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Department for Medicaid Services

Division of Program Quality and Outcomes

Kentucky Newborn Readmissions Focused Study

FINAL REPORT
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EXECUTIVE SUMMARY

Background

Unplanned newborn readmission rates may be considered an indicator of "inadequate assessment" (AAP Committee on Fetus and Newborn, 2010) of newborn discharge readiness, as well as an "undesirable event" (Young *et al*., 2013) by parents, physicians and payers. A 2009 study conducted by IPRO on behalf of KDMS analyzed newborn readmissions within 14 days of birth hospitalization; readmission diagnoses were consistent with the scientific literature and included respiratory distress, bronchiolitis, sepsis and jaundice. Only one Medicaid Managed Care Organization (MCO) was in operation in the state at the time of the study, whereas there are currently four MCOs operating in Kentucky. The current study aims to expand the scope of the original study by analyzing 30-day readmission rates to identify risk factors for newborn readmission among this expanded population of Kentucky Medicaid Managed Care enrollees, and to identify potentially actionable areas for quality improvement efforts.

Neonatal readmissions for jaundice, feeding difficulty and dehydration have been considered potentially preventable causes for admissions (Paul *et al*. 2006; Young *et al*., 2013). For example, establishing early feeding prior to discharge (AAP, 2004; Whyte, 2012) can potentially avert readmission due to dehydration and poor weight gain (Whyte, 2010). Guidelines for the inpatient and post discharge management of hyperbilirubinemia include supportive interventions such as promotion of successful breastfeeding and thorough assessment for hyperbilirubinemia prior to discharge (AAP, 2004). Studies have also shown that newborn readmission rates are associated with younger gestational age (Dietz *et al*., 2012; Escobar *et al*., 2005). Therefore, strategies to ensure appropriate care and discharge practices for this high-risk group could potentially impact readmissions.

According to the AAP periodicity schedule, every infant should have an evaluation within 48 to 72 hours after discharge from the hospital and, for newborns discharged in less than 48 hours after delivery, the AAP recommends examination within 48 hours of discharge (AAP, 2008). A recent study, however, found that newborns with Medicaid insurance were more likely to have a follow-up visit beyond three days post-discharge (O'Donnell *et al*., 2014). Timely follow-up is important to detect previously unidentified problems, such as breastfeeding difficulty and jaundice, which typically peak at three to four days postpartum.

Study Objectives

1. Describe newborn and maternal characteristics, overall and by cause-specific readmission subsets.

2. Assess hospital care and discharge practices overall and by cause-specific readmission subsets for newborns requiring re-hospitalization within 30 days of delivery discharge.

3. Identify the timing of the newborn readmission stay.

4. Assess consistency with clinical guidelines recommendations.

5. Assess MCO care management received by newborns requiring re-hospitalization.

6. Identify the frequency of outpatient follow-up visits and the number of days between the birth discharge date and the 1st outpatient follow-up visit.

7. Compare newborns with and without readmissions with regard to outpatient visits, geographic region, MCO, delivery mode, term status, newborn diagnoses and procedures, race/ethnicity, and evaluate risk factors for readmission.

Methods

This study entailed two parts:

Part I was a retrospective cohort study using an administrative data set that included both members with and without readmissions in order to evaluate risk factors for postpartum readmission.

Each of the four MCOs operating during the study timeframe, i.e., CoventryCares of Kentucky, Passport Health Plan, Kentucky Spirit Health Plan, and WellCare of Kentucky, submitted electronic data files with claims data containing ICD-9 diagnosis and procedure codes, demographic and service utilization data for the eligible population, i.e., newborns born alive in the hospital during an index (birth) stay during the period from November 6, 2011 through September 5, 2012. MCOs also identified whether or not a member was readmitted within 30 days of discharge from birth hospitalization. Statistical analysis was conducted using the *chi*-squared test to evaluate differences in the distribution of members (readmission rates) with and without readmissions among key clinical, demographic and service utilization factors. Multivariable binomial logistic regression results are presented for statistically significant birth-stay diagnostic categories, i.e., respiratory distress, sepsis, congenital anomalies, other birth complications, as well as for statistically significant birth-stay procedure categories, i.e., mechanical ventilation and other intubation/irrigation. Findings are also presented for a supplemental analysis using (multivariable) multinomial logistic regression in order to evaluate the relationship between outpatient visits and readmission status by duration of post-birth hospitalization period in order to estimate the effect of having an outpatient visit on the timing of readmission.

Part II was a retrospective medical record review restricted to newborns with the outcome of readmission and was conducted to profile member characteristics and care received by newborns in order to identify potentially actionable areas that might be addressed by hospitals and MCOs to improve the quality of care.

The eligible population derived from the electronic database submitted by the MCOs for Part I of the study was the source of the medical record review sample. From each MCO, a random sample of 100 members, plus an oversample of 10 (for MCOs with sufficient sample size), was selected using the criterion of members with a readmission within 30 days of the delivery discharge. A total of 363 medical records were requested. Kentucky Spirit Health Plan did not submit any records as they terminated their Kentucky Medicaid Managed Care contract at the time of the medical record request. Of the remaining 260 medical records requested, 254 (98%) were submitted electronically to IPRO's secure File Transfer Protocol (FTP) site from Passport Health Plan, CoventryCares of Kentucky, and WellCare of Kentucky. Of the 254 submitted records, 243 (96%) were confirmed eligible for the study using administrative data to confirm a birth stay with the outcome of a live birth and a newborn readmission within 30 days of the birth-stay discharge date; however, there were 15 additional members who were excluded from the primary chart review study due to absence of a birth record determined upon chart review, and another 12 members with an incomplete birth record who were excluded, for a primary chart review sample of 216 newborns. Study data elements were abstracted using a Microsoft Access database developed by IPRO and a data element instructional tool developed by IPRO and reviewed by KDMS.

Part I: Newborn Readmissions Retrospective Cohort Study/Administrative Data – Findings

Key overall findings:

Common reasons for newborn readmission include RSV, other respiratory conditions, and jaundice.

The newborn readmission rate for the total sample was 1.92% (416 of 21,686 live-born babies). Readmissions for respiratory syncytial virus (RSV; n = 42) and jaundice (n = 37) were the highest-volume cause-specific readmission categories, and readmission for an aggregated grouping of respiratory conditions (including RSV, non-RSV bronchiolitis, and other respiratory diagnoses) comprised 19% of all newborn readmissions. RSV and jaundice readmission diagnoses, however, were not predominant among early premature neonates, but instead, among term infants. A birth-stay diagnosis of jaundice was not a risk factor for readmission. In addition, although a birth-stay diagnosis of respiratory distress was a risk factor for readmission, respiratory distress during the birth stay was not a prominent diagnosis among newborns readmitted for RSV.

Whereas the majority of respiratory readmissions occurred between 11 and 30 days, most readmissions for jaundice occurred between days 1–3 post birth discharge. There was a statistically significant difference in the readmission rates by gestational age, with the highest rate among early pre-term (< 33 weeks) newborns (6.72%), followed by late pre-term (≥ 33 weeks and < 37 weeks) newborns (3.08%) and post-term (> 40 weeks) newborns (2.12%). The readmission rate for term (37–40 weeks) newborns was the lowest at 1.79%. Readmission rates were significantly higher for males, "other" race/ethnicity and urban residence, as well as for newborns with any birth-stay diagnosis of sepsis, respiratory distress, apnea, gastrointestinal problem, cardiovascular abnormality, congenital anomaly or other newborn complications, and for newborns with any birth-stay procedure of mechanical ventilation, other intubation/irrigation, injection/infusion (non-routine vaccine) or transfusion. The distribution of newborns with a readmission across MCOs was significantly different.

Key multivariable logistic regression findings:

Risk factors for all-cause newborn readmission include prematurity, any birth-stay diagnosis of respiratory distress, sepsis, congenital anomalies, or other birth complications, mechanical ventilation and other intubation during the birth stay.

Early pre-term newborns (< 33 weeks) were at more than twice the odds of readmission compared to term newborns (OR=2.6; 95% CI=1.5, 4.4), and late pre-term (≥ 33 weeks and < 37 weeks) newborns had 60% greater odds for readmission (OR=1.6; 95% CI=1.1, 2.4) compared to term newborns (37–40 weeks). Any birth-stay diagnosis of respiratory distress was significantly associated with 70% greater odds for all-cause readmissions (OR=1.7; 95% CI=1.2, 2.3), independent of sex, race/ethnicity, foster care status, urban/rural residence, birth during RSV season, gestational age, cesarean delivery, MCO and outpatient follow-up; this odds ratio increased to 2.8 (95% CI=1.6, 4.9) when the cause-specific outcome of an aggregate measure of respiratory conditions was evaluated.

Birth during RSV season was shown to be a risk factor for readmission for respiratory conditions.

Birth during RSV season was significantly associated with increased odds of readmission for the aggregate respiratory condition outcome measure (OR=2.7; 95% CI=1.8, 4.2). Any birth-stay diagnoses of sepsis, congenital anomalies and other birth complications were also significantly associated with greater odds for all-cause readmission, as were birth-stay procedures of mechanical ventilation and other intubation/irrigation.

Male sex, "other" race/ethnicity and lack of outpatient-follow-up were additional risk factors.

Males were at 50% greater odds for readmission (OR=1.5; 95% CI=1.3, 1.9). Of note, readmissions for congenital pyloric stenosis, a physical malformation, i.e., obstruction, of the gastrointestinal tract, comprised 10% (26 of 255) of male readmissions and 3% (5 of 160) of female readmissions, reflecting the known male-to-female predominance of this

condition (Singh, 2012). The definitive treatment is corrective surgery; therefore, readmission for congenital pyloric stenosis, a condition that is rare in premature infants and usually diagnosed at 3 weeks of life (Singh, 2012) may be considered unavoidable. Newborns of "other" race/ethnicity were 60% more likely than White newborns to be readmitted (OR=1.60; 95% CI=1.1, 2.3). Comparing the risk for readmission within 4–10 days post birth discharge to no readmission, newborns with zero outpatient follow-up visits had more than twice the odds for readmission than newborns with one outpatient follow-up visit (OR=2.7; 95% CI=1.7, 4.4), and newborns with multiple follow-up visits had 88% lesser odds for readmission than newborns with one outpatient follow-up visit (OR=0.12; 95% CI=0.05, 0.28).

MCO findings should be interpreted with caution.

Compared to newborns enrolled in Kentucky Spirit Health Plan, newborns enrolled in Passport Health Plan were 40% more likely to be readmitted, whereas WellCare of Kentucky members were 30% less likely to readmitted. As in any observational study, there may have been residual confounding. For example, there may have been unmeasured confounding influences such as hospital-specific differences or other unmeasured factors that might be correlated with both the MCO and the outcome of newborn readmissions, and thus, it is possible that the observed relationship between MCO and newborn readmission may be spurious.

Conclusion for Part I:

Findings provide evidence to suggest the opportunity to reduce newborn readmissions by targeting case management interventions, e.g., facilitation of outpatient follow-up visits, to high-risk members.

Furthermore, whereas prematurity is a known risk factor confirmed by this study, the highest volume readmission diagnosis subsets, e.g., jaundice and RSV, were prominent among term infants, raising questions about possible gaps in hospital support practices, discharge planning and care management, and thus, opportunities to improve care for all newborns, including those without the recognized risk factors that trigger heightened vigilance. In this regard, medical and care management record review findings shed important insights.

Part II: Medical Record Review of a Random Sample of Newborns with Readmission – Findings

Birth to teen mothers and mothers lacking in partner and/or family support may indicate a need for heightened vigilance.

Teen mothers comprised 16% of the sample; however, this subset comprised 29% of early pre-term newborns readmitted and 42% of newborns readmitted with gastro-esophageal reflux or other gastrointestinal problems. Newborns of single parents comprised 41% of the total readmission chart review sample; however, they comprised approximately half of early pre-term (3/7) and late pre-term newborns (21/41), and more than half of newborns readmitted for gastroesophaeal reflux or other gastrointestinal problems (7/12). Whereas 72% and 42% of the total (all-cause) sample of readmitted newborns were discharged home to a primary responsible person (PRP) with partner and family support, respectively, only 66% (19/29) and 38% (11/29) of the subset of newborns readmitted for RSV were discharged home to a PRP with partner and/or family support, respectively.

Newborn sex, race and geographic residence differently characterize cause-specific readmission subsets.

Males comprised 60% of the total readmission sample and 75% (9/12) of newborns readmitted for gastroesophageal reflux or other GI problems; however, females comprised 52% (n = 15/29) of newborns readmitted for RSV and 60% (6/10) readmitted for failure to thrive, dehydration or feeding problems. White newborns comprised the majority of readmissions (n = 168; 78%), followed by Black newborns (n = 30; 14%), who comprised 22% (9/41) of late pre-term newborns readmitted. Whereas Asian newborns comprised only 3% of the total sample, this subset comprised 26% (5/19) of newborns readmitted for jaundice. Most newborns originated from urban locations (138/216 = 64%); these newborns comprised 72% of early term births (55/76). Although newborns originating from rural areas comprised only 36% of the total readmission sample, these newborns comprised 52% of newborns readmitted for RSV (15/29) and 58% readmitted for gastroesophageal reflux or other gastrointestinal problems (7/12). In addition, newborns residing in rural areas comprised 57% of early pre-term births (4/7).

Shorter length of birth stay is a prominent characteristic of newborn readmissions for high-volume diagnoses, such as RSV and jaundice.

Newborns with a length of stay less than or equal to 2 days, without a subsequent transfer, comprised 57% of the total chart review study sample, yet 70% (14/20) of the subset readmitted for bronchiolitis or other respiratory problems and 84% (16/19) of the subset readmitted for jaundice . Newborns with a length of stay of 3–4 days, without a subsequent transfer, comprised 24% of the total chart review sample, yet 41% (12/29) of the subset readmitted for RSV and 33% (4/12) readmitted for gastroesophageal reflux or other gastrointestinal problems. Newborns discharged from the newborn nursery comprised 82%

of the total chart review study sample, and 90% of newborns readmitted for RSV, as well as 92% of newborns readmitted for gastroesophageal reflux or other gastrointestinal problems. Of note, newborns discharged from the newborn nursery comprised 100% of newborns readmitted for jaundice. Furthermore, whereas newborns without an outpatient follow-up visit comprised 31% of the total chart review sample, this subset comprised 84% of newborns readmitted for jaundice.

A greater proportion of newborns discharged from the NICU than the newborn nursery were diagnosed with hyperbilirubinemia during the birth stay, yet all newborns readmitted for jaundice were discharged from the newborn nursery; a greater proportion of the latter were breastfed.

All newborns readmitted for jaundice were discharged from the newborn nursery. Compared to newborns discharged from the newborn nursery, newborns discharged from the NICU had a greater proportion diagnosed with hyperbilirubinemia during the birth hospitalization (47% versus 15%). Of note, the mean length of stay for newborns discharged from the NICU was 20.5 days compared to 2.5 days for newborns discharged from the newborn nursery; therefore, because bilirubin levels typically peak several days after birth, newborns with a longer length of birth stay would be more likely than newborns with shorter stays to have hyperbilirubinemia diagnosed during the birth stay. On the other hand, compared to newborns discharged from the NICU, newborns discharged from the newborn nursery had a higher proportion of newborns whose mothers initiated breastfeeding (57% versus 38%). Newborns discharged from the newborn nursery had a greater proportion of mothers who were educated about jaundice (68% versus 44%), as well as a greater proportion of bilirubin re-evaluation visits scheduled (36% versus 14%). The percentage of newborns without an outpatient follow-up visit, however, was greater for newborns discharged from the nursery (33%) than those discharged from the NICU (24%), albeit this difference was not statistically significant.

Full term status characterized most newborns readmitted for RSV and jaundice.

Most newborns included in the newborn chart review study sample were born full term (41 weeks; 38%). Early-term gestational age characterized the greatest proportion of newborns readmitted for bronchiolitis or other respiratory problems (30%), gastroesophageal reflux or other gastrointestinal problems (50%), and failure to thrive, dehydration, or feeding problems (50%),whereas full-term gestational age characterized the greatest percentage of newborns readmitted for RSV (41%) and jaundice (42%).

Low-risk and early term births may merit a closer look at delivery indications.

Non-operative vaginal delivery comprised the greatest proportion of the newborn readmission chart review sample (57%). Among low-risk births (n = 49), i.e., term (37–41 weeks), singleton, and vertex presentation, 28% were delivered by cesarean section. Of the 10 who were delivered by cesarean section without labor, 4 newborn births (40%) lacked documentation of complications/possible indicators for cesarean delivery. Among

early term newborns who underwent cesarean delivery without TOLAC, 9 of 13 (69%) were without documented obstetric complications/possible indications (Figure 15). There was also an absence of documented obstetric complications/possible indications for 33% (4 of 12) early term newborns who underwent primary cesarean delivery without labor and for 38% (3 of 8) newborns who underwent induction of labor for non-operative vaginal delivery.

Further research regarding maternal receipt of prenatal progesterone may be informative regarding potential opportunities to reduce pre-term birth.

Antenatal corticosteroids were documented as administered to 20% (4/20) of mothers of infants born at less than or equal to 34 weeks gestation. Among newborns born to mothers with a prior pre-term birth, antenatal progesterone was documented as received by only 2 of 17 (12%) mothers, and these newborns were delivered at early pre-term and late pre-term gestational ages; however, as this study requested only the newborn chart, it is not clear to what extent this is a measure of documentation in the newborn chart.

Tobacco use and substance abuse were prominent maternal co-morbidities.

Maternal tobacco use during the perinatal period is the highest volume maternal co-morbid condition, comprising 22% of all-cause readmissions and 31% of readmissions for RSV. Maternal substance abuse during the perinatal period comprised 13% of all-cause readmissions and 17% and 15% of readmissions for RSV and bronchiolitis or other respiratory problems, respectively. Only 8% of all-cause readmissions were complicated by fetal growth restriction; however, 20% of newborns readmitted for bronchiolitis or other respiratory problems were characterized by this complication.

Most newborns readmitted for jaundice and RSV were not diagnosed with jaundice/hyperbilirubinemia or respiratory distress, respectively, during the birth stay. None of the newborns in the primary chart review sample received RSV prophylaxis.

Newborns with a birth-stay diagnosis of jaundice comprised 21% of readmissions for this same diagnosis; however, the majority was not diagnosed with jaundice during the birth stay. Newborns with a birth-stay diagnosis of respiratory distress comprised 20% of readmissions for bronchiolitis or other respiratory problems; however, the majority of these and RSV readmissions were not diagnosed with respiratory distress during the birth stay. Mechanical ventilation and other intubation/irrigation comprised 20%, each, of readmissions for bronchiolitis or other respiratory problems; however, newborns with these birth-stay procedures comprised a much lesser proportion of newborns readmitted for RSV. Newborns who underwent a respiratory surgical procedure comprised 15% of newborns readmitted for bronchiolitis or other respiratory problems, but again, a lesser percentage of those readmitted for RSV. None of the newborns in the chart review sample (with a complete birth-stay record) received RSV prophylaxis.

A minority of parents was comprehensively educated about feeding problems. The highest percentage of mothers who initiated breastfeeding was among newborns readmitted for jaundice, and the lowest among newborns readmitted for RSV. Of note, scientific research has shown that breastfeeding difficulty is a risk factor for neonatal jaundice and breastfeeding has been shown to be protective against RSV.

Two successful feedings were observed for most newborns (87%), with the lowest percent among newborns readmitted for bronchiolitis or other respiratory problems (80%). Parent education for both (1) general education about feeding problems and (2) when to call the physician were documented for 36% of newborns, with the lowest percentages among newborns readmitted for RSV (10%) and for failure to thrive, dehydration, or feeding problems (20%). Overall, 54% of mothers initiated breastfeeding; the highest percentage was among newborns readmitted for jaundice (100%) and the lowest percentages were among newborns readmitted for RSV (41%) and for bronchiolitis or other respiratory problems (30%). Fifty-two percent of newborns' mothers received breastfeeding counseling during the birth stay and 61% received information about breastfeeding upon discharge.

Although 100% of newborns readmitted for jaundice did have their bilirubin levels measured during the birth stay in accordance with AAP recommendations for universal bilirubin screening, only 16% of this subset had their hour-specific bilirubin levels graphed; the latter is "the best documented method for assessing the risk of subsequent hyperbilirubinemia" per AAP guidelines.

Bilirubin levels were measured in 89% of all newborns in the chart review sample, and in 100% of newborns readmitted for jaundice. Hour-specific bilirubin was measured in 19% of all newborns, and in 16% of newborns readmitted for jaundice. A birth-stay diagnosis of hyperbilirubinemia was made in 20% of all newborns in the study sample, and in 26% of newborns readmitted for jaundice. Whereas 50% of the total newborn medical record review sample had documentation of the presence of one or more jaundice risk factors, 74% of newborns readmitted for jaundice showed signs of risk. Considering documentation of hyperbilirubinemia or presence of a risk factor for jaundice as an indication for the need for jaundice re-evaluation, 55% of the total sample was in need of re-evaluation of bilirubin levels, compared to 74% of newborns readmitted for jaundice. Among newborns for whom a jaundice/bilirubin re-evaluation were thus indicated, 33% of the total sample were scheduled for re-evaluation, and 93% of newborns readmitted for jaundice were scheduled. Furthermore, among newborns with a scheduled re-evaluation for jaundice, 41% of the total chart review sample was without any outpatient follow-up visit, and 85% of newborns readmitted for jaundice were without any outpatient follow-up visit.

The AAP emphasizes hygiene education as a prime means to prevent RSV transmission.

Overall, 52% of parents were educated about respiratory problems (warning signs and when to call the physician), but only 35% of parents of newborns readmitted for bronchiolitis or other respiratory problems received this education, and only 45% of parents of newborns readmitted for RSV were educated about respiratory problems.

Perinatal tobacco use was the most prevalent maternal risk factor, yet no mothers were referred by MCO care management for tobacco cessation.

Perinatal tobacco use was the most prevalent maternal risk factor identified by the hospital (n = 48/216; 22%); however, only 6% of infants born to these mothers received a comprehensive needs assessment, and none received care management facilitation, e.g., maternal tobacco cessation. Lack of a newborn primary care provider was identified as a barrier to care by the hospital for 5% (n = 10) of newborns, and among these newborns, the hospital addressed this barrier for 4 out of 10 newborns (40%). There were no comprehensive needs assessments or care management facilitation, e.g., referrals, conducted by MCOs for these newborns; however, MCO care management facilitated 2 pediatrician visits for newborns not identified by the hospital as having this barrier to care. There were 27 newborns (13%) referred by the hospital to a specialist physician, and 2 of these newborns received a comprehensive needs assessment by an MCO. Hospitals referred 45 (21%) newborns for Women, Infants and Children (WIC) nutritional services and, of these newborns, 1 was referred to WIC services by an MCO. There were 2 additional newborns referred by MCOs to WIC services. Hospitals referred 23 (11%) newborns to Social Services and MCOs performed a comprehensive needs assessment on 2 (9%) of these newborns, but no care management facilitation was provided. Five percent (n = 11) of newborns were referred by hospitals to child protective services and none of these newborns received a comprehensive needs assessment or care management facilitation.

The vast majority of newborns who were readmitted did not receive care management services.

A minority of members with a newborn readmission received MCO care management services (17/228 = 7%). The proportion of newborns with care management documentation was greatest among early pre-term (24–33 weeks gestation) newborns (3/11 = 27%), followed by late pre-term (34–36 weeks) newborns (6/43 = 14%), full term (41 weeks) newborns (5/86 = 6%), and early term (37–38 weeks) newborns (3/78 = 4%). Twenty one percent of newborns discharged from the NICU (8/38) had documentation of care management, compared to only 5% (9/184) of newborns discharged from the newborn nursery. Only 2 of 33 (6%) infants born to teen mothers had documentation of care management. Among newborns with either a birth-stay or readmission-stay diagnosis of gastrointestinal or feeding problems or failure to thrive, only 2 of 34 (6%) had

documentation of care management, and corresponding percentages were 6% for jaundice, 13% for any respiratory diagnosis, and 23% for sepsis.

Care management outreach was minimal during the prenatal period, with most outreach attempts made after the readmission stay. Successful contact and engagement in care management occurred primarily after the readmission stay; however, most comprehensive needs assessments were performed after the birth stay. Passport Health Plan completed 2 comprehensive needs assessments during the birth stay, 4 after the birth-stay discharge, and 2 during the readmission stay. Both CoventryCares of Kentucky and WellCare of Kentucky performed only one comprehensive needs assessment; the former after the birth stay and the latter during the readmission stay.

Feeding problems were a prominent chief complaint across cause-specific readmission subsets.

Common chief complaints among the total readmission record subset (n = 193) were fever (26%), poor feeding (25%), cough (23%), irregular breathing (21%), irritability/ inconsolable crying (21%), and vomiting (19%). Among newborns readmitted for RSV, cough (69%), irregular breathing (62%), and poor feeding (23%) were the most prevalent presenting symptoms. Poor feeding was the most prevalent chief complaint (55%) among newborns readmitted for respiratory diagnoses other than RSV. Yellowing of skin and eyes (67%) and poor feeding (33%) characterized newborns readmitted for jaundice. The most common chief complaints among newborns readmitted for gastrointestinal and feeding problems and failure to thrive were poor feeding (27%), vomiting (25%), and cough (25%). Newborns readmitted for fever and infections were characterized by fever (74%), irritability/inconsolable crying (48%), and poor feeding (45%).

Conclusion for Parts I and II

Prominent newborn readmission diagnoses among KY Medicaid Managed Care (KYMMC) members include RSV and other respiratory problems, jaundice, gastrointestinal and feeding problems, and thus, highlight the importance of preventing avoidable readmissions for these specific causes, as feasible. Study findings revealed that risk factors for newborn readmission among KYMMC members include newborn male sex, race/ethnicity other than White or Black, prematurity (especially early-term gestational age), as well as the following birth-stay diagnoses: respiratory distress, sepsis, and congenital anomalies, and the following invasive procedures: mechanical ventilation and intubation or irrigation. Therefore, premature newborns and newborns with these birth-stay diagnoses and procedures represent susceptible subpopulations.

It is notable that feeding problems were prominent among chief complaints communicated by parents upon their newborn's readmission to the hospital. Feeding problems are known to characterize newborns with the birth-stay diagnosis risk factors identified in this study, e.g., respiratory distress (Hermansen and Lorah, 2007) and sepsis (Kopelman, 2009), and feeding problems also characterize prominent readmissions conditions such as jaundice

(Gibson and Nawab, 2009), respiratory problems, and gastrointestinal problems. The importance of addressing feeding problems is highlighted by inter-relatedness of these newborn conditions; for example, feeding problems are a manifestation of sepsis (Kopelman, 2009), respiratory problems make it difficult for infants to feed (Hermanesen and Lorah, 2007), and breastfeeding jaundice is common and occurs in newborns who consume insufficient breastmilk (Gibson and Nawab, 2009). Thus, there are opportunities for MCO/hospital collaboration for clinical care enhancements, such as more comprehensive parent education and follow-up to optimize feeding, in order to improve the care received by all newborns.

Jaundice was a prominent readmission-stay diagnosis, but a birth-stay diagnosis of jaundice was not a risk factor for readmission. Whereas the birth medical record for all newborns readmitted for jaundice did document bilirubin measurement, most newborns' charts did not include documentation of an hour-specific bilirubin level as recommended by the AAP to optimally assess the risk of subsequent hyperbilirubinemia. Thus, there is an opportunity to education providers and collaborate for prevention of jaundice in accordance with guideline recommendations.

In addition, birth during RSV season was a risk factor for readmission for respiratory problems, yet none of the newborns in the medical record review sample received RSV prophylaxis; however, most were term newborns for whom RSV prophylaxis is not recommended. Parent education about hygiene practices for the prevention of RSV is a prime opportunity for quality improvement.

Lack of a newborn follow-up visit was also a risk factor for readmission and, together with the finding that the vast majority of newborns with a hospital readmission were not receiving MCO care management services, findings suggest the potential to improve newborn outcomes by better facilitating care transitions for vulnerable members.

Recommendations for health plans

- During the birth stay, identify newborns of premature gestational age and newborns with birth-stay diagnoses of respiratory distress, sepsis, and congenital anomalies, as well as newborns undergoing intubation and mechanical ventilation, for comprehensive needs assessment and engagement in care management in order to target and facilitate improvements in morbidity management, care coordination and transitions for the most vulnerable newborns.
- During the birth stay, identify newborns born to adolescent mothers, and engage in care management.
- Collaborate with hospitals to educate all parents of newborns about how to prevent transmission of RSV and other respiratory illness.
- Collaborate with hospitals to increase the percentage of newborns with hour-specific bilirubin documented in accordance with AAP recommendations (AAP, 2004), and develop care management interventions, including, but not limited to,

facilitation of timely outpatient follow-up for newborns who fall within the "High-Intermediate Risk Zone."

- Collaborate with hospitals to educate providers and parents in accordance with multidisciplinary guidelines for the care of late pre-term infants (Phillips *et al*., 2013).
- Collaborate with hospitals to increase the percentage of breastfed newborns with timely follow-up visits.
- Collaborate with hospitals and providers to improve parent education about newborn feeding from the birth stay through outpatient follow-up, for all newborns, and with targeted attention to nulliparous mothers for facilitation of outpatient follow-up, as well as additional attention to identifying best practices for encouraging breastfeeding in the NICU and maintenance post-NICU discharge.
- Collaborate with providers to identify women of childbearing age who use tobacco, drugs or alcohol, and who lack social supports, and to engage in care management, as well as pre- and inter-conception preventive interventions.

Recommendations for KDMS

Future improvement initiatives could focus on collaborating with health plans, hospitals and physicians to:

- Identify late pre-term newborns who may be candidates for RSV prophylaxis according to clinical guidelines (AAP, 2009);
- Strengthen efforts to refer mothers and fathers to smoking cessation programs, antenatally, during the birth hospitalization, and postpartum.
- Develop programs for concurrent monitoring, reporting and evaluation of indications for cesarean delivery without TOLAC, primary cesarean delivery without labor, and induced vaginal delivery among early term deliveries; and
- Survey provider knowledge and implementation of the comprehensive set of AAP recommendations for "Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation" (AAP, 2004), and develop quality improvement interventions to address gaps in care identified from survey findings.
- Assess provider knowledge of and compliance with ACOG recommendations for use of progesterone to reduce pre-term births, as well as member and provider barriers to progesterone therapy (ACOG, 2008).

INTRODUCTION

In support of the Kentucky Department for Medicaid Services' (KDMS) efforts to improve the quality of care for Medicaid Managed Care enrollees, Island Peer Review Organization (IPRO), the External Quality Review Organization (EQRO) for the Commonwealth of Kentucky, conducted a focused study to evaluate newborn characteristics and hospital and outpatient patterns of practice associated with newborn hospital readmission. Perinatal care management, hospital discharge practices and post-discharge follow-up are potentially actionable areas for quality improvement efforts to reduce newborn readmissions.

Unplanned newborn readmission rates may be considered an indicator of "inadequate assessment" of newborn discharge readiness (AAP Committee on Fetus and Newborn, 2010), as well as an "undesirable event" by parents, physicians and payers (Young *et al*., 2013). A 2009 study conducted by IPRO on behalf of KDMS, **"**Newborn Utilization Patterns Assessed Using MCO Encounter Data," identified a 1.2% rate of readmission within fourteen days of birth hospitalization among all neonates (59 of 5,021 newborn members of Passport Health Plan, the sole Medicaid Managed Care Organization (MCO) in Kentucky at the time). This rate is similar to, albeit somewhat lower than, that of a recent study conducted in a large multi-hospital U.S. healthcare system that reported a 28-day readmission rate of 1.8% specifically for newborns with gestational ages of 34 to 42 weeks discharged from 21 well-baby nurseries (Young *et al*., 2013).

In the 2009 IPRO/KDMS study, diagnoses comprising newborn 14 day-readmissions were consistent with the scientific literature and included sepsis (47.5%), respiratory distress (22.0%), bronchiolitis (17%), and jaundice (15.3%); however, jaundice accounted for 35% of readmissions in the recent U.S. multi-center study of infants ≥ 34 weeks gestation (Young *et al*., 2013) and comprised the majority of readmissions among infants of all gestational ages in an earlier multi-hospital study (Escobar *et al*., 2005). Since the initial IPRO/KDMS study, additional Medicaid MCOs have contracted to provide services to KDMS Medicaid enrollees, and risk factors for readmission have yet to be evaluated for this expanded KDMS membership. Furthermore, the use of administrative data to conduct the original study limited IPRO's ability to evaluate discharge practices, care management, perinatal practice patterns, follow-up visits, and care management throughout the perinatal period.

The American Academy of Pediatrics (AAP) Policy Statement titled "Hospital Stay for Healthy Term Newborns" states that inadequate discharge readiness assessment of "physiologic stability, family preparedness and competence to provide newborn care at home" can put infants at risk for readmission (AAP Committee on Fetus and Newborn, 2010). In addition, discharge planning guidelines published by both the AAP and the American College of Obstetricians and Gynecologist (ACOG) recommend comprehensive assessment of newborn readiness for discharge (Lockwood and Lemons, 2007). Neonatal

readmissions for jaundice, feeding difficulty and dehydration have been considered potentially preventable admission causes (Paul *et al*. 2006; Young *et al*., 2013). For example, establishing early feeding prior to discharge (AAP, 2004; Whyte, 2012) can potentially avert readmission due to dehydration and poor weight gain (Whyte, 2010). Guidelines for the inpatient and post-discharge management of hyperbilirubinemia (i.e., jaundice) include supportive interventions such as promotion of successful breastfeeding and thorough assessment for bilirubinemia prior to discharge (AAP, 2004). Of note, implementation of a universal pre-discharge bilirubin screening program in a regional hospital system reduced readmissions for moderate hyperbilirubinemia (20.0 and 25.0 mg/dL; Eggert *et al*., 2006) and, in a multistate national hospital system, eliminated readmissions for both moderate and severe (> 30.0 mg/dL) hyperbilirubinemia in normal newborns whose parents adhered to care instructions (Mah *et al*., 2010).

According to the AAP periodicity schedule, every infant should have an evaluation within 48 to 72 hours after discharge from the hospital and, for newborns discharged less than 48 hours after delivery, the AAP recommends examination within 48 hours of discharge (AAP, 2008). A multi-hospital study of newborns of all gestations found that newborns with a scheduled outpatient visit within 72 hours of discharge home after birth hospitalization were at 27% lower odds for readmission compared to newborns without timely outpatient follow-up (Escobar *et al*., 2005). A recent study, however, found that newborns with Medicaid insurance were more likely to have a follow-up visit beyond three days post-discharge (O'Donnell *et al*., 2014). Timely follow-up is important to detect previously unidentified problems, such as breastfeeding difficulty and jaundice, which typically peak at three to four days postpartum, the timeframe when the majority of readmissions have been reported to occur according to Madden *et al*. (2002); however, a more recent study extends this highest risk time period to two weeks (Young *et al*., 2013).

Studies have also shown that newborn readmission rates are associated with younger gestational age (Dietz *et al*., 2012; Escobar *et al*., 2005); strategies to ensure appropriate care and discharge practices for this high-risk group could potentially impact readmissions. Compared to term infants, premature breastfed infants, including late pre-term infants (gestational age 34–36 weeks) with short hospital stays, are at increased risk for readmission (Hall *et al*., 2000; Tomashek *et al*., 2006). In the 2009 IPRO/KDMS study, pre-term infants comprised 8.5% (5 of 59) of newborn readmissions within 14 days of delivery. In another study, late pre-term infants who were never admitted to the Neonatal Intensive Care Unit (NICU) were found to be at higher risk for readmission compared to younger newborns (Escobar *et al*., 2005). Comprehensive follow-up newborn care for very low birthweight infants has been shown to impact post-discharge utilization (Broyles *et al*., 2000). Thus, both early and late pre-term newborns are an important group to target for appropriate level of care, enhanced discharge practices and close follow-up.

There are also maternal characteristics and conditions that are risk factors for neonatal morbidity and readmission. Pre-term infants born to adolescent mothers are at higher risk than other pre-term infants for readmission for respiratory and infectious illness, as well as

for feeding and gastrointestinal problems, within the first 3 months after delivery discharge (Ray *et al*., 2010). Exposure of late pre-term infants to the maternal conditions of hypertensive disorders of pregnancy and diabetes are additional risk factors for newborn morbidity (Gouyon *et al*., 2012), as is exposure to pre-gravid obesity (Parsons *et al*., 2012) and prenatal smoking (Meztger *et al*., 2012). Ensuring appropriate discharge procedures and follow-up for infants born to these high-risk mothers could be of particular benefit in reducing neonatal readmission.

The current study aims are twofold: the first study aim is to identify risk factors for newborn readmission, and the second aim is to provide a descriptive profile of maternal and infant characteristics of newborns with a hospital readmission within 30 days of birth discharge from the hospital, as well as to identify the types of inpatient, outpatient and care management services provided to these newborns. Taken together, these two aims are intended to provide data-driven guidance to identify potential opportunities for improvement that can lead to reduction in neonatal readmissions.

STUDY OBJECTIVES

1. Describe newborn and maternal characteristics, overall and by cause-specific readmission subsets, of newborns requiring re-hospitalization within 30 days of delivery discharge.

2. Assess hospital care and discharge practices overall and by cause-specific readmission subsets, of newborns requiring re-hospitalization within 30 days of delivery discharge.

3. Identify the timing of the newborn readmission stay.

4. Assess consistency with clinical guideline recommendations.

5. Assess MCO care management received by newborns requiring re-hospitalization, and assess characteristics of newborns who were and who were not targeted for care management.

6. Identify the frequency of outpatient follow-up visits and the number of days between the birth discharge date and the 1st outpatient follow-up visit for newborns requiring re-hospitalization within 30 days of discharge.

7. Compare newborns with and without readmissions with regard to outpatient visits, geographic region, MCO, delivery mode, term status, newborn diagnoses and procedures, race/ethnicity, and evaluate risk factors for readmission.

METHODS

Part I: Newborn Readmissions Retrospective Cohort Study/Administrative Data

Study Sample: IPRO requested an eligible population electronic database with claims data containing ICD-9 diagnosis and procedure codes, demographic and service utilization data from each of the Kentucky Medicaid MCOs, including Kentucky Spirit Health Plan, Passport Health Plan, WellCare of Kentucky, and CoventryCares of Kentucky, according to the following specifications:

- Eligible population: Newborns born alive in the hospital during an index (birth) stay during the period from November 6, 2011 through September 5, 2012.
- Outcome variable: Newborn readmission within 30 days of the birth (index) hospitalization discharge date no later than October 5, 2012.

Statistical Analysis: Statistical analysis was conducted using SAS (Cary, N.C.) version 9.3. The primary outcome variable evaluated was all-cause newborn inpatient readmissions within 30 days of the birth-stay discharge. In addition, frequency distributions were assessed for cause-specific readmissions (defined by principal diagnosis codes in Appendix A) by timing of readmission, i.e., between 1–3 days from birth-stay discharge, between 4–10 days, and between 11 and 30 days post–birth-stay discharge, as well as by birth-stay diagnosis groupings (any of the first 9 ICD-9 diagnosis codes assigned during the birth stay; see Appendix B). Potential risk factors evaluated for associations with all-cause newborn readmissions included birth-stay diagnostic grouping, member characteristics, i.e., gestational age (defined based upon any of the first nine birth-stay diagnosis codes; see Appendix B), race/ethnicity, cesarean delivery versus other type of delivery (defined using any of the first five procedure codes assigned for the birth stay; see Appendix B), urban/rural residence, sex, in foster care or at risk of foster care (defined by Kentucky Medicaid eligibility categories), birth during RSV season (November 1, 2011-March 31, 2012); and service/utilization factors, i.e., MCO and newborn outpatient follow-up visits. An acuity proxy defined by length of stay and transfer status was also assessed. This variable counted length of stay during the birth hospitalization and identified whether or not the newborn was subsequently transferred using the birth hospital discharge status.

The *chi*-squared test statistic was used to evaluate differences in the distribution of members with newborn readmissions within 30 days of delivery discharge by potential risk factors. Thus, notations regarding statistical significance in the descriptive statistics tables refer to readmission rates. Prevalence rates are also presented in descriptive statistics tables.

Logistic regression is a statistical method used to model the relationships between the outcome variable, i.e., newborn readmission, and possible risk factors, such as clinical and demographic characteristics, and healthcare utilization. In the following explanation, the term “multivariable” refers to the measurement of the influence of multiple potential risk factors, the term “binomial” refers to an outcome measure with one reference group (not

readmitted) and one comparison group (readmitted), and the term “multinomial” refers to an outcome category with one reference group (not readmitted) and three comparison groups. The term “model” refers to the statistical analysis of the relationship between the set of possible risk factors and the outcome variable.

Multivariable binomial logistic regression is a type of statistical analysis in which the dependent variable, i.e., the newborn readmission outcome variable, compares one category {readmission} to the reference group {no readmission} and statistically adjusts for multiple potential risk factors {sex, race/ethnicity, foster care, member residence, birth during respiratory syncytial virus (RSV) season, gestational age, whether or not delivered by cesarean section, MCO, and newborn follow-up visit}. Multivariable binomial logistic regression results are presented for statistically significant birth-stay diagnostic categories, i.e., respiratory distress, sepsis, congenital anomalies, other birth complications, as well as for statistically significant birth-stay procedure categories, i.e., mechanical ventilation and other intubation/irrigation. Examples of statistically non-significant birth-stay diagnostic categories not presented include jaundice, feeding problems, substance abuse and temperature dysregulation (Table 2). Each statistical model includes common model factors comprised of the potential risk factors previously noted, i.e., sex, race/ethnicity, foster care, member residence, birth during respiratory syncytial virus (RSV) season, gestational age, whether or not delivered by cesarean section, MCO, and newborn follow-up visit . Results are also presented for a model that included only these common model factors in order to assess changes with inclusion of diagnostic and procedure covariates. All models presented in Table 3 evaluate the outcome of all-cause newborn readmissions. In addition, in the “Findings” section, results are presented for cause-specific newborn readmissions for any respiratory diagnosis.

Findings are also presented for a supplemental analysis using (multivariable) multinomial logistic regression; a type of statistical analysis in which the dependent variable, i.e., the newborn readmission outcome variable, compares more than one category to the reference group {no readmission} in order to evaluate the relationship between outpatient visits and readmission status by duration of post-birth hospitalization period, i.e., readmitted within 1–3 days of birth discharge, readmitted between 4–10 days post-birth discharge, readmitted between 11 and 30 days post-birth discharge, relative to no readmission. Supplemental analysis findings are presented for statistically significant findings with sufficient sample size to generate stable confidence intervals. For both binomial and multinomial logistic regression, odds ratios and 95% confidence intervals are presented as measures of estimated effects. Alpha significance levels were set a priori at 5%. Logistic regression model validity, i.e., statistical integrity of the estimated model parameters, was assessed using the convergence criterion, model fit (of observed event rates to expected event rates) was assessed using the Hosmer-Lemeshow test, and multicollinearity, e.g., correlation of covariates, was assessed using the tolerance statistic; these diagnostics were utilized to specify the logistic regression models.

Part II: Medical Record Review of a Random Sample of Newborns with a Readmission within 30 days of birth-stay discharge

Study Sample: The eligible population derived from the electronic database submitted by the MCOs for Part I of the study was the source of the medical record review sample. From each MCO, a random sample of 100 members, plus an oversample of 10 (for MCOs with sufficient sample size), was selected using the criterion of members with a readmission within 30 days of the birth discharge. The entire birth-stay record was requested, including both the birth-stay hospital and the receiving hospital for newborns who were transferred. The admission note and the discharge summary were requested for the readmission stay.

A total of 363 medical records were requested. Kentucky Spirit Health Plan did not submit any records as they terminated their Kentucky Medicaid Managed Care contract at the time of the medical record request. Of the remaining 260 medical records requested, 254 (98%) were submitted electronically to IPRO's secure File Transfer Protocol (FTP) site from Passport Health Plan, CoventryCares of Kentucky, and WellCare of Kentucky. Of the 254 submitted records, 243 (96%) were confirmed eligible for the study using administrative data to confirm a birth stay with the outcome of a live birth and a newborn readmission within 30 days of the birth-stay discharge date; however, there were 15 additional members who were excluded from the study due to absence of a birth record determined upon chart review. Of the remaining 228 newborns, there were 216 newborns with complete birth records, i.e., birth-stay record documentation of the member stay from admission to discharge. For newborns who were transferred from the birth hospital to another hospital, a complete birth record was defined as one that included both the birth hospital record and the transfer hospital record. The chart review sample of 216 newborns with complete birth records served as the primary chart review sample for analysis of demographic characteristics; term status and delivery type; obstetric intake information; maternal co-morbid conditions and obstetric complications; newborn diagnoses, procedures, and interventions; and newborn discharge readiness, planning and education.

In order to include all care management records submitted by MCOs, however, a second chart review sample not limited to newborns with a complete birth record was utilized (n = 228) for the comprehensive assessment of care management interventions; thus, this second sample included 228 newborns with a hospital readmission, both those with and without a care management record. Therefore, the sample not limited to newborns with a complete birth record may include newborns who were transferred to another hospital, and for whom the record of the hospital of origin was available, but the record of the receiving hospital of transfer was not available. Both the primary chart review sample (n = 216) and the sample not limited to newborns with a complete birth record (n = 228) used the readmission ICD-9 diagnostic groupings indicated in Appendix A.

In order to comprehensively assess the newborn readmission stay, a third sample was restricted to only those newborns with a readmission record (n = 193), and used the abstracted groupings of documented readmission diagnoses indicated in Appendix C. All

of the newborns in this third sample had a readmission record, but not all had a complete birth record.

For all of the medical record review study samples, term status was based upon medical record-abstracted gestational age, grouped as follows: birth at 24–33 weeks of gestation = early pre-term; 34–36 weeks = late pre-term; 37–38 weeks = early term; 39–40 weeks = late term; 41 weeks = full term; 42+ weeks = post-term; and unknown term status. Study data elements were abstracted using a Microsoft Access database developed by IPRO and a data element instructional tool developed by IPRO and reviewed by KDMS.

Data Analysis: Frequencies and percentages are presented for study data elements abstracted from the medical records of the study sample. In addition, using the primary subset, a supplemental analysis compared discharge readiness and education between newborns discharged from the NICU and newborns discharged from the newborn nursery; this analysis excluded 4 newborns with a discharge unit other than the NICU or newborn nursery. For this supplemental analysis, the *chi*-squared statistics was used to evaluate statistically significant differences between proportions of newborns discharged from the NICU versus the newborn nursery.

RESULTS

Part I: Newborn Readmissions Retrospective Cohort Study/Administrative Data – Findings

The retrospective cohort study includes both newborns with the outcome event of interest, i.e., readmission within 30 days of birth-stay discharge, and newborns without the outcome event; therefore, statistically significant associations and risk factors may be identified.

Descriptive statistical findings

This section presents findings based upon statistical evaluation of associations between the outcome of all-cause newborn readmission and possible risk factors, without statistical adjustment for the influence of multiple risk factors.

Overview: The newborn readmission rate for the total sample of live births during the period from November 6, 2011 through September 5, 2012 was 1.92%, or 416 of 21,686 members (Table 1). Readmissions for respiratory syncytial virus (RSV; n = 42) and jaundice (n = 37) were the highest volume cause-specific readmission categories, and readmissions for an aggregated grouping of respiratory conditions (RSV, non-RSV bronchiolitis and all other respiratory conditions) comprised 19% of all newborn readmissions (Figure 1). Whereas the majority of respiratory readmissions occurred between 11 and 30 days (n = 37 for RSV; n = 11 for bronchiolitis; n = 19 for other respiratory), most readmissions for jaundice occurred between days 1–3 post-birth-discharge (n = 31; Figure 1). Readmissions for congenital pyloric stenosis also comprised a considerable number of readmissions (n = 31), with most newborns readmitted between 11 and 30 days post-birth-discharge. Taken together, principal readmission diagnoses of gastrointestinal-system-related disorders (congenital pyloric stenosis, dehydration, reflux/gastritis, failure-to-thrive, feeding problems, and other gastrointestinal problems) comprised 17% of newborn readmissions. Overall, 28% of newborn readmissions occurred between days 1–3 post–birth-stay discharge, 20% occurred between days 4–10, and 52% occurred between days 11–30.

Table 1. Descriptive statistics for key demographic, service, and member characteristics

Characteristics[a]	# Admissions	Prevalence rate	# Readmissions	Readmission rate
Total:	**21,686**	**100%**	**416**	**1.92%**
Sex:[b]				
Male	11,169	51.50%	255	2.28%
Female	10,392	47.92%	160	1.54%
Not documented	125	0.58%	1	0.80%
Race/Ethnicity:[b]				
White	18,380	84.76%	323	1.76%
Black	2,345	10.81%	54	2.30%
Other	961	4.43%	39	4.06%
In or at risk of foster care:				
Yes	333	1.54%	11	3.30%
No	21,353	98.46%	405	1.90%
Member residence:[b]				
Urban	10,824	49.91%	245	2.26%
Rural	10,815	49.87%	170	1.57%
Unknown	47	0.22%	1	2.13%
Born during RSV season:				
Yes	10,640	49.06%	215	2.02%
No	11,046	50.94%	201	1.82%
Gestational age:[b]				
Term, not post-date	19,506	89.95%	349	1.79%
Early pre-term	253	1.17%	17	6.72%
Late pre-term	974	4.49%	30	3.08%
Post-term	944	4.35%	20	2.12%
Unspecified	9	0.04%	0	0%
Cesarean delivery:				
Yes	7,168	33.05%	125	1.74%
No	14,518	66.95%	291	2.00%
MCO:[b]				
Kentucky Spirit Health Plan	6,586	30.37%	132	2.00%
CoventryCares of Kentucky	5,804	26.76%	81	1.40%
Passport Health Plan	4,525	20.87%	137	3.03%
WellCare of Kentucky	4,758	21.94%	66	1.39%
Unknown	13	0.06%	0	0%
Newborn follow-up:[b]				
No visit	3,497	16.13%	158	4.52%
One visit	6,431	29.66%	123	1.91%
Two or more visits	11,758	54.22%	135	1.15%

[a] Key demographic, service, and member characteristics entered into all logistic regression models, i.e., common model factors. The number of birth-stay admissions, number of newborn readmissions, and newborn readmission rates for Medicaid members born alive during the period from November 6, 2011 through September 5, 2012.

[b] Statistically significant differences between subgroups, *chi*-squared statistic *p*-value ≤ 0.05

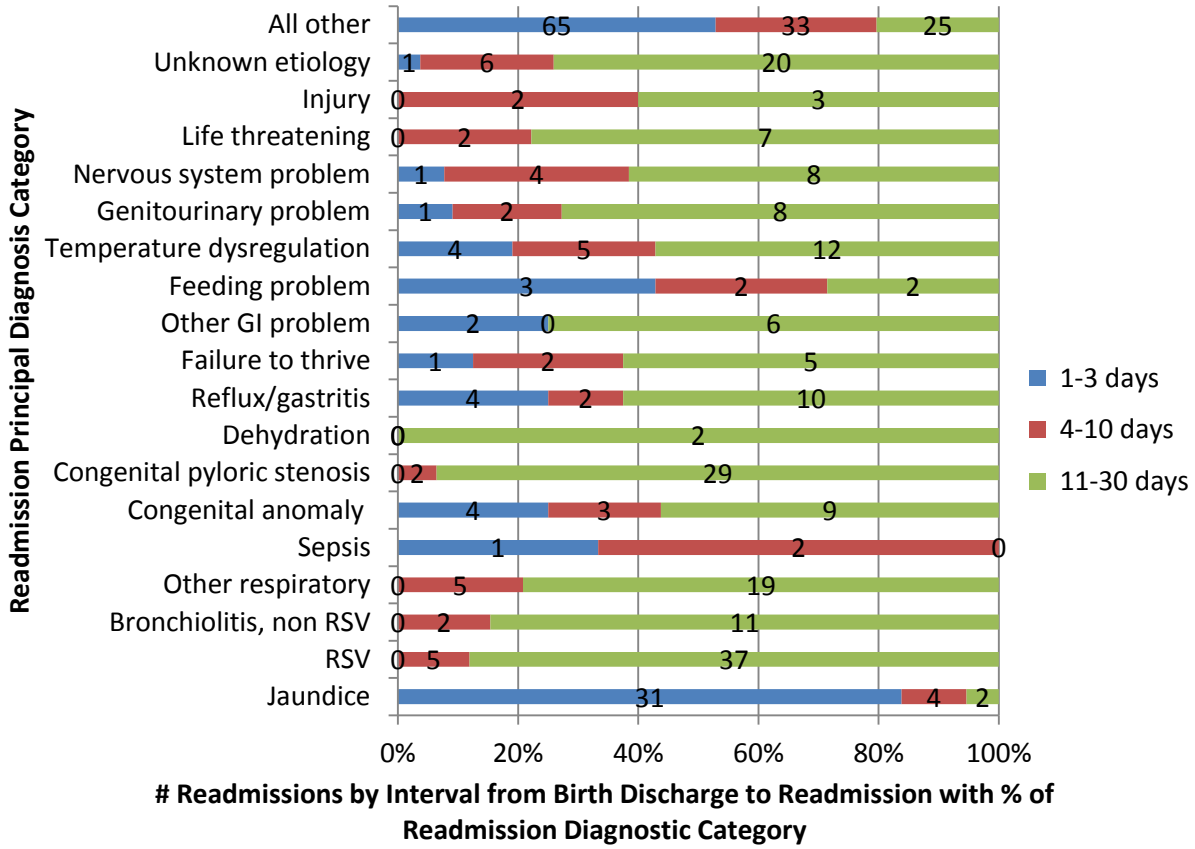

Figure 1. Count by readmission timing interval and readmission diagnosis category. The number and percentage of newborn readmissions at 1–3 days (blue), 4–10 days (red), or 11–30 days (green) after birth discharge by readmission principal diagnosis category (n = 416).

Key member characteristics: There was a statistically significant difference in the readmission rate by gestational age, with the highest rate among early pre-term (< 33 weeks) newborns (6.72%), followed by late pre-term (≥ 33 weeks and < 37 weeks) newborns (3.08%) and post-term (> 40 weeks) newborns (2.12%); prevalence rates for these subsets were 1.17%, 4.49%, and 4.35%, respectively (Table 1). The lowest readmission rate (1.79%) was for term newborns (37–40 weeks). Readmissions for jaundice, RSV, congenital pyloric stenosis, temperature dysregulation, failure to thrive, dehydration, genitourinary conditions and apparent life threatening event characterized late-pre-term, but not early pre-term newborns, who were characterized more by respiratory problems other than RSV; however, both of these subgroups were largely characterized by miscellaneous cause-specific diagnoses grouped into the “All other” category (e.g., “ill-defined conditions originating in the perinatal period;” Figure 2), as were all subsets examined.

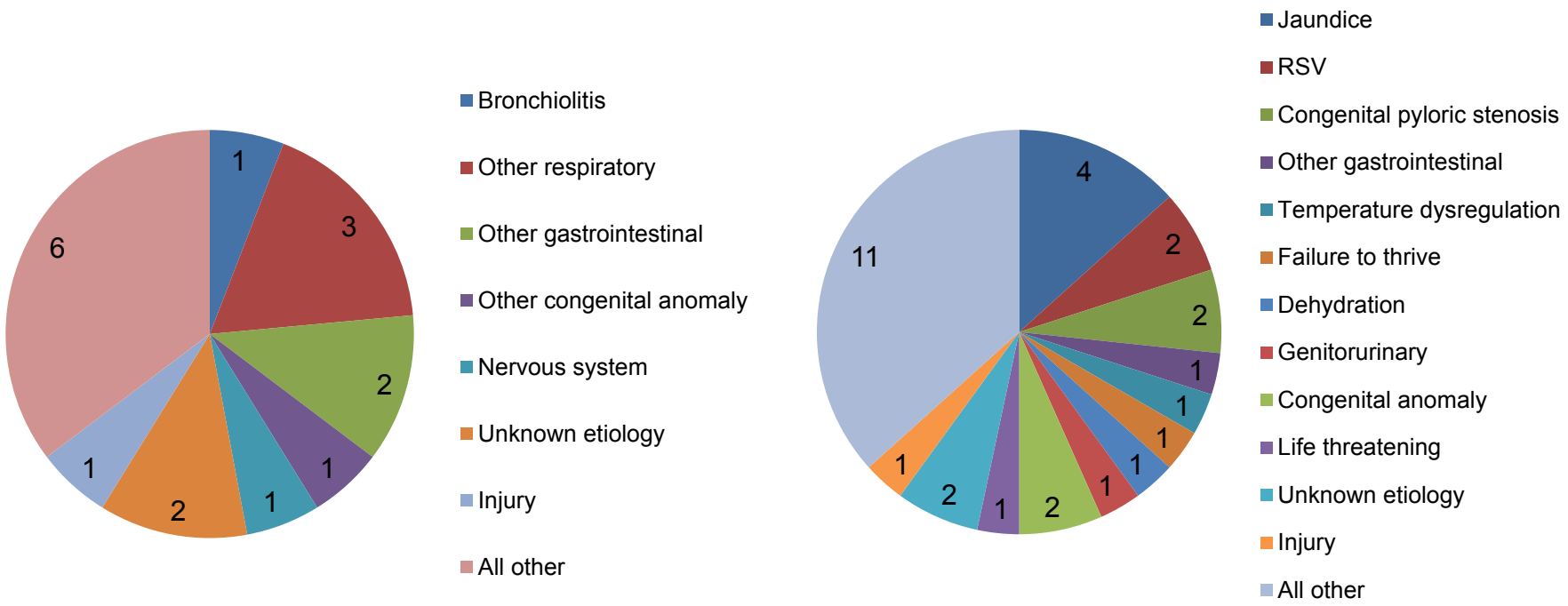

Figure 2. Early and late pre-term newborn readmission count by readmission diagnosis category. Readmission count by principal diagnosis category for early pre-term newborns (n = 17; left panel) and for late pre-term newborns (n = 30; right panel).

Among term newborns, the majority of cause-specific readmissions were for RSV (n = 37 of 349), jaundice (n = 33 of 349), and congenital pyloric stenosis (n = 29 of 349; Figure 3). Male sex was also significantly associated with readmission, with a readmission rate of 2.28% compared to 1.54% among female newborns (Table 1). Readmissions for congenital pyloric stenosis comprised the highest cause-specific volume (n = 26 of 255) among male newborns, followed by RSV (n = 20 of 255) and jaundice (n = 20 of 255), whereas readmissions for RSV (n = 22 of 160) and jaundice (n = 17 of 160) comprised the highest cause-specific readmission volume among females.

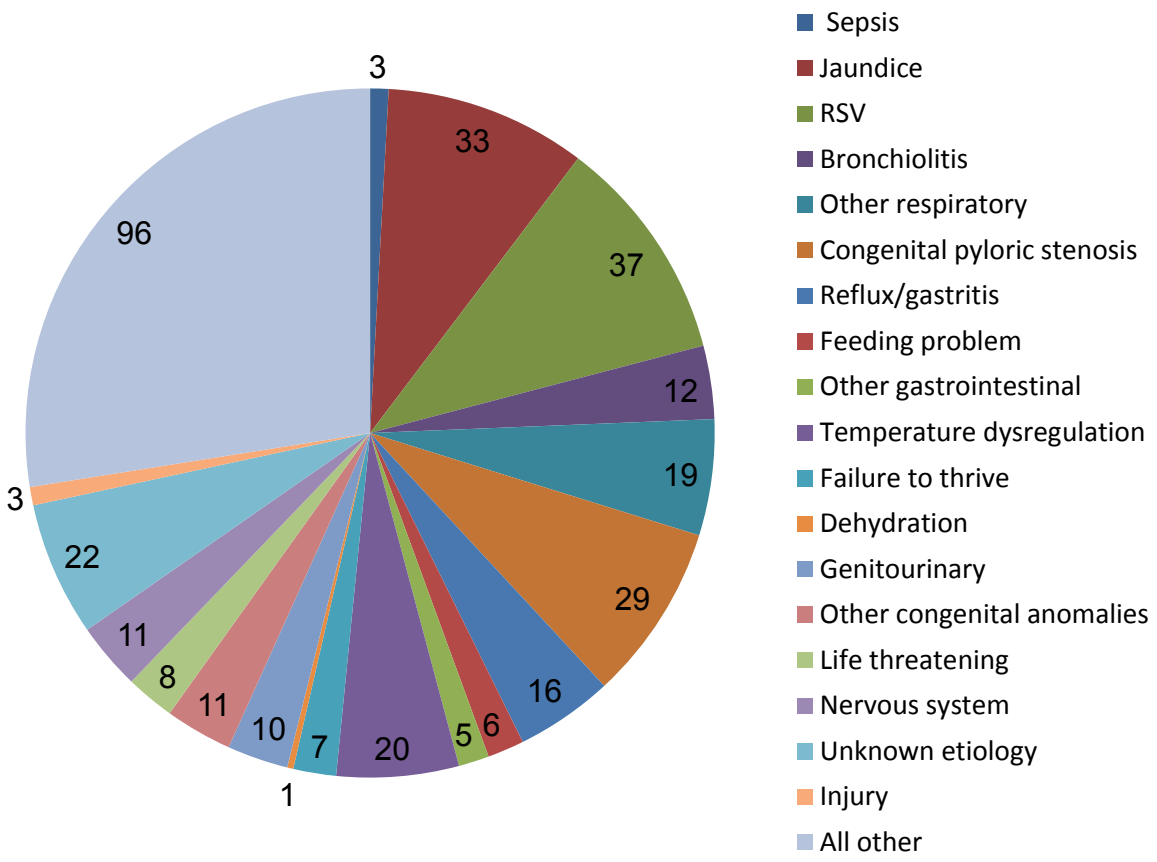

Figure 3. Term newborn readmission count by readmission diagnosis category. Readmission count by principal diagnosis category for term newborns (n = 349).

The readmission rate was significantly different by race/ethnicity, with newborns of “other” race/ethnicity showing the highest readmission rate (4.06%), relative to Black (2.30%) and White (1.76%) newborns, with corresponding prevalence rates of 4.43%, 10.81%, and 84.76%, respectively. Urban/rural residence was also significantly associated with newborn readmissions, with newborns from urban areas showing a higher readmission rate (2.26%) than those from rural areas (1.57%; Table 1). Prevalence rates for urban and

rural residence were similar. The newborn readmission rate also differed significantly by region, with Region 3 showing the highest readmission rate (3.05%; Figure 4). Within Region 3, MCO readmission rates were 10% (4 of 40) for Kentucky Spirit Health Plan, 2.99% (130 of 4,345) for Passport Health Plan, and 0% (0 of 15) for Wellcare of Kentucky. The readmission rate for newborns in or at risk of foster care was not significantly different from those not in or at risk of foster care; however, their readmission rate was higher, at 3.30% compared to 1.90%. The prevalence rate for newborns either in or at risk of foster care was only 1.54%. Although newborns born during RSV season (49.06%) had a higher readmission rate (2.02%) compared to those not (1.82%), this difference was not statistically significant. Newborns delivered by cesarean section had a lower readmission rate (1.74%) compared to those not (2.00%; Table 1), though the difference between these rates was not significant. The overall prevalence of cesarean births was 33.05%.

Region	Readmission Rate	Plan Comparisons in Regions with Readmission Rates Greater than the Overall Readmission Rate of 1.92%
1	0.92%	Region readmission rate < overall readmission rate of 1.92%
2	1.86%	Region readmission rate < overall readmission rate of 1.92%
3	3.05%	PHP: 130/4345 (2.99%); Spirit: 4/40 (10.00%); WellCare: 0/15 (0%); CoventryCares: 0/0*
4	1.62%	Region readmission rate < overall readmission rate of 1.92%
5	1.61%	Region readmission rate < overall readmission rate of 1.92%
6	1.65%	Region readmission rate < overall readmission rate of 1.92%
7	1.80%	Region readmission rate < overall readmission rate of 1.92%
8	1.70%	Region readmission rate < overall readmission rate of 1.92%

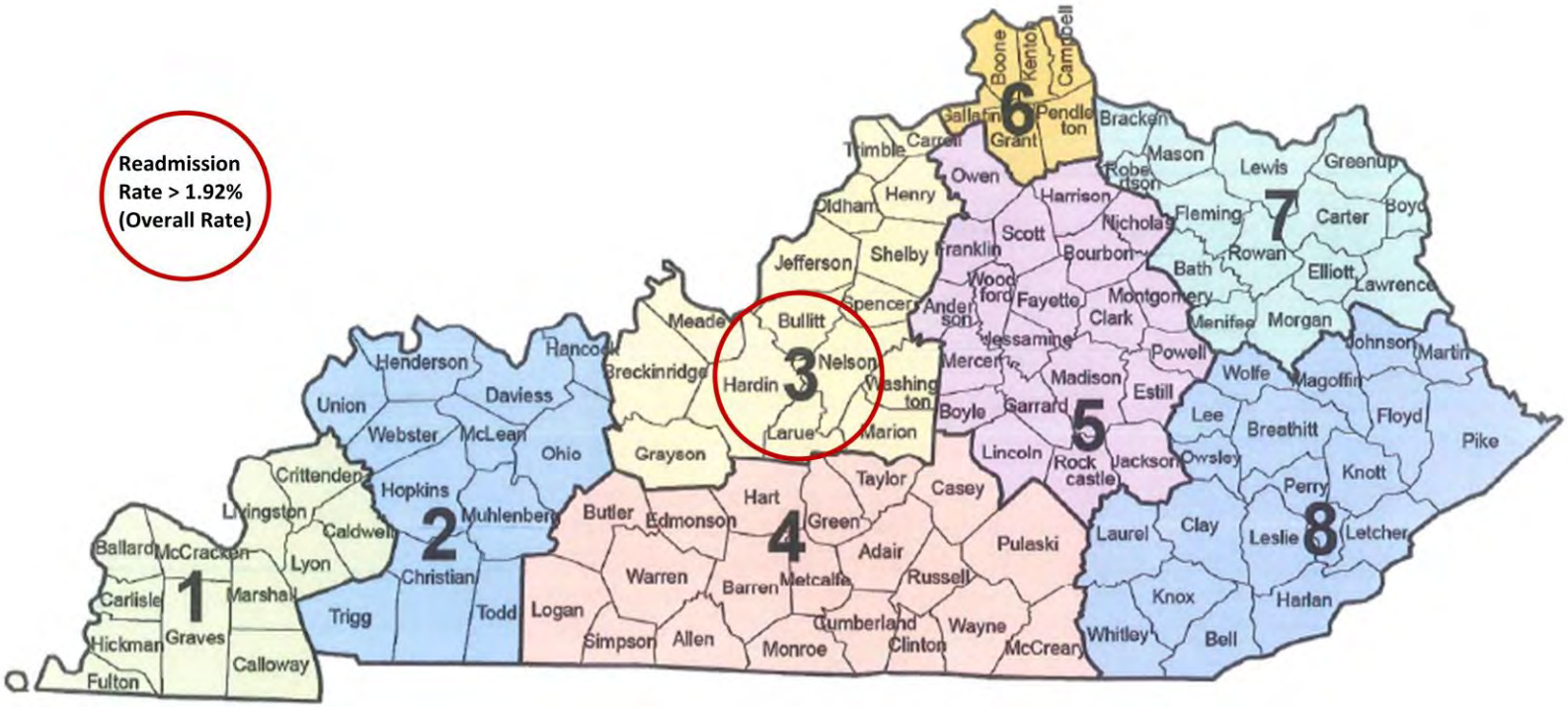

Figure 4. Newborn readmission rate by region. The rates of newborn readmissions (n = 416/21,686= 1.92%) are shown by region. Rates per plan are shown in table (red) and circled on map (red) for Region 3, for which the newborn readmission rate is statistically different from other regions ($p \leq 0.05$). *PHP: Passport Health Plan; Spirit: Kentucky Spirit Health Plan; WellCare: WellCare of Kentucky; CoventryCares: CoventryCares of Kentucky.

Service/Utilization factors: Kentucky Spirit Health Plan, CoventryCares of Kentucky, WellCare of Kentucky, and Passport Health Plan comprised 30.37%, 26.76%, 21.94%, and 20.87% of the cohort study sample, respectively. There was a statistically significant difference between MCO readmission rates, with Passport Health Plan showing the highest rate (3.03%), followed by Kentucky Spirit Health Plan (2.00%; Table 1). Whether a newborn had zero, one, or multiple post-birth discharge follow-up visits was also significantly associated with readmissions, with the highest readmission rate among newborns having no follow-up visit (4.52%) and the lowest rate among those with two or more visits (1.15%; Table 1). Among newborns readmitted within 1–3 days of discharge from the birth-stay hospital, most (95%) had no follow-up visits, whereas slightly less than half (46%) of newborns readmitted within 4–10 days had one or more visits, and half (50%) of newborns readmitted within 11–30 days had multiple visits (Figure 5).

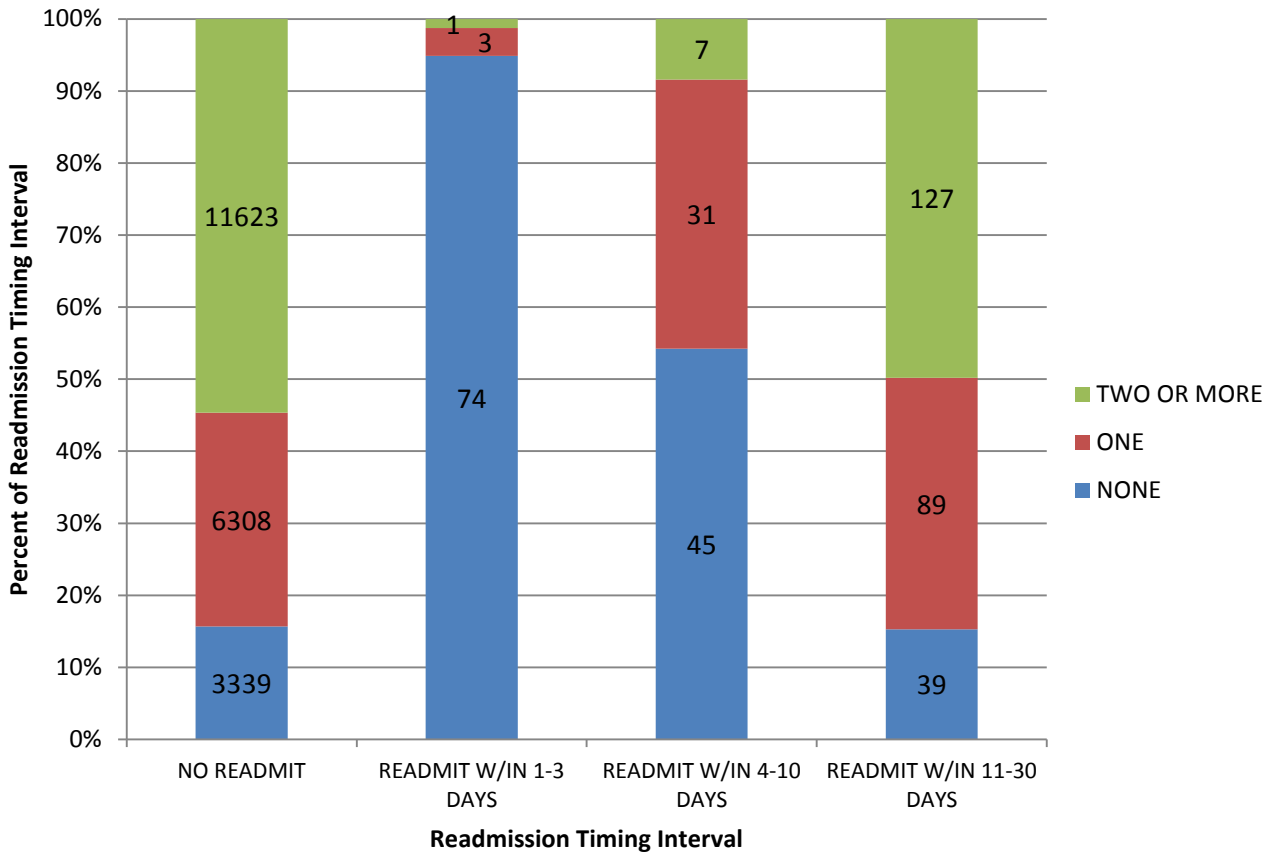

Figure 5. Outpatient visits by readmission timing interval. The number and percentage of newborns with 0 (blue), 1 (red), or 2 or more (green) outpatient visits by newborn readmission timing interval of admission within 1–3 days, 4–10 days, and 11–30 days, including newborns without readmission (no readmit).

Key birth-stay clinical characteristics: Any birth-stay diagnosis code of sepsis, respiratory distress, apnea, gastrointestinal problem, cardiovascular abnormality, congenital anomaly and other newborn complications were significantly associated with newborn readmission (Table 2). Prevalence rates were as follows: sepsis (6.80%), respiratory distress (8.00%), apnea (1.06%), gastrointestinal problem (3.77%), cardiovascular abnormality (3.81%), congenital anomaly (9.40%), and other newborn complications (12.20%).

Table 2. Descriptive statistics for key birth-stay clinical characteristics

Key clinical characteristics[a]	# Admissions	Prevalence rate	# Readmissions	Newborn readmission rate
Total:	**21,686**	**100%**	**416**	**1.92%**
Jaundice +	3,375	15.56%	76	2.25%
Jaundice -	18,311	84.88%	340	1.86%
Sepsis +[b]	1,474	6.80%	46	3.12%
Sepsis -	20,212	93.20%	370	1.83%
Respiratory distress +[b]	1,735	8.00%	67	3.86%
Respiratory distress -	19,951	92.00%	349	1.75%
Apnea +[b]	229	1.06%	12	5.24%
Apnea -	21,457	98.94%	403	1.88%
Gastrointestinal problem +[b]	818	3.77%	25	3.06%
Gastrointestinal problem -	20,868	96.23%	391	1.87%
Feeding problem +	400	1.84%	10	2.50%
Feeding problem -	21,286	98.16%	406	1.91%
Cardiovascular abnormality +[b]	827	3.81%	30	3.63%
Cardiovascular abnormality -	20,859	96.19%	386	1.85%
Cardiac operation +[b]	509	2.35%	24	4.72%
Cardiac operation -	21,177	97.65%	392	1.85%
Congenital anomaly +[b]	2,038	9.40%	62	3.04%
Congenital anomaly -	19,648	90.60%	354	1.80%
Substance abuse +	399	1.84%	8	2.01%
Substance abuse -	21,287	98.16%	408	1.92%
Temperature dysregulation +	187	0.86%	4	2.14%
Temperature dysregulation -	21,499	99.14%	412	1.92%
Other newborn complications +[b]	2,646	12.20%	68	2.57%
Other newborn complications -	19,040	87.80%	348	1.83%
Mechanical ventilation +[b]	304	1.40%	20	6.58%
Mechanical ventilation -	21,382	98.60%	396	1.85%
Other intubation/irrigation +[b]	526	2.43%	33	6.27%
Other intubation/irrigation -	21,160	97.57%	383	1.81%
Injection/Infusion +[b]	445	2.05%	17	3.82%
Injection/Infusion -	21,241	97.95%	399	1.88%
Transfusion +[b]	60	0.28%	6	10.00%
Transfusion -	21,626	99.72%	410	1.90%
Birth length of stay/transfer:[b]				

Key clinical characteristics[a]	# Admissions	Prevalence rate	# Readmissions	Newborn readmission rate
≤ 2 days, no transfer	14,746	68.00%	231	1.57%
3–4 days, no transfer	4,519	20.84%	90	1.99%
≤ 4 days, with subsequent transfer	407	1.88%	28	6.88%
5–10 days, with or without subsequent transfer	934	4.31%	23	2.46%
11–29 days, with or w/o subsequent transfer	758	3.50%	24	3.17%
30–187 days, with or w/o subsequent transfer	322	1.48%	20	6.21%

[a] The number of birth-stay admissions, number of newborn readmissions, and newborn readmission rates for Medicaid members born alive during the period from November 6, 2011 through September 5, 2012. High readmission volume or high interest for newborn risk and/or case management. Not restricted to principal diagnosis. Members may fall into more than one diagnostic category.
[b] Statistically significant differences between subgroups, *chi*-squared statistic *p*-value ≤ 0.05, or Fisher's Exact Test statistic *p*-value for variables with 25% of cells with an expected count < 5.

Newborns with any birth-stay diagnosis of sepsis were readmitted at a rate of 3.12% (46 of 1,474; Table 2). Of this subpopulation, 3 were readmitted for a principal diagnosis of RSV and 7 were readmitted for a principal diagnosis of other respiratory disorders, with the remainder readmitted for a variety of principal diagnosis codes, with most of less well-defined etiology (Figure 6).

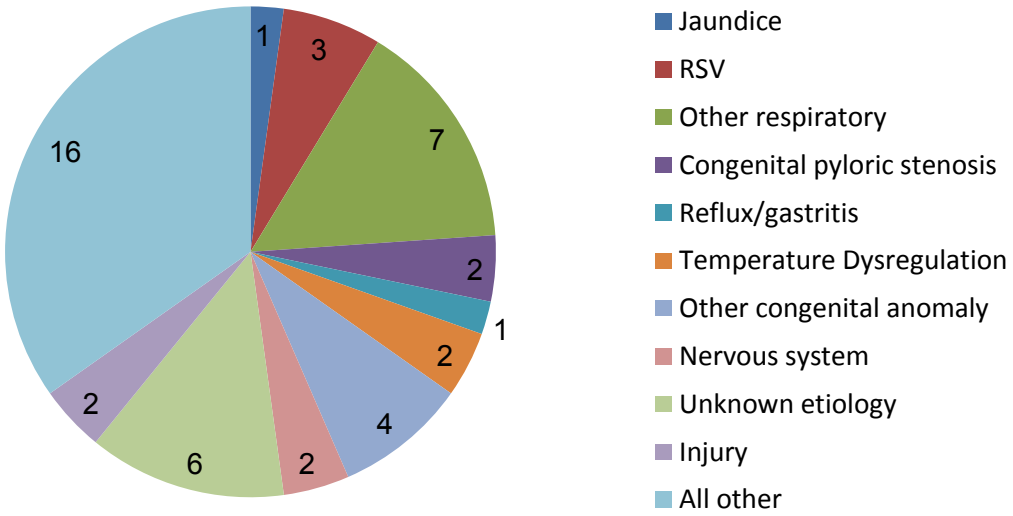

Figure 6. Readmission count by readmission diagnosis category (Sepsis during birth stay). Newborn readmission count by readmission principal diagnosis category for newborns with any birth-stay diagnosis of sepsis (n = 46).

Newborns with any birth-stay diagnosis of respiratory distress were readmitted at a rate of 3.86% (67 of 1,735; Table 2). Of this subpopulation, principal reasons for readmission included RSV (n = 5), bronchiolitis (n = 2) and other respiratory conditions (n = 9), as well as gastrointestinal-related conditions, congenital anomalies and temperature dysregulation; again, with the remainder characterized by a variety of less readily categorized diagnoses (Figure 7).

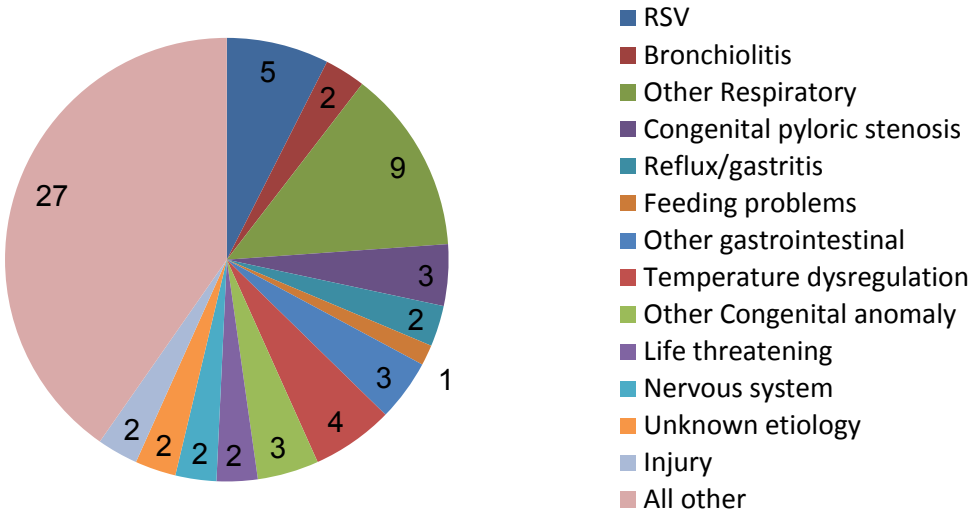

Figure 7. Readmission count by readmission diagnosis category (Respiratory Distress during birth stay). Newborn readmission count by readmission principal diagnosis category for newborns with any birth-stay diagnosis of respiratory distress (n = 67).

Newborns with any birth-stay diagnosis of newborn complications were readmitted at a rate of 2.57% (68 of 2,646; Table 2). Of this subpopulation, 5 were readmitted for a principal diagnosis of RSV, 3 for bronchiolitis, and 10 for other respiratory conditions, with another 4 readmitted for congenital pyloric stenosis and 4 for temperature dysregulation (Figure 8). Readmission rates for any birth-stay diagnoses of jaundice, substance abuse, temperature dysregulation and feeding problems were elevated relative to newborns without these conditions, although the increase in these rates was not statistically significant.

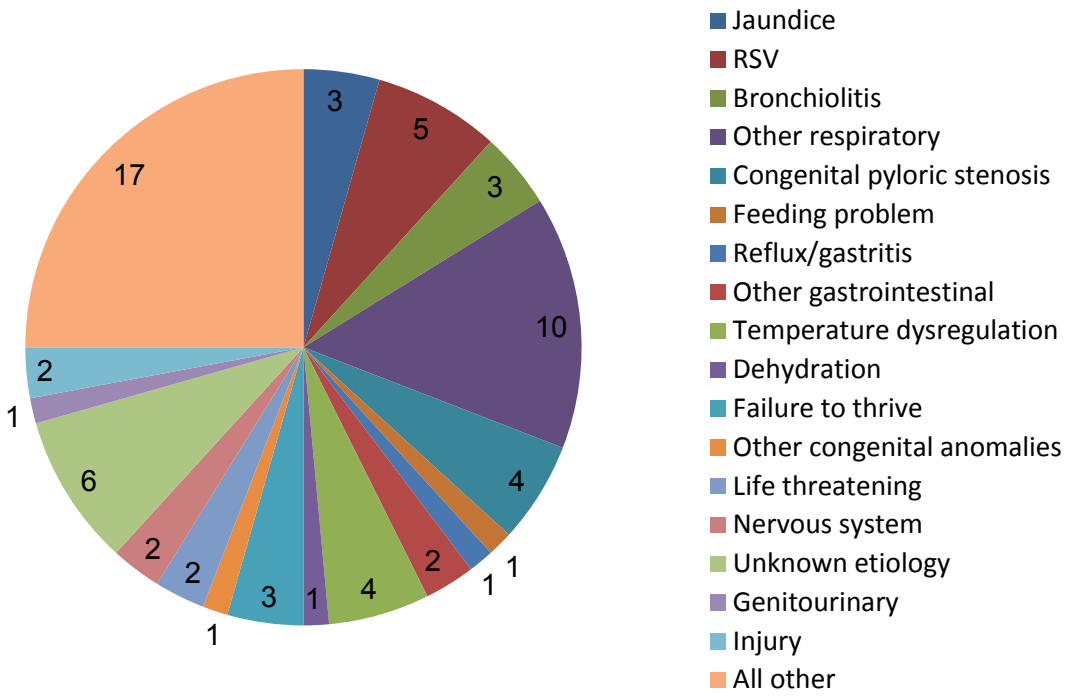

Figure 8. Readmission count by readmission diagnosis category (Newborn Complications during birth stay). Newborn readmission count by readmission principal diagnosis category for newborns with any birth-stay diagnosis of newborn complications (n = 68).

Any birth-stay procedure code of mechanical ventilation, other intubation/irrigation, injection/infusion (non-routine vaccine), and transfusion were significantly associated with newborn readmission (Table 2). Prevalence rates for newborns undergoing these procedures were 1.40%, 2.43%, and 0.28%, respectively. Newborns with any birth-stay procedure code for mechanical ventilation were readmitted at a rate of 6.58% (20 of 304; Table 2). Of this subpopulation, 2 were readmitted for a principal diagnosis of RSV and 5 for other respiratory conditions, as well as 2 each for congenital anomaly, other gastrointestinal problem, and nervous system disorders (Figure 9). Newborns with any birth-stay procedure code for other intubation/irrigation were readmitted at a rate of 6.27% (33 of 526; Table 2). Similar principal readmission diagnoses in this subpopulation were observed (Figure 10).

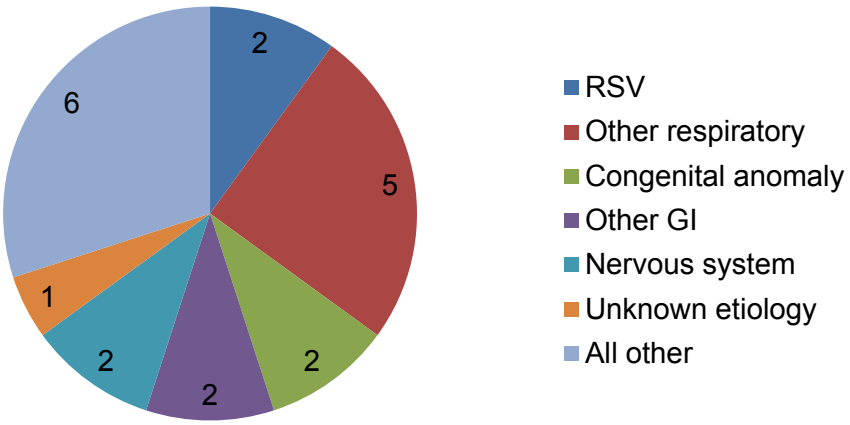

Figure 9. Readmission count by readmission diagnosis category (Mechanical Ventilation during birth stay). Newborn readmission count by readmission principal diagnosis category for newborns with any birth-stay procedure coded as mechanical ventilation (n = 20).

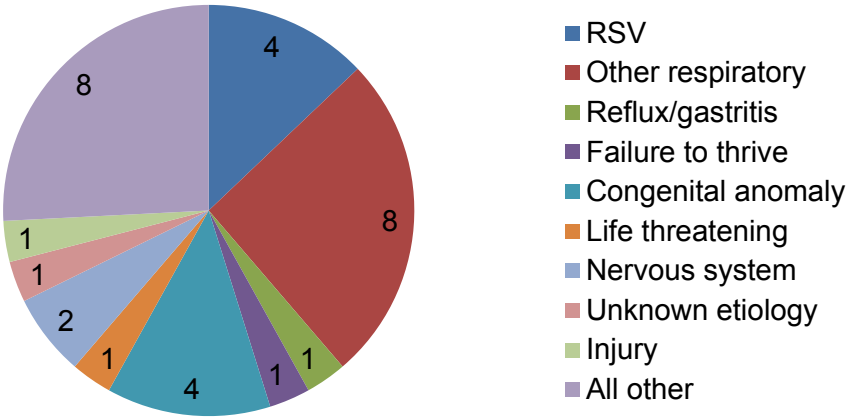

Figure 10. Readmission count by readmission diagnosis category (Other Intubation during birth stay). Newborn readmission count by readmission principal diagnosis category for newborns with any birth-stay procedure coded as other intubation (n = 33).

The majority of newborns' length of stay at the hospital of birth for the total sample was for a period of less than or equal to 2 days without a subsequent transfer (68%), followed by 3–4 days, also without a subsequent transfer (20.84%). Birth length of stay with transfer status was significantly associated with newborn readmission, e.g., length of stay ≤ 4 days with subsequent transfer showed the highest readmission rate, at 6.88% (28 of 407), followed by length of stay between 30–187 days with or without subsequent transfer, at 6.21% (20 of 322), with decreasing rates observed as length of stay decreased (Table 2).

Multivariable logistic regression findings

This section presents findings based on statistical evaluation of associations between the outcome of all-cause newborn readmission and possible risk factors, with statistical adjustment for the influence of multiple risk factors. Therefore, findings may be used to identify risk factors for all-cause newborn readmission.

Member characteristics: In the model with only key demographic, service and member characteristics (i.e., the common model factors) and without a birth-stay diagnosis or procedure included, males were at significantly greater odds for readmission (OR=1.5; 95% CI=1.3, 1.9). Similar findings were observed in the models that additionally assessed the relationships between newborn readmission and the following birth-stay diagnoses and procedures: respiratory distress, sepsis, congenital anomalies, other birth complications, mechanical ventilation, and other intubabion (Table 3). Relative to White newborns, newborns of "other" race/ethnicity were 60% more likely to be readmitted (OR=1.60; 95% CI=1.1, 2.3). Odds were 50% greater among "other" race/ethnicity in the models that separately evaluated the relationships between newborn readmission and any birth stay diagnosis of respiratory distress, sepsis, congenital anomalies and other birth complications. However, odds ratios were attenuated and lost statistical significance for the "other" race/ethnicity group when the relationship between newborn readmission and birth-stay procedures (mechanical ventilation and other intubation) were evaluated (Table 3).

In the model with only key demographic, service and member characteristics, compared to term newborns who were not delivered post-date, early pre-term newborns were at more than twice the odds of readmission (OR=2.6; 95% CI=1.5, 4.4), and late pre-term newborns had 60% greater odds for readmission (OR=1.6; 95% CI=1.1, 2.4). As such, early pre-term newborns had the highest odds for readmission, and late pre-term newborns also had higher odds compared to term newborns.

Corresponding risk estimates varied across the separate models that also assessed birth-stay diagnoses and procedures, with similar, albeit somewhat attenuated, findings in the models with birth-stay diagnoses of sepsis, congenital anomalies, and other birth complications (Table 3). As such, in the sepsis, congenital anomalies, and other birth complications models odds of readmission were higher at differing magnitudes for early and late pre-term newborns compared to term newborns. In the model with a birth-stay diagnosis of respiratory distress, odds were elevated, though not significantly, for early and late pre-term newborns and, in the model that assessed other intubation, odds were elevated, again not significantly, for early pre-term newborns, but were significantly elevated, although slightly attenuated, for late pre-term newborns. The model that assessed birth-stay procedure of mechanical ventilation showed significantly higher odds for readmission among both early and late pre-term newborns; however, the odds for early pre-term newborns were attenuated (Table 3).

Compared to newborns who were enrolled in Kentucky Spirit Health Plan, newborns enrolled in Passport Health Plan were 40% more likely to be readmitted, whereas Wellcare of Kentucky members were 30% less likely to be readmitted; findings were similar across the separate models that included covariates for birth-stay diagnoses and procedures (Table 3). Newborns diagnosed with respiratory distress, sepsis, congenital anomalies, other birth complication, as well as those that had mechanical ventilation and other intubation during their birth stay had similar patterns in their odds of being readmitted based on the MCO they were members of.

Foster care status, urban/rural residence, cesarean delivery, and birth during RSV season were not significantly associated with readmission in any of the readmission models shown (Table 3).

Birth-stay diagnosis and procedures:

Respiratory distress and birth during RSV season: In the all-cause readmission model, any birth-stay diagnosis of respiratory distress was significantly associated with 70% greater odds for all-cause readmission (OR=1.7; 95% CI=1.2, 2.3; Table 3). Thus, newborns who had had a diagnosis of respiratory distress during their birth stay had significantly higher odds of being readmitted compared to newborns who did not have respiratory distress during their birth stay. In the cause-specific model for the outcome of readmission for respiratory disorders, newborns with any birth-stay diagnosis of respiratory distress had almost three times greater odds for readmission for respiratory conditions (OR=2.8; 95% CI=1.6, 4.9; data not shown). Therefore, newborns who had had a diagnosis of respiratory distress during their birth stay had significantly higher odds of not only being readmitted, but also being readmitted for respiratory conditions, compared to newborns who did not have respiratory distress during their birth stay. In addition, newborns born during RSV season showed significantly greater odds for readmission for respiratory problems (OR=2.7; 95% CI=1.8, 4.2; data not shown). Thus, birth during RSV season was a risk factor for readmission for respiratory problems.

Sepsis, congenital anomalies, and other birth complications: In the all-cause readmission model, any birth-stay diagnosis of sepsis was significantly associated with 50% greater odds for all-cause readmission (OR=1.5; 95% CI=1.1, 2.1); congenital anomalies significantly associated with 40% greater odds for readmission (OR=1.4; 95% CI=1.1, 1.9); and other birth complications significantly associated with 40% greater odds for readmission (OR=1.4; 95% CI=1.1, 1.9; Table 3). Therefore, newborns, who had a diagnosis of sepsis, congenital anomalies, or other birth complications during their birth stay, had greater odds of being readmitted compared to newborns who did not have these conditions during their birth stay.

Jaundice: A birth-stay diagnosis of jaundice, however, was not significantly associated with readmission (OR= 1.1; 95% CI=0.8, 1.4; data not shown). Thus, a birth stay diagnosis of jaundice was not a risk factor for readmission.

Mechanical ventilation or other intubation/irrigation: Newborns who had undergone mechanical ventilation or other intubation/irrigation during their birth stay had at more than twice the odds for being readmitted compared to newborns who had not undergone these invasive procedures during their birth stay (OR=2.1; 95% CI=1.2, 3.6 and OR=2.4; 95% CI=1.6, 3.7, respectively; Table 3).

Outpatient follow-up visits: Newborns without any follow-up visit within 30 days of being discharged after their birth stay had more than twice the odds for being readmitted within 30 days compared to newborns with one follow-up visit within 30 days of their discharge. Newborns with two or more follow-up visits within 30 days of being discharged after their birth stay had 40% smaller odds for being readmitted compared to newborns with only one follow-up visit (Table 3).

Table 3. Multiple logistic regression results to evaluate risk factors for newborn readmission

		Separate models that included a covariate for a birth-stay diagnoses or procedures[d]					
	Model with only key demographic, service, and member characteristics[d]	Respiratory distress	Sepsis	Congenital anomalies	Other birth complications	Mechanical ventilation	Other intubation
Birth-stay diagnoses:							
Respiratory distress	-	1.7[b] (1.2, 2.3)	-	-	-	-	-
Sepsis	-	-	1.5[c] (1.1, 2.1)	-	-	-	-
Congenital anomalies	-	-	-	1.4[c] (1.1, 1.9)	-	-	-
Other birth complications	-	-	-	-	1.4[c] (1.1, 1.9)	-	-
Birth-stay procedures:							
Mechanical ventilation	-	-	-	-	-	2.1[b] (1.2, 3.6)	-
Other intubation	-	-	-	-	-	-	2.4[a] (1.6, 3.7)
Common model factors:							
Sex:							
Male	1.5[a] (1.3, 1.9)	1.5[a] (1.2, 1.8)	1.5[a] (1.2, 1.9)	1.5[a] (1.2, 1.9)	1.5[a] (1.3, 1.9)	1.5[a] (1.2, 1.9)	1.5[a] (1.2, 1.8)
Female (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Not documented	0.4 (0.0, 2.6)	0.3 (0.0, 2.5)	0.3 (0.0, 2.6)	0.4 (0.0, 2.7)	0.4 (0.0, 2.7)	0.4 (0.1, 2.8)	0.4 (0.0, 2.8)
Race/Ethnicity:							
White (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Black	1.0 (0.8, 1.4)	1.0 (0.7, 1.4)	1.0 (0.7, 1.4)	1.0 (0.7, 1.3)	1.0 (0.7, 1.4)	1.0 (0.8, 1.4)	1.0 (0.8, 1.4)
Other	1.6[c] (1.1, 2.3)	1.5[c] (1.0, 2.2)	1.5[c] (1.1, 2.2)	1.5[c] (1.0, 2.2)	1.5[c] (1.1, 2.2)	1.4 (1.1, 2.1)	1.4 (1.0, 2.0)
In/At risk foster care:							
Yes	1.4 (0.8, 2.6)	1.4 (0.8, 2.6)	1.4 (0.8, 2.6)	1.4 (0.8, 2.6)	1.4 (0.8, 2.6)	1.4 (0.8, 2.7)	1.4 (0.8, 2.6)
No (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Member Residence:							
Urban	1.1 (0.9, 1.4)	1.1 (0.9, 1.4)	1.1 (0.9, 1.4)	1.1 (0.9, 1.4)	1.1 (0.9, 1.4)	1.1 (0.9, 1.4)	1.1 (0.9, 1.4)
Rural (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unknown	0.7 (0.1, 5.6)	0.8 (0.1, 5.7)	0.8 (0.1, 5.6)	0.7 (0.1, 5.6)	0.8 (0.1, 5.6)	0.7 (0.1, 5.5)	0.7 (0.1, 5.1)
Born during RSV Season:							
Yes	1.0 (0.9, 1.3)	1.0 (0.9, 1.3)	1.0 (0.9, 1.3)	1.0 (0.9, 1.3)	1.0 (0.9, 1.3)	1.0 (0.9, 1.3)	1.0 (0.9, 1.3)

		Separate models that included a covariate for a birth-stay diagnoses or procedures[d]					
	Model with only key demographic, service, and member characteristics[d]	Respiratory distress	Sepsis	Congenital anomalies	Other birth complications	Mechanical ventilation	Other intubation
No (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Gestational age:							
Term, not post-date (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Early pre-term	2.6 [a](1.5, 4.4)	1.7 (1.0, 3.1)	2.2[b] (1.3, 3.9)	2.4[b] (1.4, 4.1)	2.2 [b](1.3, 3.8)	1.9[c] (1.1, 3.5)	1.6 (0.9, 3.1)
Late pre-term	1.6[c] (1.1, 2.4)	1.3 (0.9, 2.1)	1.5[c] (1.0, 2.2)	1.6 [c](1.1, 2.3)	1.6[c] (1.1, 2.3)	1.6[c] (1.1, 2.3)	1.5[c] (1.0, 2.2)
Post-term	1.1 (0.7, 1.7)	1.1 (0.7, 1.7)	1.1 (0.7, 1.7)	1.1 (0.7, 1.7)	1.1 (0.7, 1.7)	1.1 (0.7, 1.7)	1.1 (0.7, 1.7)
Unspecified	-	-	-	-	-	-	-
Cesarean delivery:							
Yes	0.8 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)
No (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
MCO:							
Kentucky Spirit Health Plan (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CoventryCares of Kentucky	0.8 (0.6, 1.0)	0.8 (0.6, 1.0)	0.8 (0.6, 1.0)	0.8 (0.6 , 1.0)	0.7[c] (0.5, 1.0)	0.8 (0.6, 1.0)	0.8 (0.6, 1.0)
Passport Health Plan	1.4[c] (1.1, 1.8)	1.4[c] (1.1, 1.8)	1.4[c] (1.1, 1.8)	1.4[c] (1.1, 1.8)	1.4[c] (1.1, 1.8)	1.4[c] (1.1, 1.8)	1.4[c] (1.1, 1.8)
WellCare of Kentucky	0.7[c] (0.5, 1.0)	0.7[c] (0.5, 1.0)	0.7[c] (0.5, 1.0)	0.7[c] (0.5, 1.0)	0.7[c] (0.5, 1.0)	0.7[c] (0.5, 1.0)	0.7[c] (0.5, 1.0)
Unknown	-	-	-		-	-	-
Newborn follow-up:							
No visit	2.4[a] (1.9, 3.1)	2.4[a] (1.9, 3.0)	2.4[a] (1.9, 3.1)	2.4[a] (1.9, 3.0)	2.4[a] (1.9, 3.0)	2.4[a] (1.9, 3.0)	2.3[a] (1.8, 3.0)
One visit (referent)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Two or more visits	0.6[a] (0.5, 0.8)	0.6[a] (0.5, 0.8)	0.6[a] (0.5, 0.8)	0.6[a] (0.5, 0.8)	0.6[a] (0.5, 0.8)	0.6[a] (0.5, 0.8)	0.6[a] (0.5, 0.8)

[a] $p \leq 0.001$; [b] $p \leq 0.01$; [c] $p \leq 0.05$

[d] Adjusted odds ratios (95% confidence interval) for the relationship between the outcome of newborn readmission within 30 days of birth discharge (n = 416) and independent covariates for birth-stay diagnoses, procedures and key demographic, service, and member characteristics (i.e., common model factors) for Medicaid members born alive between November 6, 2011 and September 5, 2012 (n = 21,686). The first model (second column) did not include birth-stay diagnoses or procedures.

Supplemental analysis of the relationship between outpatient visits and timing of readmission: Comparing the risk for readmission within 4–10 days post birth discharge to no readmission, newborns who did not have any outpatient follow-up visits had more than twice the odds for readmission than newborns with one outpatient follow-up visit (OR=2.7; 95% CI=1.7, 4.4). Furthermore, newborns with multiple follow-up visits had 88% lesser odds for readmission in this time period than newborns with one outpatient follow-up visit (OR=0.12; 95% CI=0.05, 0.28).

Part II: Medical Record Review of a Random Sample of Newborns with Readmission – Findings

Overview: The total primary chart review sample was comprised of 216 newborns readmitted within 30 days of discharge from the birth hospital (Table 4). Prominent readmission diagnoses were RSV (13%), bronchiolitis or other respiratory problems (9%), jaundice (9%), gastroesophageal reflux or other gastrointestinal problems (6%), and failure to thrive, dehydration, or feeding problems (5%; Table 5). Because only newborns who were readmitted are included in the medical record review, this portion of the study cannot be used to identify risk factors for the outcome of newborn readmission. Instead, findings from the chart review may be used to identify gaps in care and opportunities for improvement.

Demographic Characteristics:

The most prevalent maternal age group was comprised of mothers aged 20–34 years of age (n = 162), who comprised 77% the newborn readmission sample (Table 4). Teen mothers comprised 16% of the sample; however, this subset comprised 29% of early pre-term newborns readmitted (Table 4) and 42% of newborns readmitted with gastro-esophageal reflux or other gastrointestinal problems (Table 5). Newborns of single parents comprised 41% of the total readmission chart review sample; however, they comprised approximately half of early pre-term (3/7) and late pre-term newborns (21/41), and more than half of newborns readmitted for gastroesophaeal reflux or other gastrointestinal problems (7/12). Whereas 72% and 42% of the total sample of readmitted newborns were discharged home to a primary responsible person (PRP) with partner or family support, respectively, only 66% (19/29) and 38% (11/29) of the subset of newborns readmitted for RSV were discharged home to a PRP with partner and/or family support, respectively (Table 5).

Males comprised 60% of the total readmission sample and 75% (9/12) of newborns readmitted for gastroesophageal reflux or other GI problems; however, females comprised 52% (n = 15/29) of newborns readmitted for RSV and 60% (6/10) readmitted for failure to thrive, dehydration or feeding problems (Table 5). White newborns comprised the majority of readmissions (n = 168; 78%), followed by Black newborns (n = 30; 14%), who

comprised 22% (9/41) of late pre-term newborns readmitted (Table 4). Whereas Asian newborns comprised only 3% of the total sample, this subset comprised 26% (5/19) of newborns readmitted for jaundice (Table 5). Most newborns resided in urban locations (138/216 = 64%; Table 4), with urban residence comprising 84% of newborns readmitted for jaundice (16/19) and 70% readmitted for failure to thrive, dehydration, or feeding problems (7/10; Table 5). In addition, newborns residing in urban areas comprised 72% of early term births (55/76; Table 4). Although newborns residing in rural areas comprised only 36% of the total readmission sample, these newborns comprised 52% of newborns readmitted for RSV (15/29) and 58% readmitted for gastroesophageal reflux or other gastrointestinal problems (7/12; Table 5). In addition, newborns residing in rural areas comprised 57% of early pre-term births (4/7; Table 4).

Passport Health Plan members comprised 44% of the newborn readmission chart review sample, followed by members of CoventryCares of Kentucky (32%) and Wellcare of Kentucky (24%; Table 4). Newborn members of CoventryCares of Kentucky comprised the greatest proportion of RSV readmissions (15/29 = 52%). There were no newborn members of CoventryCares of Kentucky readmitted for jaundice, whereas Passport Health Plan members comprised the greatest percentage of readmissions for jaundice (15/19 = 79%; Table 5). Although Wellcare of Kentucky members comprised 24% of the overall chart review sample (Table 4), they comprised 31% (9/29) of RSV readmissions and 33% (4/12) of readmissions for gastroeosphageal reflux or other gastrointestinal problems (Table 5).

Table 4. Demographic characteristics by term status

	All readmissions[a] (n = 216) # (Col %)	Early pre-term (24–33 weeks) (n = 7) # (Col %)	Late pre-term (34–36 weeks) (n = 41) # (Col %)	Early term (37–38 weeks) (n = 76) # (Col %)	Late term (39–40 weeks) (n = 5) # (Col %)	Full term (41 weeks) (n = 83) # (Col %)	Post-term (42+ weeks) (n = 2) # (Col %)
Maternal age group:[b]							
12–19 yrs.	33 (16%)	2 (29%)	7 (17%)	11 (15%)	0	13 (16%)	0
20–34 yrs.	162 (77%)	5 (71%)	32 (78%)	57 (78%)	5 (100%)	60 (75%)	1 (100%)
35–45 yrs.	14 (7%)	0	2 (5%)	5 (7%)	0	7 (9%)	0
Sex of baby:[c]							
Female	86 (40%)	2 (29%)	19 (46%)	27 (36%)	5 (100%)	32 (38%)	1 (50%)
Male	129 (60%)	4 (57%)	22 (54%)	49 (64%)	0	51 (61%)	1 (50%)
Race/Ethnicity:							
Black	30 (14%)	1 (14%)	9 (22%)	11 (14%)	0	9 (11%)	0
White	168 (78%)	4 (57%)	30 (73%)	60 (79%)	5 (100%)	65 (78%)	2 (100%)
Asian	6 (3%)	0	0	2 (3%)	0	4 (5%)	0
Native American/ Hawaiian/Alaskan	2 (1%)	0	0	0	0	2 (2%)	0
Other	10 (5%)	2 (28%)	2 (5%)	3 (4%)	0	3 (4%)	0
Residence:[d]							
Rural	77 (36%)	4 (57%)	17 (41%)	21 (28%)	0	33 (40%)	0
Urban	138 (64%)	2 (29%)	24 (58%)	55 (72%)	5 (100%)	50 (60%)	2 (100%)
Eligibility:							
Disabled	6 (3%)	2 (29%)	1 (2%)	2 (3%)	0	1 (1%)	0
Foster care	6 (3%)	0	2 (5%)	2 (3%)	0	1 (1%)	1 (50%)
Income-based	201 (93%)	4 (57%)	38 (93%)	72 (95%)	5 (100%)	80 (96%)	1 (50%)
Unknown	3 (1%)	1 (14%)	0	0	0	1 (1%)	0
PRP[e] (parent):							
Biological	206 (95%)	7 (100%)	38 (93%)	73 (96%)	5 (100%)	80 (96%)	1 (50%)
Foster	3 (1%)	0	2 (5%)	1 (1%)	0	0	0
Other	6 (3%)	0	1 (2%)	2 (3%)	0	2 (2%)	1 (50%)
Not documented	1 (0.5%)	0	0	0	0	1 (1%)	0

	All readmissions[a] (n = 216) # (Col %)	Early pre-term (24–33 weeks) (n = 7) # (Col %)	Late pre-term (34–36 weeks) (n = 41) # (Col %)	Early term (37–38 weeks) (n = 76) # (Col %)	Late term (39–40 weeks) (n = 5) # (Col %)	Full term (41 weeks) (n = 83) # (Col %)	Post-term (42+ weeks) (n = 2) # (Col %)
PRP's marital status:[f]							
Married	39 (18%)	1 (17%)	6 (15%)	21 (28%)	0	11 (13%)	0
Divorced	4 (2%)	1 (17%)	0	1 (1%)	1 (20%)	1 (1%)	0
Separated	3 (1%)	0	1 (2%)	1 (1%)	0	1 (1%)	0
Single	88 (41%)	3 (50%)	21 (51%)	26 (34%)	1 (20%)	36 (43%)	1 (50%)
Not reported	81 (38%)	1 (17%)	13 (32%)	27 (35%)	3 (60%)	34 (41%)	1 (50%)
PRP's social support system:[g]							
Partner	156 (72%)	6 (86%)	26 (63%)	57 (75%)	4 (80%)	61 (73%)	1 (50%)
Family	90 (42%)	4 (57%)	14 (34%)	40 (53%)	5 (100%)	26 (31%)	1 (50%)
Other	8 (4%)	0	0	2 (3%)	0	6 (7%)	0
None	2 (1%)	0	0	1 (1%)	0	1 (1%)	0
Not reported	37 (17%)	0	10 (24%)	10 (13%)	1 (20%)	15 (18%)	0
PRP's education:							
Advanced degree	3 (1%)	0	1 (2%)	1 (1%)	0	1 (1%)	0
College graduate	7 (3%)	0	0	3 (4%)	0	4 (5%)	0
Some college	12 (6%)	1 (14%)	3 (7%)	2 (3%)	0	6 (7%)	0
High school graduate	30 (14%)	0	5 (12%)	12 (16%)	1 (20%)	12 (14%)	0
< High school	26 (12%)	2 (29%)	3 (7%)	12 (16%)	0	9 (11%)	0
Not reported	138 (64%)	4 (57%)	29 (71%)	46 (61%)	4 (80%)	51 (61%)	2 (100%)
PRP's primary language:[h]							
English	82 (38%)	3 (50%)	14 (34%)	36 (47%)	2 (40%)	25 (30%)	1 (50%)
Spanish	12 (6%)	0	0	6 (8%)	0	6 (7%)	0
Other	5 (2%)	0	0	2 (3%)	0	3 (4%)	0
Not reported	116 (54%)	3 (50%)	27 (66%)	32 (42%)	3 (60%)	49 (59%)	1 (50%)
Translation services provided:							
Yes	10 (5%)	0	0	4 (5%)	0	6 (7%)	0
No	4 (2%)	0	1 (2%)	1 (1%)	0	2 (2%)	0
Not indicated	53 (25%)	2 (33%)	7 (17%)	25 (33%)	1 (20%)	17 (20%)	1 (50%)

	All readmissions[a] (n = 216) # (Col %)	Early pre-term (24–33 weeks) (n = 7) # (Col %)	Late pre-term (34–36 weeks) (n = 41) # (Col %)	Early term (37–38 weeks) (n = 76) # (Col %)	Late term (39–40 weeks) (n = 5) # (Col %)	Full term (41 weeks) (n = 83) # (Col %)	Post-term (42+ weeks) (n = 2) # (Col %)
Not reported	148 (69%)	4 (67%)	33 (80%)	46 (60%)	4 (80%)	58 (70%)	1 (50%)
MCO:							
CoventryCares of Kentucky	69 (32%)	6 (86%)	18 (44%)	21 (28%)	0	23 (28%)	0
Passport Health Plan	96 (44%)	1 (14%)	17 (41%)	34 (45%)	3 (60%)	40 (48%)	1 (50%)
WellCare of Kentucky	51 (24%)	0	6 (15%)	21 (28%)	2 (40%)	20 (24%)	1 (50%)

[a] Two observations with unknown term status; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization.
[b] Seven observations with missing data for either maternal age or maternal birth date.
[c] One observation with unknown value for sex of baby.
[d] One observation with unknown value for rural/urban residence.
[e] Primary Responsible Person
[f] One observation with missing data for marital status.
[g] Categories of involved/supportive people are not mutually exclusive.
[h] One observation with missing data for primary language.

Table 5. Demographic characteristics by cause of readmission

	All-cause readmissions (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
Maternal age group:[a]						
12–19 yrs.	33 (16%)	3 (11%)	1 (5%)	3 (17%)	5 (42%)	2 (22%)
20–34 yrs.	162 (77%)	24 (89%)	19 (95%)	12 (67%)	7 (58%)	6 (67%)
35–45 yrs.	14 (7%)	0	0	3 (17%)	0	1 (11%)
Sex of baby:[b]						
Female	86 (40%)	15 (52%)	6 (30%)	7 (37%)	3 (25%)	6 (60%)
Male	129 (60%)	14 (48%)	13 (65%)	12 (63%)	9 (75%)	4 (40%)
Race/Ethnicity:						
Black	30 (14%)	4 (14%)	4 (20%)	1 (5%)	0	5 (50%)
White	168 (78%)	25 (86%)	12 (60%)	13 (68%)	11 (92%)	5 (50%)
Asian	6 (3%)	0	0	5 (26%)	0	0
Native American/ Hawaiian/Alaskan	2 (1%)	0	0	0	1 (8%)	0
Other	10 (5%)	0	4 (20%)	0	0	0
Residence:[c]						
Rural	77 (36%)	15 (52%)	6 (30%)	3 (16%)	7 (58%)	3 (30%)
Urban	138 (64%)	14 (48%)	13 (65%)	16 (84%)	5 (42%)	7 (70%)
Eligibility:						
Disabled	6 (3%)	0	2 (10%)	0	1 (8%)	1 (10%)
Foster care	6 (3%)	0	0	0	0	1 (10%)
Income-based	201 (93%)	29 (100%)	16 (80%)	19 (100%)	11 (92%)	8 (80%)
Unknown	3 (1%)	0	2 (10%)	0	0	0
PRP[d] (parent):						
Biological	206 (95%)	28 (97%)	19 (95%)	19 (100%)	12 (100%)	10 (100%)
Foster	3 (1%)	0	0	0	0	0
Other	6 (3%)	1 (3%)	1 (5%)	0	0	0
Not documented	1 (0.5%)	0	0	0	0	0
PRP's marital status:[e]						
Married	39 (18%)	7 (24%)	3 (16%)	6 (32%)	2 (17%)	3 (30%)
Divorced	4 (2%)	0	1 (5%)	0	0	0
Separated	3 (1%)	3 (10%)	0	0	0	0
Single	88 (41%)	12 (41%)	4 (21%)	7 (37%)	7 (58%)	4 (40%)
Not reported	81 (38%)	7 (24%)	11 (58%)	6 (32%)	3 (25%)	3 (30%)
PRP's social support system:[f]						
Partner	156 (72%)	19 (66%)	14 (70%)	16 (84%)	10 (83%)	8 (80%)
Family	90 (42%)	11 (38%)	9 (45%)	10 (53%)	5 (42%)	3 (30%)
Other	8 (4%)	2 (7%)	0	1 (5%)	0	1 (10%)
None	2 (1%)	0	0	0	0	0
Not reported	37 (17%)	6 (21%)	3 (15%)	1 (5%)	2 (17%)	2 (20%)

	All-cause readmissions (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
PRP's education:						
Advanced degree	3 (1%)	0	0	2 (10%)	0	0
College graduate	7 (3%)	2 (7%)	0	2 (10%)	1 (8%)	0
Some college	12 (6%)	2 (7%)	0	0	3 (25%)	2 (20%)
High school graduate	30 (14%)	7 (24%)	3 (15%)	2 (10%)	0	1 (10%)
< High school	26 (12%)	2 (7%)	3 (15%)	1 (5%)	2 (17%)	1 (10%)
Not reported	138 (64%)	16 (55%)	14 (70%)	12 (63%)	6 (50%)	6 (60%)
PRP's primary language:[g]						
English	82 (38%)	16 (55%)	3 (16%)	6 (32%)	5 (42%)	7 (70%)
Spanish	12 (6%)	2 (7%)	0	2 (10%)	0	0
Other	5 (2%)	0	1 (5%)	3 (16%)	0	0
Not reported	116 (54%)	11 (38%)	15 (79%)	8 (42%)	7 (58%)	3 (30%)
Translation services provided:						
Yes	10 (5%)	1 (3%)	1 (5%)	3 (16%)	0	0
No	4 (2%)	1 (3%)	0	2 (10%)	0	0
Not indicated	53 (25%)	8 (28%)	2 (10%)	5 (26%)	3 (25%)	5 (50%)
Not reported	148 (69%)	19 (66%)	16 (84%)	9 (47%)	9 (75%)	5 (50%)
MCO:						
CoventryCares of Kentucky	69 (32%)	15 (52%)	9 (45%)	0	4 (33%)	4 (40%)
Passport Health Plan	96 (44%)	5 (17%)	7 (35%)	15 (79%)	4 (33%)	5 (50%)
WellCare of Kentucky	51 (24%)	9 (31%)	4 (20%)	4 (21%)	4 (33%)	1 (10%)

[a] Seven observations with missing data for either maternal age or maternal birth date. Demographic information by all-cause and selected high-volume cause-specific readmissions (using principal ICD9 readmission diagnosis; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization.)
[b] One observation with unknown value for sex of baby.
[c] One observation with unknown value for rural/urban residence.
[d] Primary Responsible Person
[e] One observation with missing data for marital status.
[f] Categories of involved/supportive people are not mutually exclusive.
[g] One observation with missing data for primary language.

Utilization:

Newborns with a length of stay less than or equal to 2 days, without a subsequent transfer, comprised 57% of the total chart review study sample, yet 70% (14/20) of the subset readmitted for bronchiolitis or other respiratory problems and 84% (16/19) of the subset readmitted for jaundice (Table 6). Newborns with a length of stay of 3–4 days, without a

subsequent transfer, comprised 24% of the total chart review sample, yet 41% (12/29) of the subset readmitted for RSV and 33% (4/12) readmitted for gastroesophageal reflux or other gastrointestinal problems. Newborns discharged from the newborn nursery comprised 82% of the total chart review study sample, and 90% of newborns readmitted for RSV, as well as 92% of newborns readmitted for gastroesophageal reflux of other gastrointestinal problems (Table 6). Of note, newborns discharged from the newborn nursery comprised 100% of newborns readmitted for jaundice. Furthermore, whereas newborns without an outpatient follow-up visit comprised 31% of the total chart review sample, this subset comprised 84% of newborns readmitted for jaundice (Table 6).

Table 6. Utilization by cause of readmission

	All-cause readmissions (n = 216)[a] # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
Prenatal care:						
Received	125 (58%)	19 (66%)	11 (55%)	12 (63%)	9 (75%)	5 (50%)
Not received	11 (5%)	0	1 (5%)	0	0	1 (10%)
Unable to determine	80 (37%)	10 (34%)	8 (40%)	7 (37%)	3 (25%)	4 (40%)
Length of stay/transfer (Tx) status:						
0–2 days, No subsequent Tx	124 (57%)	13 (45%)	14 (70%)	16 (84%)	7 (58%)	6 (60%)
3–4 days, No subsequent Tx	53 (24%)	12 (41%)	1 (5%)	3 (16%)	4 (33%)	2 (20%)
≤ 4 days, Yes subsequent Tx	6 (3%)	0	0	0	1 (8%)	1 (10%)
5–10 days[b]	14 (6%)	2 (7%)	1 (5%)	0	0	1 (10%)
11–29 days[b]	13 (6%)	0	3 (15%)	0	0	0
30+ days[b]	6 (3%)	2 (7%)	1 (5%)	0	0	0
Discharge unit:						
NICU	34 (16%)	2 (7%)	6 (30%)	0	1 (8%)	2 (20%)
Newborn nursery	178 (82%)	26 (90%)	13 (65%)	19 (100%)	11 (92%)	7 (70%)
Other	4 (2%)	1 (3%)	1 (5%)	0	0	1 (10%)
No outpatient follow-up visit	68 (31%)	4 (14%)	5 (25%)	16 (84%)	3 (25%)	5 (50%)

[a] Utilization information by all-cause and selected high-volume cause-specific readmissions (using principal ICD9 readmission diagnosis; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization)
[b] Includes both newborns transferred and not transferred.

Comparison of NICU versus Newborn Nursery Assessment, Discharge Planning and Education:

This portion of the chart review study compared hospital support practices among newborns discharged from the NICU to those discharged from the newborn nursery; therefore, statistically significant associations between the unit of discharge and support practices may be evaluated. All newborns readmitted for jaundice were discharged from the newborn nursery (Table 6). Compared to newborns discharged from the newborn nursery, newborns discharged from the NICU had a greater proportion diagnosed with hyperbilirubinemia during the birth hospitalization (47% versus 15%), as well as a greater proportion of newborns referred for physician specialty care (47% versus 5%; Table 7). Of note, the mean length of stay for newborns discharged from the NICU was 20.5 days compared to 2.5 days for newborns discharged from the newborn nursery (data not shown); therefore, because bilirubin levels typically peak several days after birth, newborns with a longer length of birth stay would be more likely than newborns with shorter stays to have hyperbilirubinemia diagnosed during the birth stay. On the other hand, compared to newborns discharged from the NICU, newborns discharged from the newborn nursery had a higher proportion of newborns whose mothers initiated breastfeeding (57% versus 38%). Newborns discharged from the newborn nursery had a greater proportion of mothers who were educated about jaundice (68% versus 44%), as well as a greater proportion of bilirubin re-evaluation visits scheduled (36% versus 14%; Table 7).

Yet, the percentage of newborns discharged from the NICU with a routine newborn follow-up visit scheduled for within 48 hours of birth discharge (24%) was greater than that of newborns discharged from the nursery (17%), although this difference was not statistically significant (Table 7; Figure 11). The overall percent of newborns with a readmission (n = 216) for whom a 48 hour follow-up appointment was scheduled was 18% (39/216; Table 7). The percentage of newborns without an outpatient follow-up visit, however, was greater for newborns discharged from the nursery (33%) than those discharged from the NICU (24%), albeit this difference was not statistically significant either (Table 7).

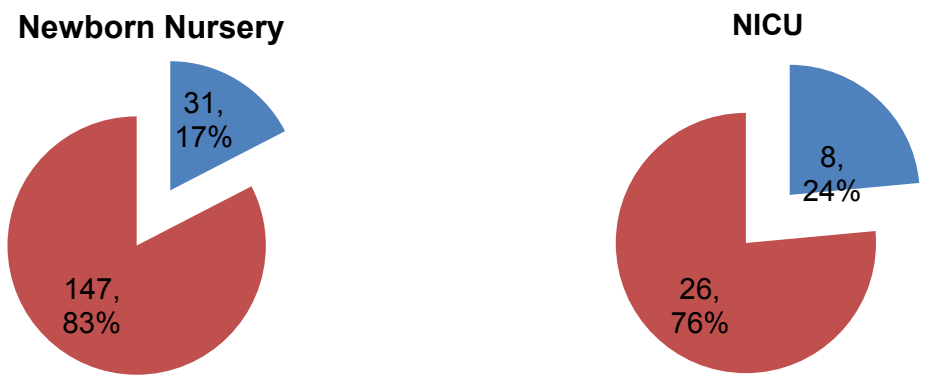

Figure 11. Post-birth follow-up appointment. The frequency (%) of newborns with a follow-up appointment scheduled for the 48-hour period post-birth discharge from either the newborn nursery (left panel) or the NICU (right panel). The overall percent of newborns with a readmission documented based on the medical record review study (n = 216) for whom a follow-up was scheduled for the 48 hours post-birth discharge was 18%. Four newborns were discharged from a unit other than newborn nursery or NICU (adjusted n = 212). Number of newborns with (blue) and without (red) a follow-up visit are based on n = 212. The difference between the newborn nursery and NICU proportions is not statistically significant.

Table 7. Discharge readiness and education: NICU compared to newborn nursery

	Discharged from NICU (n = 34)[a] # (Col %)	Discharged from newborn nursery (n = 178)[a] # (Col %)
Routine newborn follow-up outpatient visit scheduled for within 48 hours of birth discharge	8 (24%)	31 (17%)
Newborn referral for physician specialty care[b]	16 (47%)[b]	9 (5%)
No outpatient follow-up visit post-birth discharge and pre-newborn readmission	8 (24%)	59 (33%)
Education about feeding problems: general education, warning signs, and when to call the PCP[c]	10 (29%)	66 (37%)
Two successful feedings observed by healthcare provider (either breast- or bottle-feeding)	30 (88%)	155 (87%)
Breastfeeding counseling received by mother	14 (41%)	97 (54%)
Mother initiated breastfeeding[b]	13 (38%)[b]	101 (57%)
Breastfeeding information provided at discharge[b]	15 (44%)[b]	113 (63%)
Timely discharge readiness examination (within 12 hours prior to discharge)	29 (85%)	157 (88%)
Normal examination results, i.e., all vital signs WNL[d]	27 (79%)	162 (91%)
Bilirubin measured	29 (85%)	160 (90%)
Hourly bilirubin measured	3 (9%)	37 (21%)

	Discharged from NICU (n = 34)[a] # (Col %)	Discharged from newborn nursery (n = 178)[a] # (Col %)
Hyperbilirubinemia diagnosed during birth hospitalization[b]	16 (47%)[b]	27 (15%)
Jaundice risk factors: any one present[e]	17 (50%)	90 (51%)
Bilirubin re-evaluation indicated[f]	22 (65%)	94 (53%)
Bilirubin re-evaluation scheduled[b]	3 (14%)[b]	34 (36%)
Parent educated about jaundice[b]	15 (44%)[b]	121 (68%)
Parent educated about respiratory problems	15 (44%)	95 (53%)
Parent educated about infection	24 (71%)	121 (68%)
WIC referral[b]	17 (50%)[b]	27 (15%)

[a] Comparisons between newborns discharged from the NICU and newborns discharged from the newborn nursery (n = 212). Excludes 4 newborns with a discharge unit other than NICU or newborn nursery.
[b] Statistically significant difference between newborns discharged from NICU vs. nursery at $p < 0.05$.
[c] Primary Care Physician
[d] Within Normal Limits
[e] Jaundice risk factors include: visible jaundice within the first 24 hours after birth; previous sibling received with jaundice requiring phototherapy; blood group incompatibility; cephalohematoma; significant brusing; documentation of other risk factors for jaundice, e.g., breastfeeding, 37–38 weeks gestation.
[f] Either hyperbilirubinemia diagnosed or jaundice risk factor present.

Term status and delivery type:

Most of the newborns included in the chart review study sample were born full term (39–41 weeks; 38%), followed by early term (37–38 weeks; 35%), late pre-term (34–36 weeks; 19%), early pre-term (24–33 weeks; 3%), post-term (42+ weeks; 1%), and unknown term status (1%; Table 8). Early-term gestational age characterized the greatest proportion of newborns readmitted for bronchiolitis or other respiratory problems (30%), gastroesophageal reflux or other gastrointestinal problems (50%), and failure to thrive, dehydration, or feeding problems (50%), whereas full-term gestational age characterized the greatest percentage of newborns readmitted for RSV (41%) and jaundice (42%). Readmissions for bronchiolitis or other respiratory problems comprised 44% of early pre-term newborn readmissions (Table 8). Readmissions for RSV comprised 0% of early pre-term newborn readmissions, 17% of late pre-term newborn readmissions, 13% of early term newborn readmissions, 0% of later term newborn readmissions, and 0% of post-term newborn readmissions. Readmissions for jaundice comprised 0% of early pre-term newborn readmissions, 7% of late pre-term newborn readmissions, 9% of early term newborn readmissions, and 10% of full term newborn readmissions (Table8).

Table 8. Term status by cause of readmission

	All-cause readmissions[a] (n = 216) # (Col %) (Row %)	Respiratory syncytial virus[b] (RSV) (n = 29) # (Col %) (Row %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %) (Row %)	Jaundice (n = 19) # (Col %) (Row %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %) (Row %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %) (Row %)
Early pre-term (24–33 weeks)	7 (3%) (100%)	0	3 (15%) (44%)	0	0	0
Late pre-term (34–36 weeks)	41 (19%) (100%)	7 (24%) (17%)	5 (25%) (12%)	3 (16%) (7%)	1 (8%) (2%)	2 (20%) (5%)
Early term (37–38 weeks)	76 (35%) (100%)	10 (34%) (13%)	6 (30%) (8%)	7 (37%) (9%)	6 (50%) (8%)	5 (50%) (7%)
Late term (39–40 weeks)	5 (2%) (100%)	0	1 (5%) (20%)	0	0	0
Full term (41 weeks)	83 (38%) (100%)	12 (41%) (14%)	5 (25%) (6%)	8 (42%) (10%)	5 (42%) (6%)	3 (30%) (4%)
Post-term (42+ weeks)	2 (1%) (100%)	0	0	0	0	0
Unknown	2 (1%) (100%)	0	0	1 (5%) (50%)	0	0

[a] Term status by all-cause and selected high-volume cause specific readmissions was determined by using principal ICD9 readmission diagnosis; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization.
[b] None of the newborns in the chart review focused study had documentation of receiving RSV prophylaxis. Per the Synagis Prior Authorization Request Form (http://chfs.ky.gov), which uses criteria based upon the AAP Red Book, RSV prophylaxis-eligible newborns include those of gestational age ≤ 28

weeks or newborns of older gestational age with certain congenital or medical conditions, as well as newborns ≤ 34 weeks gestation with a sibling(s) in school.

Information on gestational dating method was limited, as 71% of members had no gestational dating method documented. In addition, of those who underwent ultrasound, the gestational timing of ultrasound was not specified for most. The most prevalent method documented was based upon the last menstrual period (23%; Table 9).

Table 9. Method of gestational dating by term status

Gestational dating method (n = 216)[a] (#; Col %)	Early pre-term (24–33 weeks) (n = 7) # (Col %)	Late pre-term (34–36 weeks) (n = 41) # (Col %)	Early term (37–38 weeks) (n = 76) # (Col %)	Late term (39–40 weeks) (n = 5) # (Col %)	Full term (41 weeks) (n = 83) # (Col %)	Post-term (42+ weeks) (n = 2) # (Col %)	Unknown term status (n = 2) # (Col %)
Last menstrual period (n = 49; 23%)	1 (14%)	12 (29%)	14 (18%)	2 (40%)	19 (23%)	1 (50%)	0
Ultrasound at < 20 weeks (n = 4; 2%)	0	0	0	0	4 (5%)	0	0
Ultrasound at ≥ 20 weeks (n = 4; 2%)	0	1 (2%)	2 (3%)	0	0	1 (50%)	0
Ultrasound, gestational age not specified (n = 20; 9%)	0	1 (2%)	9 (12%)	0	9 (11%)	1 (50%)	0
Not documented (n = 153; 71%)	5 (71%)	28 (68%)	59 (78%)	3 (60%)	56 (67%)	0	2 (100%)

[a] Newborn chart review focused study; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization.

Non-operative vaginal delivery comprised the greatest proportion of the newborn readmission chart review sample (57%), followed by cesarean birth without trial of labor after previous cesarean delivery (TOLAC; 15%), operative vaginal delivery (8%), primary cesarean delivery after failed labor (5%), primary cesarean delivery without labor (1%), and cesarean delivery with TOLAC (0.5%; Table 10).

Table 10. Type of delivery by term status

	Early pre-term (24–33 weeks) (n = 7) # (Col %)	Late pre-term (34–36 weeks) (n = 41) # (Col %)	Early term (37–38 weeks) (n = 76) # (Col %)	Late term (39–40 weeks) (n = 5) # (Col %)	Full term (41 weeks) (n = 83) # (Col %)	Post-term (42+ weeks) (n = 2) # (Col %)	Unknown term status (n = 2) # (Col %)
Primary C-section after failed labor (n = 10)	0	3 (7%)	2 (3%)	0	5 (6%)	0	0
Primary C-section, no labor (n = 3)	2 (29%)	7 (17%)	12 (16%)	1 (20%)	11 (13%)	0	0
C-section, TOLAC (n = 1)	1 (14%)	0	0	0	0	0	0
C-section, no TOLAC (n = 32)	0	5 (12%)	13 (17%)	0	14 (17%)	0	0
Non-operative vaginal delivery (n = 123)	4 (57%)	23 (56%)	41 (54%)	3 (60%)	48 (58%)	2 (100%)	2 (100%)
Operative vaginal delivery (n = 17)	0	3 (7%)	8 (11%)	1 (20%)	5 (6%)	0	0

Note: n = 216 newborns readmitted within 30 days after discharge from birth hospitalization

Among low-risk births (n = 49), i.e., term (37–41 weeks), singleton, and vertex presentation, 28% were delivered by cesarean section (Figure 12). Of the 10 who were delivered by cesarean section without labor, 4 newborn births (40%) were absent documentation of complications/possible indicators for cesarean delivery (Figure 12). Complications abstracted from medical records include the following: oligohydramnios, abnormal placentation, multiple gestation, fetal growth restriction, pelvic abnormality, nonvertex presentation, dystocia, fetal distress, cephalopelvic disproportion, mother refused vaginal birth after C-section, premature rupture of membranes, alloimmunization, fetal congenital malformations, HELLP syndrome, polyhydramnios, cervical insufficiency, major puerperal infection, sepsis, macrosomia. No other types of complications were identified in the medical records (Figure 12).

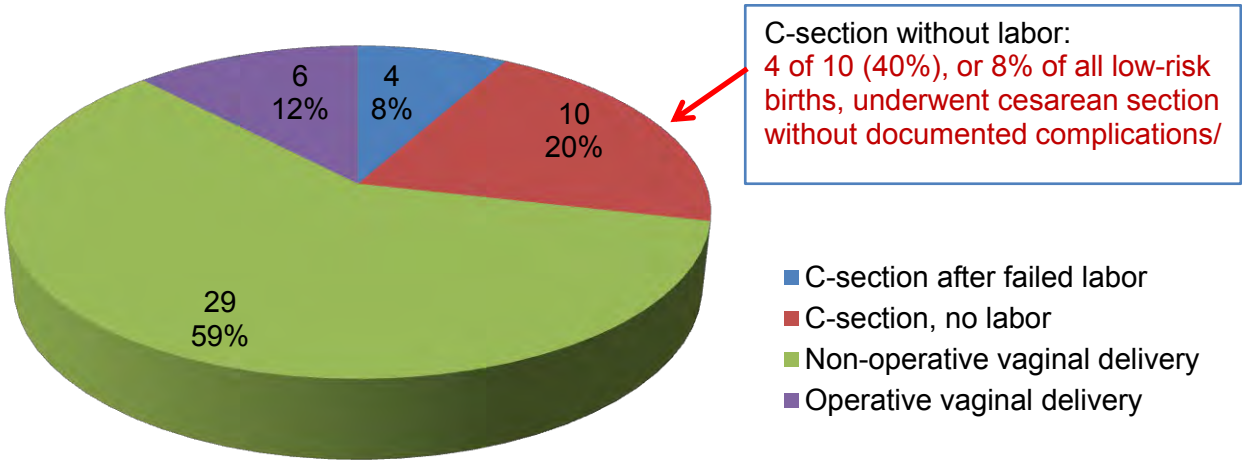

Figure 12. Low-risk births by delivery type. Number and frequency (%) of low-risk births (nulliparous, term: 37–41 weeks, singleton, vertex presentation) by delivery type determined by the newborn readmission chart review (n = 49).

Among early term newborns who underwent cesarean delivery without TOLAC, 9 of 13 (69%) were without documented obstetric complications/possible indications (Figure 13). There was also an absence of documented obstetric complications/possible indications for 33% (4 of 12) early term newborns who underwent primary cesarean delivery without labor and for 38% (3 of 8) newborns who underwent induction of labor for non-operative vaginal delivery (Figure 13). Complications abstracted from medical records include the following: oligohydramnios, abnormal placentation, multiple gestation, fetal growth restriction, pelvic abnormality, nonvertex presentation, dystocia, fetal distress, cephalopelvic disproportion, mother refused vaginal birth after C-section, premature rupture of membranes, alloimmunization, fetal congenital malformations, HELLP syndrome, polyhydramnios, cervical insufficiency, major puerperal infection, sepsis, macrosomia. No other types of complications were identified in the medical records (Figure 13).

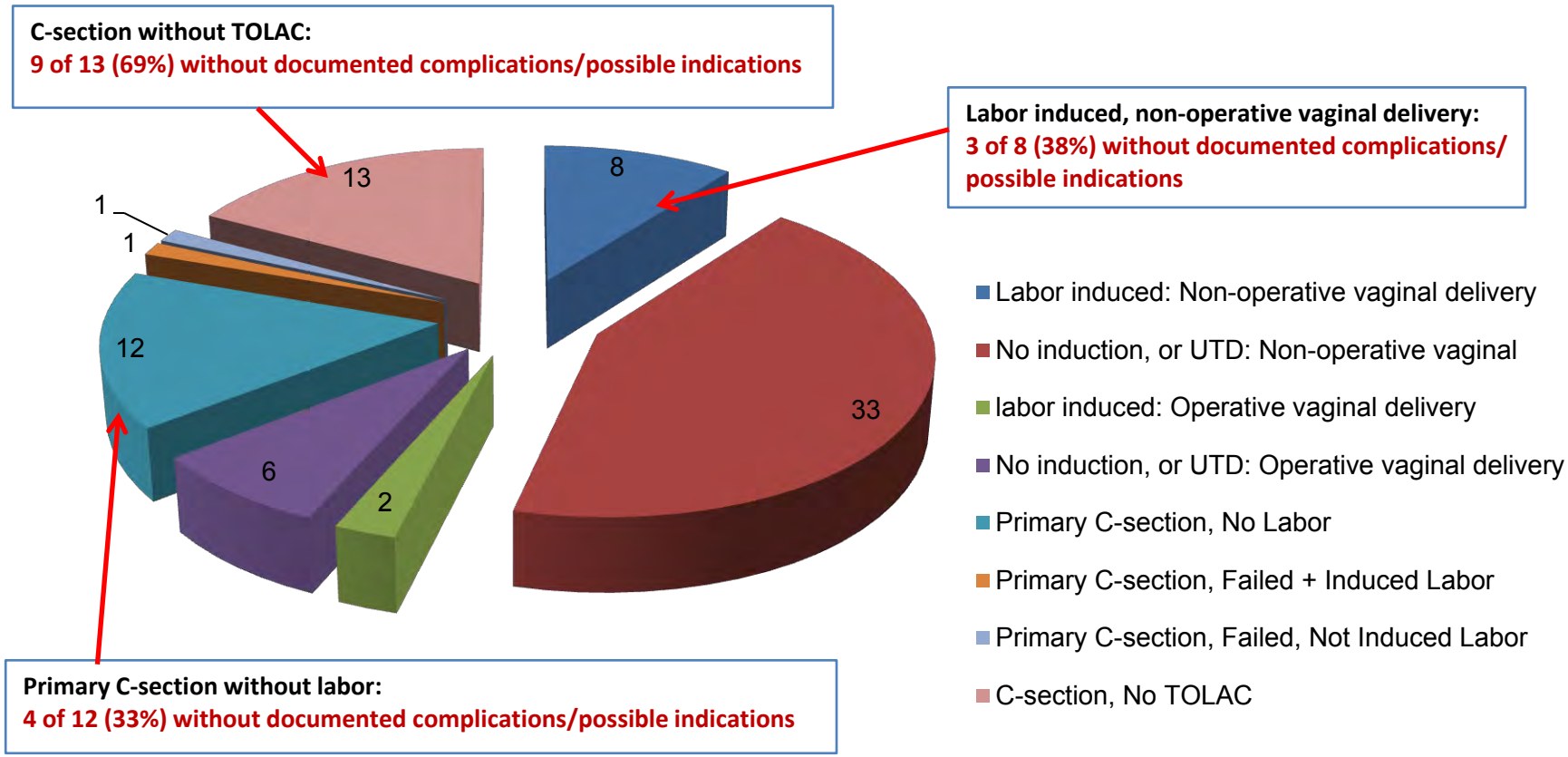

Figure 13. Early-term newborns by delivery type. The number of early-term (37–38 weeks) newborns by delivery type determined by newborn readmissions chart review (n = 76).

Obstetric intake information:

The most prevalent parity status was a single prior delivery at greater than 20 weeks of gestation (32%), followed by nulliparous status (28%), 2 prior deliveries (19%), and 3 or more (16%; Table 11). Although only 4 of 10 newborns readmitted for failure to thrive, dehydration, or feeding problems were born to nulliparous mothers, this represents 40% of this subset, as opposed to only 28% of all-cause readmissions. Antenatal corticosteroids were documented as administered to 20% (4/20) of mothers of infants born at less than or equal to 34 weeks gestation. (Table 11). Among newborns born to mothers with a prior pre-term birth, antenatal progesterone was documented as received by only 2 of 17 (12%) mothers, and these two newborns were delivered at early pre-term and late pre-term gestational ages (Table 11); however, as this study requested only the newborn chart, it is not clear to what extent this is a measure of documentation in the newborn chart.

Table 11. Obstetric intake by cause of readmission

	All-cause readmissions[a] (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
Parity (# prior deliveries at > 20 weeks gestation):						
0	61 (28%)	3 (10%)	4 (20%)	5 (26%)	3 (25%)	4 (40%)
1	70 (32%)	11 (38%)	5 (25%)	8 (42%)	7 (58%)	1 (10%)
2	42 (19%)	11 (38%)	7 (35%)	2 (10%)	1 (8%)	2 (20%)
3+	34 (16%)	4 (14%)	4 (20%)	2 (10%)	0	2 (20%)
Not documented	9 (4%)	0	0	2 (10%)	1 (8%)	1 (10%)
Antenatal corticosteroids administered to mothers of infants born at ≤ 34 weeks gestation (to enhance fetal lung maturation)	4 of 20 (20%)	0	1 of 4 (25%)	0	0	0
Antenatal progesterone received by mother with prior pre-term birth during pregnancy (to minimize risk pre-term birth)	2 of 17 (12%) 1 early pre-term birth; 1 late pre-term birth	0	0	0	1 of 2 (50%) 1 late pre-term birth	0
Prior pre-term birth:						
Yes	17 (8%)	3 (10%)	3 (16%)	1 (5%)	2 (17%)	1 (10%)
No	117 (54%)	16 (55%)	7 (37%)	11 (58%)	4 (33%)	7 (70%)
Not documented	81 (38%)	10 (34%)	9 (47%)	7 (37%)	6 (50%)	2 (20%)

[a] Newborn readmission chart review focused study using principal ICD9 readmission diagnosis; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization.

Maternal co-morbid conditions and obstetric complications:

Maternal tobacco use during the perinatal period is the highest-volume maternal co-morbid condition, comprising 22% of all-cause readmissions and 31% of readmissions for RSV (Table 12). Maternal substance abuse during the perinatal period comprised 13% of all-cause readmissions and 17% and 15% of readmissions for RSV and bronchiolitis or other respiratory problems, respectively. Maternal pre-existing diabetes comprised only 7% of all-cause readmissions, yet 14% and 30% of readmissions for RSV and failure to thrive, dehydration or feeding problems, respectively. Forty-one percent of the total sample was without any maternal co-morbid conditions; this percentage was even higher for newborns readmitted for jaundice (53%).

Forty-three percent of the total sample was without any obstetric complication; this proportion was even greater among newborns readmitted for jaundice (68%), a subset that showed the greatest percentage without any maternal co-morbid conditions or obstetric complications (42%), almost double the percentage for the total sample (Table 12). Although prior cesarean section prevalence was 15% among all-cause readmissions, prevalence was higher at 28% for RSV readmissions. Only 8% of all-cause readmissions were complicated by fetal growth restriction; however, 20% of newborns readmitted for bronchiolitis or other respiratory problems were characterized by this complication (Table 12).

Table 12. High-volume maternal co-morbid conditions and obstetric complications by cause of readmission

	All-cause readmissions[a] (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
High-volume maternal co-morbid conditions:						
Tobacco use during perinatal period	48 (22%)	9 (31%)	8 (40%)	1 (5%)	3 (25%)	1 (10%)
Substance abuse during perinatal period	27 (13%)	5 (17%)	3 (15%)	0	0	1 (10%)
Presenting or pre-existing diabetes	16 (7%)	4 (14%)	0	2 (10%)	0	3 (30%)
Presenting or pre-existing hypertension	13 (6%)	0	1 (5%)	1 (5%)	1 (8%)	2 (20%)
Presenting or pre-existing depression	9 (4%)	1 (3%)	1 (5%)	2 (10%)	0	0
No co-morbid conditions	88 (41%)	10 (34%)	7 (35%)	10 (53%)	5 (42%)	3 (30%)
High-volume obstetric complications:						
Prior C-section	33 (15%)	8 (28%)	2 (10%)	1 (5%)	3 (25%)	1 (10%)
Fetal distress	19 (9%)					
Fetal growth restriction	17 (8%)	0	4 (20%)	0	1 (8%)	0
Fetal congenital malformation	8 (4%)	1 (3%)	0	0	2 (17%)	1 (10%)
No obstetric complications	94 (43%)	14 (48%)	8 (40%)	13 (68%)	5 (42%)	4 (40%)
No maternal co-morbid conditions or obstetric complications:						
No maternal co-morbid conditions or obstetric complications	47 (22%)	7 (24%)	3 (15%)	8 (42%)	3 (25%)	1 (10%)

[a] Newborn readmission chart review focused study using principal ICD9 readmission diagnosis; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization.

Among newborns born at less than 37 weeks gestation to mothers who either tested positive for group B *Streptococcus* (GBS) or had unknown GBS status (n = 35), 31% of mothers received no antibiotic prophylaxis (Figure 14); however, there were no newborns who tested positive for GBS (data not shown).

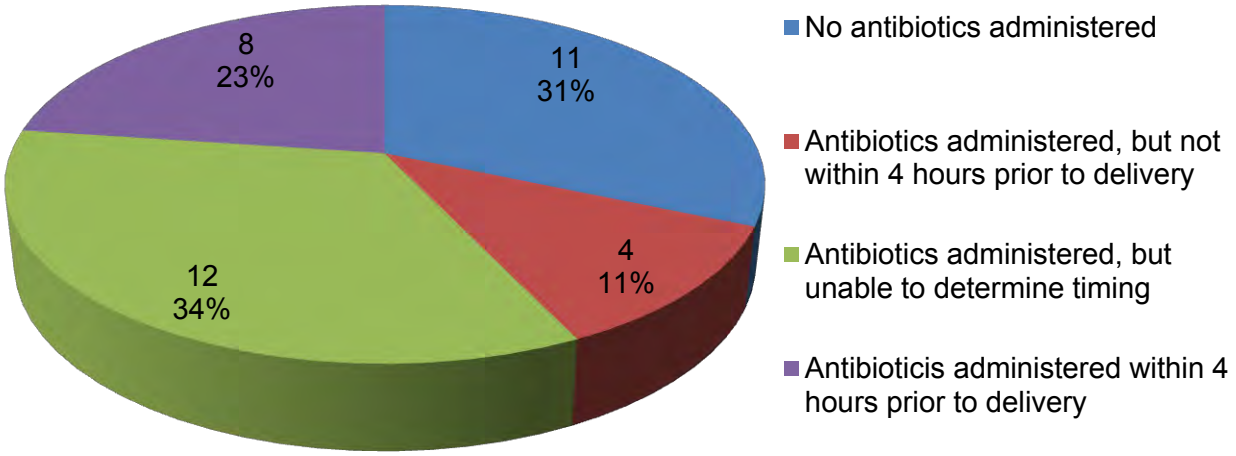

Figure 14. Intrapartum group B *Streptococcus* (GBS) antimicrobial administration. The number and frequency (%) of newborns whose mothers received GBS antimicrobial prophylaxis among newborns born to mothers at < 37 weeks gestation with unknown or positive maternal GBS status (n = 35), as determined by newborn readmissions chart review focused study.

Newborn diagnoses, procedures and interventions:

Newborns with a birth-stay diagnosis of jaundice comprised 21% of readmissions for this same diagnosis; however, the majority was not diagnosed with jaundice during the birth stay (Table 13). Newborns with a birth-stay diagnosis of respiratory distress comprised 20% of readmissions for bronchiolitis or other respiratory problems; however, the majority of these and RSV readmissions was not diagnosed with respiratory distress during the birth stay. Mechanical ventilation and other intubation/irrigation comprised 20%, each, of readmissions for bronchiolitis or other respiratory problems; however, newborns with these birth-stay procedures comprised a much lesser proportion of newborns readmitted for RSV. Newborns who underwent a respiratory surgical procedure comprised 15% of newborns readmitted for bronchiolitis or other respiratory problems, but again, a lesser percentage of those readmitted for RSV. None of the newborns in the chart review sample (with a complete birth-stay record) received RSV prophylaxis. Although 12% of the all-cause readmission sample received antimicrobial treatment, there were no newborns with positive blood cultures for Methicillin-Resistant *Staphylococcus aureus* (MRSA) or group B *Streptococcus* (GBS). Ninety-three percent of the newborn chart review sample was vaccinated for Hepatitis B, and none of the mothers tested positive for the Hepatitis B surface antigen (Table 13).

Table 13. Select newborn diagnoses and procedures/interventions by cause of readmission

	All-cause readmissions[a] (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
Select newborn birth-stay diagnoses:[a]						
Newborn complications	32 (15%)	4 (14%)	6 (30%)	2 (10%)	1 (8%)	4 (40%)
Jaundice*	31 (14%)	1 (3%)	0	4 (21%)	2 (17%)	0
Congenital anomalies	31 (14%)	3 (10%)	4 (20%)	3 (16%)	3 (25%)	0
Respiratory distress	21 (10%)	2 (7%)	4 (20%)	0	0	0
Sepsis	17 (8%)	2 (7%)	2 (10%)	0	0	0
Newborn birth-stay procedures/interventions:[b]						
Mechanical ventilation[b]	10 (5%)	2 (7%)	4 (20%)	0	0	0
Other intubation/irrigation[b]	13 (6%)	2 (7%)	4 (20%)	0	0	1 (10%)
Gastrointestinal surgical procedure	6 (3%)	0	2 (10%)	0	1 (8%)	0
Respiratory surgical procedure	4 (2%)	1 (3%)	3 (15%)	0	0	0
No surgical procedure	110 (51%)	16 (55%)	9 (45%)	11 (58%)	6 (50%)	6 (60%)
RSV prophylaxis	0	0	0	0	0	0
Antimicrobial treatment/antibiotics[c]	27 (12%)	2 (7%)	3 (15%)	0	1 (8%)	2 (20%)
Hepatitis B prophylaxis:						
Hepatitis B vaccination (HBV), only[d]	201 (93%)	28 (97%)	18 (90%)	18 (95%)	12 (100%)	8 (80%)
HBV + Hepatitis B immunoglobulin	1 (0.5%)	0	0	0	0	0
None	14 (6%)	1 (3%)	2 (10%)	1 (5%)	0	2 (20%)

[a] Newborn diagnoses and procedures/interventions by all-cause and select high-volume cause of readmissions using principal ICD9 readmission diagnosis; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization. Birth-stay diagnostic groupings for birth-stay diagnoses analysis (aggregate groupings of any ICD-9 diagnosis codes) identified as risk factors (*except for jaundice) for newborn readmission from Part I: Administrative/Retrospective Cohort Study.
[b] Birth-stay procedure groupings (aggregate groupings of any ICD-9 procedure codes) identified as risk factors for newborn readmission from Part I: Administrative/Retrospective Cohort Study.
[c] Medical record abstraction findings: 155 (72%) of newborns without blood cultures; 58 (27%) with negative blood culture findings; 3 with positive results other than Group B Streptococcus and Methicillin-Resistant Staphylococcus Aureus .

[d] There were 0 newborns with mothers who tested positive for the Hepatitis B surface antigen.

Newborn discharge readiness, planning and education:

Two successful feedings were observed for most newborns (87%), with the lowest percent among newborns readmitted for bronchiolitis or other respiratory problems (80%; Table 14). Parent education for both (1) general education about feeding problems and (2) when to call the physician were documented for 36% of newborns, with the lowest percentages among newborns readmitted for RSV (10%) and for failure to thrive, dehydration, or feeding problems (20%). Overall, 54% of mothers initiated breastfeeding; the highest percentage was among newborns readmitted for jaundice (100%) and the lowest percentages were among newborns readmitted for RSV (41%) and bronchiolitis or other respiratory problems (30%). Fifty-two percent of newborns' mothers received breastfeeding counseling during the birth stay and 61% received information about breastfeeding upon discharge (Table 14).

Bilirubin levels were measured in 89% of all newborns in the chart review sample, and in 100% of newborns readmitted for jaundice (Table 14). Hour-specific bilirubin was measured in 19% of all newborns, and in 16% of newborns readmitted for jaundice. A birth-stay diagnosis of hyperbilirubinemia was made in 20% of all newborns in the study sample, and in 26% of newborns readmitted for jaundice. Whereas 50% of the total newborn medical record review sample had documentation of the presence of one or more jaundice risk factors, 74% of newborns readmitted for jaundice showed signs of risk. Considering documentation of hyperbilirubinemia or presence of a risk factor for jaundice as an indication for the need for jaundice re-evaluation, 55% of the total sample was in need of re-evaluation of bilirubin levels, compared to 74% of newborns readmitted for jaundice. Among newborns for whom a jaundice/bilirubin re-evaluation were thus indicated, 33% of the total sample were scheduled for re-evaluation, and 93% of newborns readmitted for jaundice were scheduled. Furthermore, among newborns with a scheduled re-evaluation for jaundice, 41% of the total chart review sample was without any outpatient follow-up visit, and 85% of newborns readmitted for jaundice were without any outpatient follow-up visit. Overall, 64% of parents were educated about warning signs of jaundice and when to call the physician, and 79% of parents of newborns readmitted for jaundice received this education (Table 14).

Most newborns (88%) had documentation that a physical examination was performed within 12 hours prior to discharge, with the lowest percent among infants readmitted for bronchiolitis or other respiratory problems (80%; Table 14). Overall, there was documentation that 94% of newborns were ready for discharge, with the lowest percentages among newborns readmitted for RSV (86%) and for bronchiolitis or other respiratory problems (85%); the latter subset showed the highest percentage with an abnormal respiratory rate (15%), as well as an abnormal heart rate (20%). Of note, a finding that there was documentation of abnormal examination findings does not imply that such findings were not addressed prior to discharge. Overall, 52% of parents were educated about respiratory problems (warning signs and when to call the physician), but only 35% of parents of newborns readmitted for bronchiolitis or other respiratory problems

received this education; the latter subset, as well as the subset of newborns readmitted for failure to thrive, dehydration or feeding problems, had the lowest percentage of newborns with all vital signs within normal limits (80%), compared to 89% for the total newborn chart review sample (Table 14). Only 45% of parents of newborns readmitted for RSV were educated about respiratory problems. Approximately one-third of parents were not educated about placing their baby in the supine position for sleep.

Overall, 68% of parents were educated about warning signs of infection and when to call the physician, with the lowest percentages among newborns readmitted for bronchiolitis or other respiratory problems (50%) and for failure to thrive, dehydration or feeding problems (60%; Table14). Discharge education about normal voiding and stooling was received by 42% and 30%, respectively, of parents of newborns readmitted for jaundice and for failure to thrive, dehydration or feeding problems, respectively. Among newborns discharged home with one or more prescription medications (n = 62), 61% of parents received no education regarding their newborn's prescription medication (Table 14).

Table 14. Discharge readiness and education by cause of readmission

	All-cause readmissions (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
Two successful infant feedings observed	188 (87%)	25 (86%)	16 (80%)	17 (89%)	10 (83%)	10 (100%)
PRP[a] education: infant feeding problems:						
General education, only	80 (37%)	18 (62%)	8 (40%)	7 (37%)	3 (25%)	5 (50%)
Warning signs & when to call PCP, only	26 (12%)	4 (14%)	3 (15%)	0	0	1 (10%)
Both	77 (36%)	3 (10%)	5 (25%)	10 (53%)	5 (42%)	2 (20%)
Neither	16 (7%)	1 (3%)	3 (15%)	0	2 (17%)	1 (10%)
UTD[b]	17 (8%)	3 (10%)	1 (5%)	2 (10%)	2 (17%)	1 (10%)
Initiated breastfeeding	117 (54%)	12 (41%)	6 (30%)	19 (100%)	7 (58%)	6 (60%)
Received breastfeeding counseling during newborn birth stay	113 (52%)	14 (48%)	7 (35%)	15 (79%)	7 (58%)	3 (30%)
Received discharge education information on breastfeeding	131 (61%)	17 (59%)	9 (45%)	18 (95%)	6 (50%)	5 (50%)
Bilirubin levels measured	192 (89%)	27 (93%)	16 (80%)	19 (100%)	11 (92%)	9 (90%)
Hour-specific bilirubin	40 (19%)	7 (24%)	2 (10%)	3 (16%)	1 (8%)	1 (10%)
Hyperbilirubinemia diagnosis	44 (20%)	3 (10%)	4 (20%)	5 (26%)	2 (17%)	3 (30%)
Presence of 1 or more jaundice risk factors[c]	109 (50%)	13 (45%)	10 (50%)	14 (74%)	6 (50%)	4 (40%)
Parents educated about jaundice[d]	138 (64%)	17 (59%)	9 (45%)	15 (79%)	6 (50%)	5 (50%)
Jaundice re-evaluation indicated[e]	118 (55%)	13 (45%)	11 (55%)	14 (74%)	6 (50%)	4 (40%)
Jaundice re-evaluation scheduled	39 /118 = 33%	2/13 = 15%	5/11 = 45%	13/14 = 93%	1/6 = 17%	2/4 = 50%
No actual outpatient visit among newborns with scheduled re-evaluation for jaundice	16/39 = 41%	1/2 = 50%	0/5	11/13 = 85%	0/1	0/2
Newborn physical exam within 12 hours prior to discharge	190 (88%)	24 (83%)	16 (80%)	16 (84%)	11 (92%)	10 (100%)
MD exam finding:[f]						
Not ready for d/c	8 (4%)	2 (7%)	2 (10%)	0	0	1 (10%)

	All-cause readmissions (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
No exam	5 (2%)	2 (7%)	1 (5%)	1 (5%)	0	0
Ready for d/c	203 (94%)	25 (86%)	17 (85%)	18 (95%)	12 (100%)	9 (90%)
Vital signs:						
Resp rate > 60 breaths/min.	5 (2%)	0	3 (15%)	0	0	0
Heart rate < 100 or > 160 beats/min	8 (4%)	1 (3%)	4 (20%)	0	0	1 (10%)
Temperature < 97.7F or > 99.3F	2 (1%)	0	0	0	0	1 (10%)
All vitals WNL[h]	192 (89%)	25 (86%)	16 (80%)	18 (95%)	12 (100%)	8 (80%)
1 or more vital signs not documented prior to d/c	13 (6%)	3 (10%)	0	1 (5%)	0	0
Parents educated about respiratory problems[d]	112 (52%)	13 (45%)	7 (35%)	14 (74%)	6 (50%)	4 (40%)
Parents educated about putting baby to sleep in supine position	142 (66%)	21 (72%)	13 (65%)	13 (68%)	6 (50%)	5 (50%)
Parents educated about environmental tobacco smoke	111 (51%)	14 (48%)	9 (45%)	8 (42%)	6 (50%)	4 (40%)
Parents educated about infection[d]	147 (68%)	18 (62%)	10 (50%)	16 (84%)	7 (58%)	6 (60%)
Circumcision site exam:						
Exam done – bleeding	3 (1%)	1 (3%)	0	0	1 (8%)	0
Exam done – no bleeding/UTD time	17 (8%)	0	0	1 (5%)	1 (8%)	1 (10%)
Exam done – no bleeding ≥ 2 hrs	57 (26%)	6 (21%)	7 (35%)	5 (26%)	2 (17%)	3 (30%)
No Exam	23 (11%)	5 (17%)	2 (10%)	2 (10%)	1 (8%)	0
Not Applicable[h]	116 (54%)	17 (59%)	11 (55%)	11 (58%)	7 (58%)	6 (60%)
Exam – voiding:						
Not documented	14 (6%)	1 (3%)	1 (5%)	2 (10%)	1 (8%)	0
Yes, UTD finding	4 (2%)	1 (3%)	2 (10%)	0	0	0
Yes, abnormal void	1 (0.5%)	0	0	1 (5%)	0	0

	All-cause readmissions (n = 216) # (Col %)	Respiratory syncytial virus (RSV) (n = 29) # (Col %)	Bronchiolitis or other respiratory problems (n = 20) # (Col %)	Jaundice (n = 19) # (Col %)	Gastro-esophageal reflux or other GI problems (n = 12) # (Col %)	Failure to thrive, dehydration, or feeding problems (n = 10) # (Col %)
Yes, normal void	197 (91%)	27 (93%)	17 (85%)	16 (84%)	11 (92%)	10 (100%)
Exam – stool:						
Not documented	17 (8%)	2 (7%)	1 (5%)	3 (16%)	1 (8%)	0
Yes, UTD finding	4 (2%)	1 (3%)	1 (5%)	0	0	0
Yes, abnormal stool	1 (0.5%)	0	0	0	0	0
Yes, normal stool	194 (90%)	26 (90%)	18 (90%)	16 (84%)	11 (92%)	10 (100%)
Parents received discharge education about normal voiding and stooling	102 (47%)	17 (59%)	11 (55%)	8 (42%)	6 (50%)	3 (30%)
Parents received discharge education about cord/skin care	149 (69%)	20 (69%)	12 (60%)	15 (79%)	9 (75%)	5 (50%)
Prescription medication education:						
Drug purpose	11/62 = 18%	2/8 = 25%	0/6	1/5 = 20%	1/1 = 100%	0/2
Dosage, frequency	22/62 = 35%	4/8 = 50%	2/6 = 33%	0/5	1/1 = 100%	0/2
Adverse effects	5/62 = 8%	1/8 = 12%	0/6	0/5	1/1 = 100%	0/2
No education	38/62 = 61%	4/8 = 50%	4/6 = 67%	4/5 = 80%	0/1	2/2 = 100%
Education about maternal depression[i]	6 (3%)	1 (3%)	0	0	0	0
No discharge education at all[j]	19 (9%)	1 (3%)	2 (10%)	0	2 (17%)	1 (10%)
Discharge status:						
Routine	205 (95%)	26 (90%)	20 (100%)	19 (100%)	11 (92%)	9 (90%)
Transferred	7 (3%)	1 (3%)	0	0	1 (8%)	1 (10%)
Home health	3 (1%)	1 (3%)	0	0	0	0
Other	1 (0.5%)	1 (3%)	0	0	0	0

Note: All-cause and select cause-specific readmissions determined using principal ICD9 readmission diagnosis in newborn readmission chart review focused study; n = 216 newborns readmitted within 30 days after discharge from birth hospitalization.
[a] PRP=primary responsible person at newborn discharge.
[b] Unable To Determine

[c] Documented risk factors include one or more of the following: visible jaundice, previous sibling with jaundice requiring phototherapy, blood group incompatibility, cephalohematoma, significant bruising (other, e.g., breastfeeding, 37–38 weeks gestational age, documented as risk factors).
[d] Parents educated about warning signs and symptoms and when to call the PCP.
[e] Either a diagnosis of hyperbilirubinemia was documented or one of the jaundice risk factors was identified.
[f] Ready for d/c: physical exam documented finding of normal newborn ready for discharge; Not ready for d/c: physical exam documented abnormal findings and/or indicated that newborn was not ready for discharge (note that this does not mean that the newborn was discharged home without abnormal findings being addressed); Not documented: physical exam to evaluate newborn discharge readiness was not documented. d/c: discharge. .
[g] Within normal limits
[h] Female or uncircumcised male
[i] Newborn chart was reviewed, but not maternal chart was not.
[j] Parent received none of the above discharge education, nor education about child car seat use, safe infant handling, injury prevention, or pacifier use during sleep.

Hospital care transition and MCO care management:

Inconsistency between hospital and plan risk identification was apparent. Among the primary chart review sample (n = 216), there were only 15 newborns who received MCO case management (CM) services. Perinatal tobacco use was the most prevalent maternal risk factor identified by the hospital (n = 48/216; 22%); however, only 6% of infants born to these mothers received an MCO comprehensive needs assessment (CNA), and none received MCO CM facilitation, e.g., maternal tobacco cessation (Table 15). Lack of a newborn primary care provider was identified as a barrier to care by the hospital for 5% (n = 10) of newborns, and among these newborns, the hospital addressed this barrier for 4 out of 10 newborns (40%). There were no MCO CNAs or MCO CM facilitation, e.g., referrals, conducted by MCOs for these newborns; however, MCO CM facilitated 2 pediatrician visits for newborns not identified by the hospital as having this barrier to care. There were 27 newborns (13%) referred by the hospital to a specialist physician, and 2 of these newborns received a CNA by an MCO. Hospitals referred 45 (21%) newborns for Women, Infants and Children (WIC) nutritional services and, of these newborns, 1 was referred to WIC services by an MCO. There were 2 additional newborns referred by MCOs to WIC services. Hospitals referred 23 (11%) newborns to Social Services and MCOs performed a CNA on 2 (9%) of these newborns. Five percent (n = 11) of newborns were referred by hospitals to Child Protective Services and none of these newborns received an MCO CNA. Transportation was identified by the hospital as a barrier to care for 7 (3%) newborns, and hospital staff addressed this barrier for 6 (86%) newborns, whereas no MCO CM services were received by newborns with this hospital-identified barrier (Table 15).

Table 15. Barriers/risk factors, referrals, and CM interventions

	Barrier identified by hospital # (%[b])	Barrier addressed or referral made by hospital # (%[b])	CM CNA performed prior to readmission, newborns with barrier identified or addressed by hospital or CM # (%)	CM facilitation for newborns, with hospital-identified barriers/risks/ referrals # (%)	CM facilitation for newborns, with and/or without hospital-identified barriers # (%[b])
Barrier: no newborn PCP[c]	10 (5%)	4/10 (40%)	0	0	2 (1%) (pediatrician visits facilitated by CM)
Barrier: transportation	7 (3%)	6/7 (86%)	0	0	0
Risk factor: perinatal tobacco use	48 (22%)	NA[d]	3/48 (6%)	0	0
Referral: newborn specialist	NA[d]	27 (13%)	2/27 (7%)	0	0
Referral: WIC	NA[d]	45 (21%)	1/45 (2%)	1/45 (2%)	2 (1%)
Referral: Home Health	NA[d]	8	1/8 (12%)	0	0
Referral: HANDS[e]	NA[d]	3 (1%)	0	0	1 (0.5%)
Referral: Social Services	NA[d]	23 (11%)	2/23 (9%)	NA[d]	NA[d]
Referral: Child Protective Services	NA[d]	11 (5%)	0	NA[d]	NA[d]
Referral: maternal depression counseling	NA[d]	0	0	0	0
Referral: maternal substance abuse treatment	NA[d]	0	0	0	0
Referral: other maternal mental health problem	NA[d]	1 (0.5%)	0	0	0

Note: n = 216 newborns readmitted within 30 days after discharge form birth hospitalization; n = 15 with care management documentation.

[a] Seven percent of newborns in the chart review focused study have documentation of care management; this excludes 2 newborns with an incomplete medical record; both early pre-term, cesarean delivery without trial of labor, born during RSV season and received RSV prophylaxis (one with a principal readmission diagnosis of RSV and the other with a principal readmission diagnosis of cyanosis), discharged from NICU, engaged in care management with Passport Health Plan, received a comprehensive needs assessment after birth and upon readmission, as well as after readmission.

[b] Percent of all newborns in chart review sample (n = 216), unless otherwise indicated.

[c] Primary Care Provider

[d] Not Applicable, e.g., not a barrier, but instead, a referral; or Not Available, e.g., not an abstracted data element for care management or hospital portion of study.

[e] Health Access Nurturing Development Services (a voluntary home visitation program)

Care management sample characteristics and MCO interventions:

This portion of the chart review study included newborns without a complete birth record, as well as those with a complete birth record, in an effort to avoid excluding any newborns who had received MCO care management services (n = 228). A minority of members with a newborn readmission received MCO CM services (17/228 = 7%; Table 16). The proportion of newborns with MCO CM documentation was greatest among early pre-term newborns (3/11 = 27%), followed by late pre-term newborns (6/43 = 14%), full term newborns (5/86 = 6%), and early term newborns (3/78 = 4%). Twenty-one percent of newborns discharged from the NICU (8/38) had documentation of MCO CM, compared to only 5% (9/184) of newborns discharged from the newborn nursery. Only 2 of 33 (6%) infants born to teen mothers had documentation of MCO CM. Among newborns with either a birth-stay or readmission-stay diagnosis of gastrointestinal or feeding problems or failure to thrive, only 2 of 34 (6%) had documentation of MCO CM, and corresponding percentages were 6% for jaundice, 13% for any respiratory diagnosis, and 23% for sepsis (Table 16).

Table 16. MCO CM documentation by newborn characteristics

	MCO CM documentation[a] # (%)
Term status:	
Early pre-term (24–33 weeks gestation; n = 11)	3 (27%)
Late pre-term (34–36 weeks gestation; n = 43)	6 (14%)
Early term (37–38 weeks gestation; n = 78)	3 (4%)
Late term (39–40 weeks gestation; n = 5)	0
Full term (41 weeks gestation; n = 86)	5 (6%)
Post-term (42+ weeks gestation; n = 2)	0
Unknown term status (n = 3)	0
Discharge unit:[b]	
NICU (n = 38)	8 (21%)
Newborn nursery (n = 184)	9 (5%)
Other (n = 4)	0
Maternal age group:[c]	
12–19 years (n = 33)	2 (6%)
20–34 years (n = 169)	13 (8%)
35+ years (n = 17)	2 (12%)
Any respiratory diagnosis, birth or readmission stay (n = 68)	9 (13%)
Any jaundice diagnosis, birth or readmission stay (n = 47)	3 (6%)
Any gastrointestinal/feeding/failure to thrive diagnosis, birth or readmission stay (n = 34)	2 (6%)
Any sepsis diagnosis, birth or readmission stay (n = 22)	5 (23%)

[a] Includes 216 newborns with a complete birth record, 1 newborn without any birth chart, and 11 newborns with incomplete birth records (n = 228). Excludes 17 newborns with missing data for CM documentation (n = 17 of 228 = 7%).
[b] Two newborns with missing data excluded.
[c] Nine newborns with missing data excluded.

Care management outreach was minimal during the prenatal period (Table 17), with most outreach attempts made after the readmission stay. Successful contact and engagement in MCO CM occurred primarily after the readmission stay; however, most MCO CNAs were performed after the birth stay. Passport Health Plan completed 2 MCO CNAs during the birth stay, 4 after the birth-stay discharge, and 2 during the readmission stay. Both CoventryCares of Kentucky and WellCare of Kentucky performed only one CNA; the former after the birth stay and the latter during the readmission stay (Table 17).

Table 17. CM interventions by MCO

	Total newborn readmission chart review sample (n = 228[a]) # (Col %)	CoventryCares of Kentucky (n = 74) # (Col %)	Passport Health Plan (n = 101) # (Col %)	WellCare of Kentucky (n = 53) # (Col %)
Outreach:				
Prenatal	1 (< 0.5%)	0	0	1 (2%)
Birth stay	3 (%)	0	3 (3%)	0
After birth stay	7 (3%)	1 (1%)	6 (6%)	0
Readmission stay	5 (2%)	2 (3%)	3 (3%)	0
After readmission stay	11 (5%)	2 (3%)	3 (3%)	6 (11%)
Contact:				
Prenatal	0	0	0	0
Birth stay	3 (1%)	0	3 (3%)	0
After birth stay	5 (2%)	1 (1%)	4 (4%)	0
Readmission stay	3 (1%)	1 (1%)	2 (2%)	0
After readmission stay	9 (4%)	1 (1%)	4 (4%)	4 (8%)
Engagement:				
Prenatal	0	0	0	0
Birth stay	3 (1%)	0	3 (3%)	0
After birth stay	5 (2%)	1 (1%)	4 (4%)	0
Readmission stay	3 (1%)	1 (1%)	2 (2%)	0
After readmission stay	7 (3%)	1 (1%)	5 (5%)	1 (2%)
CNA:[b]				
Birth stay	2 (1%)	0	2 (2%)	0
After birth stay	5 (2%)	1 (1%)	4 (4%)	0
Readmission stay	3 (1%)	0	2 (2%)	1 (2%)

a. Includes 216 newborns with a complete birth record, 1 newborn without any birth chart, and 11 newborns with an incomplete birth record (n = 228). Excludes 17 newborns with missing data for care management documentation (n = 17 of 228 = 7%).
b. Comprehensive needs assessment

Readmission stay – newborn chief complaint:

This portion of the chart review study included all newborns with a readmission record, regardless of the completeness of their birth-stay record (n = 193). Common chief complaints among the total readmission record subset (n = 193) were fever (26%), poor feeding (25%), cough (23%), irregular breathing (21%), irritability/ inconsolable crying (21%), and vomiting (19%; Table 18). Among newborns readmitted for RSV, cough (69%), irregular breathing (62%), and poor feeding (23%) were the most prevalent presenting symptoms. Poor feeding was the most prevalent chief complaint (55%) among newborns readmitted for respiratory diagnoses other than RSV. Yellowing of skin and eyes (67%) and poor feeding (33%) characterized newborns readmitted for jaundice. The most common chief complaints among newborns readmitted for gastrointestinal and feeding problems and failure to thrive were poor feeding (27%), vomiting (25%), and cough (25%). Newborns readmitted for fever and infections were characterized by fever (74%), irritability/inconsolable crying (48%), and poor feeding (45%).

Table 18. Chief complaint by abstracted high-volume readmission diagnostic categories

	All (n = 193[a]) # (Col %)	Respiratory syncytial virus (RSV) (n = 26) # (Col %)	Respiratory diagnoses, excluding RSV (n = 29) # (Col %)	Jaundice (n = 21) # (Col %)	Gastrointestinal diagnoses, reflux, feeding problems, and failure to thrive (n = 44) # (Col %)	Fever and infections, including sepsis and UTI (n = 31) # (Col %)
Lethargy	7 (4%)	3 (11%)	1 (3%)	1 (5%)	2 (4%)	2 (6%)
Irritability/inconsolable crying	40 (21%)	3 (11%)	7 (24%)	3 (14%)	7 (16%)	15 (48%)
Fever	51 (26%)	5 (19%)	6 (21%)	2 (9%)	7 (16%)	23 (74%)
Urinary problems	2 (1%)	0	0	0	0	2 (6%)
Yellowing of skin, eyes	17 (9%)	1 (4%)	0	14 (67%)	4 (9%)	1 (3%)
Skin problems	5 (3%)	0	0	1 (5%)	0	1 (3%)
Bowel problems	6 (3%)	0	0	0	2 (4%)	2 (6%)
Vomiting	37 (19%)	3 (11%)	2 (7%)	0	11 (25%)	6 (19%)
Poor feeding	49 (25%)	6 (23%)	16 (55%)	7 (33%)	12 (27%)	14 (45%)
Choking	10 (5%)	0	2 (7%)	1 (5%)	6 (14%)	0
Cough	44 (23%)	18 (69%)	14 (48%)	0	11 (25%)	3 (10%)
Irregular breathing	40 (21%)	16 (62%)	14 (48%)	1 (5%)	9 (20%)	2 (6%)
Eye discharge	8 (4%)	0	2 (7%)	1 (5%)	1 (2%)	0

a. Readmission chart subset analysis includes all 193 newborns for whom a readmission chart was received, including 183 newborns from the main chart review focused study with both a complete newborn medical record and a readmission chart, 2 newborns without a birth chart and 8 newborns with an incomplete birth chart.

DISCUSSION

The retrospective cohort study used claims-based administrative data provided by the MCOs to evaluate the relationship between the outcome of newborn readmission and these risk factor domains: member characteristics, MCO/utilization factors, and birth-stay diagnoses. In contrast to the retrospective cohort study, which included both members with and without a newborn readmission in order to quantify these comparisons and evaluate statistically significant differences, the medical record review was restricted to only those newborns with a readmission within the 30 day period following discharge from the birth hospitalization. Therefore, the retrospective cohort study is informative for risk factor identification, whereas the chart review study is useful to profile more specific aspects of study domains and to identify gaps in care, particularly those representing potentially actionable areas that could be addressed by hospitals and MCOs. Readmission diagnoses that included respiratory syncytial virus (RSV), jaundice, gastrointestinal problems were identified as high volume in both the administrative and chart review studies; therefore, findings lend support to the development of targeted interventions to reduce these cause-/diagnosis-specific readmissions. Taken together, both studies shed important insights regarding opportunities to improve the healthcare of KDMS members.

Prematurity is a known risk factor for newborn readmission (Dietz *et al*., 2012; Escobar *et al*., 2005), and the retrospective cohort study findings were consistent with this knowledge regarding both early- and late pre-term births. Infants born at late pre-term gestational age merit heightened vigilance because they are at greater risk for the development of complications and readmission compared to term newborns, yet because they appear similar to term newborns in their size and weight, their increased risk may be overlooked by parents and clinicians (Engle *et al*., 2007). Therefore, late pre-term infants may benefit from MCO-hospital collaborative efforts to educate staff and family in accordance with recent multidisciplinary guidelines (Phillips *et al*., 2013).This cohort study also identified birth-stay conditions such as sepsis and respiratory distress that are characteristic of pre-term newborns, as well as associated interventions, i.e., mechanical ventilation and intubation. These conditions were identified as risk factors for readmission independent of newborn sex, race/ethnicity, gestational age, delivery mode, foster care status, urban/rural residence, MCO, birth during RSV season, and outpatient follow-up. Yet, results from the chart review study indicate that a minority of these susceptible newborns received care management (CM) services. Thus, there is an opportunity to improve the coordination of newborn care by targeting CM to newborns with identifiable risk factors during the birth stay, e.g., prematurity, sepsis, respiratory distress, mechanical ventilation and intubation.

The high-volume cause-specific readmission subsets, however, were not predominantly comprised of premature newborns. Non-pre-term infants may represent potentially avoidable readmissions, given a comprehensive assessment of these newborns' characteristics and the interventions they did and did not receive, from hospital support

practices, discharge planning and parent education to care management. Of note, readmissions for congenital pyloric stenosis, a physical malformation, i.e., obstruction, of the gastrointestinal tract, comprised 10% (26 of 255) of male readmissions and 3% (5 of 160) of female readmissions, reflecting the known male-to-female predominance of this condition (Singh, 2012). The definitive treatment is corrective surgery; therefore, readmission for congenital pyloric stenosis, a condition that is rare in premature infants and usually diagnosed at 3 weeks of life (Singh, 2012) may be considered unavoidable. On the other hand, some readmissions for RSV, jaundice, gastrointestinal and feeding problems may be potentially preventable.

Birth during RSV season was a risk factor for readmission for respiratory problems and RSV was the most prominent readmission diagnosis, yet none of the newborns in the primary chart review subset received RSV prophylaxis. The American Academy of Pediatrics (AAP) Red Book recommends RSV prophylaxis in vulnerable premature newborns, and KDMS policy is consistent with these clinical guidelines (CHFS, 2014). In the primary chart review study, late pre-term newborns were characterized by readmissions for respiratory problems, including RSV. Identification of late pre-term newborn candidates for RSV prophylaxis may be beneficial to ensure appropriate implementation of existing guidelines for RSV prophylaxis; for example, newborns born at 32–35 weeks of gestation during RSV season who have a sibling younger than 5 years of age could be possible candidates (CHFS, 2014). In the primary chart review study, the majority of readmissions for RSV, however, were among term newborns, and there were no early pre-term newborns readmitted for RSV. Thus, gaps in care, regardless of term status, suggest potential opportunities for improvement. The current study showed that only 45% of parents of newborns readmitted for RSV received discharge education about respiratory problems. According to the AAP Red Book (AAP, 2009), parent education about how to decrease exposure to and transmission of RSV is critical for prevention. Specific measures include limiting exposure to child care centers and other contagious settings as feasible, and encouraging hand hygiene at home, particularly when the newborn is exposed to people with respiratory tract infections.

Highlighting the importance of identifying gaps in care beyond subsets of known risk, is the finding that the vast majority of RSV readmissions were among newborns discharged from the newborn nursery, and who did not experience respiratory distress, mechanical ventilation or respiratory surgical procedures during the birth stay. Therefore, other factors within the scope of managed care quality improvement strategies merit consideration as potential means to prevent RSV readmissions. Chart review findings suggest a lack of partner and family support among newborns readmitted for RSV, relative to the general chart review sample. Thus, newborns discharged home to a primary responsible person (PRP) who lacks social supports might benefit from CM. Maternal tobacco use and substance abuse also characterized a relatively considerable proportion of newborns readmitted for RSV, who thus, may also benefit from CM, including pre- and inter-conception preventive interventions (ACOG, 2005; D'Angelo *et al*., 2007). Increasing the proportion of breastfed newborns may also potentially reduce RSV readmission by

improving newborn immune function (Alvarez *et al*., 2013). Murray *et al*. (2014) concluded that, in the absence of a cost-effective approach to prevent RSV infection at a population level, prevention efforts should include reducing environmental exposure such as perinatal smoking, substance abuse and overcrowded housing, as well as increasing parental and hospital staff compliance with optimal hand-washing and hygiene practices.

Whereas respiratory distress was a risk factor for newborn readmission, jaundice was not; however, jaundice was a predominant readmission diagnosis. Indeed, babies readmitted with jaundice were not among the sickest during the birth stay, as full-term gestational age characterized a substantial proportion and none were discharged from the NICU. This raises the question of whether progression to jaundice severe enough to warrant hospitalization might have been prevented. Of note, the vast majority of newborns readmitted for jaundice did not have an outpatient follow-up visit, and most readmissions for jaundice occurred between days 1–3 post–birth-stay discharge, highlighting the importance of early follow-up. This finding, taken together with the retrospective cohort study finding that lack of outpatient follow-up was a risk factor for newborn readmission, suggests an opportunity to reduce newborn readmissions for jaundice by educating parents about when to call the physician and facilitating early outpatient visits, particularly for infants experiencing feeding difficulties shortly after birth-stay discharge (AAP, 2008).

Early follow-up is especially important for breastfed infants, as breastfeeding difficulty is a known risk factor for jaundice (Wells *et al*., 2013). Of note, the percentage of mothers who initiated breastfeeding was greatest among newborns readmitted for jaundice. In addition, early follow-up is critical for infants discharged at or before 2 days postpartum, as early discharge is another known risk factor (Wells *et al*., 2013). Notably, most infants readmitted for jaundice were discharged within the first two days post–birth-stay discharge. It is also notable that, although 100% of newborns readmitted for jaundice did have their bilirubin levels measured during the birth stay in accordance with AAP recommendations for universal bilirubin screening (AAP, 2004), hour-specific bilirubin levels were graphed for only 16% of this subset, despite the fact that the latter is “the best documented method for assessing the risk of subsequent hyperbilirubinemia” (AAP, 2004). This finding, together with recent findings in the scientific literature that hour-specific bilirubin measurements were predictive of the need for phototherapy (Bhutani *et al*., 2013) suggest the merits of investigating whether increasing the percentage of newborns with hourly bilirubin monitoring may present an opportunity for earlier identification of neonatal jaundice. Closer follow-up and care facilitation may be particularly beneficial for Asian newborns, as Asian race is a known risk factor for neonatal hyperbilirubinemia (Bhutani *et al*., 2013), and this subgroup was disproportionately represented among newborns readmitted for jaundice in the current study.

Lack of parent education about feeding problems suggests another opportunity for MCO-hospital collaboration for quality improvement. Of note, poor feeding was a relatively prominent chief complaint across all readmission subsets. Feeding problems are known to characterize newborns with the birth-stay diagnosis risk factors identified in this study, e.g.,

respiratory distress (Hermansen and Lorah, 2007) and sepsis (Kopelman, 2009), and feeding problems also characterize prominent readmissions conditions such as jaundice (Gibson and Nawab, 2009), respiratory problems, and gastrointestinal problems. Furthermore, lack of breastfeeding among newborns readmitted for RSV and non-RSV bronchioitis suggests additional opportunities for improvement. Early outpatient follow-up presents a timely opportunity to assess this key aspect of newborn health for all newborns, especially in light of the retrospective cohort study finding that lack of an outpatient follow-up visit was a risk factor for newborn readmission. Ensuring that nulliparous mothers receive education about feeding problems both during and after the birth stay may be of particular benefit to preventing readmissions for failure to thrive, dehydration or feeding problems. In addition, birth to an adolescent mother is another known risk factor for newborn morbidity, and, in the primary chart review study, these infants comprised a disproportionate share of newborns readmitted for gastrointestinal problems; however, most infants of adolescent mothers in the current study were not engaged in care management.

Studies highlight the importance of breastfeeding promotion in the NICU (Renfrew *et al*., 2009) and feeding support after discharge from the NICU (Hookway, 2013). According to the Center for Disease Control and Prevention's Breastfeeding Report Card (CDC, 2013), the State of Kentucky falls below national percentages for infants who were: ever breastfed (52.6% versus 76.5%); breastfeeding at 6 months (32.5 versus 49.0%); breastfeeding at 12 months (18.9% versus 27.0%); exclusively breastfeeding at 3 months (33.4% versus 37.7%); and exclusively breastfeeding at 6 months (14.4 versus 16.4). In light of the current study findings that a statistically significant lesser proportion of mothers of newborns admitted to the NICU initiated breastfeeding, these vulnerable newborns may benefit from enhanced breastfeeding surveillance, as well as the identification and dissemination of best practices to encourage and maintain breastfeeding. The Strategic Plan for Improving Breastfeeding Rates in Kentucky was collaboratively developed by the Kentucky Women, Infant and Children (WIC) program and the Lactation Improvement Network of Kentucky (LINK), and provides a pertinent resource for providing healthcare professional support and educating mothers and families (KWIC and LINK, 2011).

Finally, among early term newborns, chart review findings raise questions regarding the presence of medical indications for cesarean delivery without TOLAC, primary cesarean delivery without labor, and induced vaginal delivery; therefore, real-time MCO-hospital collaborative efforts to evaluate indications for these procedures may shed insights (Main *et al*., 2010).

Study limitations include the potential for residual confounding in the retrospective cohort study, as in any observational study. For example, neither illness acuity nor differences in hospital practices were measured and statistically controlled for; therefore, MCO findings should be interpreted with caution. In the medical record review study, the possibility that services were undocumented, rather than not rendered, is another limitation. For example, only the newborn charts were requested, and consequently, maternal data that was

documented in the maternal chart, but not the newborn chart was not assessed. In addition, retrospective review of either hospital-coded or medical-record-documented clinical indicators, e.g., obstetric risk factors, complications and co-morbid conditions, does not equate to real-time clinical interpretation and medical judgment regarding the risks and benefits of specific medical decisions, such as whether a cesarean delivery, TOLAC, or induction is indicated or contraindicated. Corresponding study strengths, however, are that potential confounders were statistically controlled for using multivariable logistic regression analysis, and medical record review sources were largely standard reporting items, e.g., admission summary, labor and delivery progress report, discharge summary; with medical record over-reads conducted by IPRO clinical staff to ensure reliability of data abstraction. In addition, the cohort study identification of lack of a newborn follow-up visit as a risk factor for readmission should be interpreted with caution, as early readmission due to illness severity might have precluded an outpatient visit, i.e., confounding by indication and reverse causality. Multinomial logistic regression, however, examined timeframe-specific readmission outcomes and outpatient follow-up visits, and the association persisted. In addition, although acuity level was proxied based upon length of stay and transfer status, standardized severity-adjustment was not conducted, and the high volume of different hospitals of service precluded adjustment for hospital-specific influences; therefore, findings regarding MCO-associated risk for readmission should also be interpreted with caution.

Conclusion

Prominent newborn readmission diagnoses among KDMS members include RSV and other respiratory problems, jaundice, gastrointestinal and feeding problems, and thus, highlight the importance of preventing avoidable readmissions for these specific causes, as feasible. Study findings revealed that risk factors for newborn readmission among KDMS members include newborn male sex, race/ethnicity other than White or Black, prematurity (especially early-term gestational age), as well as the following birth-stay diagnoses: respiratory distress, sepsis, and congenital anomalies, and the following invasive procedures: mechanical ventilation and intubation or irrigation. Therefore, premature newborns and newborns with these birth-stay diagnoses and procedures represent susceptible subpopulations. Jaundice was a prominent readmission-stay diagnosis, but a birth-stay diagnosis of jaundice was not a risk factor for readmission. Whereas the birth medical record for all newborns readmitted for jaundice did document bilirubin measurement, most newborns' charts did not include documentation of an hour-specific bilirubin level as recommended by the AAP to optimally assess the risk of subsequent hyperbilirubinemia. In addition, birth during RSV season was a risk factor for readmission for respiratory problems, yet none of the newborns in the medical record review sample received RSV prophylaxis; however, most were term newborns for whom RSV prophylaxis is not recommended. Lack of a newborn follow-up visit was also a risk

factor for readmission and, together with the finding that the vast majority of newborns with a hospital readmission were not receiving MCO care management services, findings suggest the potential to improve newborn outcomes by better facilitating care transitions for vulnerable members. In addition, there are opportunities for MCO-hospital collaboration for clinical care enhancements to improve the care received by all newborns.

Recommendations for health plans

- During the birth stay, identify newborns of premature gestational age and newborns with birth-stay diagnoses of respiratory distress, sepsis, and congenital anomalies, as well as newborns undergoing intubation and mechanical ventilation, for comprehensive needs assessment and engagement in care management in order to target and facilitate improvements in morbidity management, care coordination and transitions for the most vulnerable newborns.
- Collaborate with hospitals to educate all parents of newborns about how to prevent transmission of RSV and other respiratory illnesses.
- Collaborate with hospitals to increase the percentage of newborns with hour-specific bilirubin documented in accordance with AAP recommendations (AAP, 2004), and develop care management interventions, including, but not limited to, facilitation of timely outpatient follow-up for newborns who fall within the "High-Intermediate Risk Zone."
- Collaborate with hospitals to educate providers and parents in accordance with multidisciplinary guidelines for the care of late pre-term infants (Phillips *et al*., 2013).
- Collaborate with hospitals to increase the percentage of breastfed newborns with timely follow-up visits.
- Collaborate with hospitals and providers to improve parent education about newborn feeding from the birth stay through outpatient follow-up, for all newborns, and with targeted attention to nulliparous mothers for facilitation of outpatient follow-up, as well as additional attention to identifying best practices for encouraging breastfeeding in the NICU and maintenance post-NICU discharge.
- Collaborate with providers to identify women of childbearing age who use tobacco, drugs or alcohol, and who lack social support, and to engage in care management, as well as pre- and inter-conception preventive interventions.

Recommendations for KDMS

Future improvement initiatives could focus on collaborating with health plans, hospitals and physicians to:

- Explore hospital policies regarding identification of late pre-term newborns who may be candidates for RSV prophylaxis according to clinical guidelines (AAP, 2009);
- Strengthen efforts to refer mothers and fathers to smoking cessation programs, antenatally, during the birth hospitalization, and postpartum.

- Develop programs for concurrent monitoring, reporting and evaluation of indications for cesarean delivery without TOLAC, primary cesarean delivery without labor, and induced vaginal delivery among early term deliveries; and
- Survey provider knowledge and implementation of the comprehensive set of AAP recommendations for “Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation” (AAP, 2004), and develop quality improvement interventions to address gaps in care identified from survey findings.
- Assess provider knowledge of and compliance with ACOG recommendations for use of progesterone to reduce pre-term births (ACOG, 2008), as well as member and provider barriers.

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