Clinical Monitoring of Well-Appearing Infants Born to Mothers With Chorioamnionitis

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abstract

BACKGROUND: The risk of early-onset sepsis is low in well-appearing late-preterm and term infants even in the setting of chorioamnionitis. The empirical antibiotic strategies for chorioamnionitis-exposed infants that are recommended by national guidelines result in antibiotic exposure for numerous well-appearing, uninfected infants. We aimed to reduce unnecessary antibiotic use in chorioamnionitis-exposed infants through the implementation of a treatment approach that focused on clinical presentation to determine the need for antibiotics.

METHODS: Within a quality-improvement framework, a new treatment approach was implemented in March 2015. Well-appearing late-preterm and term infants who were exposed to chorioamnionitis were clinically monitored for at least 24 hours in a level II nursery; those who remained well appearing received no laboratory testing or antibiotics and were transferred to the level I nursery or discharged from the hospital. Newborns who became symptomatic were further evaluated and/or treated with antibiotics. Antibiotic use, laboratory testing, culture results, and clinical outcomes were collected.

RESULTS: Among 277 well-appearing, chorioamnionitis-exposed infants, 32 (11.6%) received antibiotics during the first 15 months of the quality-improvement initiative. No cases of culture result–positive early-onset sepsis occurred. No infant required intubation or inotropic support. Only 48 of 277 (17%) patients had sepsis laboratory testing. The implementation of the new approach was associated with a 55% reduction (95% confidence interval 40%–65%) in antibiotic exposure across all infants ≥34 weeks' gestation born at our hospital.

CONCLUSIONS: A management approach using clinical presentation to determine the need for antibiotics in chorioamnionitis-exposed infants was successful in reducing antibiotic exposure and was not associated with any clinically relevant delays in care or adverse outcomes.

Routine intrapartum antibiotic prophylaxis in mothers with Group B *Streptococcus* (GBS) colonization and/or chorioamnionitis has substantially reduced the risk of early-onset sepsis (EOS). Among late-preterm and term infants, reported rates of culture result–positive EOS are now only 0.5 to 0.7 per 1000 live births.[1–3] However, concern regarding EOS in newborn infants still prompts frequent antibiotic use, and up to 5% to 7% of late-preterm and term infants receive antibiotic treatment in the newborn period.[1,4,5]

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Dr Joshi collected data, helped perform initial analyses, and helped draft the initial manuscript; Dr Gupta helped conceptualize and design the study, critically interpreted data, and helped draft the initial manuscript; Dr Frymoyer helped conceptualize and design the study, supervised data collection, helped perform initial analyses and interpretation of data, and helped draft the initial manuscript; Dr Allan helped conceptualize and design the study, critically interpreted data, and critically reviewed and revised the manuscript; Drs Cohen, Aby, Weldon, Kim, and Benitz helped conceptualize and design the study, provided interpretations of data, and critically reviewed the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Chorioamnionitis, which is diagnosed clinically in 3% to 5% of mothers, is a major driver of antibiotic use in late-preterm and term infants.[1,6–8] National guidelines from the Centers for Disease Control and Prevention[9] and the American Academy of Pediatrics[10] recommend laboratory evaluation (a complete blood cell [CBC] count and blood culture) and empirical antibiotic treatment for all chorioamnionitis-exposed infants. However, even for this higher-risk group, reported rates of EOS are low, ranging from 1.3 to 7.2 per 1000 live births.[1,7,8] In addition, most infants found to have culture result–positive EOS were clinically symptomatic at birth, and the risk of EOS in those who remain well appearing was even lower. Given this low risk of EOS, the empirical antibiotic treatment of chorioamnionitis-exposed infants results in antibiotic exposure for a large number of well-appearing infants for every identified case (estimated number needed to treat [NNT] of >450).[11] With increasing data suggesting detrimental effects of antibiotics on an infant's microbiome and the potential downstream effects of early maternal-infant separation on bonding and breastfeeding, providers are struggling to balance the risk of EOS and unnecessary overuse of antibiotics.[12–14] Updated treatment approaches that provide higher value care are needed for chorioamnionitis-exposed infants.[15]

At our institution, which had been applying the American Academy of Pediatrics and Centers for Disease Control and Prevention guidelines, chorioamnionitis-exposed infants accounted for ~50% of antibiotic use in our late-preterm and term infants. In an effort to reduce unnecessary antibiotic use in this population, we updated our institution's approach for chorioamnionitis-exposed infants to focus on clinical monitoring and examination to determine the need for antibiotics and laboratory testing. The updated approach was guided by (1) the low risk of EOS in well-appearing late-preterm and term infants regardless of risk factors,[1,7,8,11,16,17] (2) the limited clinical utility of CBC counts and C-reactive proteins (CRPs) to guide antibiotic treatment decisions in well-appearing infants,[15,18,19] and (3) the potential utility of clinical examination to identify EOS in at-risk infants.[20,21] Our specific aim was to reduce unnecessary antibiotic exposure and laboratory testing in well-appearing, late-preterm and term, chorioamnionitis-exposed infants. The objective of the current quality-improvement (QI) report was to evaluate the impact of the new care approach after the first 15 months of implementation.

METHODS

Context

Lucile Packard Children's Hospital Stanford is a free-standing, academic, tertiary-care children's hospital that offers obstetric and neonatal services (~4500 deliveries annually). Newborn services include a well-baby nursery (WBN), level II NICU, and level III and IV NICU. Maternal chorioamnionitis is diagnosed by the obstetric team and treated with intravenous, broad-spectrum antibiotics. Institutional guidelines for clinical diagnosis include the presence of fever (≥38.0°C) and at least 1 of the following: maternal tachycardia (>100 beats per minute), fetal tachycardia (>160 beats per minute), fundal tenderness, and/or foul-smelling vaginal discharge. In addition, a diagnosis can be made on the basis of amniotic fluid laboratory evaluation. An in-house neonatal hospitalist is available 24 hours per day to attend all high-risk deliveries, including those of infants who were exposed to chorioamnionitis. Before our QI intervention, institutional practice for all chorioamnionitis-exposed infants ≥34 weeks' gestation included admission to the NICU (level II if not requring critical care) and empirical treatment with ampicillin and gentamicin until EOS was excluded. Infants had laboratory evaluations that included a CBC count, serial CRPs, and a blood culture (single aerobic tube with a minimum of 1 mL of blood). Antibiotic duration was determined by the treating physician on the basis of clinical presentation, laboratory evaluation, and blood culture results. Infants remained in the NICU for the duration of the antibiotic treatment.

Intervention

A multidisciplinary team of nurses and physicians met over the course of 6 months to develop an updated, institution-specific treatment guideline for the management of well-appearing, chorioamnionitis-exposed infants ≥34 weeks' gestation. The approach focused on the use of clinical monitoring and examination to determine the need for antibiotics and laboratory evaluation. The neonatal hospitalist continued to attend all deliveries of chorioamnionitis-exposed infants and provided an initial assessment of clinical status. For infants who were symptomatic at birth, empirical antibiotics and sepsis laboratory evaluations were performed. Well-appearing infants remained with their mothers for skin-to-skin contact for the first 2 hours after birth. During this time, a level II trained nurse remained with the infants to assess every 30 minutes. The infants were then admitted to the level II NICU for ongoing clinical monitoring, which included continuous cardiorespiratory monitoring and checking vital signs every 4 hours. Laboratory evaluation and antibiotic treatment were not routinely performed. If an infant remained well-appearing during the first 24 hours after birth, the infant was transferred to room in with the mother until discharge. If the infant developed clinical signs that were concerning for sepsis,

then laboratory evaluation and/or antibiotics were initiated. No formal criteria were established to define a symptomatic infant who warranted antibiotics, and instead treatment decisions were left to the discretion of the treating physician.

Study of the Intervention

After the implementation of the updated treatment approach (March 2015), all chorioamnionitis-exposed infants were tracked, and an in-depth chart review was performed over the first 15 months. Data were obtained from the electronic health record and maintained in a Research Electronic Data Capture database.[22]

Measures

Outcome measures included the percentage of infants who received antibiotic treatment, sepsis laboratory evaluation, or both. Cases of culture result–positive sepsis and culture result–negative clinical sepsis (defined as a negative blood culture result and ≥5 days of antibiotics) were also evaluated. Additional metrics that were collected included demographic information, perinatal risk factors, birth history, and the infant's clinical course. Infants ≥34 weeks' gestation who received ampicillin or gentamicin within the first 3 days after birth were identified through a query of the electronic health record for the 10 months before and the 15 months after implementation.

To compare our approach with a reported alternative approach, the risk of EOS at birth was calculated retrospectively for each patient by using the published neonatal sepsis calculator (NSC), which is based on a multivariate prediction model using 5 objective perinatal risk factors (highest antepartum maternal temperature, GBS status, duration of the rupture of membranes, and the nature and timing of intrapartum antibiotic prophylaxis).[2,16] A background EOS risk of 0.6 per 1000 was used.[3] According to the initial recommendations, the threshold for antibiotic treatment in a well-appearing infant at birth is an NSC score of >1.54 per 1000. The number of infants in our cohort exceeding this threshold at birth was compared with actual antibiotic use. We then updated the NSC score on the basis of the severest clinical presentation of the infant during the first 24 hours after birth, as was recently recommended.[17,23] After the incorporation of clinical presentation, the recommended threshold for antibiotics was an NSC score of >3 per 1000. The number of infants exceeding this threshold after the incorporation of clinical presentation was compared with actual antibiotic use.

Statistical Analysis

Categorical data were summarized as count (percent), whereas continuous data were summarized as mean (SD) or median (interquartile range). Comparisons between well-appearing and symptomatic infants were made by using the χ^2 test or 2-sided *t* test for categorical and continuous data, respectively. A control chart of the percentage of infants who received ampicillin or gentamicin during the first 3 days of life was constructed with 3 SDs of control limits. A shift in the center line was considered at ≥6 consecutive points, either all above or all below the mean. A between-group comparison of NSC scores was performed by using a 1-way analysis of variance of log-transformed data. Statistical significance was set at $P < .05$. Data were analyzed by using Stata 13 (StataCorp, College Station, TX).

Ethical Considerations

This project was reviewed by the local institutional review board and determined to be a local QI project that did not meet the definition of human subjects research. The authors have no conflicts of interest or financial disclosures relevant to the QI initiative.

RESULTS

Study Population

During the 15-month QI study period, 5425 infants ≥34 weeks' gestation were born at Lucile Packard Children's Hospital. Figure 1 depicts the flow diagram of infants. Chorioamnionitis was diagnosed in the mothers of 310 infants (5.7%). Of the chorioamnionitis-exposed infants, 23 (7.4%) were ill appearing at birth and started on antibiotics. An additional 10 (3.2%) were prenatally diagnosed with a congenital anomaly (eg, congenital heart disease) and admitted directly to the NICU. The remaining 277 (89%) were well appearing at birth and included in the primary analysis.

Characteristics of the chorioamnionitis-exposed infants are shown in Table 1. Those who were well appearing at birth were similar to those who were symptomatic at birth or had a known congenital anomaly except for late-preterm status ($P < .01$). Of the infants who were well appearing at birth, 149 (53.8%) were exposed to GBS-specific and/or broad-spectrum intrapartum antibiotics for >2 hours before delivery.

Outcomes of Initially Well-Appearing Infants

Of the 277 initially well-appearing, chorioamnionitis-exposed infants, 245 (88.4%) did not receive antibiotics during their hospitalizations, and 229 (82.7%) never had laboratory testing for EOS. Thirty-two infants (11.6%) who were initially well appearing developed signs and/or symptoms that were concerning for infection (detailed in Supplemental Table 3); all had laboratory testing (CBC count, CRP, and/or blood culture; 9 had a lumbar puncture) and were treated

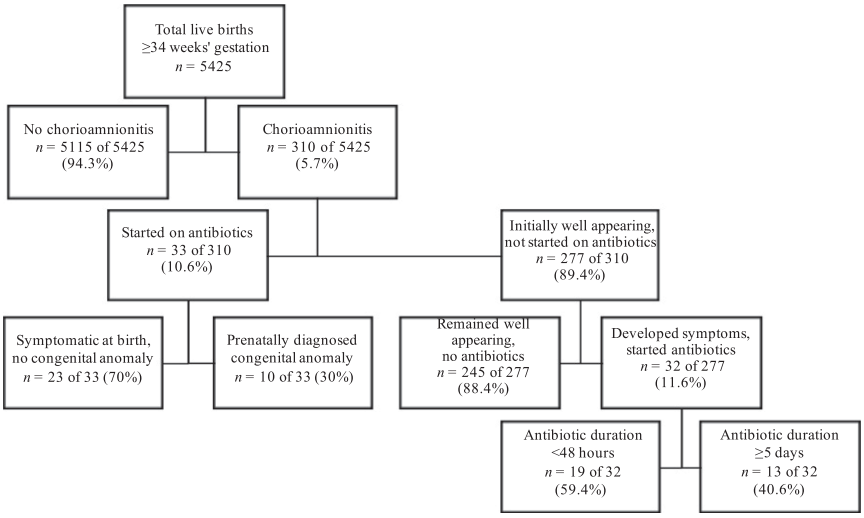

FIGURE 1
Flow diagram of infants born during the QI study period.

TABLE 1 Characteristics of Chorioamnionitis-Exposed Infants by Clinical Appearance at Birth

Characteristic	Well-Appearing (*n* = 277)	Symptomatic or Congenital Anomaly (*n* = 33)	*P*
Birth wt, kg	3.43 (0.46)	3.27 (0.55)	.06
Late preterm, *n* (%)	8 (2.9)	6 (18.2)	<.01
Female sex, *n* (%)	124 (44.8)	9 (27.3)	.06
Maximum maternal temperature, °C	38.5 (0.47)	38.4 (0.54)	.34
ROM ≥18 h, *n* (%)	79 (28.5)	8 (24.2)	.61
Maternal GBS status, *n* (%)			.39
Negative	219 (79.1)	23 (69.7)	
Positive	45 (16.3)	7 (21.2)	
Unknown	13 (4.7)	3 (9.1)	
GBS-specific intrapartum antibiotics ≥2 h before birth, *n* (%)	49 (17.7)	9 (27.3)	.18
Broad-spectrum intrapartum antibiotics ≥2 h before birth, *n* (%)	119 (43.0)	13 (39.4)	.7

All data are in mean (SD) or number of patients (%). ROM, rupture of membranes.

with antibiotics. Cultures yielded only a single isolate of *Micrococcus* after 56 hours of incubation, which was considered to be a contaminant; there were no true-positive blood or cerebrospinal fluid culture results. One infant required continuous positive airway pressure (CPAP) for <24 hours after developing tachypnea and mild respiratory distress at 2 hours of life. No infant required intubation or inotropic support. Thirteen infants (4.7%) were treated with antibiotics for ≥5 days despite negative blood culture results; 19 infants (6.9%) received antibiotics for <48 hours. Among all neonates ≥34 weeks' gestation born at our hospital, the proportion exposed to ampicillin or gentamicin during the first 3 days after birth decreased after the implementation of the new treatment approach (Fig 2) from 12.3% (*n* = 422 of 3434) to 5.5% (*n* = 299 of 5425), representing a 55% reduction (95% confidence interval 40%–65%; *P* < .001).

Sepsis Calculator Risk

The retrospective application of the NSC in our cohort of initially well-appearing, chorioamnionitis-exposed infants resulted in an NSC score at birth of <0.65, 0.65 to 1.54, and >1.54 per 1000 in 75 (27.1%), 106 (38.3%), and 96 (34.7%) infants, respectively. If an NSC score of >1.54 per 1000 at birth was used as the criterion for treatment, an additional 64 infants (23.1%) would have received antibiotics. Waiting to incorporate an infant's clinical findings during the first 24 hours of life into the NSC score before determining the need for antibiotics would have resulted in antibiotic recommendations similar to the actual antibiotic use in our study cohort (on the basis of clinical presentation alone), with agreement for 93.1% of infants (Table 2).

DISCUSSION

Within a QI framework, we implemented a new management approach for well-appearing, chorioamnionitis-exposed infants that focused on clinical monitoring and examination to determine the need for antibiotics and laboratory testing. Compared with our previous empirical approach, in which 100% of well-appearing infants born to mothers with chorioamnionitis received antibiotics and laboratory testing, only 11.6% of infants received antibiotics, and 17.3% of infants received laboratory testing during the first 15 months after the implementation of our new management approach. The reduction in both antibiotic use and laboratory testing occurred without clinically relevant delays in care or poor outcomes.

Of the 277 well-appearing, chorioamnionitis-exposed infants during our study period, none had culture result–positive EOS. Our low rate of culture result–positive EOS (95% confidence interval 0–11 cases per 1000 births, corresponding to 95% confidence that NNT is >90) is in agreement with 3 recent clinical studies in

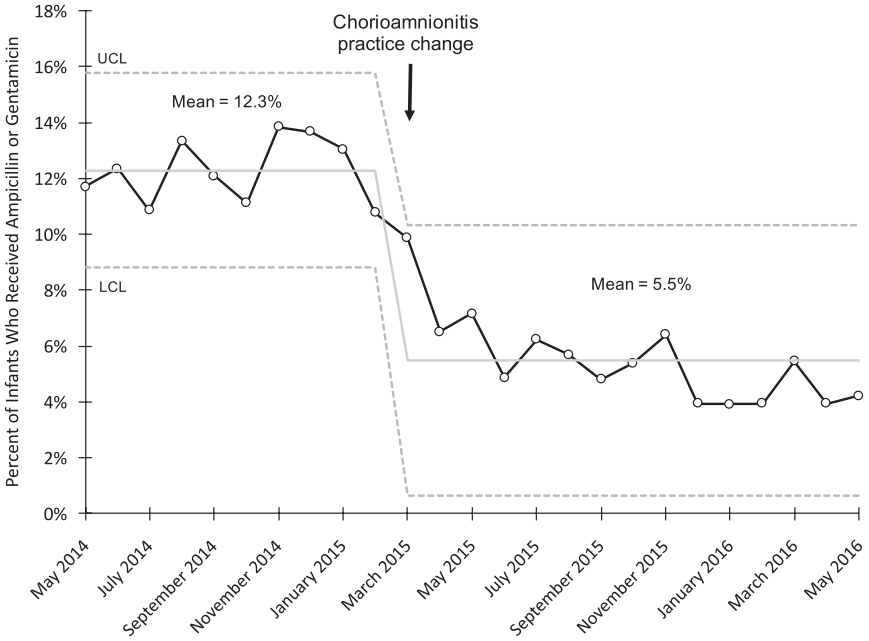

FIGURE 2

Percentage of infants ≥34 weeks' gestation who received ampicillin or gentamicin at any time during the first 3 days after birth before and after the chorioamnionitis practice change. Data represent all infants born at the study hospital during the reported time period. The median number of live births per month was 353 (interquartile range 332–371). LCL, lower control limit; UCL, upper control limit.

TABLE 2 Comparison of Antibiotic Treatment Status During QI Study Period and NSC Risk After Incorporating Clinical Presentation

		Received Antibiotics During Study Period[a]	
		No (%)	Yes (%)
Sepsis calculator risk >3 per 1000 after incorporating clinical presentation[b]	No	237 (85.6)	11 (4.0)
	Yes	8 (2.9)	21 (7.6)

[a] Need for antibiotics was determined by clinical presentation alone.

[b] The NSC recommends antibiotics if risk is >3 in 1000 after incorporating clinical presentation.

chorioamnionitis-exposed infants in which culture result–positive EOS rates of 1.3 to 7.2 per 1000 live births have been reported.[1,7,8] Two of these studies also reported on the timing of symptoms of sepsis, and all infants who had positive culture results were symptomatic at birth and required resuscitation, CPAP, and/or intubation.[7,8] As such, an infant who is well appearing at birth likely has an even lower risk of EOS even in the setting of chorioamnionitis, and an empirical antibiotic treatment strategy for chorioamnionitis-exposed infants will result in a large number of uninfected infants being treated (NNT >450).[11] Updated treatment approaches are needed to reduce unnecessary antibiotic exposure and provide higher-value care in this population.

The recently published NSC is a multivariate prediction model that estimates the risk of sepsis at birth on the basis of 5 perinatal risk factors, allowing for the risk stratification of patients and potentially helping with treatment decisions.[2,16] For example, the original stratification algorithm proposed empirical antibiotic treatment of any infant with an NSC score at birth of >1.54 per 1000 even if well-appearing. When we applied the NSC to our cohort, the NSC score at birth was higher, on average, in our at-risk, chorioamnionitis-exposed infants compared with the background EOS risk for all late-preterm and term infants (1.18 vs 0.6 per 1000). This was not unexpected given that highest maternal temperature is the strongest predictor of sepsis in the calculator.[2] When applying the threshold of >1.54 per 1000, empirical antibiotic treatment at birth would have been recommended by the NSC in 34.7% of our patients. In comparison, the actual use of antibiotics in our cohort was 11.6%, which was based on clinical presentation alone to determine the need for antibiotic treatment. The use of the NSC would have resulted in an additional 23.1% of well-appearing infants receiving antibiotics if the decision to treat was based on perinatal risk factors at birth alone.

The use of clinical examination to guide treatment decisions in infants who are at risk for EOS has been previously suggested. Cantoni et al[21] found no difference in clinical outcomes in term infants who were monitored with serial physical examinations versus those who additionally received laboratory testing. Berardi et al[20] noted fewer laboratory tests, less antibiotic use, and unchanged outcomes in at-risk infants ≥34 weeks' gestation when solely using serial physical examinations. In addition, the NSC has recently been updated to factor in the clinical presentation of the infant in the sepsis risk score before any treatment decisions are made.[17] This change was in part to reflect the low individual risk of sepsis in most infants who remain well-appearing even if several perinatal risk factors exist. Interestingly, when we factored clinical presentation in the NSC score in our study cohort, the recommended antibiotic treatment per the NSC and the actual antibiotic

treatment in our cohort were in high concordance (93.1%). This suggests that clinical presentation is the strongest driver of antibiotic recommendation in the NSC. The importance of close clinical monitoring to evaluate for EOS and determine the need for antibiotics in infants is further highlighted in the largest prospective implementation of the NSC to date.[23] In a cohort of 56 261 infants, 6 cases of culture result–positive EOS were identified in infants who were initially well-appearing at birth, 5 (83%) of whom had an NSC score at birth of <0.5 per 1000. EOS was identified in these low-risk infants because of a change in their clinical presentations, which occurred at ≥12 hours of life in 4 of the 5 infants. Taken together, any updated care approach for chorioamnionitis-exposed infants (or infants with other perinatal risk factors) will need to incorporate and focus on repeated assessments of clinical status to determine the need for antibiotics.

In conjunction with our QI project on chorioamnionitis-exposed infants, we also began instituting a protocol of increased clinical monitoring in our WBN of all infants regardless of perinatal risk factors. This was due in part to the concern that more than half of the cases of EOS in late-preterm and term infants occur in those with a low risk at birth.[2,23] Thus, it is important to be vigilant in all infants and not just those who are exposed to chorioamnionitis or those with high NSC scores at birth. Vital signs and nursing assessments of clinical status focusing on color, perfusion, and respiratory status are now performed every 4 hours for all infants in our WBN during the first 24 hours after birth. The increased clinical surveillance in the WBN (along with a decreased reliance on laboratory testing to screen for sepsis) has helped our nursing staff gain the confidence and knowledge necessary to be able to assess and identify infants who become symptomatic and may need further evaluation.

With the experience and knowledge gained during the current QI study period combined with the concurrent, increased clinical surveillance instituted in the WBN, we have moved forward with a second phase of our updated treatment approach for chorioamnionitis-exposed infants in which well-appearing infants ≥35 weeks' gestation are no longer admitted to the level II NICU for 24 hours of clinical monitoring. Instead, infants who remain well-appearing after an initial assessment by the neonatal hospitalist and level II NICU nurse now remain with their mothers for couplet care in the WBN with vital signs and nursing clinical assessments every 4 hours for the first 24 hours after birth. To allow for enhanced monitoring, we were able to set nursing-to-couplet care ratios of 1:3 for all infants in the WBN. We hope this second phase will further promote maternal-infant bonding and breastfeeding in these well-appearing infants. Monitoring and evaluation of this second phase is ongoing.

This QI study has several limitations. Close clinical monitoring of chorioamnionitis-exposed infants was possible at our institution because of the presence of neonatal hospitalists, who attend all high-risk deliveries, as well as the availability of level II NICU nurses, who provide frequent neonatal assessments in the first few hours after birth. Our results may not be generalizable to centers where it is not practical to perform such frequent clinical evaluations, such as smaller community hospitals. We also did not define criteria for a symptomatic infant and the threshold for starting antibiotics. Clinical signs of sepsis in infants are heterogeneous, nonspecific, and often indistinguishable from other noninfectious conditions, making it challenging to define precisely. By leaving the decision to the discretion of the physicians, variability in practice may have occurred. We were unable to capture this potential variability in clinical decision-making and understand its significance.

An additional limitation is the fact that we were not able to confirm postdischarge follow-up for all infants. Therefore, safety data on readmission rates outside the birth hospitalization may be incomplete. Another study using clinical examination to determine the need for antibiotics in infants who are at risk for sepsis did not demonstrate an increased risk of readmission after hospital discharge.[20] Finally, the sample size in this study was small, especially in light of the low incidence of EOS. Consistent with the epidemiology of chorioamnionitis, we also had a low representation of late-preterm infants in our cohort. As such, although our approach has safely achieved reduced antibiotic use and laboratory testing in a high-use population, further experience is needed in multiple care settings and larger populations of at-risk term and late-preterm infants to substantiate the safety of using a clinical monitoring–based approach.

CONCLUSIONS

The risk of EOS is low in well-appearing late-preterm and term infants even in the setting of chorioamnionitis. As a result, a strategy of empirical antibiotic use for chorioamnionitis-exposed infants leads to a high number of well-appearing, uninfected infants being treated for every case of EOS.

Updated treatment approaches are needed in this population to reduce unnecessary and potentially harmful antibiotic exposure. We successfully implemented a treatment approach in chorioamnionitis-exposed infants that focused on clinical monitoring and presentation to determine the need for antibiotics. This approach reduced antibiotic use by 88% in our well-appearing, chorioamnionitis-exposed infants and was associated with a 55% reduction in antibiotic exposure across all infants ≥34 weeks' gestation born at our hospital. No clinically relevant delays in care or poor outcomes were found. Additional experience with larger sample sizes will help further substantiate the safety of this approach. Consideration of the local health care systems, resources, personnel, and patient populations will be important in the development of any updated treatment approaches for chorioamnionitis-exposed infants.

ABBREVIATIONS

CBC: complete blood cell
CPAP: continuous positive airway pressure
CRP: C-reactive protein
EOS: early-onset sepsis
GBS: Group B *Streptococcus*
NNT: number needed to treat
NSC: neonatal sepsis calculator
QI: quality improvement
WBN: well-baby nursery

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. Braun D, Bromberger P, Ho NJ, Getahun D. Low rate of perinatal sepsis in term infants of mothers with chorioamnionitis. *Am J Perinatol*. 2016;33(2):143–150
2. Puopolo KM, Draper D, Wi S, et al. Estimating the probability of neonatal early-onset infection on the basis of maternal risk factors. *Pediatrics*. 2011;128(5). Available at: www.pediatrics.org/cgi/content/full/128/5/e1155
3. Stoll BJ, Hansen NI, Sánchez PJ, et al; Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. Early onset neonatal sepsis: the burden of Group B Streptococcal and E. coli disease continues. *Pediatrics*. 2011;127(5):817–826
4. Mukhopadhyay S, Dukhovny D, Mao W, Eichenwald EC, Puopolo KM. 2010 perinatal GBS prevention guideline and resource utilization. *Pediatrics*. 2014;133(2):196–203
5. Mukhopadhyay S, Eichenwald EC, Puopolo KM. Neonatal early-onset sepsis evaluations among well-appearing infants: projected impact of changes in CDC GBS guidelines. *J Perinatol*. 2013;33(3):198–205
6. Alexander JM, McIntire DM, Leveno KJ. Chorioamnionitis and the prognosis for term infants. *Obstet Gynecol*. 1999;94(2):274–278
7. Kiser C, Nawab U, McKenna K, Aghai ZH. Role of guidelines on length of therapy in chorioamnionitis and neonatal sepsis. *Pediatrics*. 2014;133(6):992–998
8. Shakib J, Buchi K, Smith E, Young PC. Management of newborns born to mothers with chorioamnionitis: is it time for a kinder, gentler approach? *Acad Pediatr*. 2015;15(3):340–344
9. Verani JR, McGee L, Schrag SJ; Division of Bacterial Diseases, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention. Prevention of perinatal group B streptococcal disease–revised guidelines from CDC, 2010. *MMWR Recomm Rep*. 2010;59(RR–10):1–36
10. Polin RA; Committee on Fetus and Newborn. Management of neonates with suspected or proven early-onset bacterial sepsis. *Pediatrics*. 2012;129(5):1006–1015
11. Wortham JM, Hansen NI, Schrag SJ, et al; Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. Chorioamnionitis and culture-confirmed, early-onset neonatal infections. *Pediatrics*. 2016;137(1):e20152323
12. Azad MB, Konya T, Persaud RR, et al; Canadian Health Infant Longitudinal Development Study Investigators. Impact of maternal intrapartum antibiotics, method of birth and breastfeeding on gut microbiota during the first year of life: a prospective cohort study. *BJOG*. 2016;123(6):983–993
13. Gibson MK, Crofts TS, Dantas G. Antibiotics and the developing infant gut microbiota and resistome. *Curr Opin Microbiol*. 2015;27:51–56
14. Mukhopadhyay S, Lieberman ES, Puopolo KM, Riley LE, Johnson LC. Effect of early-onset sepsis evaluations on in-hospital breastfeeding practices among asymptomatic term neonates. *Hosp Pediatr*. 2015;5(4):203–210
15. Benitz WE, Wynn JL, Polin RA. Reappraisal of guidelines for management of neonates with suspected early-onset sepsis. *J Pediatr*. 2015;166(4):1070–1074
16. Escobar GJ, Puopolo KM, Wi S, et al. Stratification of risk of early-onset sepsis in newborns ≥34 weeks' gestation. *Pediatrics*. 2014;133(1):30–36
17. Kuzniewicz MW, Walsh EM, Li S, Fischer A, Escobar GJ. Development and implementation of an early-onset sepsis calculator to guide antibiotic management in late preterm and term neonates. *Jt Comm J Qual Patient Saf*. 2016;42(5):232–239
18. Hofer N, Zacharias E, Müller W, Resch B. An update on the use of C-reactive protein in early-onset neonatal sepsis: current insights and new tasks. *Neonatology*. 2012;102(1):25–36

19. Hornik CP, Benjamin DK, Becker KC, et al. Use of the complete blood cell count in early-onset neonatal sepsis. *Pediatr Infect Dis J*. 2012;31(8):799–802

20. Berardi A, Buffagni AM, Rossi C, et al. Serial physical examinations, a simple and reliable tool for managing neonates at risk for early-onset sepsis. *World J Clin Pediatr*. 2016;5(4):358–364

21. Cantoni L, Ronfani L, Da Riol R, Demarini S; Perinatal Study Group of the Region Friuli-Venezia Giulia. Physical examination instead of laboratory tests for most infants born to mothers colonized with Group B Streptococcus: support for the Centers for Disease Control and Prevention's 2010 recommendations. *J Pediatr*. 2013;163(2):568–573

22. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377–381

23. Kuzniewicz MW, Puopolo KM, Fischer A, et al. A quantitative, risk-based approach to the management of neonatal early-onset sepsis. *JAMA Pediatr*. 2017;171(4):365–371

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