95% CI: 0.47, 0.92).[41]

A prospective cohort study published in 2010 by Duijts et al. on duration of exclusive breastfeeding presented statistically significant decreased morbidity due to respiratory infections and gastroenteritis in infants exclusively breastfed until 4 months of age. Exclusive breastfeeding for the first 4 months of life and partially thereafter was associated with a decreased incidence of upper respiratory tract infections, adjusted OR 0.65 (95% CI: 0.51, 0.83), decreased LRTI, adjusted OR 0.50 (95% CI: 0.32, 0.79), and decreased gastrointestinal infections, adjusted OR 0.41 (95% CI: 0.26, 0.67).[42] Of note, non-exclusive or partial breastfeeding was not shown to significantly reduce any disease incidence in this study.

In sum, literature reports breastfeeding to be a health promotive and a cost effective health behavior. Breastfeeding has been associated with a decrease in infant morbidity and mortality due to several diseases, and with decreased health care expenditures. This thesis aims to address the specific costs associated with lower than recommended exclusive breastfeeding percentages in a population of infants insured by Medicaid, with respect to two frequent pediatric inpatient diagnoses.

Design and Methodology

This analysis assumes the perspective of insurance payer (Medicaid), incorporating direct inpatient hospitalization costs. Indirect costs were not analyzed. Diagnosis specific inpatient hospital mean costs are calculated within HCUPnet based on hospital charges using Center for Medicare and Medicaid Services (CMS) accounting reports.[43] These hospital costs are inclusive of all acute care hospital fees but do not

include physician charge or cost data.[43]

In the manner of previously published reports, categories were limited to either breastfeeding or non-breastfeeding. For the purposes of this report, only breastfeeding exclusively for 6 months will be categorized as breastfeeding.

2007 NCHS breastfeeding percentages, 2009 NIS breastfeeding percentages, 2009 HCuP hospital costs, and 2009 US dollars were used. As all data utilized was de-identified, neither informed consent nor institutional review board approval was required.

Data Sources

Data regarding Medicaid breastfeeding percentages were obtained from the National Child Health Survey (NCHS). This national telephone survey is conducted by the National Center of Health Statistics at the CDC, and is marked for the depth and breadth of health indicators and measurements included.[44] The survey question utilized for this analysis was Indicator 1.3a, exclusive breastfeeding, specifically stated "How many children between the ages of 6 months and 5 years old were exclusively breastfed or given breast milk for their first six months?" This indicator was compiled via the responses to four separate infant feeding questions, inclusive of "whether the child was ever breastfed of fed breast milk, age at which breastfeeding stopped, age at which formula was introduced, and age at which anything other than breast milk was introduced." These data were then further grouped into type of insurance, from which the Medicaid percentage was obtained from the subgroup "Public Insurance, such as Medicaid or SCHIP".[29]

Data regarding national exclusive breastfeeding percentages were obtained from the National Immunization Survey (NIS), which is managed by two organizations within the CDC: the National Immunization Program and the National Center for Health Statistics.[45] NIS provisional

data collected from the 2009 birth cohort were utilized for the current national percentage of 6 months of exclusive breastfeeding. The NIS question used to determine length of exclusive breastfeeding in this analysis is specifically, "This next question is about the first thing that [child] was given other than breast milk or formula. Please include juice, cow's milk, sugar water, baby food, or anything else that [child] may have been given, even water. How old was [child's name] when (he/she) was first fed anything other than breast milk or formula?"[22]

Odds ratios in favor of breastfeeding were obtained by the AHRQ report by Ip et al., published in 2007. This comprehensive report analyzed 115 studies (this number expands to approximately 400 articles when inclusive of papers in review and meta-analyses) to determine the "benefits and harms" for breastfeeding mothers and infants in terms of health outcomes. Outcomes were grouped into the categories of term infants, preterm infants, and maternal health. For term infants, data in favor of breastfeeding and disease reduction was presented for acute otitis media, asthma, atopic dermatitis, gastroenteritis, leukemia, LRTI, obesity, sudden infant death syndrome, and types I and II diabetes mellitus.[2]

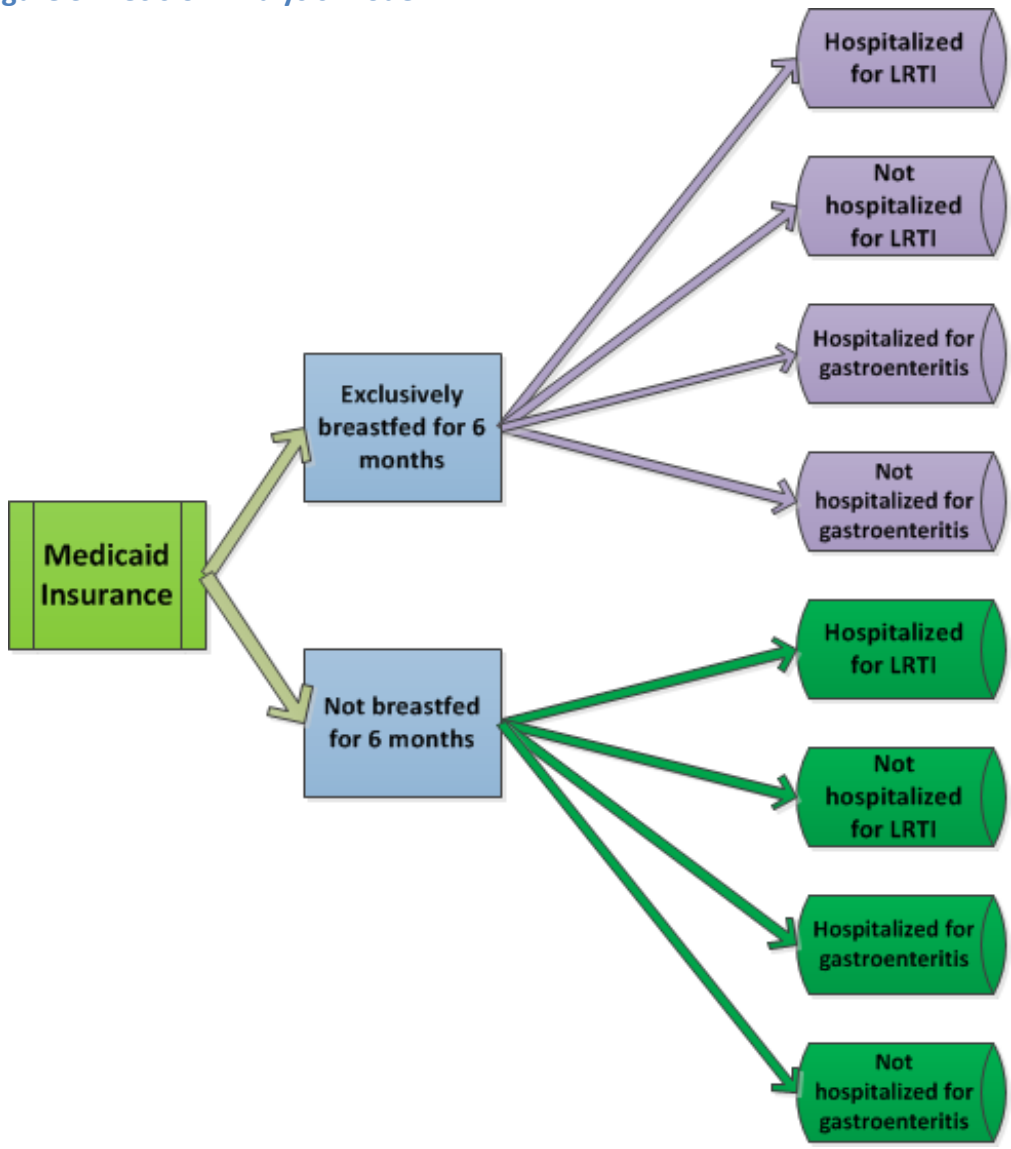
Cost data regarding mean inpatient cost were obtained from the Kids' Inpatient Database (KID), a collection of databases within the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization Project (HCuP).[46] The KID contains de-identified data from more than 2 million pediatric inpatient discharges. The 2009 dataset utilized in this analysis contains data from 44 states and more than 4,000 hospitals.[47] The HCUPnet tool queries the KID database for cost data. Cost statistics were combined for desired ICD-9 codes, when documented as principal diagnosis. The outcome measure queried was mean hospital cost in patients less than 1 year of age with Medicaid as expected payer. In the KID, Medicaid payer category is inclusive of both fee-for-service Medicaid and Medicaid managed care. SCHIP is not included in this category as SCHIP billing is dependent upon state specific variables.[46]

Lower respiratory tract infection (LRTI) is not a single ICD-9 code, nor is gastroenteritis. Therefore, a combination of multiple ICD-9 codes was used to assemble a reasonable count of hospital admissions secondary to each diagnosis. For LRTI, the ICD-9 codes utilized were 480-488. A combination of multiple ICD-9 codes (001-0031, 0033-005, 0080-0085, 006-007, 0063-0066, 0086-0088, 0090-0093, 5589, 787.91) was used to assemble a reasonable count of hospital admissions secondary to gastroenteritis. These combinations were replicated from previously published studies.[48,49] When entered into the AHRQ's HCuPnet query, all codes were combined to present a single mean cost statistic for LRTI and gastroenteritis diagnoses.

Methodology

A decision analysis model was built, presenting the steps taken in progression of data analysis (See Figure 3). This decision tree presents the possible course of events during the first year of life, as related to outcomes of hospitalizations secondary to lower respiratory tract infection and gastroenteritis. Analysis included determining the US population with Medicaid insurance, the percentages of exclusive breastfeeding versus non-breastfed, and the incidence of hospitalization for the particular illnesses being evaluated. Costs were then calculated for each cohort.

Figure 3: Decision Analysis Model



The population of infants in each breastfeeding cohort was calculated by multiplying the current breastfeeding percentages by the population estimate of US Children under age 1 insured by Medicaid.

Disease incidence was calculated via the formula x= s/ (br +1-b), replicated from prior published breastfeeding cost analyses.[34,35] In this calculation, variables are defined as:

x= incidence rate of disease in non-breastfed

s= overall disease incidence

b= current breastfeeding percentage

r= odds ratio in favor of breastfeeding

In other words, the incidence of 1 disease in non-breastfed is equal to the overall disease incidence, divided by the product of breastfeeding percentage and the odds ratio in favor of breastfeeding, plus 1 minus the current breastfeeding percentage. To calculate the incidence of disease in breastfed subjects, the incidence rate of disease in non-breastfed is multiplied by the odds ratio in favor of breastfeeding (product of x*r).

To present costs for comparison, this methodology was repeated for the national US exclusive breastfeeding percentage for 6 months as well as the Healthy People 2020 goal percentage.

Costs were calculated by multiplying the incidence of disease in each cohort by the cost for hospitalization. Total cost savings is presented as the potential cost difference if breastfeeding percentage is increased from current Medicaid percentage to current national US exclusive breastfeeding percentage for 6 months as well as to the Healthy People 2020 goal percentage.

Data Collection, Analysis, and Results

To calculate the population of infants in each Medicaid breastfeeding cohort, population estimates from the CDC's National Vital Statistics System (NVSS) were utilized. According to the NSCH, 34.7% (95% CI: 33.2, 36.2) of US children under the age of 6 had public insurance in 2007.[29] According to the NVSS, the 2007 total US population under age 1 was 4,257,020.[50] The population estimate of children under age 1 insured by Medicaid is 1,477,186.

Disease incidence was calculated using these population estimates, the overall hospitalization rate, odds ratios in favor of breastfeeding, incidence of disease in non-breastfed,

and current breastfeeding percentages (see Figures 4 and 5). According to analysis of NIS data, the Lower respiratory tract infection inpatient hospitalization rate among the US children less than 1 year of age was 37.1 (95% CI: 34.3, 40.0) per 1000 children between 2006-2008.[48] Utilized value for LRTI inpatient hospitalization incidence was 0.0371. Odds ratio in favor of breastfeeding, as stated in the AHRQ report, was 0.28 (95% CI: 0.14, 0.54).[2] According to analysis of KID data from 2003, the gastroenteritis hospitalization rate among US children less than 1 year of age was 2.987 (95% CI: 2.769, 3.205) per 1000 children in 2003.[31] Utilized value for gastroenteritis inpatient hospitalization incidence was 0.00298. Odds ratio in favor of breastfeeding, as stated in the AHRQ report, was 0.36 (95% CI: 0.32, 0.41).[2]

Figure 4. Overall hospitalization rates and Odds ratios in favor of breastfeeding

	Overall hospitalization rate[31,48]	OR in favor of breastfeeding[2]
LRTI	0.0371	0.28
Gastroenteritis	0.00298	0.36

The percentage of exclusive breastfeeding for 6 months among public insurance recipients (Medicaid or SCHIP) in 2007 was 10.0% (95% CI: 8.2, 11.8).[20] The provisional percentage of US children in 2009 who were breastfed exclusively through 6 months was 16.3% (95% CI: 15.1,17.5).[22]

Exclusive breastfeeding prevalence for Medicaid at 6 months is 10.0%. Therefore, 147,718.6 infants insured by Medicaid are breastfed exclusively for 6 months. If overall hospitalization for LRTI incidence is 0.0371, when adjusting for the OR in favor of breastfeeding of 0.28, we expect 1649 hospitalizations for LRTI in exclusively breastfed infants.

If overall hospitalization for gastroenteritis incidence is 0.00298, we expect 441.20 hospitalizations for gastroenteritis in exclusively breastfed infants, without adjusting for the OR in favor of breastfeeding. Accounting for this OR of 0.36, we expect 170 in exclusively breastfed infants.

Non-breastfeeding prevalence for Medicaid is 90%. Therefore, 503,720.43 infants insured by Medicaid are non-breastfed exclusively for 6 months. If overall hospitalization for LRTI incidence is 0.0371, when adjusting for the OR in favor of breastfeeding of 0.28, we expect 53,007 hospitalizations in the non-breastfed. If overall hospitalization for gastroenteritis incidence is 0.00298, we expect 1,501.09 hospitalizations for gastroenteritis in any breastfed infants, without adjusting for the OR in favor of breastfeeding. Accounting for this OR of 0.36, we expect 4233 hospitalizations in the non-breastfed.

If Medicaid breastfeeding percentages were equivalent to the current US exclusive breastfeeding for 6 months percentage of 16.3%, we expect 2689 hospitalizations for LRTI and 276 for gastroenteritis in the breastfeeding cohort. At Healthy People 2020 goal percentage of 25.5% exclusively breastfeeding for 6 months, we expect 4206 hospitalizations for LRTI and 432 for gastroenteritis in the breastfed cohort.

Hospitalization cost data was obtained from AHRQ HCUPnet. The 2009 pediatric inpatient mean hospital cost for principle diagnosis of LRTI in children less than 1 year of age is equal to $5,099.[46] The 2009 pediatric inpatient mean hospital cost for principle diagnosis of gastroenteritis in children less than 1 year of age is equal to $3,230.[46]

Figure 5. Hospitalization Incidence at each percentage: Current Medicaid Breastfeeding Percentage, Current US Population Breastfeeding Percentage, Healthy People 2020 Goal Percentage

	Current	Cases of LRTI	Cases of

	Medicaid Percentage	Hospitalization	Gastroenteritis Hospitalization
Breastfed	147718.6	1649.10	169.31
Non-breastfed	1,329,467	53006.78	4232.71

	At Current US Population Percentage	Cases of LRTI Hospitalization	Cases of Gastroenteritis Hospitalization
Breastfed	240781.32	2688.03	275.97
Non-breastfed	1,236,405	49296.31	3936.42

	At Healthy People 2020 goal	Cases of LRTI Hospitalization	Cases of Gastroenteritis Hospitalization
Breastfed	376682.43	4205.20	431.74
Non-breastfed	1,100,504	43877.84	3503.74

Results

If current Medicaid breastfeeding percentages increased, a decrease in incidence of LRTI and gastroenteritis hospitalization would result. Excess cost can be attributed to this lower than goal breastfeeding percentage. The model presents the end outcome of potential costs savings due to lower respiratory tract infection (LRTI) and gastroenteritis hospitalizations averted secondary to exclusive breastfeeding.

A summary of results is presented in Figure 6.

Figure 6. Summary Table: Total and Projected Costs

Comparators	Excess cost demonstrated (US Dollars)	Excess disease incidence
LRTI: Medicaid breastfeeding % and Current US breastfeeding %	13,622,191.73	2,671.54
gastroenteritis: Medicaid breastfeeding % and Current US breastfeeding %	612,489.49	189.63
LRTI: Medicaid% and HP 2020%	33,514,916.17	6,572.84
gastroenteritis: Medicaid % and HP 2020 goal%	1,506,918.60	466.54

If Medicaid exclusive breastfeeding percentage at 6 months increased from its current level of 10.0% to the current national exclusive breastfeeding percentage at 6 months of 16.3%, more than $14,234,680 could be saved annually due to pediatric hospitalizations secondary to LRTI and gastroenteritis. $13,622,191 in savings would be due to decreased lower respiratory tract infection hospitalizations. Over $600,000 in savings would be secondary to decreased gastroenteritis inpatient care.

These cost savings increase if a greater goal for exclusive breastfeeding is met. If Medicaid exclusive breastfeeding percentage at 6 months could increase from its current level of 10.0% to the Healthy People 2020 exclusive breastfeeding percentage at 6 months of 25.5%, more than $35,000,000 could be saved annually due to pediatric hospitalizations secondary to LRTI and gastroenteritis. Over $33,500,000 in savings would be due to a decreased lower respiratory tract infection incidence, and over $1,500,000 in savings would be secondary to decreased gastroenteritis inpatient care.

In sum, increasing Medicaid exclusive breastfeeding from 10.0% to 16.3% could save more than $14 million annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis. If Medicaid exclusive breastfeeding percentage increased to the Healthy People 2020 goal of 25.5%, more than $35,000,000 could be saved annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis.

The analysis maintains an assumption of *ceteris paribus.* This important assumption simplifies the conceptual analysis and allows an outcomes investigation to proceed within a manageable facet. The model reflects equality in both arms on levels not affected by feeding method.

Discussion

Exclusive breastfeeding averts healthcare costs in comparison to non-breastfeeding; it is less expensive and more effective based on the outcome of lower respiratory tract infection and gastroenteritis hospitalizations. This indicates that it is cost effective for Medicaid to encourage recipients to continue exclusive breastfeeding for 6 months after infant delivery, when accounting for hospitalizations averted due to lower respiratory tract infection and gastroenteritis. It is possible to present similar cost effective analyses with respect to hospitalizations averted from additional diseases that show a reduced risk ratio in those exclusively breastfed for 6 months. The hypothesis would be similar; exclusive breast-feeding is a cost effective measure with respect to hospitalizations averted.

In addition to the many infant health benefits of breast milk, this analysis presents its associated decreased health care costs. Policy recommendations are that increased effort should be made to encourage breastfeeding in the population of Medicaid and SCHIP recipients, as it is a cost effective health behavior.

Medicaid coverage requires referral of breastfeeding women to the federally funded WIC, which provides the aforementioned expanded packages to women who are breastfeeding.[51] WIC efforts have expanded to offer larger food supplements and educational resources to women who exclusively breastfeed; it is proposed that these efforts should be extended and outreach amplified. An additional policy recommendation is to encourage Medicaid to increase outreach for those eligible for but not receiving WIC. These suggestions are dependent upon the assumption that WIC programming is successful at increasing breastfeeding percentages.

Of note, this study is limited to 2 mutually exclusive categories: breastfed and non-breastfed. This does not include categories for analysis of those partially breastfed or of those who breastfed exclusively for less than 6 months. The odds ratios in favor of breastfeeding in the 2007 AHRQ report specifically noted the type and duration of breastfeeding in the studies used for odds ratio determination. LRTI hospitalization odds ratio utilized data from infants exclusively breastfed for 4 months. Gastroenteritis odds ratio utilized data from infants exclusively breastfed for 6 months. There are variations in the type and duration of breastfeeding in study subjects within the AHRQ report, ranging from any breastfeeding ("ever breastfed") to shorter periods of exclusive breastfeeding. Cost savings is assumed from disease reduction due to breastfeeding, yet the impact of partial and shorter duration of breastfeeding on disease reduction varies between diagnoses. NSCH data reports 65.9% (95% CI: 63.4, 68.4) of infants under the age of 5 insured by Medicaid in 2007 were "ever breastfed or given breast milk." As the exclusively breastfed cohort is only 10.0% (95% CI: 8.2, 11.8)[29] of those under age 5 insured by Medicaid, it is hypothesized that inclusion of additional cohorts of breastfed infants (ever breastfed, partially breastfed, exclusively breastfed for 3 months) would increase costs savings presented to Medicaid in terms of LRTI and gastroenteritis.

Study limitations and assumptions

- Principal diagnosis codes only were used for identification of mean hospital costs. This may under-represent total inpatient expenditure data by not including inpatient costs of those children who received inpatient care for LRTI or gastroenteritis if their primary inpatient diagnosis differed from these two conditions. The principal diagnosis is the chief medical reason for admission.[43]
- This analysis incorporated direct costs alone. If a society or employer perspective was

utilized, indirect costs could also be assessed and may include time/productivity loss, wages lost, purchase cost of over-the-counter medication and supportive care items, and other consumptions such as transportation. When analyzing indirect cost of infant disease, parental indirect costs to consider include costs as related to missed workdays, exposure to illness, and the costs of pain and suffering.

- KID Medicaid inpatient cost data is not inclusive of SCHIP participants, whereas the utilized 2007 Percentage of exclusive breastfeeding for 6 months among public insurance recipients was inclusive of both Medicaid and SCHIP recipients.
- It is assumed that the percentage of exclusive breastfeeding for 6 months remains constant between survey data in 2007 and the year 2009 (which was used for inpatient cost & charge estimation).
- Recall bias of breastfeeding duration is a possibility with telephone survey respondents.

Disclaimer

Data analysis and interpretations including cost analysis and conclusion are the responsibility of the author of this thesis and not of the CDC, NCHS, or HCuP.

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Appendix 1. Total Costs, Inclusive of Current and Projected Costs

Current Medicaid Percentage (10.0)					
	Cases of LRTI Hospitalization	Total Cost (US Dollars)		Cases of Gastroenteritis Hospitalization	Total Cost (US Dollars)
Exclusively breastfed for 6 months	1,649.10	8,408,760.33		169.31	546,865.62
Non breastfed	53,006.78	270,281,581.99		4,232.71	13,671,640.50
Sum	54,655.88	278,690,342.32		4,402.01	14,218,506.12

Current US Population Percentage (16.3)					
	Cases of LRTI Hospitalization	Total Cost (US Dollars)		Cases of Gastroenteritis Hospitalization	Total Cost (US Dollars)
Exclusively breastfed for 6 months	2,688.03	13,706,279.34		275.97	891,390.96
Non breastfed	49,296.31	251,361,871.25		3,936.42	12,714,625.67
Sum	51,984.34	265,068,150.59		4,212.39	13,606,016.63

Healthy People 2020 goal Percentage (25.5)					
	Cases of LRTI Hospitalization	Total Cost (US Dollars)		Cases of Gastroenteritis Hospitalization	Total Cost (US Dollars)
Exclusively breastfed for 6 months	4,205.20	21,442,338.84		431.74	1,394,507.33
Non breastfed	43,877.84	223,733,087.31		3,503.74	11,317,080.20
Sum	48,083.04	245,175,426.15		3,935.48	12,711,587.53

APPENDIX 2: Journal Article

Intended Journal: The Annals of Family Medicine
Guidelines: "Uniform Requirements for Manuscripts Submitted to Biomedical Journals"[1]

Title: Benefits of Exclusive Breastfeeding for 6 months of Life: A cost analysis in Medicaid population

Authors: Andrea Caplea, MD; Zhou Yang, PhD, MPH

Abstract:

Objectives: Evidence suggests cost savings if exclusive breastfeeding for 6 months national goals are met. This analysis fills a knowledge gap of inpatient Medicaid cost expenditures due to exclusive breastfeeding percentages under goal. It was hypothesized that in a Medicaid population, exclusive breastfeeding for 6 months is cost effective in comparison to other feeding methods with regards to inpatient hospitalizations averted due to the high prevalence primary diagnoses of lower respiratory tract infections (LRTI) and gastroenteritis.
Methods: A decision analysis model was built. Analysis included determination of the under 1 year of age US population with Medicaid insurance, the percentages of exclusive breastfeeding versus non-breastfeeding within this group, and the incidence of hospitalization for LRTI and gastroenteritis in each cohort. Costs were then calculated for each cohort and diagnosis. This methodology was repeated for the national US exclusive breastfeeding percentage and the Healthy People 2020 goal percentage.
Results: If Medicaid exclusive breastfeeding percentage at 6 months increased from its current level of 10.0% to the current national exclusive breastfeeding percentage at 6 months of 16.3%, more than $14,234,680 could be saved annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis. If Medicaid exclusive breastfeeding percentage at 6 months increased to the Healthy People 2020 exclusive breastfeeding percentage at 6 months goal of 25.5%, more than $35,000,000 could be saved annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis.
Conclusions: Medicaid breastfeeding percentages are below US National breastfeeding percentages and well below Healthy People 2020 goal percentages; this difference is costly in terms of infant morbidity as well as inpatient hospitalization costs. Appropriate cost research may encourage further outreach aimed to increase exclusive breastfeeding in Medicaid recipients.

Introduction

Breast milk is the physiologic form of infant nutrition and contains maternal antibodies that are protective of infant health via passive immunity. Breastfed infants have fewer episodes of many common childhood infections including respiratory infections, gastrointestinal infections, and otitis media.{U.S. Department of Health and Human Services., 2011 #28;Ip, 2007 #27;Kramer,

2012 #8} The risk of disease including eczema, asthma, obesity, type I diabetes mellitus, and acute lymphocytic and acute myelogenous leukemias is lower in breastfed babies.{Ip, 2007 #27} Reports indicate a decreased risk of type II diabetes mellitus in individuals breastfed as infants.{Ip, 2007 #27;U.S. Department of Health and Human Services., 2011 #28} Mortality due to sudden infant death syndrome (SIDS) is less prevalent in breastfed infants as well.{, 2011 #28;Ip, 2007 #27}

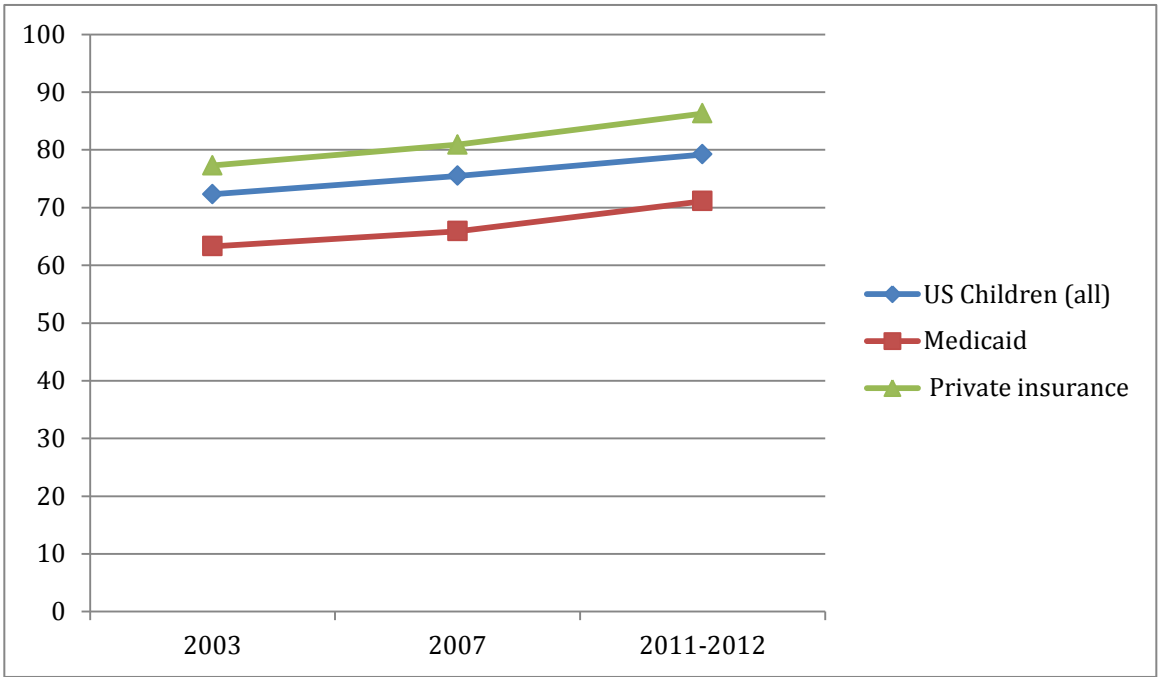
Puerperal maternal benefits of breastfeeding include decreased blood loss from delivery and decreased risk of delayed postpartum hemorrhage.{Gartner, 2005 #44} Exclusive breastfeeding can induce lactational amenorrhea and can therefore assist with birth spacing.{Kramer, 2012 #8} Mothers who breastfeed have a lower risk of breast cancer, ovarian cancer, and type 2 diabetes mellitus.{, 2011 #28;Ip, 2007 #27} Psychosocial benefits to mother and child, including a sense of bonding, are often described by women who breastfeed.{, 2011 #28}

Additionally, the social and public health benefits due to breastfeeding are marked. Direct cost savings due to breastfeeding have been demonstrated largely due to a reduction in disease burden. Indirect costs of infant formula feeding (non-breastfeeding) include an increase in parental missed workdays and decreased work productivity. Non-breastfeeding increases the environmental burdens of disposal of infant formula feeding products and energy usage for infant formula production.{Gartner, 2005 #44}

It is common for infants to receive nutrition via a combination of breast milk and infant formula. This practice is referred to as “partial breastfeeding”. Exclusive breastfeeding will be defined as the use of breast milk alone for infant nutrition. Exclusive infant breastfeeding until 6 months of age is the current recommendation of the APHA, WHO, AAFP, AAP, and ACOG and many other professional organizations.{American Academy of Family Physicians, 2012 #46;Gartner, 2005 #44;, 2007 #45;The American College of Nurse-Midwives, 2004 #47;James, 2009 #48;The National Association of Pediatric Nurse Practitioners, 2013 #49;World Health Organization, 2013 #57;American Public Health Association, Nov 06`, 2007 #69} These organizations encourage continued breastfeeding during infants’ first year of life and for as long as both mother and child mutually desire.

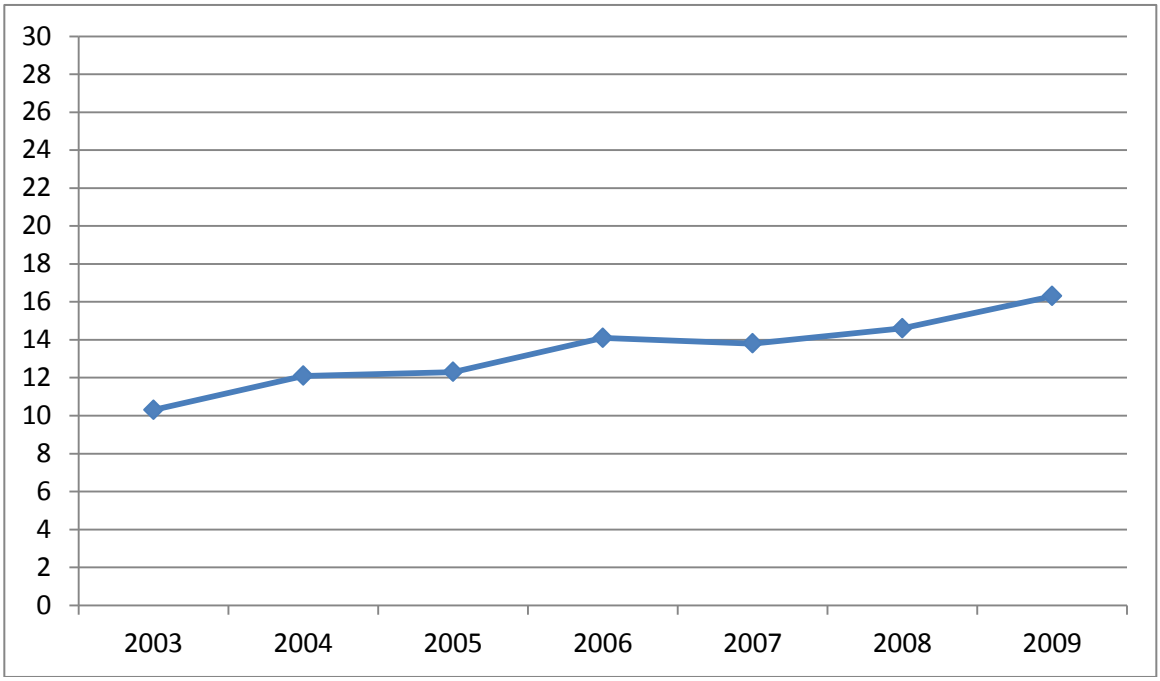
National breastfeeding practices are on the rise. Between 2000-2008, the prevalence of infants ever breastfed in the United States (US) increased from 70.3 to 74.6%.{Centers for Disease Control and Prevention, 2013 #60} The National Child Health Survey (NCHS) reports increasing rates of ever-breastfed amongst Medicaid recipients since it began collecting this information. In 2003, 63.3% (95% CI: 61.7, 65.0) of US Medicaid recipients under the age of 5 were ever breastfed. In 2007, survey results indicated 75.5% (95% CI: 74.3, 76.7) of infants insured by Medicaid were ever breastfed, and data from the most recent survey covering 2011-2102 indicate an even higher percentage at 79.2% (95% CI: 78.2, 80.2) (see Figure 1).{National Survey of Children's Health, NSCH 2007. #38}

Figure 3. Percentage of US Children (ages 0-5) ever breastfed, National Survey of Children's Health



These ever-breastfed data are encouraging, but they do not include specifics on breastfeeding duration. As the current recommendation by many public health entities is to exclusively breastfeed for 6 months, data specifically addressing a 6 month duration of exclusive breastfeeding is more indicative of compliance with this recommendation. The NCHS, the survey utilized in this research report to provide distinction between breastfed groups by insurance status, added a question specifically addressing exclusive breastfeeding for 6 months to its survey in 2007. The 2007 data set is the only published data in this survey to date; the most recent survey data from 2011-2012 is not yet reported. The CDC's National Immunization Survey (NIS) began data collection specifically regarding exclusive breastfeeding for 6 months percentages in 2003, and the documented percentages have been steadily increasing (see Figure 1).{Centers for Disease Control and Prevention, 2012 #53} Provisional 2009 data from the NIS indicate that 16.3% (95% CI: 15.1,17.5) of US infants were exclusively breastfed until 6 months of age.{U.S. Department of Health and Human Services (DHHS). National Center for Health Statistics., #35} Healthy People 2020 Objectives aim to increase this percentage of exclusive breastfeeding to 25.5% by 2020.{U.S. Department of Health and Human Services (DHHS). Office of Disease Prevention and Health Promotion., #36;U.S. Department of Health and Human Services (DHHS). National Center for Health Statistics., #35}

Figure 4: Percentage of US Children Exclusively Breastfed for 6 months, National Immunization Survey



Studies suggest significant cost savings if breastfeeding percentages increased. Jon Weimer's USDA report in 2001 calculated a direct and indirect cost savings of 3.6 billion US dollars due to projected reduction of only three diseases if there was an increase from 29% to 50% breastfeeding (partially and/or exclusively) at 6 months. Of this amount, 3.1 billion dollars was attributed to costs associated with infant fatality due to necrotizing enterocolitis, a disease with reduced incidence in breastfed infants.{Weimer, 2001 #40}

A 2010 study by Bartick and Reinhold utilized CDC NIS breastfeeding percentages from 2005 to perform a cost analysis on all diseases that the AHRQ presented with risk reductions secondary to breastfeeding. The analysis estimated 2.2 billion US dollars annual savings due to reduction in these 10 conditions if Healthy People 2010 goals of 17 percent of the population exclusively breastfed for the first six months of life. The authors estimated these savings escalated to an estimated 13 billion US dollars saved annually if ninety percent of the population complied with the recommendation for exclusive breastfeeding for 6 months (2007 cost adjustment value). {Bartick, 2010 #6}

Increased duration of exclusive breastfeeding has been shown to improve health outcomes. A 2006 secondary analysis of NHANES data by Chantry et al. compared a cohort of infants exclusively breastfed for 4 to less than 6 months with a cohort of infants exclusively breastfed for at least 6 months. They reported statistically significant increased odds for respiratory tract infection (specifically, pneumonia) in infants breastfed for less than six months, adjusted odds ratio 4.27 (95% CI: 1.27, 14.35).{Chantry, 2006 #14} (OR was adjusted for common respiratory disease confounders.)

A 2003 meta-analysis by Bachrach et al. analyzed the impact of exclusive breastfeeding upon pediatric inpatient hospitalization due to LRTI in developed nations. This study used two mutually exclusive categories for analysis: exclusively breastfed and not breastfed. The number needed to treat (exclusively breastfed for a minimum of 4 months) to prevent one

hospitalization for LRTI was 26. The calculated summary relative risk was 0.28 (0.14-0.54), demonstrating a 3.6 fold increase in hospitalizations for LRTI in those who are not exclusively breastfed.{Bachrach, 2003 #3}

It is valid to perform cost analysis of breastfeeding in Medicaid populations as Medicaid devotes significant resources towards prenatal care, infant delivery, breastfeeding promotion and lactation support. According to Medicaid data, 40% of the newborn deliveries in the US are financed via Medicaid insurance, and lactation services commonly begin during prenatal care and continue into maternity hospitalizations.{Medicaid.gov: Keeping America Healthy, 2013 #59} Many states include coverage for lactation services under Medicaid insurance, however, these services are not nationally mandated and service coverage varies by state.{Department of Health and Human Services, 2012 #15}

Total Medicaid spending in fiscal year 2010 was over 389 billion US dollars.{The Henry J Kaiser Family Foundation- statehealthfacts.org, 2013 #24} 21.2% of that expenditure, or over 82 billion US dollars (FY2010), was directed to inpatient medical costs, excluding physician, laboratory, prescription drug, and x-ray payments.{The Henry J Kaiser Family Foundation-statehealthfacts.org, 2013 #25} According to the NSCH, 34.7% (C.I. 33.2, 36.2) of US children under the age of 5 have public insurance.{National Survey of Children's Health, NSCH 2007 #23} Medicaid is the majority payer for US pediatric admissions, and "Medicaid's share of aggregate hospital costs for children increased from 40 percent in 2000 ($10.5 billion, inflation-adjusted) to 49 percent in 2009 ($16.4 billion)."{Yu, 2006 #55} Medicaid is also the major insurance payer for pediatric infectious disease hospitalizations, covering 58.5 +/- 0.8% of these pediatric admissions.{Yorita, 2008 #56} Inpatient hospital costs consume a large portion of the Medicaid budget. In addition, small pilot studies have suggested that inpatient hospitalization cost and average medical costs are lower in breastfed infants.{Hoey, 1997 #2;Weimer, 2001 #40}

Hospitalization implies a high level of disease morbidity. Almost half (42.8%) of pediatric inpatient primary diagnoses cases are of infectious etiology.{Yorita, 2008 #56} Between 2000 and 2009, respiratory diseases were the leading diagnoses for inpatient pediatric hospitalizations and accounted for approximately 25% of these admissions.{Buie VC, 2010 #54;Yu, 2006 #55} Disorders of the digestive tract comprise the second highest rate of pediatric hospital admission categories after respiratory illness between the years 2000 and 2009. Dehydration, a common complication of acute gastroenteritis that can require inpatient care, was the 6th leading inpatient diagnosis in this time period. (The fourth and fifth leading inpatient pediatric diagnoses were mood disorders and appendicitis, respectively).{Yu, 2006 #55} Lower respiratory tract infection (LRTI) and gastroenteritis are frequent causes of inpatient hospitalizations and thus important contributors to Medicaid expenditures.

Research Question

What are the potential cost savings to Medicaid due to LRTI and gastroenteritis hospitalizations averted if percentages of exclusive breastfeeding for 6 months in Medicaid recipients increased to national recommendations? This paper demonstrate the potential cost savings due to exclusive breastfeeding for 6 months in Medicaid recipients, using the outcome of cost of hospitalizations averted. Specifically, inpatient hospitalizations with the primary diagnosis of two diseases of infectious etiology will be analyzed; those due to lower respiratory tract infection (LRTI) and those due to gastroenteritis. The risk ratio in these two disease categories supports breastfeeding for disease reduction, as presented in an AHRQ meta-analysis of breastfeeding outcomes data performed by Ip et al.{Ip, 2007 #27}

Multiple publicly available data sources will be utilized: National Vital Statistics System population data, Medicaid inpatient hospital costs, National Survey of Children's Health (NCHS) breastfeeding data on breastfeeding percentages in the Medicaid population, National Immunization Survey breastfeeding percentages, and Healthcare Cost and Utilization Project (HCUP) cost data.

Definitions

Breastfeeding shall be inclusive of direct breastfeeding and the feeding of expressed human breast milk. Exclusive breastfeeding is defined as the use of breast milk as the sole form of infant nutrition. Partial breastfeeding is the use of other forms of nutrition, inclusive of infant formula, solids, table food, water, or other liquids in addition to breast milk. Infant formula feeding is regarded as the use of infant formula for infant nutrition. The term "bottle feeding" does not distinguish between breast milk and infant formula and thus shall not be used in this analysis. For the purpose of this study, those not categorized as exclusively breastfeeding for 6 months duration will be referred to as non-breastfeeding or non-breastfed. The cohorts of partially breastfed infants or infants breastfed exclusively for less than 6 months will not be analyzed. This analysis assumes the perspective of insurance payer (Medicaid), incorporating direct inpatient hospitalization costs. Indirect costs were not analyzed. Diagnosis specific inpatient hospital mean costs are calculated within HCUPnet based on hospital charges using Center for Medicare and Medicaid Services (CMS) accounting reports.{HCUP Databases- Healthcare Cost and Utilization Project (HCUP), 2009 #62} These hospital costs are inclusive of all acute care hospital fees but do not include physician charge or cost data.{HCUP Databases- Healthcare Cost and Utilization Project (HCUP), 2009 #62}

In the manner of previously published reports, categories were limited to either breastfeeding or non-breastfeeding. For the purposes of this report, only breastfeeding exclusively for 6 months will be categorized as breastfeeding.

2007 NCHS breastfeeding percentages, 2009 NIS breastfeeding percentages, 2009 HCuP hospital costs, and 2009 US dollars were used. As all data utilized was de-identified, neither informed consent nor institutional review board approval was required.

Data Sources

Data regarding Medicaid breastfeeding percentages were obtained from the National Child Health Survey (NCHS).{Blumberg, #41} The survey question utilized for this analysis was Indicator 1.3a, exclusive breastfeeding, specifically stated "How many children between the ages of 6 months and 5 years old were exclusively breastfed or given breast milk for their first six months?" These data were then further grouped into type of insurance, from which the Medicaid percentage was obtained from the subgroup "Public Insurance, such as Medicaid or SCHIP".{National Survey of Children's Health, NSCH 2007 #23}

Data regarding national exclusive breastfeeding percentages were obtained from the National Immunization Survey (NIS), which is managed by two organizations within the CDC: the National Immunization Program and the National Center for Health Statistics.{Centers for Disease Control and Prevention, #42} The NIS question used to determine length of exclusive breastfeeding in this analysis is specifically, "This next question is about the first thing that [child] was given other than breast milk or formula. Please include juice, cow's milk, sugar

water, baby food, or anything else that [child] may have been given, even water. How old was [child's name] when (he/she) was first fed anything other than breast milk or formula?"{U.S. Department of Health and Human Services (DHHS). National Center for Health Statistics., #35}

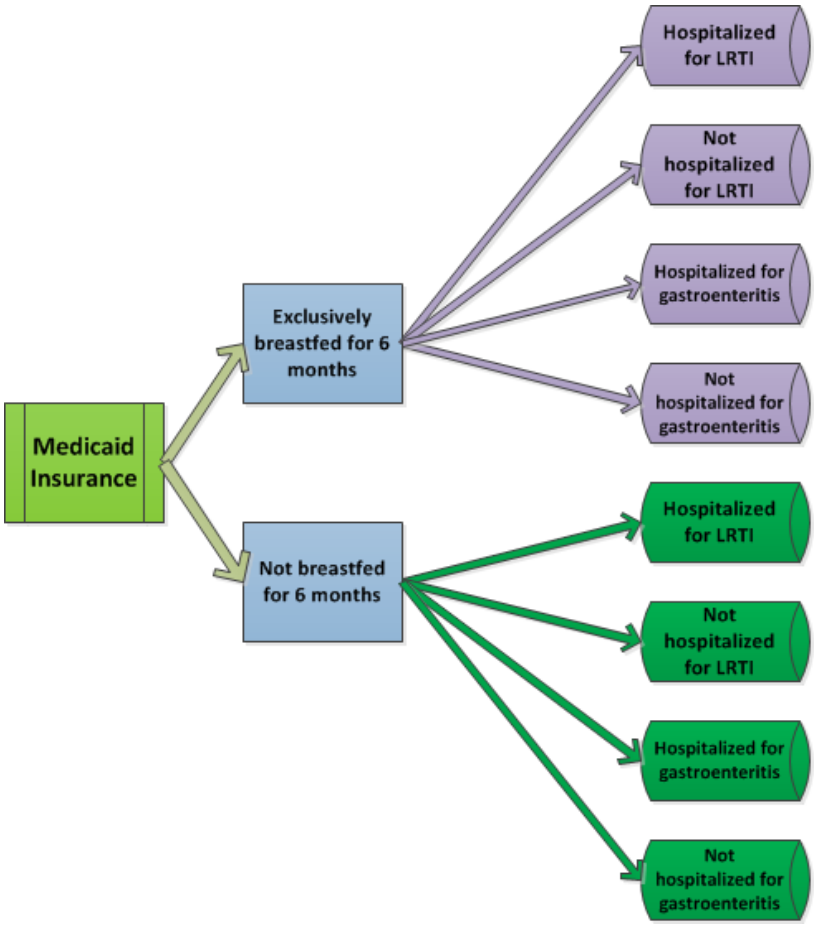
Odds ratios in favor of breastfeeding were obtained by the AHRQ report by Ip et al., published in 2007.{Ip, 2007 #67}

Cost data regarding mean inpatient cost were obtained from the Kids' Inpatient Database (KID), a collection of databases within the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization Project (HCuP).{HCUPnet, 2009 #34} The HCUPnet tool queries the KID database for cost data. Cost statistics were combined for desired ICD-9 codes, when documented as principal diagnosis. The outcome measure queried was mean hospital cost in patients less than 1 year of age with Medicaid as expected payer.{HCUPnet, 2009 #34}

Lower respiratory tract infection (LRTI) is not a single ICD-9 code, nor is gastroenteritis. Therefore, a combination of multiple ICD-9 codes was used to assemble a reasonable count of hospital admissions secondary to each diagnosis. For LRTI, the ICD-9 codes utilized were 480-488. A combination of multiple ICD-9 codes (001-0031, 0033-005, 0080-0085, 006-007, 0063-0066, 0086-0088, 0090-0093, 5589, 787.91) was used to assemble a reasonable count of hospital admissions secondary to gastroenteritis. These combinations were replicated from previously published studies.{Singleton, 2012 #32;Desai, 2012 #33} When entered into the AHRQ's HCuPnet query, all codes were combined to present a single mean cost statistic for LRTI and gastroenteritis diagnoses.

A decision analysis model was built, presenting the steps taken in progression of data analysis (See Figure 3). This decision tree presents the possible course of events during the first year of life, as related to outcomes of hospitalizations secondary to lower respiratory tract infection and gastroenteritis. Analysis included determining the US population with Medicaid insurance, the percentages of exclusive breastfeeding versus non-breastfed, and the incidence of hospitalization for the particular illnesses being evaluated. Costs were then calculated for each cohort.

Figure 3: Decision Analysis Model



The population of infants in each breastfeeding cohort was calculated by multiplying the current breastfeeding percentages by the population estimate of US Children under age 1 insured by Medicaid.

Disease incidence was calculated via the formula x= s/ (br +1-b), replicated from prior published breastfeeding cost analyses.{Bartick, 2010 #6;Ma, 2013 #5} In this calculation, variables are defined as:

x= incidence rate of disease in non-breastfed

s= overall disease incidence

b= current breastfeeding percentage

r= odds ratio in favor of breastfeeding

To calculate the incidence of disease in breastfed subjects, the incidence rate of disease in non-breastfed is multiplied by the odds ratio in favor of breastfeeding (product of x*r).

To present costs for comparison, this methodology was repeated for the national US exclusive breastfeeding percentage for 6 months as well as the Healthy People 2020 goal percentage.

Costs were calculated by multiplying the incidence of disease in each cohort by the cost for hospitalization. Total cost savings is presented as the potential cost difference if breastfeeding percentage is increased from current Medicaid percentage to current national US exclusive breastfeeding percentage for 6 months as well as to the Healthy People 2020 goal percentage.

Data Collection, Analysis, and Results

To calculate the population of infants in each Medicaid breastfeeding cohort, population estimates from the CDC's National Vital Statistics System (NVSS) were utilized. According to the NSCH, 34.7% (95% CI: 33.2, 36.2) of US children under the age of 6 had public insurance in 2007.{National Survey of Children's Health, NSCH 2007 #23} According to the NVSS, the 2007 total US population under age 1 was 4,257,020.{VitalStats., #65} The population estimate of children under age 1 insured by Medicaid is 1,477,186.

Disease incidence was calculated using these population estimates, the overall hospitalization rate, odds ratios in favor of breastfeeding, incidence of disease in non-breastfed, and current breastfeeding percentages (see Figures 4 and 5). According to analysis of NIS data, the Lower respiratory tract infection inpatient hospitalization rate among the US children less than 1 year of age was 37.1 (95% CI: 34.3, 40.0) per 1000 children between 2006-2008.{Singleton, 2012 #32} Utilized value for LRTI inpatient hospitalization incidence was 0.0371. Odds ratio in favor of breastfeeding, as stated in the AHRQ report, was 0.28 (95% CI: 0.14, 0.54).{Ip, 2007 #67} According to analysis of KID data from 2003, the gastroenteritis hospitalization rate among US children less than 1 year of age was 2.987 (95% CI: 2.769, 3.205) per 1000 children in 2003.{Yorita, 2008 #56} Utilized value for gastroenteritis inpatient hospitalization incidence was 0.00298. Odds ratio in favor of breastfeeding, as stated in the AHRQ report, was 0.36 (95% CI: 0.32, 0.41).{Ip, 2007 #67}

Figure 4. Overall hospitalization rates and Odds ratios in favor of breastfeeding

	Overall hospitalization rate{Singleton, 2012 #32;Yorita, 2008 #56}	OR in favor of breastfeeding{Ip, 2007 #67}
LRTI	0.0371	0.28
Gastroenteritis	0.00298	0.36

The percentage of exclusive breastfeeding for 6 months among public insurance recipients (Medicaid or SCHIP) in 2007 was 10.0% (95% CI: 8.2, 11.8).{National Survey of Children's Health, NSCH 2007. #38} The provisional percentage of US children in 2009 who were breastfed exclusively through 6 months was 16.3% (95% CI: 15.1,17.5).{U.S. Department of Health and Human Services (DHHS). National Center for Health Statistics., #35}

Exclusive breastfeeding prevalence for Medicaid at 6 months is 10.0%. Therefore, 147,718.6 infants insured by Medicaid are breastfed exclusively for 6 months. If overall hospitalization for LRTI incidence is 0.0371, when adjusting for the OR in favor of breastfeeding of 0.28, we expect 1649 hospitalizations for LRTI in exclusively breastfed infants.
If overall hospitalization for gastroenteritis incidence is 0.00298, we expect 441.20 hospitalizations for gastroenteritis in exclusively breastfed infants, without adjusting for the OR in favor of breastfeeding. Accounting for this OR of 0.36, we expect 170 in exclusively breastfed infants.

Non-breastfeeding prevalence for Medicaid is 90%. Therefore, 503,720.43 infants insured by Medicaid are non-breastfed exclusively for 6 months. If overall hospitalization for LRTI incidence is 0.0371, when adjusting for the OR in favor of breastfeeding of 0.28, we expect 53,007 hospitalizations in the non-breastfed. If overall hospitalization for gastroenteritis incidence is 0.00298, we expect 1,501.09 hospitalizations for gastroenteritis in any breastfed infants, without adjusting for the OR in favor of breastfeeding. Accounting for this OR of 0.36, we expect 4233 hospitalizations in the non-breastfed.

If Medicaid breastfeeding percentages were equivalent to the current US exclusive breastfeeding for 6 months percentage of 16.3%, we expect 2689 hospitalizations for LRTI and 276 for gastroenteritis in the breastfeeding cohort. At Healthy People 2020 goal percentage of 25.5% exclusively breastfeeding for 6 months, we expect 4206 hospitalizations for LRTI and 432 for gastroenteritis in the breastfed cohort.

Hospitalization cost data was obtained from AHRQ HCUPnet. The 2009 pediatric inpatient mean hospital cost for principle diagnosis of LRTI in children less than 1 year of age is equal to $5,099.[46] The 2009 pediatric inpatient mean hospital cost for principle diagnosis of gastroenteritis in children less than 1 year of age is equal to $3,230.[46]

Figure 5. Hospitalization Incidence at each percentage: Current Medicaid Breastfeeding Percentage, Current US Population Breastfeeding Percentage, Healthy People 2020 Goal Percentage

	Current Medicaid Percentage	Cases of LRTI Hospitalization	Cases of Gastroenteritis Hospitalization
Breastfed	147718.6	1649.10	169.31
Non-breastfed	1,329,467	53006.78	4232.71

	At Current US Population Percentage	Cases of LRTI Hospitalization	Cases of Gastroenteritis Hospitalization
Breastfed	240781.32	2688.03	275.97
Non-breastfed	1,236,405	49296.31	3936.42

	At Healthy People 2020 goal	Cases of LRTI Hospitalization	Cases of Gastroenteritis Hospitalization
Breastfed	376682.43	4205.20	431.74
Non-breastfed	1,100,504	43877.84	3503.74

Results

If current Medicaid breastfeeding percentages increased, a decrease in incidence of LRTI and gastroenteritis hospitalization would result. Excess cost can be attributed to this lower than goal breastfeeding percentage. The model presents the end outcome of potential costs savings due to lower respiratory tract infection (LRTI) and gastroenteritis hospitalizations averted secondary to exclusive breastfeeding.
A summary of results is presented in Figure 6.

Figure 6. Summary Table: Total and Projected Costs

Comparators	Excess cost demonstrated (US Dollars)	Excess disease incidence
LRTI: Medicaid breastfeeding % and Current US breastfeeding %	13,622,191.73	2,671.54
gastroenteritis: Medicaid breastfeeding % and Current US breastfeeding %	612,489.49	189.63
LRTI: Medicaid% and HP 2020%	33,514,916.17	6,572.84
gastroenteritis: Medicaid % and HP 2020 goal%	1,506,918.60	466.54

If Medicaid exclusive breastfeeding percentage at 6 months increased from its current level of 10.0% to the current national exclusive breastfeeding percentage at 6 months of 16.3%, more than $14,234,680 could be saved annually due to pediatric hospitalizations secondary to LRTI and gastroenteritis. $13,622,191 in savings would be due to decreased lower respiratory tract infection hospitalizations. Over $600,000 in savings would be secondary to decreased gastroenteritis inpatient care.

These cost savings increase if a greater goal for exclusive breastfeeding is met. If Medicaid exclusive breastfeeding percentage at 6 months could increase from its current level of 10.0% to the Healthy People 2020 exclusive breastfeeding percentage at 6 months of 25.5%, more than $35,000,000 could be saved annually due to pediatric hospitalizations secondary to LRTI and gastroenteritis. Over $33,500,000 in savings would be due to a decreased lower respiratory tract infection incidence, and over $1,500,000 in savings would be secondary to decreased gastroenteritis inpatient care.

In sum, increasing Medicaid exclusive breastfeeding from 10.0% to 16.3% could save more than $14 million annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis. If Medicaid exclusive breastfeeding percentage increased to the Healthy People 2020 goal of 25.5%, more than $35,000,000 could be saved annually due to averted pediatric hospitalizations secondary to LRTI and gastroenteritis.

Discussion

Exclusive breastfeeding averts healthcare costs in comparison to non-breastfeeding; it is less expensive and more effective based on the outcome of lower respiratory tract infection and gastroenteritis hospitalizations. This indicates that it is cost effective for Medicaid to encourage recipients to continue exclusive breastfeeding for 6 months after infant delivery, when accounting for hospitalizations averted due to

lower respiratory tract infection and gastroenteritis. It is possible to present similar cost effective analyses with respect to hospitalizations averted from additional diseases that show a reduced risk ratio in those exclusively breastfed for 6 months. The hypothesis would be similar; exclusive breast-feeding is a cost effective measure with respect to hospitalizations averted.

In addition to the many infant health benefits of breast milk, this analysis presents its associated decreased health care costs. Policy recommendations are that increased effort should be made to encourage breastfeeding in the population of Medicaid and SCHIP recipients, as it is a cost effective health behavior.

Medicaid coverage requires referral of breastfeeding women to the federally funded WIC, which provides the aforementioned expanded packages to women who are breastfeeding.{Center for Medicare & Medicaid Services, October 1`, 2002 #16} WIC efforts have expanded to offer larger food supplements and educational resources to women who exclusively breastfeed; it is proposed that these efforts should be extended and outreach amplified. An additional policy recommendation is to encourage Medicaid to increase outreach for those eligible for but not receiving WIC. These suggestions are dependent upon the assumption that WIC programming is successful at increasing breastfeeding percentages.

Of note, this study is limited to 2 mutually exclusive categories: breastfed and non-breastfed. This does not include categories for analysis of those partially breastfed or of those who breastfed exclusively for less than 6 months. The odds ratios in favor of breastfeeding in the 2007 AHRQ report specifically noted the type and duration of breastfeeding in the studies used for odds ratio determination. LRTI hospitalization odds ratio utilized data from infants exclusively breastfed for 4 months. Gastroenteritis odds ratio utilized data from infants exclusively breastfed for 6 months. There are variations in the type and duration of breastfeeding in study subjects within the AHRQ report, ranging from any breastfeeding ("ever breastfed") to shorter periods of exclusive breastfeeding. Cost savings is assumed from disease reduction due to breastfeeding, yet the impact of partial and shorter duration of breastfeeding on disease reduction varies between diagnoses. NSCH data reports 65.9% (95% CI: 63.4, 68.4) of infants under the age of 5 insured by Medicaid in 2007 were "ever breastfed or given breast milk." As the exclusively breastfed cohort is only 10.0% (95% CI: 8.2, 11.8)[29] of those under age 5 insured by Medicaid, it is hypothesized that inclusion of additional cohorts of breastfed infants (ever breastfed, partially breastfed, exclusively breastfed for 3 months) would increase costs savings presented to Medicaid in terms of LRTI and gastroenteritis.

Study limitations and assumptions

- Principal diagnosis codes only were used for identification of mean hospital costs. This may under-represent total inpatient expenditure data by not including inpatient costs of those children who received inpatient care for LRTI or gastroenteritis if their primary inpatient diagnosis differed from these two conditions. The principal diagnosis is the chief medical reason for admission.[43]

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