Analysis of Post-Neo-Natal Inpatient Hospitalizations in the United States by Primary Diagnoses

Huda Eldosougi, PhD*

*Research Fellow, Harvard University, USA.

REVIEW

*Corresponding Author:

Dr. Huda Eldosougi,

Research Fellow, Harvard University, USA;

E-mail: h.eldosougi@shp.rutgers.edu;

he90@shp.rutgers.edu

ABSTRACT

Healthcare equity remains a national political debate with 15% or 27.4 million non-elderly Americans still uninsured in 2017 compared to other developed countries which have almost 100% universal coverage.

Purpose: The goal of this study is to evaluate post-neo-natal healthcare, with a focus on secondary care and social determinants as some of the factors involved in healthcare inequities for socioeconomically disadvantaged families. The objective is to investigate hospitalization for infants and some of the demographics affecting inpatients in order to identify high risk populations and improve medical outcomes in post-neo-natal health. The hypothesis is to determine whether primary diagnoses, length of stay, hospital outcomes or patient disposition, and total charges of post-neo-natal admissions differ with geographic regions, income bracket, and insurance type in the United States.

Method: A Cross-Sectional Study was conducted with a population of 871845 inpatients for the years 2012-2014 with infants 28-364 days old using Hospital Cost and Utilization Project National Inpatient Sample (HCUP-NIS) data from the National Institute of Health (NIH) with length of stay and total charges as dependent variables and various components used as independent variables.

Results: These results show that infants 28-364 days old in 2012, 2013, 2014 showed utilization of hospitals for care that may be classified as routine 92.7% of the time. 75% were with low risk of dying, 45% with minor loss of function, over 96% were not under major substances of abuse, 58% did not require any procedures, 53% did not have chronic morbidities, and 45% were not even eligible for emergency room billing. The total charges accrued were paid for by Medicaid as primary payer 64% of the time, and private insurance 30% of the time. Over a third (37%) of inpatients came from the lowest household median income in the country (0- 25000 zip quartile income percentile) and quarters (25%) were of the next level (25-60000 zip quartile income). Regional dynamics accounted for variations in mean total charges of $27,704.45 in the East South Central region to $61,911.58 in the Pacific per length of stay (LOS). The mean LOS was 4.72 days and sum total charges nationally were $34,727,880,784.

Conclusion: A Learning Health System is necessary to continuously identify the root cause analysis of hospitalization and link infant postnatal care with maternal postpartum care. Patients need to be identified- stratified- triaged upon admission and redirected back to primary care if appropriate to reduce unnecessary hospitalizations and emergency visits. This could significantly move this discipline forward. There needs to be optimized transition of care post discharge to avoid readmissions, encourage routine scheduled well-visits.

BACKGROUND

According to data from the Organization for Economic Cooperation and Development (OECD), the United States expenditure on health care exceeds all other nations by far when compared to various high income countries with similar lifestyles at 17.5% and 10% GDP in the United States versus the European Union respectively. This is especially true in terms of supplies and utilization of health services and resources, yet this extra added investment is not reflected in our health outcomes.

Optimal healthcare starts just before birth at prenatal care, and the first hospitalization is at birth. Liveborn (newborn infant) is the most common reason for hospitalization in the U.S., accounting for more than 3.9 million stays in 2010 (10 percent of all stays). The highest hospitalization rate by age group in the country is for infants less than one year old. [1-5] Among hospitalized adults ages 18–44, 4 of the top 5 conditions are related to pregnancy and childbirth: trauma to the perineum and vulva due to childbirth, maternal stay with a previous Cesarean section, prolonged pregnancy, and hypertension complicating pregnancy and childbirth.''

The goal of this study is to evaluate post-neo-natal healthcare, with a focus on secondary care and social determinants as some of the factors involved in healthcare inequities for socioeconomically disadvantaged families. The objective is to investigate hospitalization for infants and some of the demographics affecting inpatients in order to identify high risk populations and improve medical outcomes in post-neo-natal health.

METHODOLOGY

Study Design

Cross-Sectional Study with a population of 871845 inpatients 2012-2014 infants 28-364 days old (inclusion criteria) using SPSS SOFTWARE on almost one million inpatient samples with 95% confidence interval to answer the addressed research questions stated at the body of this research proposal.

Source of Data

Data used was from the National Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project (HCUP). The NIS is the largest publicly available all-payer inpatient health care database in the United States, yielding national estimates of hospital inpatient stays. [1] Unweighted, it contains data from more than 7 million hospital stays each year. Weighted, it estimates more than 35 million hospitalizations nationally. Developed through a Federal-State- Industry partnership sponsored by the Agency for Healthcare Research and Quality (AHRQ), HCUP data inform decision making at the national, State, and community levels.

Dependent Variables: Total Charges and Length of Stay

Independent Variables:

Hospital Activity/Patient Centered Outcomes

1. HCUP_ED, emergency room visits

2. DISPUNIFORM, patient discharge

3. LOS, length of stay

4. YEAR, discharge calendar year

5. TOTCHG, Total charges

6. AWEEKEND, admitted in weekend

7. ADAY, weekday admission

8. DQTR, discharge quarter

9. NECODE, external injury

10. NEOMAT, neonate diagnosis and maternal diagnosis or procedure

11. CENSUS_DIVISION, US population census geographic hospital region

12. HOSP_LOCTEACH, Rural, Urban teaching, Urban non-teaching

13. HOSP_CONTRL, Hospital Control, ownership

14. HOSP_BEDSIZE

15. TRAN_IN, Transition In

16. TRAN_OUT, Transition Out

Medical Factors/Service Outcomes

    1. APR_DRG, Risk of mortality

    2. APR_DRG, Severity of illness

    3. CM_DRUG, drug comorbidity

    4. CM_ALCOHOL, alcohol comorbidity

    5. CM_DM, Diabetes Mellitus

    6. CM_HTN_C Hypertension comorbidity

    7. NCHRONIC, number of chronic conditions

    8. NCHRONB1, body system with chronic condition

    9. CM_PULM, Pulmonary condition

    10. CM_CHF, Congestive Heart Failure

    11. NDX, number of diagnosis on record

    12. NPR, number of procedures on record

    13. Dx1, primary diagnosis

    14. DIED

Demographics/Social Determinants

    1. PAY1, primary payer or health insurance type

    2. ZIPINC_QRTL, household median income

    3. RACE, ethnicity

    4. FEMALE, gender

    5. PL_NCHS, metropolitan, micropolitan, county size

Limitations of the Study

The lack of data on primary care limits extrapolations of results from primary care. Some data elements such as readmissions, maternal education, and age by month were discontinued or absent and as such could not be utilized in this analysis. There was also a lack of data on environmental exposures like air and water quality, housing data, smoking data, and genomic data.

FINDINGS

Census Divisions are used for the population, hospitalization, and mean total charges from 2012, 2013, 2014. The South Atlantic has the highest IMR of 6.7, the Midwest is 6.4 IMR, the Northeast 5.1 and the West has the lowest IMR of 4.9. The census division with the highest population is the South Atlantic and that is also reflected in the number of hospitalizations for infants with almost a fifth

(19.09%) of the country's hospitalizations. The Pacific region has the second highest population in the nation, yet it incurs by far the highest mean charge $61,911.58 for hospitalization while the lowest is East South Central at $27,704.45. The New England division has the lowest population by far and almost half as much hospitalization as any other division with mean total charges almost $36,038.94.

The mean stay in hospital nationally is 4.7 days, but the median is only 2 days, although the New England region is slightly longer at 5.29, and East North Central is 5.10 days. LOS by primary diagnosis differs for different clinical condition, Acute Bronchiolitis RSV, Pneumonia, and Esophageal Reflux have longer stays of hospitalization. Race also shows different LOS; other and Black races tend to stay longer at 5.23 and 5.17 respectively. LOS by Primary Payer varies slightly as well, with other taking longer in hospital at 6.04 and self-pay getting discharged sooner at 3.75 than other payers. "Other" refers to government programs and various other payers. However, it was noticeable in the New England region that Native infants with RSV were staying in hospital for a mean of 17 days, unlike in any other region. There were no other Native inpatients in these 7 primary diagnoses for New England.
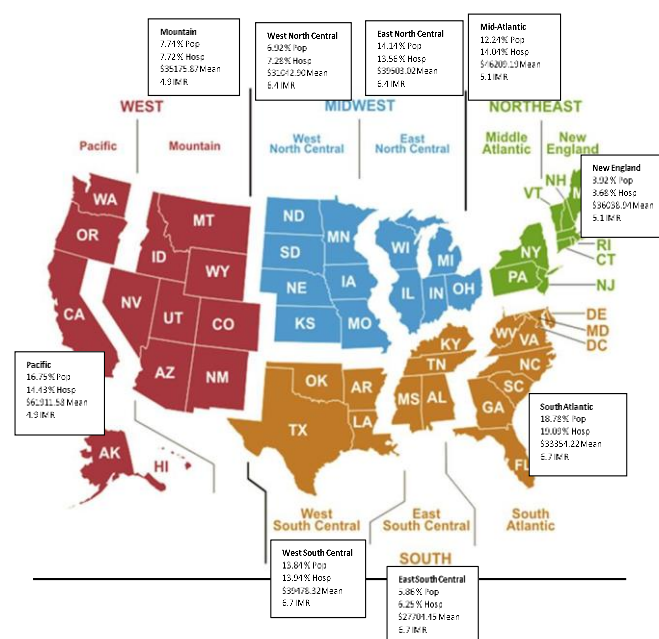
Figure 1. Percent Population, Percent Hospitalization, Mean Charge and Infant Deaths.

Table 1 Mean: a) Length of Stay by Census Division b) Primary Diagnosis c) Race d) Primary Payer

Report

Length of stay (cleaned)

Census division of hospital	Mean	N	Median
New England	5.29	32110	2.00
Middle Atlantic	4.59	122445	2.00
East North Central	5.10	118240	2.00
West North Central	4.49	63485	2.00
South Atlantic	4.89	166390	2.00
East South Central	4.23	54485	2.00
West South Central	4.65	121515	3.00
Mountain	4.26	67350	2.00
Pacific	4.77	125800	2.00
Total	4.72	871820	2.00

Report

Length of stay (cleaned)

copymostfreqDx	Mean	N	Median
RSV	3.33	119380	3.00
Non RSV	2.98	79200	2.00
Pnemonia	3.06	39430	2.00
Fever unspecified	2.28	25990	2.00
UTI	2.97	25675	2.00
Esophageal	3.70	22845	2.00
Dehydration	2.35	22335	2.00
Total	3.07	334855	2.00

Report

Length of stay (cleaned)

Race (uniform)	Mean	N	Median
White	4.38	371140	2.00
Black	5.17	136760	2.00
Hispanic	4.41	197470	2.00
Asian, Pacific Islander	4.97	25420	2.00
Native	4.88	8360	3.00
Other	5.23	47760	2.00
Total	4.60	786910	2.00

Report

Length of stay (cleaned)

Primary expected payer (uniform)	Mean	N	Median
Medicare	4.67	1915	2.00
Medicaid	4.70	554255	2.00
Private Insurance	4.67	265355	2.00
Self Pay	3.75	17230	2.00
No Charge	4.02	725	2.00
Other	6.04	31125	2.00
Total	4.72	870605	2.00

Emergency Department

Descriptive analysis showed that 45% of inpatients did not meet any HCUP criteria for Emergency Department. 37% had one revenue code on record in the Emergency Department. 10% had a positive charge on record.

Admissions by Month and Primary Diagnoses

The winter months of December, January, February, and March show higher hospitalization for the top 3 most frequent diagnoses Acute Bronchiolitis RSV, non RSV, and pneumonia.

Top Primary Diagnoses by Frequency

RSV is the number one reason for hospitalization of infants across all census regions. It is also proportional in occurrence with the population of the regions in volume. The most frequent primary diagnosis by far is Acute Bronchiolitis due to Respiratory Syncytial Virus (RSV) followed by Acute Bronchiolitis due to organisms other than RSV. The 3rd most common reason for infant hospitalization is Pneumonia due to unspecified organisms, then Unspecified Fever, followed by Urinary Tract Infection (UTI), and Esophageal Reflux. This pattern is consistent throughout the census divisions.
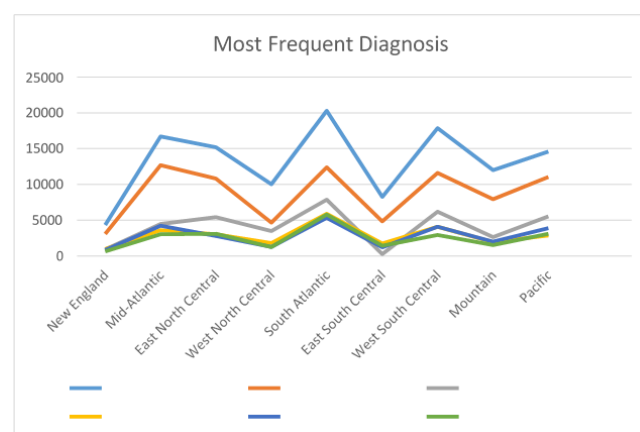
Figure 2. Primary Diagnoses by Census Division.

Mean total charges were highest for Esophageal Reflux at $23,371.26 and 6.8% cases, while second highest primary diagnoses frequency is RSV at $19,645.90 mean total charge with the highest volume nation-wide at 35.7% of hospitalizations. The South Atlantic has the highest population and also the highest hospitalizations by diagnoses, followed by West South Central, and then

Middle Atlantic. The sum total charges were highest at the Pacific division, followed by Middle Atlantic, and then West South Central.

Table 2. Total Charges for Hospitalization by Top 7 Primary Diagnosis.

Report

Total charges (cleaned)

copymostfreqDx	Mean	N	% of Total N	Sum	% of Total Sum
RSV	19645.90	117970	35.7%	2317625502	39.3%
Non RSV	18623.13	78285	23.7%	1457910891	24.7%
Pneumonia	16652.26	38710	11.7%	644608915	10.9%
Fever unspecified	11888.63	25705	7.8%	305597209	5.2%
UTI	15000.84	25385	7.7%	380796271	6.5%
Esophageal	23371.26	22555	6.8%	527138509	8.9%
Dehydration	11830.94	22095	6.7%	261404513	4.4%
Total	17825.81	330705	100.0%	5895081809	100.0%

Risk of Mortality in Hospitalization by Census Divisions

Three quarters, 75%, of the infants had minor likelihood of dying and 14% had moderate likelihood of dying. In general, the patients had a low risk of dying. This was true throughout the various census divisions as seen below.[6-10]

Severity of Illness in Hospitalization by Census Divisions

45% of the patients exhibited minor loss of function and over a third (34%) showed moderate loss of function in terms of severity of illness, while 16% had major loss of function. Hospitalization of all patients refined DRG by severity of illness was similar throughout the census divisions. This is also reflected in the mean total charge.

Chronic Conditions

A little more than half the patients (53%) were free of any chronic condition and 26% only had one chronic condition, while only 10% had 2 conditions. The most frequent chronic condition by body system was 16.3% Respiratory. Hospitalization for infants with chronic pulmonary disease mirrored that of patients with RSV, non RSV and Pneumonia. Sum total charges were highest for respiratory conditions, followed by congenital anomalies. Mean total charges were highest for perinatal originating diseases, followed by congenital anomalies.

Procedures

58% of inpatients had no procedure coded on discharge, and 24% had only 1 procedure coded on record, and 8% had 2 procedures coded. The top ten procedures most frequently carried out when those 24% of inpatients require a single procedure. Spinal tap is the most frequently of those and is done at 7.5% of cases with a mean total charge of $20, 591.84. However, the most expensive mean total charge is $310,321.39 for continuous invasive mechanical ventilation for 96 hours or more.

Maternal data and Source of Admissions

Maternal records were not linked with these inpatients as this dataset was filtered from Neonates, only inpatients 28-364 days old were included for analysis

Most infants were not transferred in or born during these admissions. A minor 11% were transferred in from acute care facilities and 1.7% from other types of health facilities.

Environmental Exposure or External Cause of Injury

The highest number of external cause of injuries on record was 19.1% of infants with an E code for external injuries from the South Atlantic census region. New England had the lowest external injuries on record at 3.7%.

Race

Almost half (47%) the admissions were Caucasian ethnicities which reflects the general population census, a 25% were Hispanic, and 18% Black which is higher than the general population.

Discharge Frequency by Census Divisions

The majority of patients (92.8%) were discharged as routine visits with a mean total charge of $32,995.95. The rest were transferred to other short-term hospitals, skilled nursing or skilled care facilities, home health care, discharged against medical advice, unknown destination or died.

Income Level and Primary Payer

37% of the patients were on a lowest income bracket of 0-25000, 25% earned 26-50000 and 22% earned 51-75K. The New England region is highest in the highest income bracket of 71000+ and the Pacific region is highest in the 54-70999 bracket.

The majority of patients were Medicaid recipients or low income families utilizing care for these hospital visits compared to a third of the patients who had private insurance and a minority self-pay group.

Income

Discharge Position. the majority of patients (92.8%) were discharged as routine visits with a mean total charge of $32,995.95. The rest were transferred to other short-term hospitals, skilled nursing or skilled care facilities, home health care, discharged against medical advice, unknown destination or died.
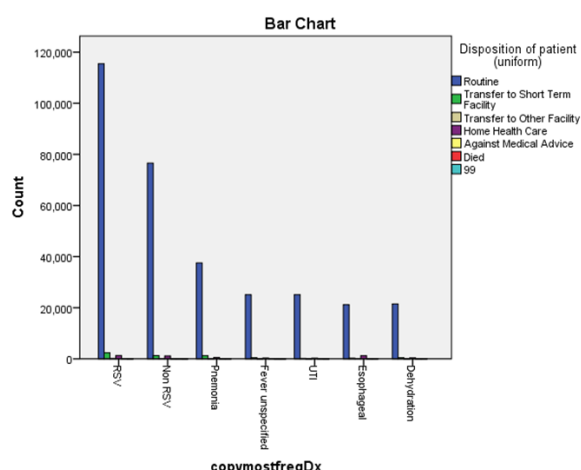
Figure 3. Discharge Frequency by Census Divisions.

DISCUSSION

The majority of post-neo-natal hospitalizations according to HCUP in 2012, 2013, 2014 were discharged as routine visits (93% and mean total charge of $32,995.99). When admitted, 45% did not have records that meet any emergency department criteria, so they could not be admitted through the Emergency Department (ED). Only 37% had an emergency department revenue code on record, 10% had a positive emergency department charge when revenue center codes are not available, so they were

admitted under ED because there was no other code to be used. While 8% had an ED CPT procedure code, so 37%+8%=45% had billable ED record on admission. [11-15]

Most of these infants were not at risk of mortality with 75% minor likelihood of dying, so they may have been admitted for an acute episode but not at risk of dying. Their severity of illness was 45% minor loss of function and 35% moderate loss of function, so there was no major debilitation. 98% of these patients did not present with comorbidity of substance abuse, there were no drugs or alcohol in their system. 53% did not show chronic conditions, and only 26% with one condition, 22% were discharged with 2 diagnoses on record, and 19% have 2-3 diagnosis upon discharge.

The patients were not chronically predisposed, which may be useful in patient risk stratification. The majority of patients were not operated on with 58% discharged with no procedure on record and 24% required one procedure during hospitalization, mainly spinal tap with mean total charge $20,591.84. These results show that infants 28-364 days old in 2012, 2013, 2014 showed utilization of hospitals for care that was classified as routine for the most part. They did not have chronic morbidities, nor severity of illness, were with low risk of dying, minor loss of function, were not under major substances of concern, did not require procedures, and were not even eligible for emergency room billing.

According to the American Academy of Pediatrics the Clinical Practice Guideline for RSV involves but is not limited to; supplemental oxygen, nasogastric or intravenous fluids for patients who cannot maintain oral hydration, nebulized hypertonic saline, avoidance of exposure to tobacco, bronchodilator medications to open the airways, antiviral medications for severe cases or high-risk infants, good handwashing techniques and contact isolation to decrease exposure. Prophylactic monoclonal antibodies (Palivizumab, Virazole) to reduce the impact and economic burden for immunocompromised infants. Breastfeeding is encouraged for at least 6 months to decrease the morbidity of respiratory infections. [16-18]

Utilizing secondary care facilities and resources for what otherwise can be done at primary care settings is expensive and duplicative effort that could be redirected to recycle spending, improve efficiency and ultimately improve health outcomes throughout the health system.

These healthcare transactions consume the majority of expenditure in total charges as shown by the Emergency Department service indicator. The total charges accrued were paid for by Medicaid as primary payer 64% of the time or a sum total charge of $22,225,844,224, and private insurance 30% of the time or a sum total charge of $10,418,364,416. Therefore, these patients were utilizing hospitals for healthcare that may not have required hospitalization and these costs may have been avoidable. Over a third (37% and a mean total charge $36,762.98) of inpatients came from the lowest household median income in the country (0-25000 zip quartile income percentile) and a quarter (25%) were of the next level (25-60000 zip quartile income). Both Medicaid as well as private insurance patients may have been reporting to hospitals for care that could have otherwise been addressed in ambulatory settings. The mean total charge by primary diagnosis for LOS with RSV was $19,645.90, non RSV $18,623.13, pneumonia $16,652.26, and esophageal reflux at $23,371.26. These primary diagnoses and the charges they incur highlight the burden of inefficiencies in our health system and the need to detect these diagnoses earlier and redirect care to primary care settings to promote preventive visits. Postpartum care in the community can prevent short, medium, and long term consequences of unrecognized and poorly managed problems plus standardized instructions can set the stage to ensure consistency of care throughout the post-natal phase of life.

Regional Discrepancies

Hospitalization for infants varied between population census divisions by total charges, length of stay, frequency of primary diagnosis, race, primary insurance payer and other factors. Patient income levels, chronic conditions, procedures done during hospitalization, severity of illness, and risk of mortality played a part in patient flow through secondary healthcare settings and consequently throughout the various census divisions.

A notable discrepancy is that states varied in their insurance structure and in their reporting methods and there is not a joint framework of continuously standardized data to allow large scale and long term analysis. The State Children's Health Insurance Program (SCHIP) may be classified as Medicaid, Private Insurance, or Other depending on each state. Most states do not identify patients in SCHIP specifically, so it is not possible to present this information separately.

Primary Diagnoses, Confounding Measures, and Diagnostic Uncertainty

The most frequent diagnoses which are mainly respiratory in nature overlap in symptoms and are challenging for patients who utilize hospitals as their usual source of care. More patients were hospitalized in the winter months of December, January, February, and March than the rest of the year. This was especially higher for Acute Bronchiolitis RSV, non RSV, and Pneumonia. Respiratory Syncytial Virus is the leading primary diagnosis for these infants, followed by Acute Bronchiolitis due to other organisms non RSV, Pneumonia due to unspecified organism, Urinary Tract Infections, Unspecified Fever, Esophageal Reflux, and Dehydration.

Discomfort with risk and diagnostic uncertainty where the probability of a diagnosis is unknown, or information is missing leads to personal risk aversion by both the patient and provider and results in further testing. [19-24] This behavior increases cost in fear of malpractice liability and is sometimes referred to as ambiguity bias. Differences in provider practice patterns sometimes create individual or institutional variation in spending, [25-29] especially when coupled with inappropriate resource utilization of preference sensitive treatment decisions. [25, 31] Hence, clinical decision support systems should be embedded in the system where appropriate and patients should consistently be informed of treatment options and alternatives for shared decision making.

Impact of Social Determinants of Health (SDoH), Environment, and Health Behaviors in Health Outcomes

According to the World Economic Forum, [2] social risk factors and the environment also have a significant part to play in the well-being of patients. Social determinants account for 20% of health outcomes, healthcare 10%, genomics 30%, and individual behavior 40%. Whether these routine hospital visits were a result of gaps in healthcare, social determinants, or individual behavior, they consume effort needed elsewhere and impact spending and resource consumption in an already strained system. In order to compile long term patient profiles for health, one must conduct risk stratification and take into account patient outcomes directly related to clinical care, genetics, environmental factors, socioeconomic circumstances, social determinants of health, and individual behavior patterns. Risk scores can be used as metrics to indicate the likelihood of a single event such as a hospital admission for readmission within the next 6 months.

A risk stratification framework may combine several individual risk scores to create a broader profile of a patient in their complex ongoing needs. These risk scores may be used to estimate costs, target interventions, gauge a patient's health literacy and lifestyle choices, and used to prevent patients from developing more serious conditions that could result in higher spending and worse outcomes. The use of Artificial intelligence or Machine Learning for health intelligence can be applied here and significantly moves this discipline forward. The American Academy of Pediatrics (AAP) recommends assessment for developmental problems in every preventive health visit but formal screening is only recommended at intervals of 9th, 18th, 24th or 30th month of the well child visits for children 10-71 months old. According to this study, screening needs to occur on every visit in order to optimize on these patient engagements, improve longitudinal health profiles and build data in real time for predictive analytics.

CONCLUSIONS

More than a fifth of post-neo-natal infants between 2012-2014 or 22.05% of infants less than one-year-old were hospitalized for a mean of 4.7 days with a mean total charge of $40,516.48 and a sum total charge of $34,727,880,784. Over 45% of these infants were not eligible for emergency room billing and 92.7% or $32,192,745,472 were discharged on routine disposition. The majority of these patients or 64% costing $22,225,844,224 were of the lowest median household income paid for by Medicaid and over half with a minor loss of function and minor likelihood of dying. The diagnoses were primarily respiratory with the majority of patients not requiring any procedure during their stay at hospital.

There needs to be a continuous real time root cause analysis of hospitalization set up in order to optimize and personalize transition of care post discharge. There needs to be an improved care process or personalized transition of care beyond 30 days and a unified patient portal. Diffusion of health care to patients allows them to take ownership of their health with a personalized healthcare plan. Therefore, the takeaway is to reduce hospitalizations and emergency visits, while encouraging routine scheduled well visits in ambulatory care settings to improve compliance with healthcare protocols for post-neo-natal infants and postpartum mothers to empower them to take more responsibility for their own health. According to the IOM, in order to improve medical outcomes, service delivery outcomes, and cost outcomes, an evolving clinical process model or Learning Health System must be established and link post-neo-natal care with postpartum care to address IMR and MMR in the US.

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