

COLLEGE OF POPULATION HEALTH

Implementing a Comprehensive Risk Assessment for Early Onset Sepsis to Reduce Antibiotic Usage in the NICU



Jefferson
Thomas Jefferson University

Master of Science in Healthcare Quality and Safety

Definition - Early Onset Sepsis

- Sepsis
 - Systemic Inflammatory Response Syndrome (SIRS) associated with suspected or proven infection
 - SIRS - Temp instability, Elevated WBC count or increase I:T ratio, Tachycardia or bradycardia, Tachypnea or bradypnea
- Early Onset Sepsis (EOS)
 - Sepsis occurring in the first 7 days of life
 - Some groups use within first 72 hours
 - National Institute of Child Health and Human Development (NICHD), Vermont Oxford Network (VON)

Epidemiology

- Low incidence
 - 0.23-0.98/1,000 live births
- High consequence
 - 2-4% mortality - much higher in preterm
 - As high as 40% have long term sequelae

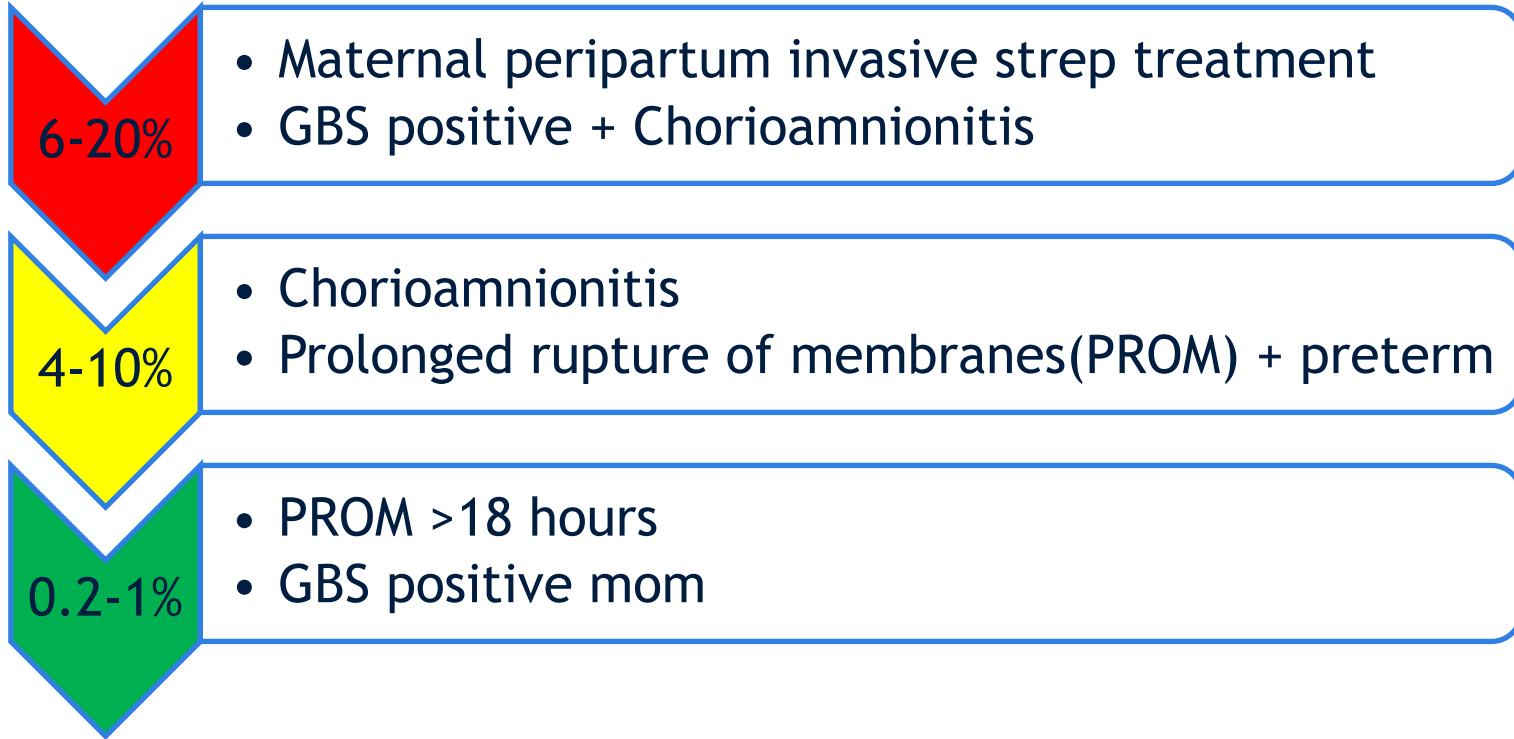
Etiology

- Bacterial infection via
 - Vertical transmission - ascending infection
 - Contact with mucous membranes
 - Transplacental (Listeria)
 - Exposure during delivery
 - Instrumented delivery, fetal scalp electrode
 - ❖ Chorioamnionitis, GBS colonization

Etiology

- Most common pathogens isolated from blood/CSF
 - Group B Strep (GBS) - 38%
 - E.Coli - 24%, increasing while GBS decreasing
 - Strep viridans - 18%
 - Staph aureus, H.flu, Listeria

Risk of EOS



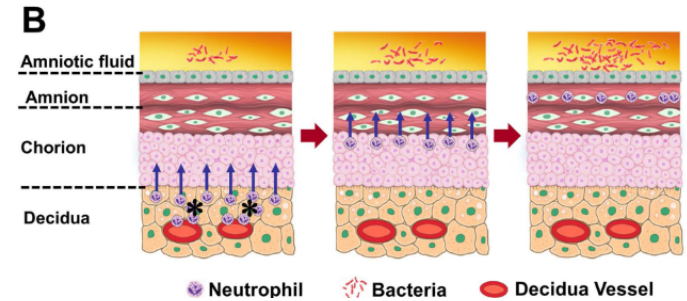
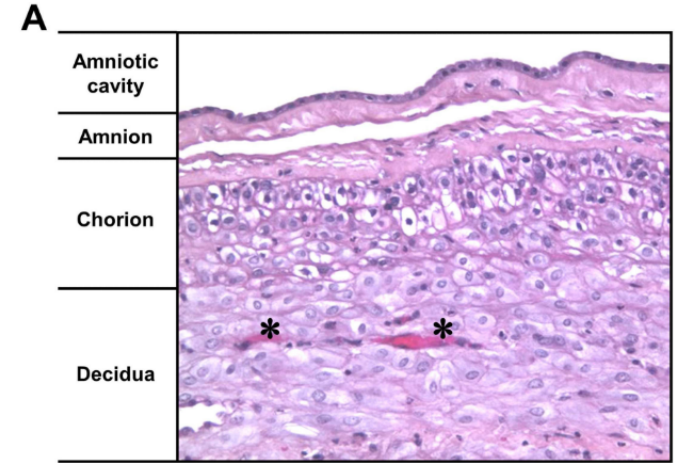
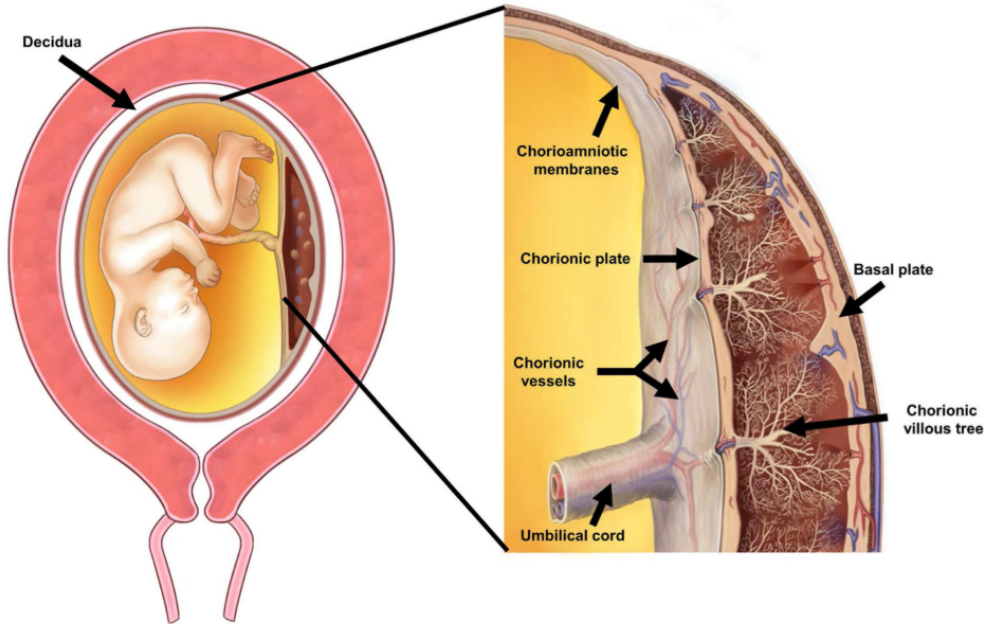
Risk of EOS

- Other maternal factors
 - Spontaneous labor <37 weeks
 - Lack of prenatal care
 - Meconium stained amniotic fluid (MSAF), foul smelling fluid
- Other neonatal factors
 - Low birth weight (LBW)
 - 5 minute APGAR <5
 - Resuscitation in the delivery room
 - Male gender
 - Acidosis

Chorioamnionitis (Chorio)

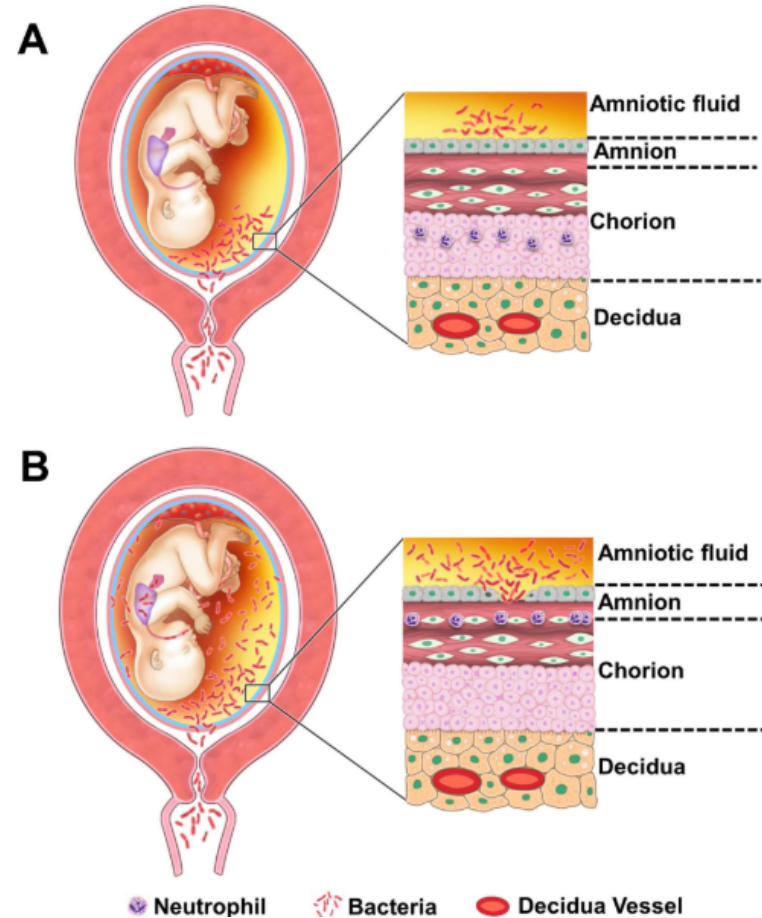
- Definition
 - Literal
 - Inflammation limited to the chorion and amnion layers of the fetal membranes
 - Colloquial
 - Inflammation of any intrauterine component
 - Clinical
 - Clinical suspicion of intra-uterine infection or inflammation
 - Fever (approaching fever), foul smelling fluid, maternal/neonatal tachycardia, uterine tenderness, increased WBC count, purulent discharge, a feeling

Chorioamnionitis



Chorioamnionitis

- Ascending infection is most common
- Severe enough ascending infection can infect the fetus through contact with mucous membranes, lungs, non-intact skin



Chorioamnionitis

- Epidemiology
 - 1-13% of all US births depending upon definition
 - Maternal morbidity
 - 2-3 fold increase in C-section
 - 2-4 fold increase in endomyometritis, wound infection, bacteremia, and postpartum hemorrhage
 - Neonatal
 - Associated with 40% of cases of EOS
 - EOS in 8% of deliveries associated with chorioamnionitis
 - This included “culture-negative” sepsis

Chorioamnionitis

- Problem with the definition
 - None of the clinical signs/symptoms are specific for the presence of chorioamnionitis
 - Fever - epidural, dehydration, elevated ambient temperature, prostaglandin for induction of labor
 - Diagnosis is not standardized but dictates maternal and neonatal care
- Triple I (Intrauterine Infection, Inflammation or Both)
 - Standardized approach to diagnosis
 - Fever + (fetal tachycardia, high WBC count, purulent fluid, bacteria in fluid)

Difficulties with Presentation

- Signs and symptoms of EOS are non-specific
 - Environmental
 - Temperature instability - low ambient temperature
 - Broad non-infectious differential diagnosis
 - Prematurity
 - Surfactant deficiency, transient tachypnea of newborn
 - Metabolic disease
 - Cardiac disease
 - Maternal medication effects
 - Could have non-bacterial cause
 - Recovering from intrauterine compromise
- May be initially asymptomatic

Diagnosis

- Definitive - positive blood culture or CSF culture
- Suspected - neonates with risk factors and/or clinical indicators for neonatal infection

- Treatment needs to be started prior to confirmation of infection
 - High risk of morbidity and mortality with delay in treatment

Management

1. Identify modifiable prenatal and intrapartum risk factors
2. Intervene prior to delivery
3. Intervene after delivery

❖ All before verification of infection

Identify Modifiable Prenatal Risk Factors

1. Group B Strep (GBS) Colonization

- GBS is the most common cause of EOS
- GBS can be cultured from the vaginal tract during pregnancy

2. Chorioamnionitis

GBS - American College of Obstetrics and Gynecology (ACOG) Committee Opinion 2019

- Screen all pregnant women for GBS
 - Between 36 0/7 and 37 6/7 weeks
 - Not necessary if GBS bacteriuria during pregnancy or previous child with GBS disease

GBS - ACOG Committee Opinion 2019

- Prophylactic antibiotics
 - Indications
 - Positive GBS cultures - vaginal tract or urine during pregnancy
 - Previous newborn with GBS disease
 - GBS unknown with any of the following:
 - Expected preterm birth
 - Prolonged rupture of membranes >18 hours
 - Maternal fever
 - +/- history of colonization in previous pregnancy

GBS - ACOG Committee Opinion 2019

- Prophylactic antibiotics
 - Exclusions
 - Cesarean section prior to onset of labor OR rupture of membranes
 - Negative Screening
 - Treatment
 - Ideally 4 hours prior to delivery
 - Do not delay obstetric interventions
 - 2 hours has been shown to have effect

Adequate Treatment

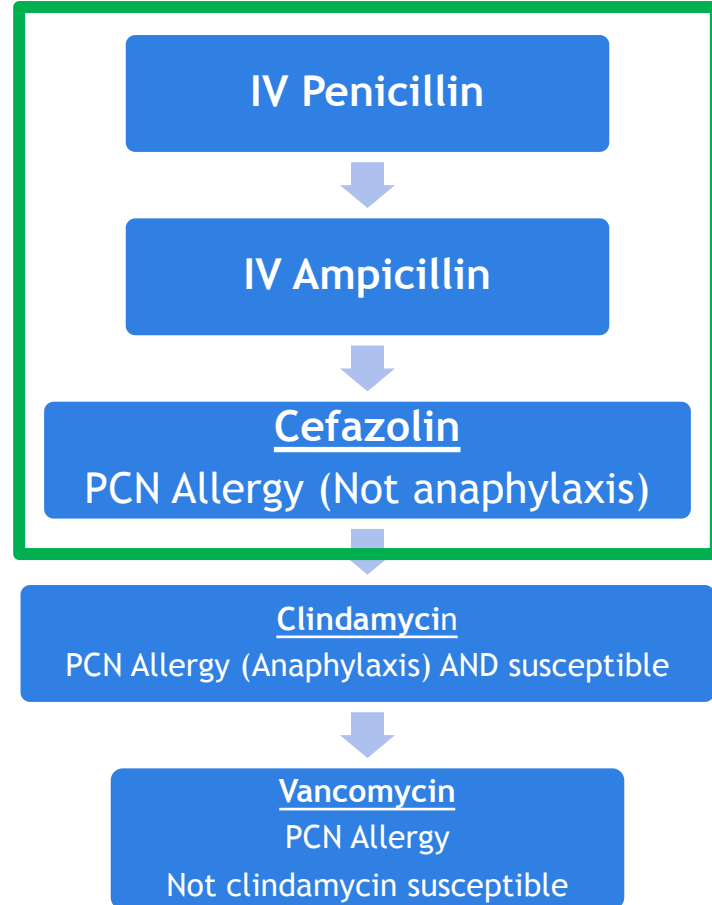
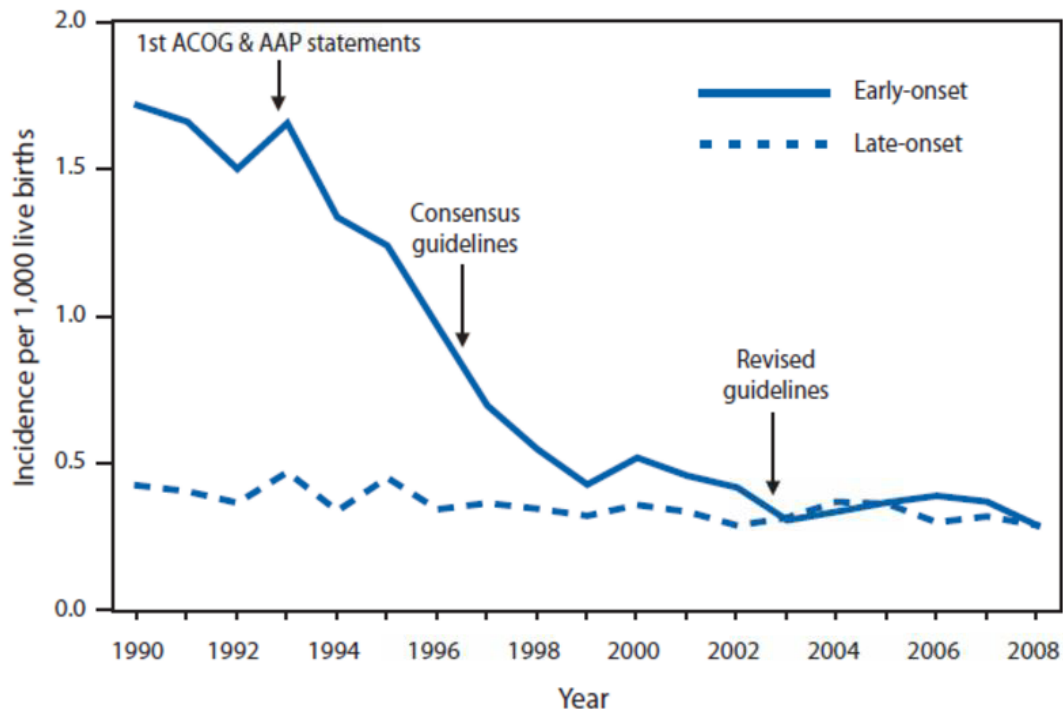


FIGURE 1. Incidence of early- and late-onset invasive group B streptococcal (GBS) disease --- Active Bacterial Core surveillance areas, 1990-2008, and activities for prevention of GBS disease



Abbreviations: ACOG = American College of Obstetricians and Gynecologists and AAP = American Academy of Pediatrics.

Source: Adapted from Jordan HT, Farley MM, Craig A, et al. Revisiting the need for vaccine prevention of late-onset neonatal group B streptococcal disease. *Pediatr Infect Dis J* 2008;27:1057--64.

* Incidence rates for 2008 are preliminary because the live birth denominator has not been finalized.

Identify and Intervene Prenatally - GBS

- Intrapartum prophylaxis is only current available strategy for EOS
- Universal screening more effective than risk based approach
- Effect of universal screening and intrapartum antibiotic prophylaxis on GBS EOS

- 1.8/1000 live births in 1990



- 0.23/1000 live births in 2015

Identify and Intervene Prenatally - Chorioamnionitis

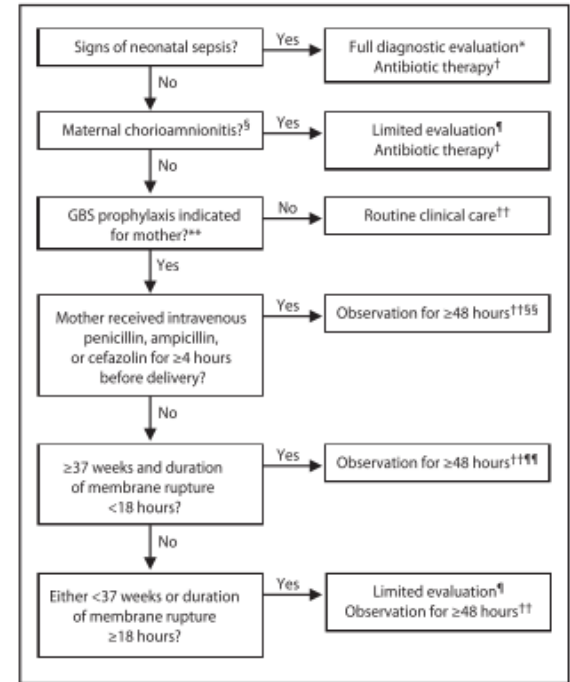
- Identify chorioamnionitis based on local practice
 - Triple I standardization at Jefferson
- Initiate targeted antibiotic therapy to limit EOS in baby and morbidity in mom
- Plan for delivery
 - induction if not in labor
 - do not jump to C-section unless clinically indicated for mom

Identify and Intervene Postnatally

- 2010 - Committee on Fetus and Newborn of the American Academy of Pediatrics (AAP)
 - All babies born to mothers with chorioamnionitis
 - Blood culture and CBC
 - Empiric antibiotics
 - Majority of other babies treated based on clinical symptoms/diagnostics

Frieden, T. R. (2009). *Morbidity and Mortality Weekly Report Prevention of Perinatal Group B Streptococcal Disease.*

FIGURE 9. Algorithm for secondary prevention of early-onset group B streptococcal (GBS) disease among newborns



* Full diagnostic evaluation includes a blood culture, a complete blood count (CBC) including white blood cell differential and platelet counts, chest radiograph (if respiratory abnormalities are present), and lumbar puncture (if patient is stable enough to tolerate procedure and sepsis is suspected).

† Antibiotic therapy should be directed toward the most common causes of neonatal sepsis, including intravenous ampicillin for GBS and coverage for other organisms (including *Escherichia coli* and other gram-negative pathogens) and should take into account local antibiotic resistance patterns.

§ Consultation with obstetric providers is important to determine the level of clinical suspicion for chorioamnionitis. Chorioamnionitis is diagnosed clinically and some of the signs are nonspecific.

¶ Limited evaluation includes blood culture (at birth) and CBC with differential and platelets (at birth and/or at 6–12 hours of life).

Identify and Intervene Postnatally

- Symptoms unreliable
- Risk factors non-specific and multiple
- Diagnostics unreliable or late
 - Blood culture only definitive assay - delayed results
 - CBC - I:T ratio ≥ 0.2 **PPV 11-51%**
 - Sensitivity 90-100%
 - CRP ≥ 1 mg/dL **PPV 7-43%**
 - Sensitivity 70-93%

Identify and Intervene Postnatally

- Wortham et. al 2016
 - NICHD 2006-2009
 - Treating all babies exposed to chorioamnionitis

❖ 60-1400 babies treated for every 1 baby with EOS

Identify and Intervene Postnatally

- At Jefferson from 2006-2017 - Following 2010 CDC guidelines
 - 6.5% of infants born \geq 35 weeks gestation were exposed to chorioamnionitis
- ❖ **231 Infants treated with empiric antibiotics for every 1 infant with EOS**

Adverse Effects of Early Empiric Antibiotics¹¹⁻¹⁵

- Increased risk for later infection
- Abnormal Immune Programming
- Independent Risk Factor for:
 - Asthma, obesity, autoimmune disorders
- Maternal-Infant Separation
 - Interfere with breast feeding and bonding
 - Prolong hospitalization
 - Increased risk of medical error and treatment complications
- Increased Healthcare Cost and Resource Utilization

Sepsis Risk Calculator

- Developed by Kaiser Permanente
- 350 cases of culture proven EOS in ~600,000 babies \geq 34 weeks gestation.
- Took characteristics of the babies with sepsis to develop a risk score
 - Provides guidelines for management based on that risk in this general population of neonates
 - Not validated in special populations such as chorio
- Spectacular decrease in empiric antibiotic treatment
 - From 5% to 2.6% overall
 - Shakib et al. showed an 88% reduction in use of antibiotics with calculator use in chorio.

Sepsis Risk Calculator

- Components for preliminary risk
 - Maternal temperature
 - Gestational age
 - Time elapsed since rupture of membranes
 - GBS status
 - Type and timing of intrapartum antibiotics
- Prelim risk + clinical status = final risk of EOS
- Risk → Recommendation for management

Predictor	Scenario
Incidence of Early-Onset Sepsis [?]	0.5/1000 live births (CDC national) <input type="text"/>
Gestational age [?]	35 <input type="text"/> weeks <input type="text"/>
	2 <input type="text"/> days <input type="text"/>
Highest maternal antepartum temperature [?]	100.8 <input type="text"/> Fahrenheit <input type="text"/>
ROM (Hours) [?]	16 <input type="text"/>
Maternal GBS status [?]	<input type="radio"/> Negative <input checked="" type="radio"/> Positive <input type="radio"/> Unknown
Type of intrapartum antibiotics [?]	<input type="radio"/> Broad spectrum antibiotics > 4 hrs prior to birth <input type="radio"/> Broad spectrum antibiotics 2-3.9 hrs prior to birth <input checked="" type="radio"/> GBS specific antibiotics > 2 hrs prior to birth <input type="radio"/> No antibiotics or any antibiotics < 2 hrs prior to birth

Risk per 1000/births			
EOS Risk @ Birth	3.32		
EOS Risk after Clinical Exam	Risk per 1000/births	Clinical Recommendation	Vitals
Well Appearing	1.36	Blood culture	Vitals every 4 hours for 24 hours
Equivocal	16.39	Empiric antibiotics	Vitals per NICU
Clinical Illness	65.98	Empiric antibiotics	Vitals per NICU

Classification of Infant's Clinical Presentation [Clinical Illness](#) [Equivocal](#) [Well Appearing](#)

Sepsis Risk Calculator

Sepsis Risk Calculator

- Problems

- **It missed half of the babies with positive BC!!**
 - They stated that all babies were “caught” before discharge and no babies died
- Requires man power, retraining staff, and resources
- Increases chance for miscalculation and holding antibiotics

- Survey of 682 members of AAP

- 169 (25%) Use calculator for CHORIO babies
- Many units are using the calculator to make the decision of empiric antibiotics



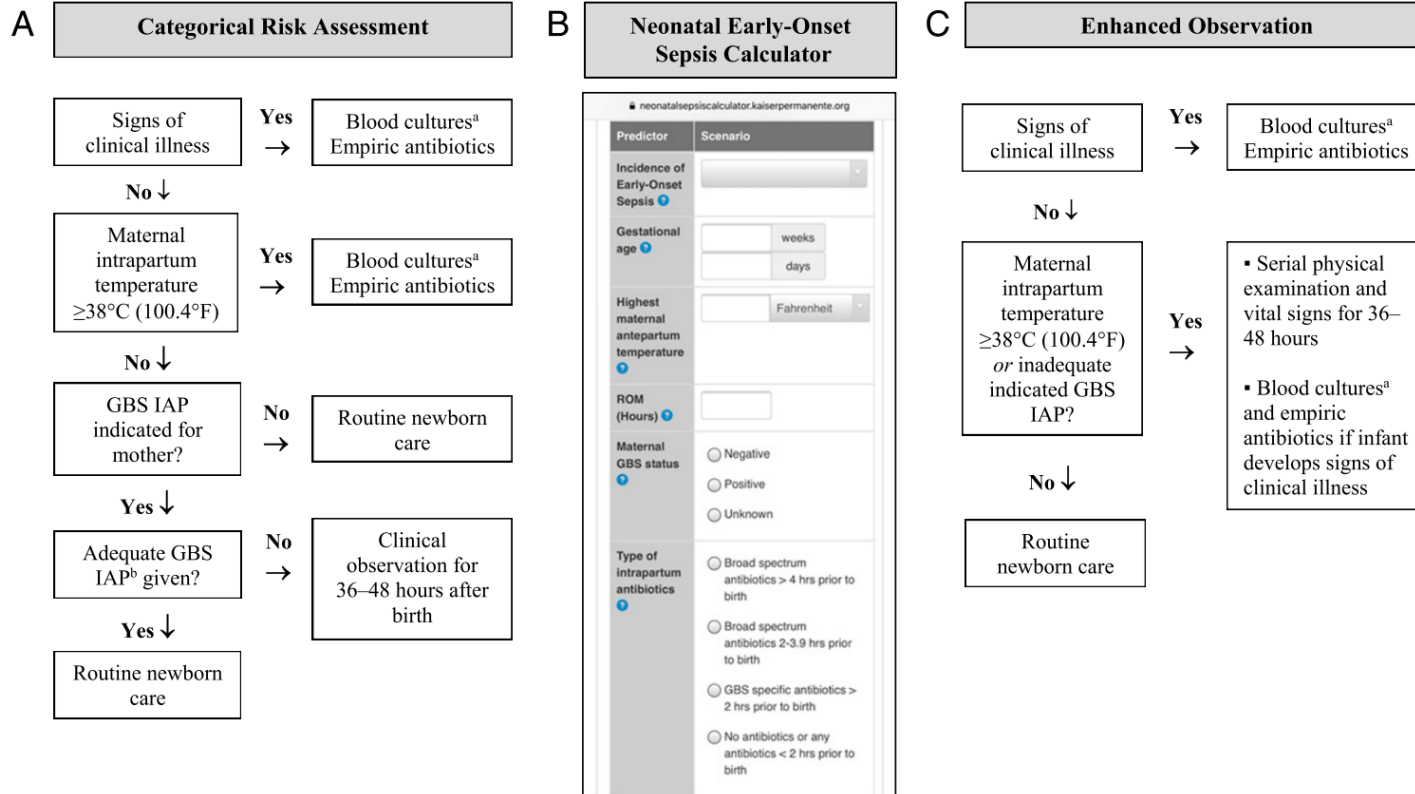
Sepsis Risk Calculator

- Jefferson Chorioamnionitis/Sepsis Risk Calculator Study
 - We looked at 1029 babies exposed to Chorio
 - Calculated EOS risk for 688
- 74% of the babies qualified for observation or limited eval without empiric antibiotics!
- But that included 2 out of 5 culture positive babies
 - Calculator missed 40% of babies with culture proven sepsis

American Academy of Pediatrics (AAP) Guidelines 2018

- $\geq 35 \frac{0}{7}$ Weeks Gestation
 - Three distinct approaches
 1. Categorical risk assessment - Empiric antibiotics for all “Chorio” babies
 2. Multivariate risk assessment - Sepsis risk calculator
 3. Enhanced observation/based on clinical condition - Increased monitoring/lab eval
 - ❖ “Each approach has merits and limitations, and each is a reasonable approach to risk assessment among infants who are born at ≥ 35 weeks gestation

EOS Risk Assessment Options ≥ 35 Weeks



AAP Guidelines 2018

- Summary
 - Distinct risk assessment and approach for ≥ 35 weeks gestation
 - Three reasonable approaches
 - Local guidelines should be developed
 - EOS is diagnosed by positive blood or CSF cultures, not CBC/CRP, surface cultures, or urine culture

AAP Guidelines 2018

- Summary
 - When Blood cultures are sterile, antibiotics should be discontinued by 36 to 48 hours unless there is evidence of site specific infection
 - Persistent cardiorespiratory instability is common among preterm infants with very low birth weight babies and is not alone an indication for prolonged empirical antibiotics
 - Laboratory test abnormalities alone rarely justify prolonged empirical antibiotics administration, especially among preterm infants at lower risk for EOS

Problem Statement

- What is the problem?
 - What is occurring OR What are we missing?
 - Overtreatment with empiric antibiotics despite increasing knowledge of adverse affects and new AAP guidelines
 - When did the problem start?
 - 10+ years - as far back as 2006
 - Where is the problem taking place?
 - The Jefferson Intensive Care Nursery
 - Extent (Gap) of the problem or opportunity
 - 1159 neonates ≥ 35 weeks gestation were treated from 2006-2017
 - Only 5 of those had culture proven early onset sepsis

Problem Statement

- All neonates born in 2018 in our NICU that were exposed to chorioamnionitis were treated with empiric antibiotics despite their relatively low risk for EOS and increasing knowledge of the possible adverse affects of antibiotics

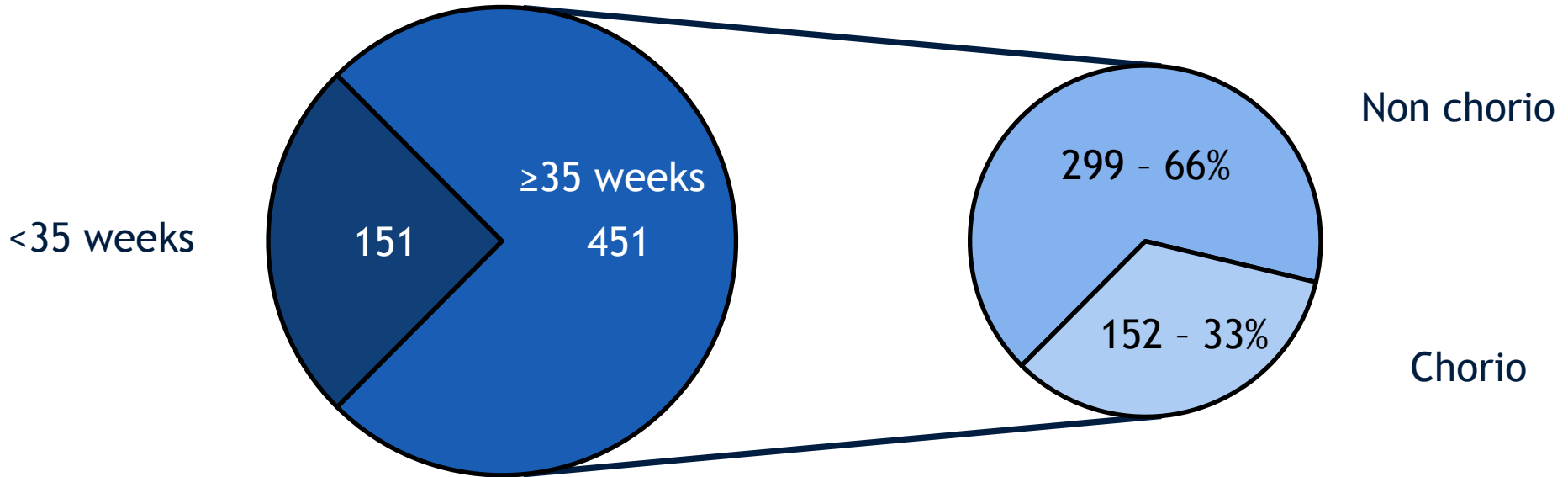
Jefferson Intensive Care Nursery (ICN) Characteristics

- 40+ Bed
- Level III
 - Multiple ventilator types
 - Premies down to 22 weeks gestation
 - Complex medical conditions
 - Not so complex surgical conditions
 - No ECMO or cardiac surgery (Level IV)
- Typical patients - prematurity, neonatal abstinence, infection



Jefferson ICN Demographics 2019

Total - 602 infants



25%

Empiric antibiotics

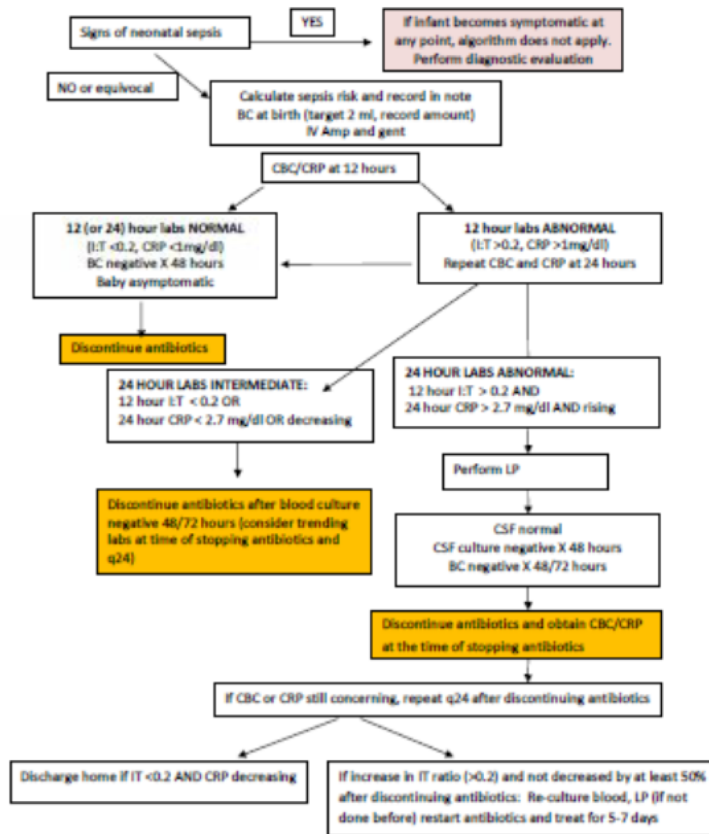
Previous Antibiotic Stewardship Project

AIM	Primary Drivers	Secondary Drivers
<p>Antibiotic Stewardship: Reduce overall AUR and implement stewardship guidelines to reduce use of Vancomycin, Zosyn, and Cefotaxime</p>	Asymptomatic Term Chorio babies	See guidelines for suggested management algorithm
	Evaluation of late onset sepsis	<ol style="list-style-type: none"> 1. Late Onset Sepsis will be considered after DOL 3 2. Full evaluation should include timely collection of CBC, CRP, CSF counts/chemistries, and culture of blood, urine, and CSF. Also optimize use of PCR studies (BIOFIRE)
	Management of late onset sepsis	<ol style="list-style-type: none"> 1. Initiate antibiotics after cultures obtained whenever possible 2. First line antibiotics: ampicillin/nafticillin and gentamicin 3. Choose ampicillin if the patient has never had a central line or if the central line was removed >14 days ago. Choose nafticillin if there is a present or recent central line. 4. Change ampicillin/nafticillin to vancomycin if: <ol style="list-style-type: none"> 1. Clinical worsening 2. Blood culture positive for COONS 5. Change gentamicin to cefotaxime if: <ol style="list-style-type: none"> 1. CSF studies nonreassuring 2. Clinical worsening suggestive of (or strong concern for) meningitis 6. Consider ID consult for positive blood cultures (MD discretion) 7. If blood culture positive, repeat Q24 h until negative <p>Ref: Chiu, et al. <i>Pediatric Infectious Disease Journal</i>. April 2011. 30(4): 273-8.</p>
	Pharmacologic Management of suspected NEC	<ol style="list-style-type: none"> 1. If LOS with nonspecific abdominal concerns, initiate LOS evaluation and add imaging 2. Initiate ampicillin/nafticillin and gentamicin, or 3. If strong concern for NEC, or clinical/imaging confirmation, change antibiotics to ampicillin, gentamicin, and flagyl
	Gentamicin Dosing Changes	<ol style="list-style-type: none"> 1. For babies > 23 6/7, 5 mg/kg/dose Q 36 h, check true trough at 36 h 2. For babies < 24 0/7, HIE patients, anuric patients, 5 mg/kg/dose x 1 and check level at 24 hours and consult with pharmacy for dosing interval <p>Ref: El Char, et al, <i>Journal of Perinatology</i>, 2016 (36), 660-665.</p>

Jefferson EOS Antibiotic Stewardship Guideline Prior 2018

- All chorio exposed babies receiving antibiotics
- Standardized approach focused on limiting extension of empiric antibiotics
- Probably decreased overall antibiotic treatment length

Algorithm for the Management of the Asymptomatic Infant ≥ 35 wks GA admitted for Maternal Chorioamnionitis



Our Project

- New AAP Guidelines
- Jefferson clinical research on EOS
- Wave of EOS quality improvement

Multidisciplinary Team

- Neonatologists
- Neonatal Nurses
- Nursing Administration
- Pharmacists
- Pediatrician

High Level Project Plan

1. Smart Aim
2. Stakeholder analysis
3. Evaluate current state
4. Baseline Data
5. Drivers
6. Education
7. Intervention
8. Communication
9. Presentation

Smart AIM

- Specific Measurable Attainable Relevant Time-Bound
- Decrease empiric antibiotic usage by 50% within 1 year of initiation in those infants exposed to chorioamnionitis and born at ≥ 35 weeks gestation

Stakeholder Analysis - ICN

Stakeholder (Name or Group)	Strongly Supportive	Supportive	Neutral	Against	Strongly Against	Issues/ Concerns	Influence Strategy
Neonatologists		X				<ul style="list-style-type: none"> Missed cases of EOS Decline in census 	<ul style="list-style-type: none"> Review data Review proposal with increased monitoring in nursery
Neonatal Nurses		X				<ul style="list-style-type: none"> Missed cases of EOS Decline in procedural experience (PIV placement) Decline in census 	<ul style="list-style-type: none"> Same as above Review newest guidelines Still admitting for initial screening
Neonatal Fellows/NNPs		X				<ul style="list-style-type: none"> Missed cases of EOS Decline in procedural experience 	<ul style="list-style-type: none"> Review data Review proposal with increased monitoring in nursery
ICN Nurse Manager		X				<ul style="list-style-type: none"> Decline in census Decline in procedural experience 	<ul style="list-style-type: none"> Review newest guidelines Still admitting for initial screening
Division Chief		X				<ul style="list-style-type: none"> Missed cases of EOS 	<ul style="list-style-type: none"> Review data Review proposal with increased monitoring in nursery
ICN Charge Nurses		X				<ul style="list-style-type: none"> Difficulty managing nurse assignments with increased patient turnover Decline in census 	<ul style="list-style-type: none"> Still admitting for initial screening Standardize sign our and patient flow between ICN and pediatrics

Stakeholder Analysis - ICN

- Concerns
 - Would we miss cases of EOS?
 - Would we see a decline in census?
 - Would we see a decline in procedural competence (Blood draws, peripheral IV placement, Lumbar Puncture)?
 - How would we handle the patient turnover?

Stakeholder Analysis - Outside ICN

Stakeholder (Name or Group)	Strongly Supportive	Supportive	Neutral	Against	Strongly Against	Issues/ Concerns	Influence Strategy
Pediatricians		X				<ul style="list-style-type: none"> Missed cases of EOS/sicker babies in nursery Increased patient load 	<ul style="list-style-type: none"> Review data Standardize screening/management
Pediatric Residents		X				<ul style="list-style-type: none"> Sicker babies in nursery More admissions/increased work load 	<ul style="list-style-type: none"> Review data Standardize screening/management
Post partum nurses		X				<ul style="list-style-type: none"> Sicker babies in nursery More admissions/increased work load 	<ul style="list-style-type: none"> Review data Standardize screening/management Neonatal staff readily available overnight
Pharmacy		X				<ul style="list-style-type: none"> Missed cases of EOS Decreased medication administration 	<ul style="list-style-type: none"> Review data Review newest guidelines
Obstetricians	X					<ul style="list-style-type: none"> Missed cases of EOS 	<ul style="list-style-type: none"> Review data Standardize screening/management
Parents		X				<ul style="list-style-type: none"> Missed cases of EOS 	<ul style="list-style-type: none"> Review data in real time Standardize screening/management

Stakeholder Analysis - Outside ICN

- Concerns
 - Would we have sicker babies in term nursery?
 - Would we see an increase in census?
 - How would we handle the patient turnover, new workload?
 - Pediatricians no longer in house over night

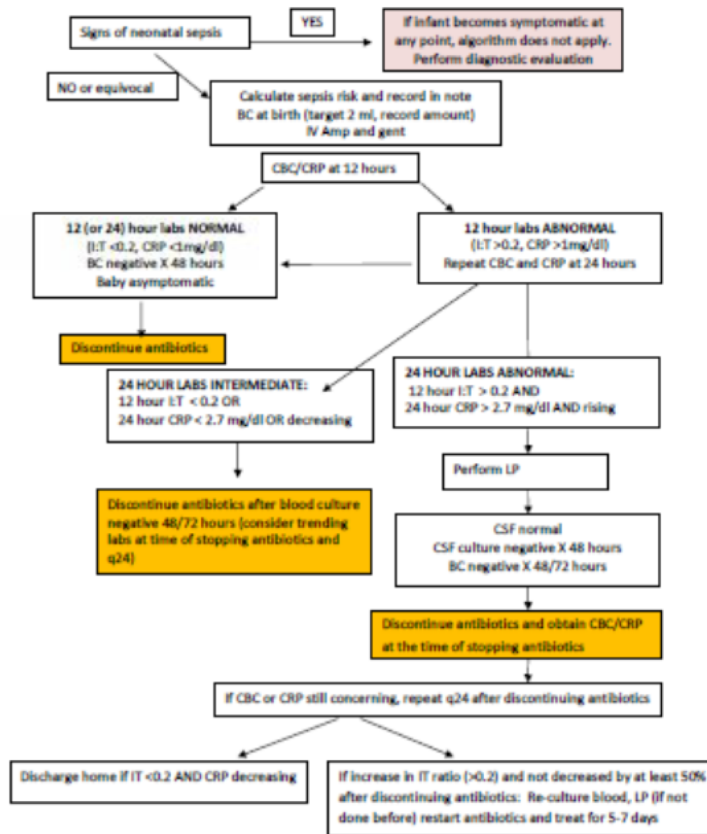
Stakeholder Analysis - Everyone

- Excited for the change
 - Long time coming
 - Many units admit these babies to nursery
 - Many using early onset sepsis calculator for years
 - Keeping mom and baby together for longer
 - Possibly improve breast feeding
 - Give less antibiotics

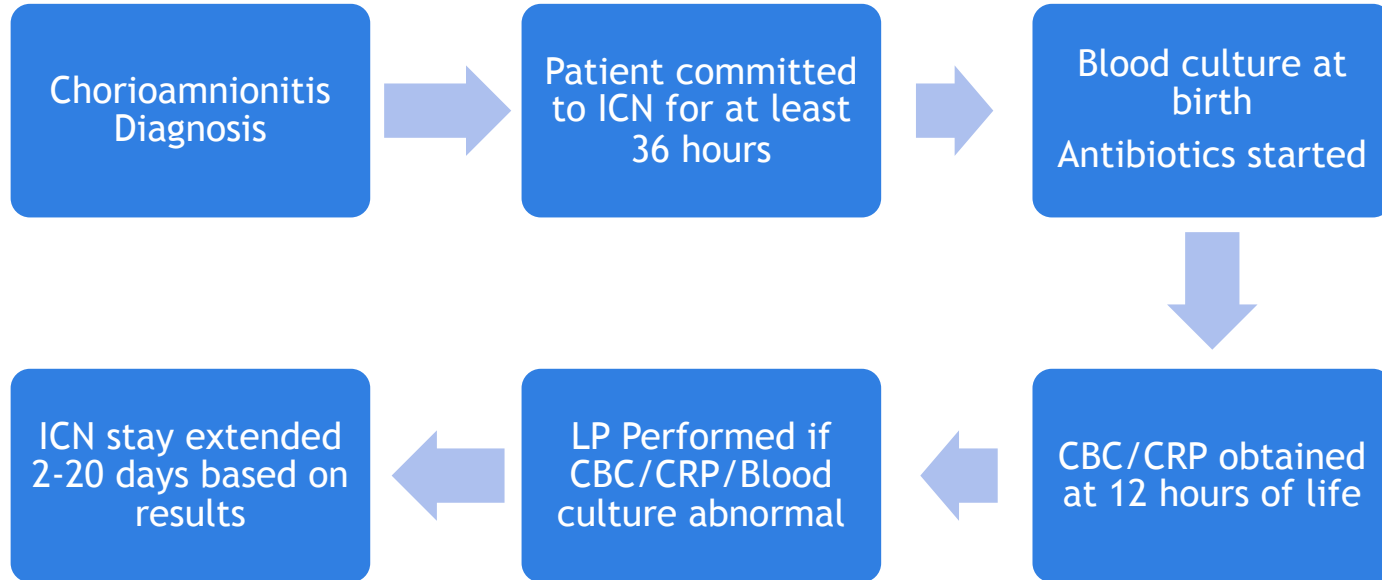
Current State Prior to 2018

- All chorio exposed = Blood culture + **empiric antibiotics**
- Standardize length of therapy dependent upon symptoms and/or CBC/CRP results

Algorithm for the Management of the Asymptomatic Infant ≥ 35 wks GA admitted for Maternal Chorioamnionitis



Process Map



Baseline Data

- 2006-2017
 - ~100 babies admitted with chorioamnionitis per year
 - 100% of those babies receive antibiotics for at least 48 hours
 - Ampicillin and Gentamicin
 - All of those babies spend at least 36-48 hours in the ICN
 - Separated from mother
 - Arterial blood sampling for blood culture, heel stick for CBC/CRP
 - IV access obtained - peripheral, umbilical, PICC

Driver Diagram

AIM

Decrease empiric antibiotic usage by 50% within 1 year of initiation in those infants exposed to chorioamnionitis and born at ≥ 35 weeks gestation

PRIMARY DRIVERS

Education

New Treatment Guidelines

Clinical Research

Coordinate workflow with nursery and OB

SECONDARY DRIVERS

- In person didactic with Neonatologists
 - In person didactic with ICN leaders
- Powerpoint for ICN, nursery, and OB staff
- In person discussion with pediatricians

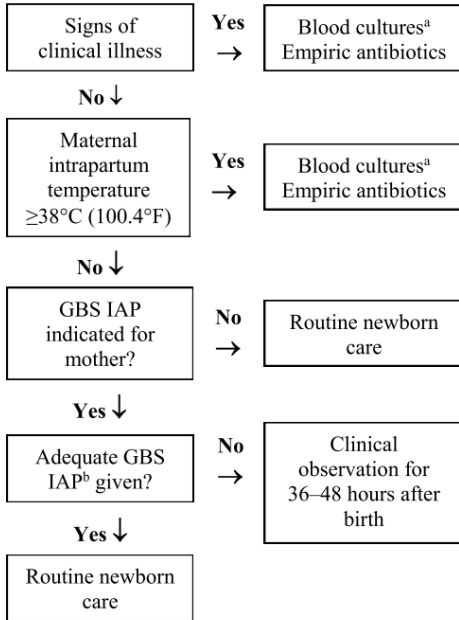
- Develop new guidelines based on clinical research at Jeff and AAP guidance
 - PDSA cycles to tighten guidelines
- Adjust guidelines based on latest research

- Continued research on EOS calculator utility
- Continued research on safety of categorical and symptom based approach

- Optimize DR care with no empiric abx
- Develop plan for transfer from ICN to nursery after sepsis screening

AAP/COFN 2018 Guidelines

A Categorical Risk Assessment

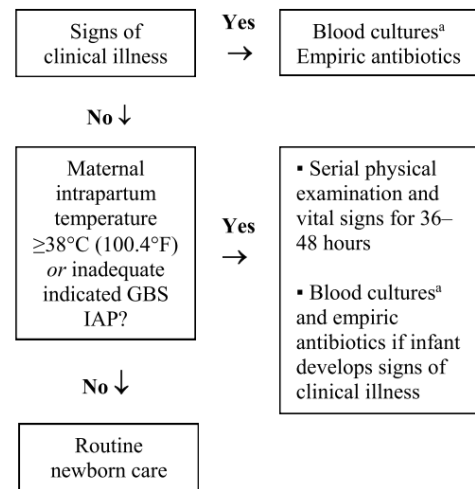


B Neonatal Early-Onset Sepsis Calculator

neonatalesepsiscalculator.kaiserpermanente.org

Predictor	Scenario
Incidence of Early-Onset Sepsis	<input type="text"/>
Gestational age	<input type="text"/> weeks <input type="text"/> days
Highest maternal antepartum temperature	<input type="text"/> Fahrenheit
ROM (Hours)	<input type="text"/>
Maternal GBS status	<input type="radio"/> Negative <input type="radio"/> Positive <input type="radio"/> Unknown
Type of intrapartum antibiotics	<input type="radio"/> Broad spectrum antibiotics > 4 hrs prior to birth <input type="radio"/> Broad spectrum antibiotics 2-3.9 hrs prior to birth <input type="radio"/> GBS specific antibiotics > 2 hrs prior to birth <input type="radio"/> No antibiotics or any antibiotics < 2 hrs prior to birth

C Enhanced Observation



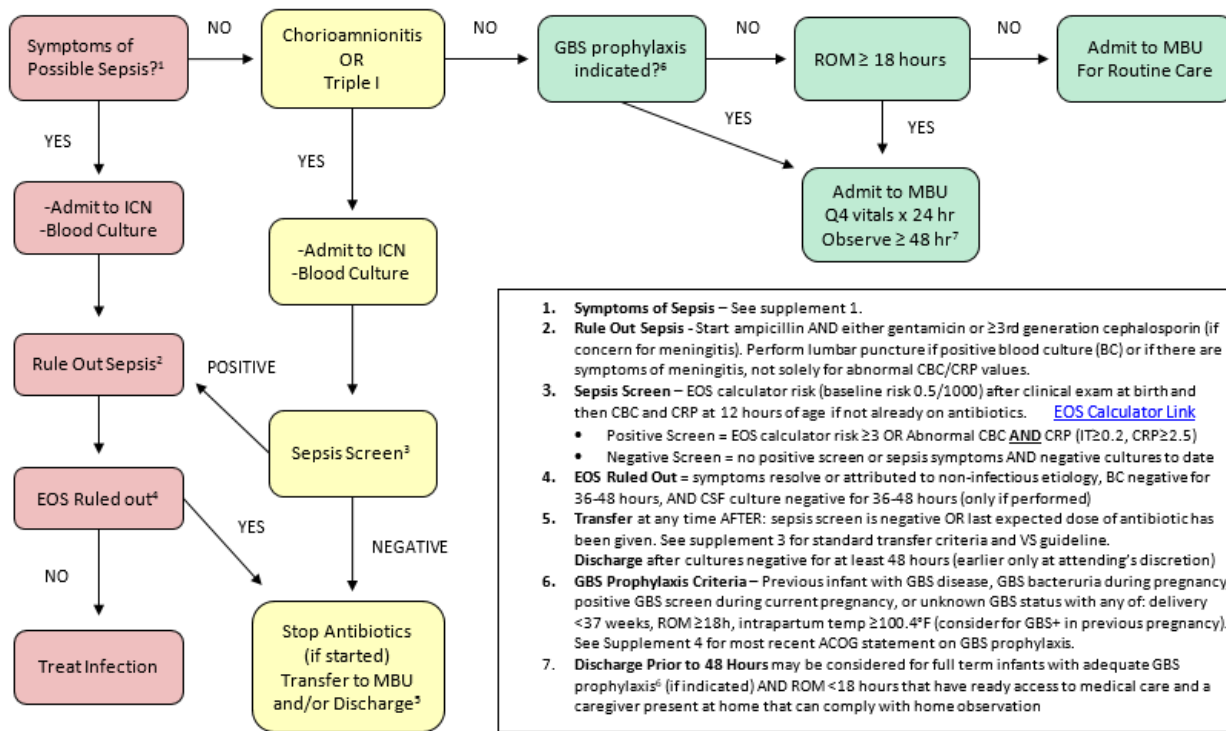
New Jefferson EOS Management Guideline

- ≥ 35 0/7 Weeks Gestation
 - Hybrid of 3 approaches
 1. Sick - Treat
 2. Chorio - Observe 12 hours in ICN, blood culture, calculator, and CBC/CRP
 3. GBS - Increased vitals, watch at least 48 hours
 4. ROM >18 - Increased vitals, watch at least 48 hours
 5. Well - Routine Care
- Categorical
 - Multivariate
 - Enhanced Observation

Thomas Jefferson University

Early Onset Sepsis Evaluation/Management Guideline

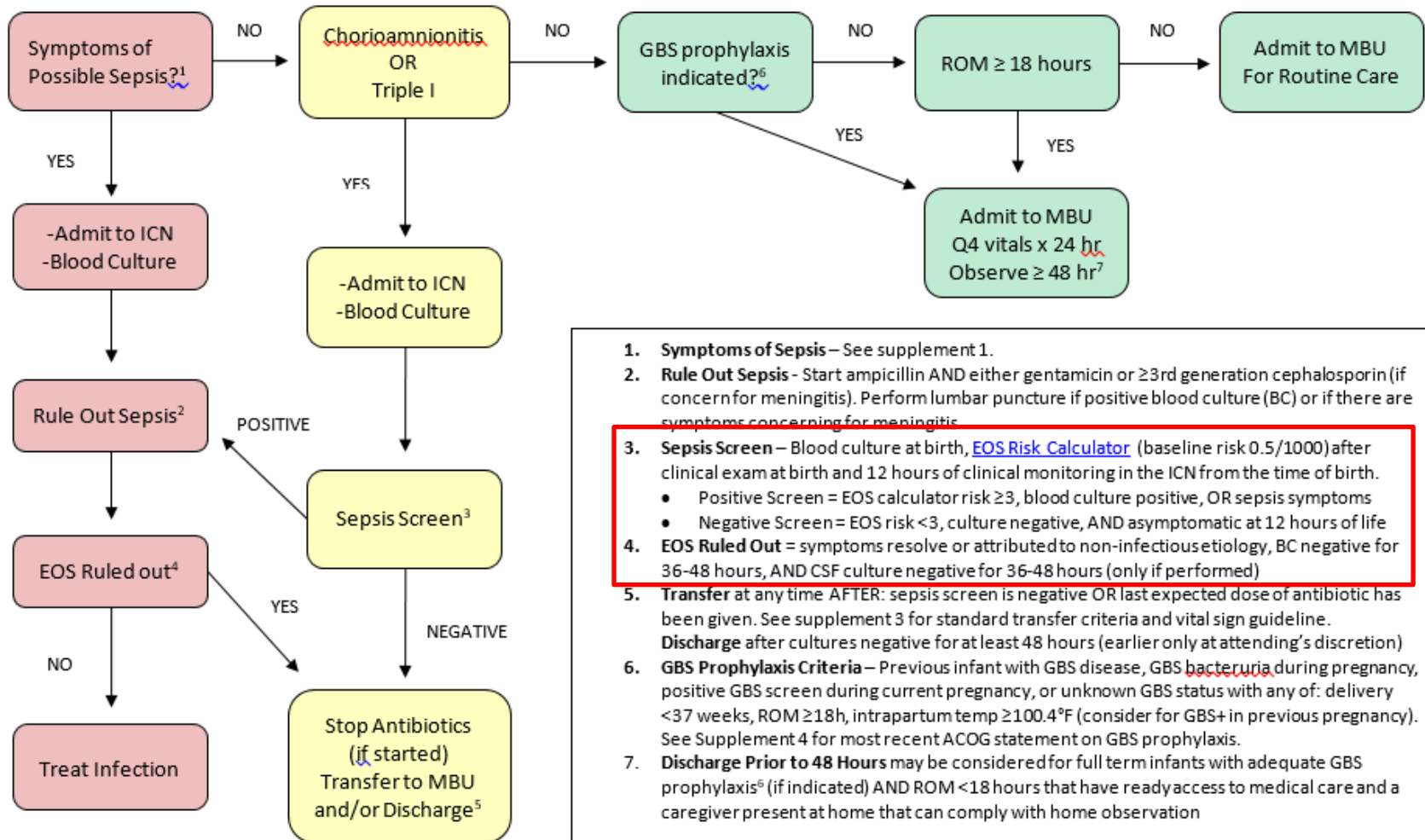
Consider in ALL Neonates ≥35 Weeks Gestation



- Symptoms of Sepsis** – See supplement 1.
- Rule Out Sepsis** – Start ampicillin AND either gentamicin or ≥3rd generation cephalosporin (if concern for meningitis). Perform lumbar puncture if positive blood culture (BC) or if there are symptoms of meningitis, not solely for abnormal CBC/CRP values.
- Sepsis Screen** – EOS calculator risk (baseline risk 0.5/1000) after clinical exam at birth and then CBC and CRP at 12 hours of age if not already on antibiotics. [EOS Calculator Link](#)
 - Positive Screen = EOS calculator risk ≥ 3 OR Abnormal CBC **AND** CRP (IT ≥ 0.2 , CRP ≥ 2.5)
 - Negative Screen = no positive screen or sepsis symptoms AND negative cultures to date
- EOS Ruled Out** = symptoms resolve or attributed to non-infectious etiology, BC negative for 36-48 hours, AND CSF culture negative for 36-48 hours (only if performed)
- Transfer** at any time AFTER: sepsis screen is negative OR last expected dose of antibiotic has been given. See supplement 3 for standard transfer criteria and VS guideline. **Discharge** after cultures negative for at least 48 hours (earlier only at attending's discretion)
- GBS Prophylaxis Criteria** – Previous infant with GBS disease, GBS bacteremia during pregnancy, positive GBS screen during current pregnancy, or unknown GBS status with any of: delivery <37 weeks, ROM ≥ 18 h, intrapartum temp $\geq 100.4^{\circ}\text{F}$ (consider for GBS+ in previous pregnancy). See Supplement 4 for most recent ACOG statement on GBS prophylaxis.
- Discharge Prior to 48 Hours** may be considered for full term infants with adequate GBS prophylaxis⁶ (if indicated) AND ROM <18 hours that have ready access to medical care and a caregiver present at home that can comply with home observation

PDSA #1

- Plan
- Do
 - Initial guideline implemented with CBC/CRP
 - Abnormal would require antibiotic administration for remainder of 48 hours of blood culture
- Study
 - Repeated insistence by AAP that CBC/CRP should not dictate antibiotic treatment in well appearing baby
 - No missed cases of EOS for 8 months
- Act
 - Second guideline produced with CBC/CRP removed
 - Blood culture at birth, 12 hour observation in ICN, EOS risk calculated



- 1. Symptoms of Sepsis** – See supplement 1.
- 2. Rule Out Sepsis** - Start ampicillin AND either gentamicin or ≥3rd generation cephalosporin (if concern for meningitis). Perform lumbar puncture if positive blood culture (BC) or if there are symptoms concerning for meningitis.
- 3. Sepsis Screen** – Blood culture at birth, [EOS Risk Calculator](#) (baseline risk 0.5/1000) after clinical exam at birth and 12 hours of clinical monitoring in the ICN from the time of birth.
 - Positive Screen = EOS calculator risk ≥3, blood culture positive, OR sepsis symptoms
 - Negative Screen = EOS risk <3, culture negative, AND asymptomatic at 12 hours of life
- 4. EOS Ruled Out** = symptoms resolve or attributed to non-infectious etiology, BC negative for 36-48 hours, AND CSF culture negative for 36-48 hours (only if performed)
- 5. Transfer** at any time AFTER: sepsis screen is negative OR last expected dose of antibiotic has been given. See supplement 3 for standard transfer criteria and vital sign guideline.
Discharge after cultures negative for at least 48 hours (earlier only at attending's discretion)
- 6. GBS Prophylaxis Criteria** – Previous infant with GBS disease, GBS bacteriuria during pregnancy, positive GBS screen during current pregnancy, or unknown GBS status with any of: delivery <37 weeks, ROM ≥18h, intrapartum temp ≥100.4°F (consider for GBS+ in previous pregnancy). See Supplement 4 for most recent ACOG statement on GBS prophylaxis.
- 7. Discharge Prior to 48 Hours** may be considered for full term infants with adequate GBS prophylaxis⁶ (if indicated) AND ROM <18 hours that have ready access to medical care and a caregiver present at home that can comply with home observation

Results

Demographics

Characteristic	Before Intervention	After Intervention	P-value
Birth Weight, mean (SD), g	3342 (413)	3383 (426)	0.48
Gestational Age, mean (SD), wk	39.3 (1.1)	39.1 (1.2)	0.18
Male, n (%)	48 (48)	60 (53)	0.58
SGA (<10 th percentile)	8 (8)	4 (4)	0.23
African American race, n (%)	28 (28)	33 (29)	1.00
C-section	27 (27)	40 (35)	0.24

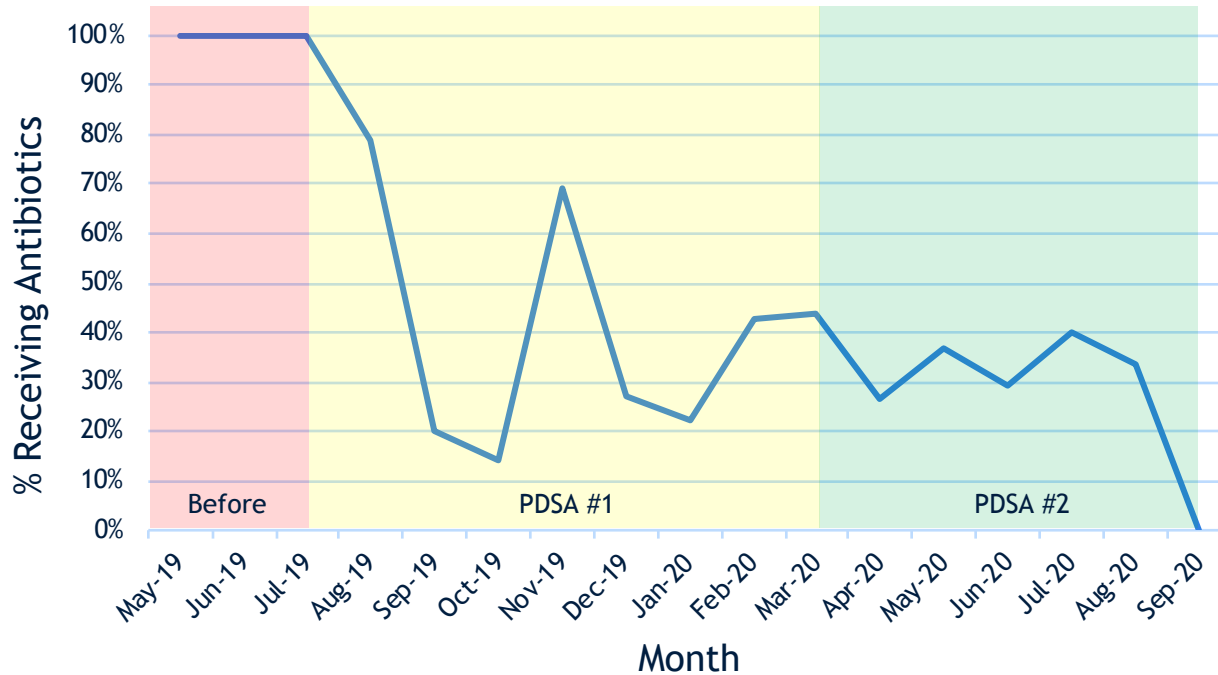
Results

Characteristic	Before	After	P-value
Empiric Antibiotic, n (%)	99 (100)	38 (34)	<.0001
Antibiotic Days (/100 Infants)	231 (233)	91 (80)	

- 34% of previous antibiotic use per baby (3x less)
- 34% of the previous antibiotic days (3x less)

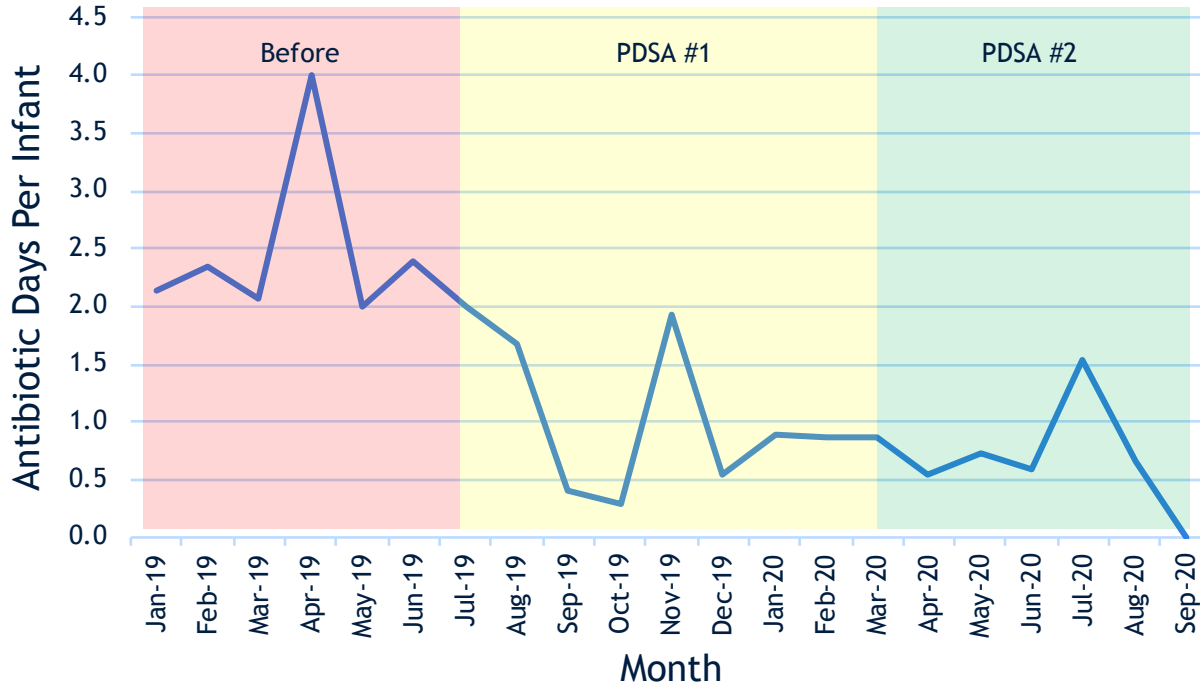
Run Chart

Empiric Antibiotic Usage for ≥ 35 Weeks Exposed to Chorio



Run Chart

Antibiotic Days Per Infant \geq 35 Weeks Exposed to Chorio



Healthcare Cost

- General Healthcare
 - ~100 chorio babies per year from 2006-2017
 - Potential to cut ICU length of stay for chorio babies from 2 to 1 day
 - Decrease of 100 ICU days
 - Decrease lifetime cost related to antibiotic exposure
 - Allergy, asthma, obesity, benefits of breast milk
- Jefferson
 - Insurance companies increasingly not paying for ICU level for exposure to chorioamnionitis
 - Improve breast feeding success, decrease mother-infant separation

Communication Plan

Group	Key Message	Delivery Mechanism (email/ phone/ etc.)	Frequency	Person Responsible to Deliver
Neonatologists	Safely limiting abx exposure and separating mother/infant less	Email, attending meeting	Every 6 months	Me
Neonatal Nurses	Safely limiting abx exposure and separating mother/infant less	Email, dashboard	Every 6 months, monthly	Me
Neonatal Fellows	Safely limiting abx exposure and separating mother/infant less	Email, dashboard	Every 6 months, monthly	Me
ICN Nurse Manager	Safely limiting abx exposure and separating mother/infant less, cutting costs	Email, dashboard, Quality and Safety meeting	Every 6 months, monthly	EOS team
Nursery Staff (Pediatricians, Nurses, lactation)	Safely decreasing mother/infant separation, improving mother/infant bonding/availability for breast feeding	EOS Case Review, Email	As needed, 6 months	Me
Parents	Safely limiting abx exposure, less separation, lower bill	In person	Case by case as needed	Admitting team

Next Steps

- EOS Calculator Incorporated into EPIC
- Blood culture from umbilical cord rather than baby
 - Limit interventions
 - Set up for eventual admission directly to nursery from DR
- Evaluate Impact on mother-infant separation, breastfeeding success
- Skip the ICN altogether

Questions?

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