Master of Public Health Field Experience Report

SOCIOECONOMIC DISPARITIES AND LATE ONSET GROUP B STREPTOCOCCUS IN TENNESSEE, 2010-2014

by

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submitted in partial fulfillment of the requirements for the degree

MASTER OF PUBLIC HEALTH

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Summary

My capstone project and field experience gave me the opportunity to increase my public health knowledge and skills. I spent the summer of 2016 at the Tennessee Emerging Infections Program at Vanderbilt University Medical Center in Nashville. Through my field experience, I learned how to obtain consent from patients for clinical trials, surveillance techniques, and how to extract pertinent health information from medical charts. I completed two projects during my time in Nashville. My minor project involved a random 10% audit of the 2015 Active Bacterial Core surveillance data and the creation of a database to house this and future audit information, and my primary project involved summarizing data on late onset group B *Streptococcus* and socioeconomic disparities in Tennessee from 2010-2015.

Group B *Streptococcus* is the leading cause of neonatal sepsis. Since the introduction of the CDC's Guidelines for the Prevention of Perinatal Group B Streptococcal Disease in 1996, the incidence rate of early onset disease has steadily declined. However, the incidence of late onset disease has remained stable. My primary project was to summarize late onset group B *Streptococcus* surveillance data for the preparation of a future, larger study. The purpose of this pilot was to identify areas of socioeconomic disparities for future analysis.

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List of Abbreviations

EIP	Emerging Infections Program
CDC	Centers for Disease Control and Prevention
MMWR	Morbidity and Mortality Weekly Report
TDH	Tennessee Department of Health
SO	Surveillance Officer
CEDEP	Communicable and Environmental Diseases and Emergency Preparedness
HPV	Human Papilloma Virus
ABCs	Active Bacterial Core Surveillance
CRF	Case Report Form
IRB	Institutional Review Board
GBS	Group B *Streptococcus*
EO	Early Onset
LO	Late Onset
IPP	Intrapartum Prophylaxis
CIN2+	Cervical Intraepithelial Neoplasm grades 2-4
AAP	American Academy of Pediatrics
ACOG	American Congress of Obstetricians and Gynecologists
IR	Incidence Rate
RR	Rate Ratio
RD	Rate Difference

Chapter 1 - Field Experience: Tennessee Emerging Infections Program, Nashville, TN

Introduction

In response to the increase in world travel and trade, antibiotic resistance, and the emergence or reemergence of infectious diseases both inside and outside of the United States, the Centers for Disease Control and Prevention (CDC) developed the Emerging Infections Program (EIP) in 1995. The CDC published its plan in the April 1994 copy of Morbidity and Mortality Weekly Report (MMWR): *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States, Executive Summary* (Centers for Disease Control & Prevention, 1994). The summary highlighted four goals for the program that focused on surveillance, research, prevention and control, and public health infrastructure. These goals are listed in Box 1.1. During its inception in 1995, there were four EIP sites: California, Connecticut, Minnesota, and Oregon. Since that time, six more sites have been established for a total of 10, as follows: Georgia, Maryland, New York, Tennessee, Colorado, and New Mexico. Figure 1.1 shows a history of the Emerging Infections Program. These sites are comprised of their respective State Health Department and academic partners. State agencies have legal authority for conducting surveillance, and academic partners function as agents of the state health departments (Pinner et al., 2015).

Goal I. Detect, investigate, and monitor emerging pathogens, the diseases they cause, and factors influencing their emergence.

Goal II. Integrate both laboratory science and epidemiology to optimize public health practice.

Goal III. Enhance communication of public health information about emerging diseases and ensure prompt implementation of prevention strategies.

Goal IV. Strengthen local, state, and federal public health infrastructures to support surveillance and implement prevention and control programs.

Box 1.1: Goals for the Emerging Infections Program outlined in the April 1994 issue of MMWR, *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States, Executive Summary*

The Emerging Infections Program (EIP) is divided into four main program areas consisting of invasive bacterial diseases, foodborne diseases, health care-associated infections (HAI), and influenza. The Active Bacterial Core Surveillance (ABCs) program focuses on invasive bacterial surveillance and epidemiology.

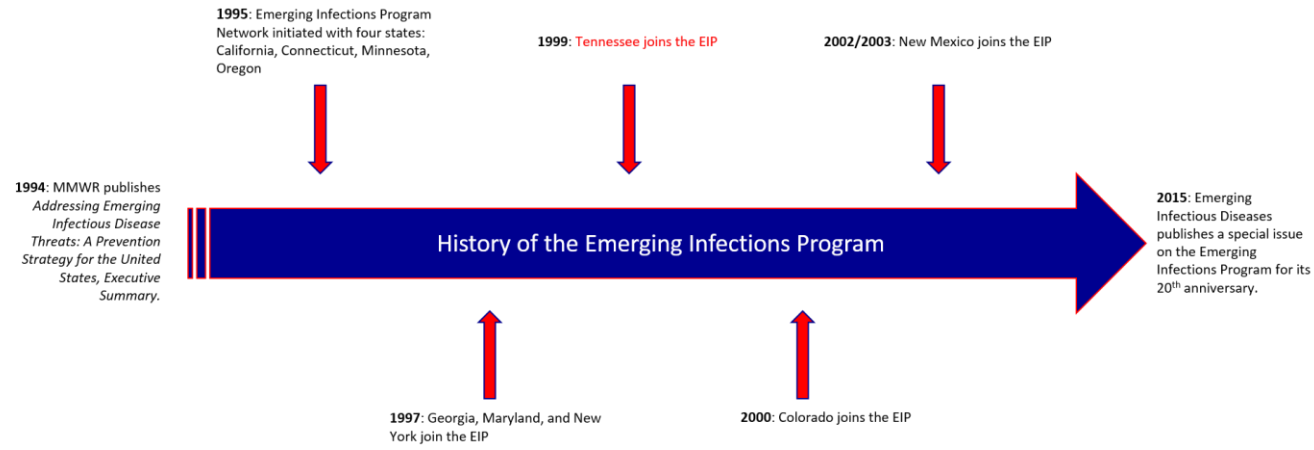


Figure 1.1 Time line of the addition of state to the Emerging Infections Program

Pathogens monitored by this program include, but are not limited to, *Streptococcus pneumoniae*, groups A and B *Streptococcus*, *Haemophilus influenzae*, and *Neisseria meningitidis*. The Foodborne Disease Active Surveillance Network (FoodNet) is a collaboration between the EIP, USDA, and the FDA and monitors pathogens such as *Campylobacter*, *Cryptosporidium*, *Cyclospora*, *Salmonella* spp., Shiga toxin-producing *Escherichia coli*, and *Shigella*, among others. The Healthcare-Associated Infections Community Surveillance (HAIC) probes into major and emerging HAIs and antibiotic resistance. The Influenza Hospitalization Surveillance Network (Flu-Surv NET), in addition to other networks, utilizes laboratory-confirmed influenza hospitalization surveillance data to understand the severity and trends of seasonal flu outbreaks and to assess the success of yearly vaccinations. EIP also houses smaller programs such as TickNET and the HPV IMPACT project. The Tennessee section of TickNet is exploring novel agents of tickborne disease by utilizing high-throughput screening and genomic sequencing. The Human Papillomavirus (HPV) IMPACT project, conducted in five of the ten EIP sites, evaluates the post-licensure success in prevention of cervical intraepithelial neoplasia, grades 2-4 (CIN2+) events, which are precursors to cervical cancer.

The CDC grants the Tennessee Department of Health (TDH) funding for the EIP, who then in turn, sub-contracts Vanderbilt University Medical Center to conduct a portion of the work. Along with the four main components of the EIP, Tennessee is also one of the five sites to participate in the HPV IMPACT project. During my field experience, I had the opportunity to work both at Vanderbilt and TDH; my preceptors at each site were Dr. William Schaffner and Dr. Tim Jones, respectively. My primary appointment was through the EIP at Vanderbilt;

however, I did have the opportunity to participate in events at the Communicable and Environmental Diseases and Emergency Preparedness (CEDEP) department at TDH.

Emerging Infections Program- Vanderbilt

The Tennessee Emerging Infections Program at Vanderbilt houses three main programs: Active Bacterial Core Surveillance, Flu-Surv NET, and the HPV-IMPACT Project. Portions of other programs such as HAIC, FoodNet, TickNet, and other special projects are also conducted onsite. Through my field experience, I was able to either shadow or work in each of these main programs.

Active Bacterial Core Surveillance

Database Audit

The Active Bacterial Core Surveillance team collects surveillance data on invasive pathogens such as *Neisseria meningitidis*, *Streptococcus pneumoniae*, Group A and B *Streptococcus*, *Listeria monocytogenes*, and *Haemophilus influenzae*. To collect these data, the surveillance officers build relationships with hospitals and infection preventionists, collect reports from public health and private labs, and utilize state databases and registries. Up until 2015, the data were stored in an Access database, and as of 2016, the data will be entered into REDCap, which is a secure web application created by Vanderbilt for building and managing online surveys and databases (Harris et al., 2009). During my field experience, I had the opportunity to conduct a 10% random audit of the 2015 Access database. This project will be covered in Chapter 2.

Pneumococcal Carriage Study

Within the ABCs there is an ongoing study focused on pneumococcal carriage in adults aged 65 and older. In 2010, the Advisory Committee on Immunization Practices (ACIP) recommended that the 7-valent pneumococcal conjugate vaccine (PCV7) be replaced with the 13-valent pneumococcal conjugate vaccine (PCV13) for children within the United States. This recommendation decreased rates of invasive pneumococcal disease for both children and adults (Centers for Disease Control, 2010); however, the rates in adults aged $\geq$ 65 years were still high.

Because of this, the ACIP recommended routine use PCV13 for adults within that age group (Tomczyk et al., 2014). This project, sponsored by the CDC, has three main objectives as listed below (Centers for Disease Control, *Adult Pneumococcal Carriage Study*, 2016):

1. Define the prevalence and serotype distribution of *S. pneumoniae* in adults ≥ 65 years prior to the widespread use of PCV-13 in this patient population.
2. Assess risk factors for *S. pneumoniae* colonization.
3. Provide baseline data to assess the impact of the new ACIP recommendation on carriage rates in the same patient population with later surveys.

This is a cross-sectional study that involves nasopharyngeal and oropharyngeal swabs, which will be utilized to assess pneumococcal carriage. Four of 10 EIP sites participate in this study: Georgia, Tennessee, Maryland, and New York. My role within this project was to enroll patients prior to the nurse collecting a biological specimen. This included obtaining informed consent and filling out the health survey and other paperwork.

Late Onset Group B Strep

My capstone project utilized group B *Streptococcal* data, which is housed within the ABCs group. Both the project and the ABCs will be explained further in Chapter 3.

Flu-Surv Net

The Flu Team at Vanderbilt collects data on laboratory confirmed hospitalized influenza cases during each annual flu season which goes from October 1st to April 30th of every year. The catchment area includes eight counties within middle Tennessee: (Cheatham, Davidson, Dickson, Sumner, Robertson, Rutherford, Williamson, and Wilson). This information is sent to the CDC where it is used in the Flu View weekly surveillance report. The Vanderbilt team also analyzes the data to assess problems such as the undetected burden of influenza hospitalization in children in Tennessee using a capture recapture method (Grijalva et al., 2007) and the socioeconomic disparities among influenza hospitalization in Tennessee (Sloan et al., 2015). During the second day of my field experience, I was able to attend a Flu Team site visit from the CDC. Through this, I gained a complete overview of the program, including an appreciation of its future directions.

The EIP team at Vanderbilt will be attending the Society of Clinical Research Associates annual meeting in October of 2016. I worked with two of the Flu team members to create a poster to present at this meeting. For this poster, I prepared the summary statistics and figures and wrote the abstract. To do this, I utilized 2015 seasonal influenza surveillance data. Figure 1.2 is a representation of the poster to be presented in October.

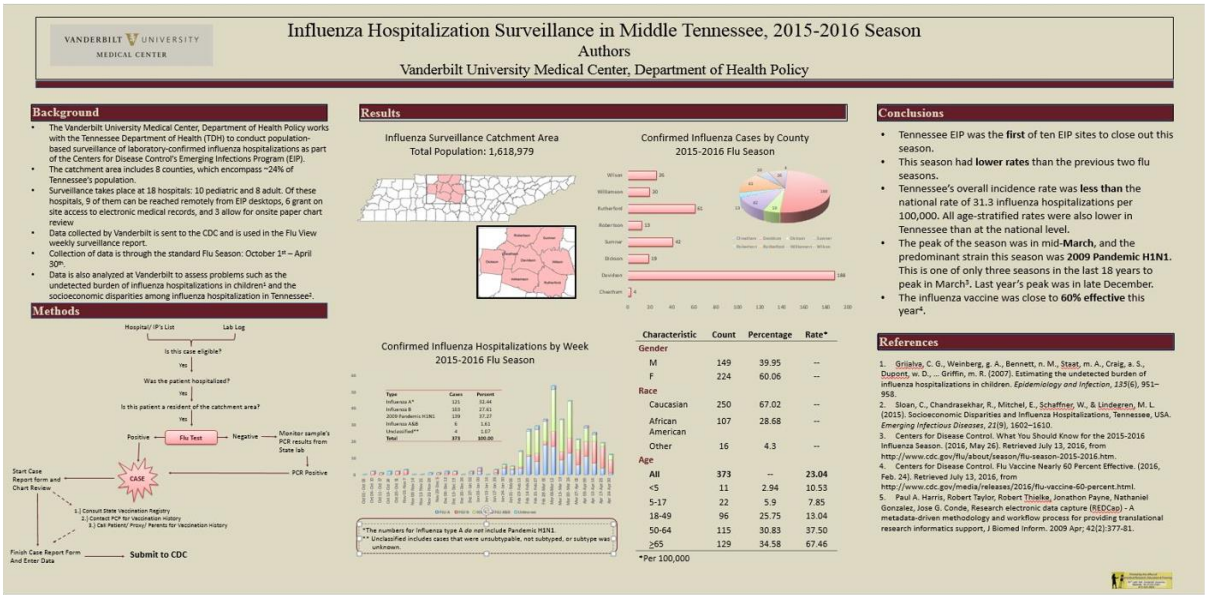


Figure 1.2: Influenza hospitalization surveillance poster to be presented at the Society of Clinical Research Associates 2016 annual conference in Montreal.

HPV Impact Project

The HPV- Impact program uses population based surveillance to evaluate the impact of the HPV vaccination program and HPV vaccine efficacies. As one of the smaller EIP projects, the catchment area is limited to Davidson County, TN. Outcomes that are assessed include the enumeration of CIN 2+ cases within catchment area, evaluation of the HPV subtypes in CIN2+ lesions, and the assessment of how the change in screening recommendations impacts screening rates in different age populations. The HPV-Impact team acquires data through many different avenues. In Tennessee, CIN 2+ is a reportable disease, and information about cases are acquired through submitted pathology reports to the Tennessee Cancer Registry. Cases are also ascertained through relationships with pathologists, laboratories, and women's clinics. For this project, I was involved in clinic site visits, during which I reviewed patient charts to complete case report forms.

Conclusions

My field experience at the Tennessee Emerging Infections Program provided me with the opportunity to experience many different aspects of public health. Participating in meetings at the Tennessee Department of Health allowed me to observe regional and state wide epidemiology and surveillance efforts. During this time, TN had an outbreak of measles, and I was able to see how state-level outbreak response takes place. Through the collection of case information for the ABCs and HPV-Impact, I learned what types of pertinent information need to be collected for disease monitoring and surveillance.

In addition to surveillance and monitoring, I also learned about good clinical practice, Institutional Review Board (IRB) protocols, and clinical trials through the pneumococcal carriage study. With this, I was able to interact with the public while following strict HIPAA and IRB regulations.

Chapter 2 - 2015 Active Bacterial Core Surveillance Database Audit

Introduction

Under the current grant cycle, the CDC does not require EIP sites to perform database audits. However, with the new grant starting in 2017, each site within the EIP will be required to perform an annual audit of each of their databases. To prepare for these audits, the TN ABCs group wanted to construct a database that would house all of the audit data and could be merged with the current REDCap database. To meet this need, I created a database and performed a random 10% audit of the 2015 ABCs data to test the utility of the database model.

Objectives

The objectives of this audit were to create a process by which future audits can be completed and to track discrepancies found between the hard copy of the case report form (CRF) and the electronic entry. The resulting report from the audit was used to assess the program's data entry protocol and highlight areas that need revisions or reeducation.

Methods

Database

REDCap is a secure web-based application created by Vanderbilt for building and managing online surveys and databases (Harris et al., 2009). In 2016, the TN ABCs program changed from using a Microsoft Access database to the REDCap platform. Because of this, I decided to create my audit database form within REDCap. This will allow my database to be merged with the main database after further optimizations. The entry form has a space to enter up to ten discrepancies between the hard copy and electronic CRF. Each error is categorized as either a data entry error or a data omission error. A data entry error is defined as an error in which an item is transferred to the electronic database incorrectly. Examples include spelling errors, incorrectly checked boxes, or correcting answers on the form without updating the database. There is a drop down menu to select which question the error was on and a section for

comments to explain what the discrepancies were. In addition, each error has a field for the data manager to comment on whether the discrepancy was fixed, why/how, and the date of correction. Figure 2.1 shows an example of the database entry form. A copy of the ABCs main CRF form is in Appendix A.

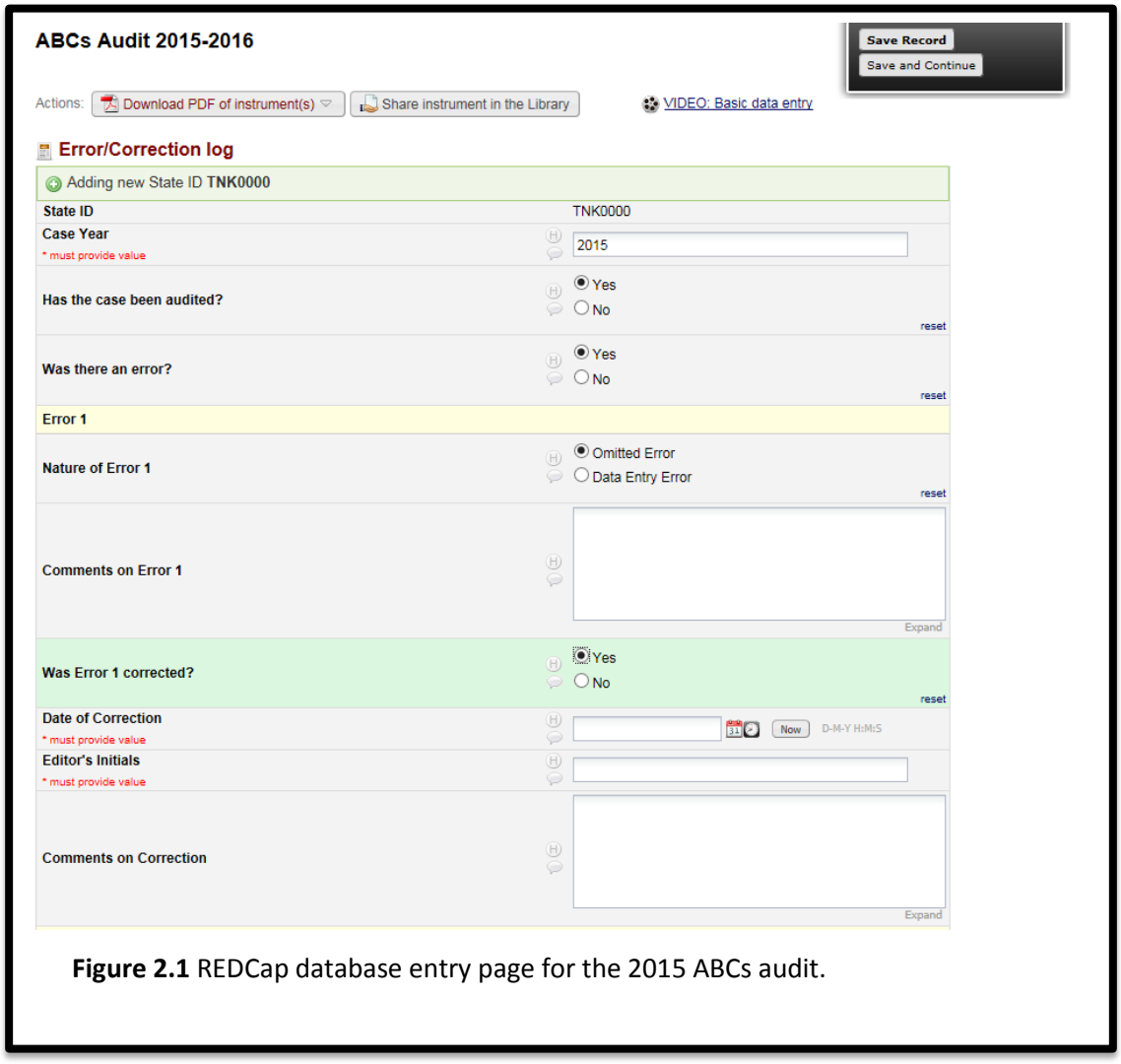


Figure 2.1 REDCap database entry page for the 2015 ABCs audit.

Audit

A random 10% sample was pulled from the 2015 database using SAS 9.4; this resulted in a sample size of 129 case report forms. Cases were then audited and errors were marked and

entered into the database. Once I completed this audit, I held a meeting with the lead Surveillance Officer and Database Manager to discuss the findings and how to move forward.

Results

Of the 129 cases audited, all of them had at least one error. Table 2.1 enumerates the errors for each CRF; as an example, 95 cases reviewed had four errors. Omitted errors were the most common with an average of 3.4 per CRF while data entry errors averaged 1.6 per CRF. There were sections of the CRF that were routinely flagged as incorrect. Table 2.2 shows the sections that had the most common errors. These include middle initials being omitted from the electronic database, improper hospital codes being reported, improper reporting of symptoms, and surveillance officer name and date being excluded from the electronic copy. Of these errors, the submitted by and date fields were the ones with the most discrepancies at 62.8% and 65.9% of the CRFs containing the error, respectively. One of the most interesting discrepancies noted involved the pregnancy status; if the male gender was selected, the surveillance officers still filled out the questions regarding pregnancy. This became a problem when entering this into the database, because the database manager skipped over these questions which left a discrepancy between the two versions of the form. This was found on 31% of the CRFs.

Table 2.1: Number and type of errors per case report form for the 2015 10% database audit.

Number of Errors Performed	Error Type		Total CRFs with Error number
	Omitted Errors	Entry Errors	
1	77	52	129
2	53	61	114
3	67	39	106
4	69	26	95
5	64	11	75
6	45	8	53
7	26	2	28
8	15	2	17
9	12	1	13
10	8		8
Total	436	202	660
Average/ CRF	3.379845	1.565891	5.12

Discussion

During the meeting with the lead SO and data manager, we were able to propose plans for future data collection and entry. A major point of emphasis is reeducation for both SOs and the data entry managers on how to utilize hospital ID and lab ID codes. The audit showed that 57 (44%) of the forms had at least one of the hospital types coded incorrectly. To remedy this, the database analyst who created the hospital ID sheet will attend a future SO meeting and walk through how to correctly identify hospitals. Another needed area of restructuring is the standardization of questions answered. Not all SOs fill out every question, and not every question needs to be filled out. For instance, when checking off symptoms of infection, SOs are only supposed to choose bacteremia without focus if no other symptom applies. However, few officers still chose this option along with other symptoms. When this happened previously, the data manager would omit bacteremia and only enter the other symptoms. However, to increase the quality of the CFR, the sheet will now be sent back to the SO to be corrected through the proper channels. This increases the integrity of the data, and helps to reeducate the officers. Finally, there were certain areas such as the name of the surveillance officer and the date submitted for entry that were routinely answered but not entered into the database. The rationale behind this was that the CDC does not collect those fields. However, because the site is moving towards paperless data, frequent audits, and increasing in-house analyses, these fields are important and should be both filled out and entered.

Table 2.2 Common Errors found on 2015 Active Bacterial Core surveillance Case Report Forms

Field	Errors	% of CRFs
Patient Information	66	51.2
Hospital ID	39	30.2
Lab ID	26	20.2
Treatment ID	40	31
Pregnancy Status	40	31
Symptoms	37	28.7
Underlying Conditions	33	25.6
Submitted By	81	62.8
Date	85	65.9

The database interface is easy to understand and use. Reports can be pulled by year, audit status, error type and question where the error was on, and more. For future use, there should be a third choice for error type- Blank CRF Field. There are a few questions that surveillance officers leave blank when reporting, but are needed for CDC purposes. This information is entered by the data manager but not annotated onto the hard copy of the CRF. I found that this type of omission does not necessarily fit in the definition of an omitted error, and believe it

would beneficial to create a category specifically for it. This problem arises because, per protocol, the data manager is not supposed to add or change any part of the case report form.

The 2015 database audit was a very insightful look into how data is cleaned and kept accurate. Through this process we were able to reach a consensus on important changes that can take place to increase the accuracy and precision of the ABCs data.

Chapter 3 - Socioeconomic Disparities and Late Onset Group B *Streptococcus* in Tennessee, 2010-2014

Introduction

Since its emergence in the 1970's, Group B *Streptococcus* (GBS) has been the leading cause of neonatal sepsis. *Streptococcus agalactiae* is a gram-positive bacterium that inhabits the gastrointestinal tract of humans and has a secondary colonization site in the urogenital tract. GBS can cause invasive disease in infants, pregnant or post-partum women, and elderly adults, with the highest incidence of disease being in neonates younger than 3 months. Within this neonatal age group there are two classifications of GBS disease, early onset (EO) and late onset (LO). Early onset, which is a result of vertical transmission, occurs in infants less than seven days old and late onset, which can be acquired from the mother or environmental sources, occurs between days seven and 89. Infant infection with primarily causes sepsis, pneumonia, and meningitis, but can also cause focal infection including osteomyelitis, septic arthritis, and cellulitis (Gibbs, Schrag, & Schuchat, 2004). Additionally, the development of meningitis can result in long-term neurologic sequelae.

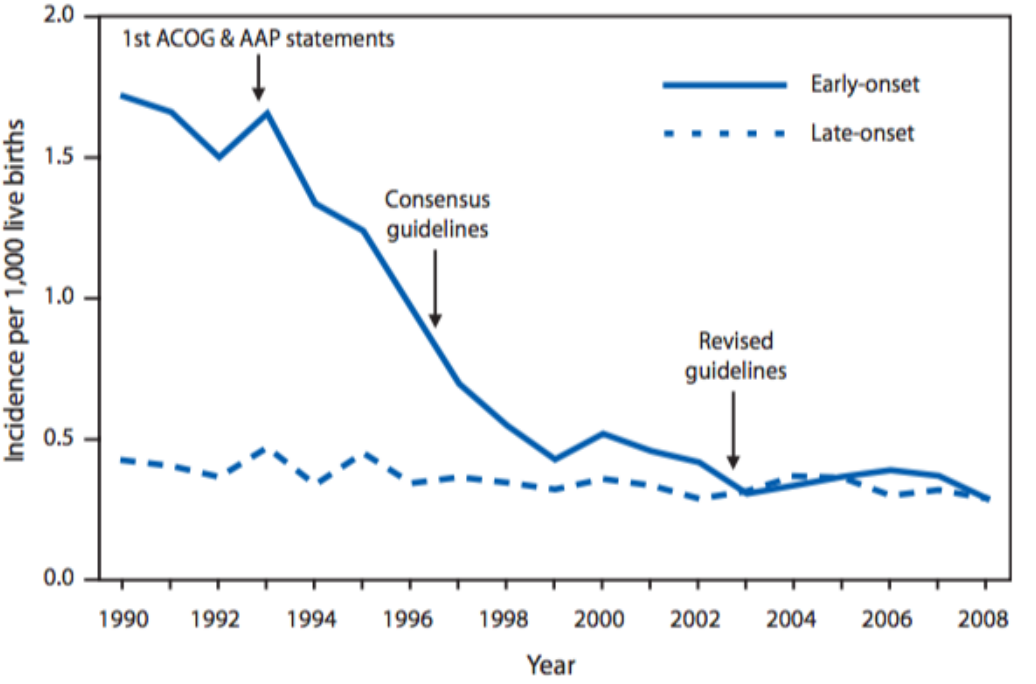
Risk factors for EO GBS have been well described (Gibbs et al., 2004) (Schuchat et al., 1990). Factors that contribute to the development of neonatal disease encompass maternal colonization of GBS in the urogenital tract, prolonged rupture of membranes, preterm delivery, GBS bacteriuria during pregnancy, birth of a previous child with GBS disease, maternal chorioamnionitis, young maternal age, African American race, Hispanic ethnicity, and low levels of GBS antigen specific antibodies. Less is known about the risk factors of LO GBS disease. Currently, it is thought that male sex, black race, maternal colonization, having a twin with LO GBS, and extreme prematurity are associated with an increased risk of disease (Le Doare & Heath, 2013).

Studies have shown that intrapartum prophylaxis (IPP) with penicillin is the best method for preventing EO disease and maternal illness from GBS (Centers for Disease Control, 1996). In 1992, the American Academy of Pediatrics (AAP) and the American College of Obstetricians and Gynecologists (ACOG) each released documents on GBS prevention in newborns. The AAP recommended that women who tested positive for GBS through prenatal cultures at or after 37

weeks and exhibited one of the following signs be treated with IPP: rupture of membranes >12 hours prior to delivery, preterm labor or membrane rupture (<37 weeks gestation), intrapartum fever (>99.5° F), a multiple gestation pregnancy, or had a previous delivery of an infant with GBS disease. The ACOG, however, supported a risk factor based approach in which all women with one or more risk factors would receive IPP. These factors included preterm labor (<37 weeks gestation), premature rupture of membranes (<37 weeks gestation), prolonged rupture of membrane (>18 hours before delivery), previous child affected by symptomatic GBS infection, or maternal fever during labor. These two views were echoed in the CDC's 1996 MMWR publication of "Prevention of Perinatal Group B Streptococcal Disease: A Public Health Perspective" and adhering to either guideline was acceptable (Centers for Disease Control， 1996). The incidence prior to these guidelines (early 1990's) was 1.7 per 1,000 live births for early onset GBS and approximately 0.4 per 1,000 live births for late onset GBS (Verani et al., 2010). After implementation of the guidelines, the incidence rate of EO GBS had decreased by 70% to 0.5 cases per 1,000 live births in 1999. However, the rate of LO remained stable (Schrag, Gorwitz, Fultz-Butts, & Schuchat, 2002).

In 2002, the CDC released a revision to the 1996 guidelines. This major revision supported the move to a unified universal prenatal screening strategy in which *all* pregnant women would be screened for GBS colonization between 35 and 37 weeks of gestation, unless a woman presents with bacteriuria or had a previous infant with invasive GBS disease. Intrapartum prophylaxis was indicated in women who had a previous infant with invasive GBS disease, GBS bacteriuria during her current pregnancy, a positive GBS screening culture during the current pregnancy- unless a planned cesarean section was performed in the absence of labor and the rupture of membrane, unknown GBS status, and any of the following- delivery at <37 weeks gestation, amniotic membrane rupture $\geq$18 hours, or an intrapartum temperature of $\geq$100.4° F (Schrag et al., 2002). A woman would not be treated with IPP if she did not test positive for GBS, even if she exhibited other risk factors. After these guidelines were implemented, the incidence of EO dropped further to 0.34 – 0.37 cases per 1,000 live births and LO stayed level at 0.32 cases per 1,000 live births (Berardi et al., 2013). Figure 3.1 shows how the incidence of early- and late- onset GBS changed from 1990-2008 in the Active Bacterial Core Surveillance areas.

The guidelines that are currently in place were published in 2010. Minor revisions took place in all of the following areas: identification of candidates for IPP, specimen collection and processing, antibiotic dosing, and newborn management. In 2014, the incidence of early onset GBS was estimated to be 0.24 cases per 1,000 live births (Centers for Disease & Prevention, 2016). Again, the incidence for late onset has remained fairly stable.



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.

Figure 3.1: Incidence of early- and late- onset GBS in the Active Bacterial Core Surveillance catchment area from 1990-2008. Image from Verani, et. al., 2010.

With the proportion of late onset GBS cases increasing from approximately 25% of total neonatal GBS cases in 1990 to 50% today, it is important to elucidate the pathogenesis and source of infection for LO GBS. Because it is not transmitted vertically, IPP treatment has no effect on the rates of infection. Instead, it is pertinent to understand the risk factors of late onset GBS more fully so that improved education and policy can be implemented to decrease these

rates. A prospective cohort study conducted from 2003-2010 found that preterm neonates had the highest rates of late onset GBS and the highest mortality. In addition, they found that most mothers carried GBS during the time of LO diagnosis and that IPP was associated with delayed presentation of symptoms (Berardi et al., 2013).

We utilized 2010-2014 ABCs late onset group B *Streptococcus* data to analyze socioeconomic disparities within middle Tennessee cases from 2010-2014. Our analysis aims to explore the socioeconomic status of late onset GBS cases in hopes to guide future studies in identifying new risk factors. This work will also be presented at the Society of Clinical Research Associates annual conference in October 2016.

Objective

The objective of this project was to evaluate data to assess risk factors for LO GBS. This is to serve as a pilot for a larger, more in depth study on the assessment of socioeconomic disparities and other risk factors associated with the development of late onset group B Strep infections in Tennessee and other EIP locations. This project will probe into risk factors for GBS to inform future policy and education.

Methods

Data Collection

Data provided by the TN EIP was analyzed for socioeconomic trends. Group B *Streptococcus* data is collected along with data from other invasive pathogens as part of the Active Bacterial Core surveillance program. The surveillance area encompasses 20 urban counties within Tennessee, which totals 3.95 million people and includes 60% of the state's population. Case ascertainment is active-, laboratory-, and population based. Surveillance officers (SO) receive reports on cases from hospital labs, diagnostic labs, and hospital infection prevention staff. Once received, the SO determines if the event meets the case definition as follows: isolation of GBS

from a normally sterile site in a resident of the surveillance catchment area. Normally sterile sites include, but are not limited to, blood, cerebrospinal fluid, pleural fluid, pericardial fluid, bone, joint fluid, and internal body sites (lymph node, brain, heart, liver, spleen, vitreous fluid, kidney, pancreas, ovary, or vascular tissue). SOs collect pertinent medical information on confirmed cases through medical report review and completion of a standardized case report form. For GBS cases, there is an additional form called the Neonatal Expanded Form, which collects data specifically pertaining to GBS risk factors. A copy of the CRF and Neonatal Expanded form located in Appendix A and Appendix B, respectively. Over the course of 2010-2014, 111 cases of GBS in children aged 7-89 days (late onset) were identified in the Tennessee surveillance area. To be included in the analysis, a case needed both the main CRF and an expanded neonatal form completed. Figure 3.2 illustrates the guidelines utilized to narrow 5 years of ABCs data down to the 111 cases utilized in these analyses. Throughout my field experience, I was able to shadow and assist SOs in the completion of CRFs in both Nashville and Knoxville; however, I was not able to collect information on a neonatal GBS case.

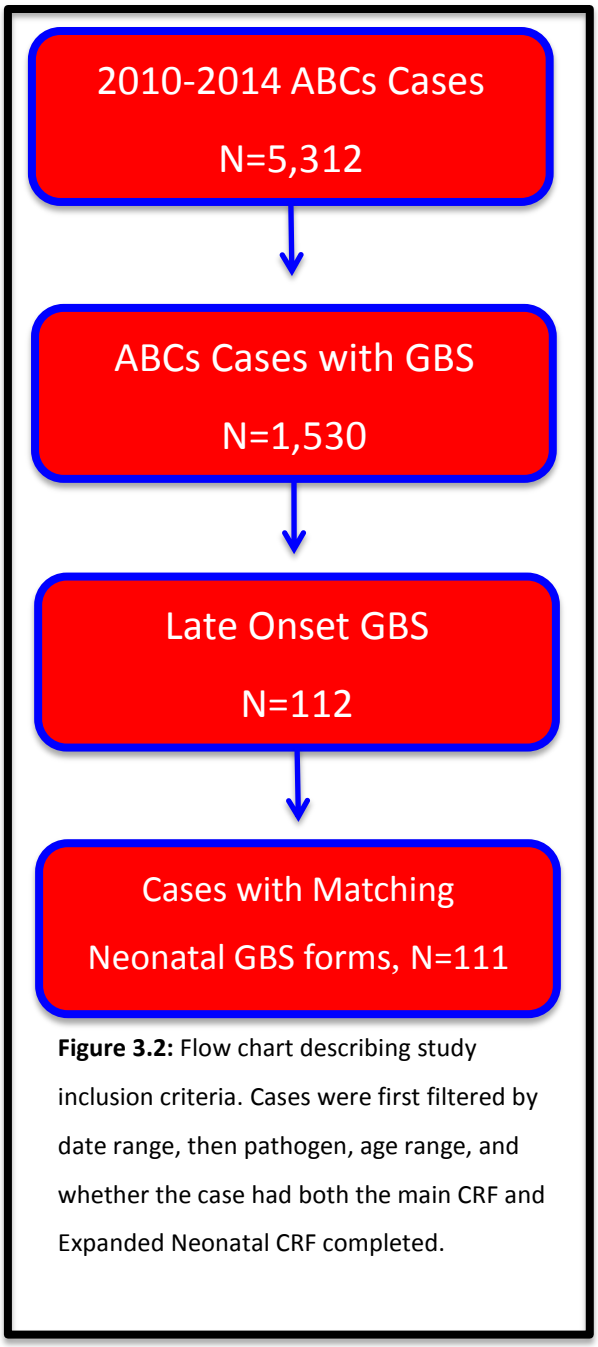


Figure 3.2: Flow chart describing study inclusion criteria. Cases were first filtered by date range, then pathogen, age range, and whether the case had both the main CRF and Expanded Neonatal CRF completed.

Data Analysis

To obtain neighborhood level information, each case was geocoded according to the patient's place of residence at the time of culture analysis. Using ArcGIS software, ArcMap, each case was assigned to a census tract. Census tract data were then merged with population information from the US Census Bureau's American Community Survey (ACS). The ACS is an ongoing survey that provides annual information about the nation and communities; the data used in this study was aggregated over five years (2010-2014), and values for socioeconomic indicators were extracted for use. Of the 111 LO GBS cases, 69 were successfully geocoded to the roof-top level, 38 were at street address level, and two were at street level. According to ArcGIS, street address level represents and interpolated location along a street given the house number within a house range and street name level uses only the street name with no house or group of houses pinpointed. Two of the cases could only be geocoded to postal code level and were, therefore, excluded from neighborhood level rates.

Table 3.1: Cases of Late Onset Group B *Streptococcus* by county from 2010-2014.

2010-2014 Tennessee Case Counts		
County	Cases	Percentage of total Cases
Anderson	1	0.90
Bledsoe	0	0.00
Cheatham	2	1.80
Davidson	21	18.92
Dickson	1	0.90
Grainger	0	0.00
Hamilton	8	7.21
Jefferson	3	2.70
Knox	10	9.01
Loudon	0	0.00
Madison	4	3.60
Roane	1	0.90
Robertson	2	1.80
Rutherford	5	4.50
Severir	1	0.90
Shelby	45	40.54
Sumner	3	2.70
Unicoi	0	0.00
Williamson	4	3.60
Wilson	0	0.00
Total	**111**	**100.00**

We calculated crude average annual incidence (IR) rates of LO GBS in Tennessee per 10,000 population during the 5-year period. This was done using yearly live birth data as a denominator for individual level characteristics (gender, race) and census tract population data of children less than five years of age for neighborhood level characteristics (population density, percent below poverty level, percent college educated, percent employed, and the percent of population with a female head of household). College educated was defined as someone who was 25 years and over that completed at least some college education, and a female head of household was defined as children/ population under the age of 18 years in households with a female head of household and no husband present. Age

standardization was not possible due to the small age range designated for the disease (7-89 days old). We also calculated the rate ratio (RR) and rate difference (RD) for each variable. Rate ratio and rate difference are defined below. Rate ratio is defined as the incidence rate of disease in the exposed group divided by the incidence rate of disease in the unexposed, or reference, group, and the rate difference is defined as the incidence rate of disease in the exposed group less the incidence rate of disease in the reference group. Analyses were performed using SAS 9.4 and Excel.

Results

From 2010 through 2014 there were 111 cases of LO GBS in the Tennessee surveillance area. Twenty-four of the cases occurred in 2010, 21 cases in 2011, 25 cases in 2013, and 22 cases in 2014. The overall crude incidence rate was 4.41 cases per 10,000 population. The number of cases per county in the catchment area is shown in Table 3.1. Shelby (Memphis) and Davidson (Nashville) Counties had the highest counts of LO GBS with 45 and 21, respectively. Frequency data showed that there is a proportionally high number of children with Medicaid assistance as opposed to private or other types of insurance. In addition, the data revealed that as the age of the mother increased, the number of GBS cases decreased. The mother's age group that had the highest amount of cases was 16-20 with one-third of the cases. Figure 3.3 shows the breakdown of cases by insurance type, mother's age at birth, gestational age at birth, birth weight, type of delivery, and whether the neonate was fed breast milk. Each of these variables have been proposed as risk factors for LO GBS. The risk factors presented in red are associated with lower socioeconomic status.

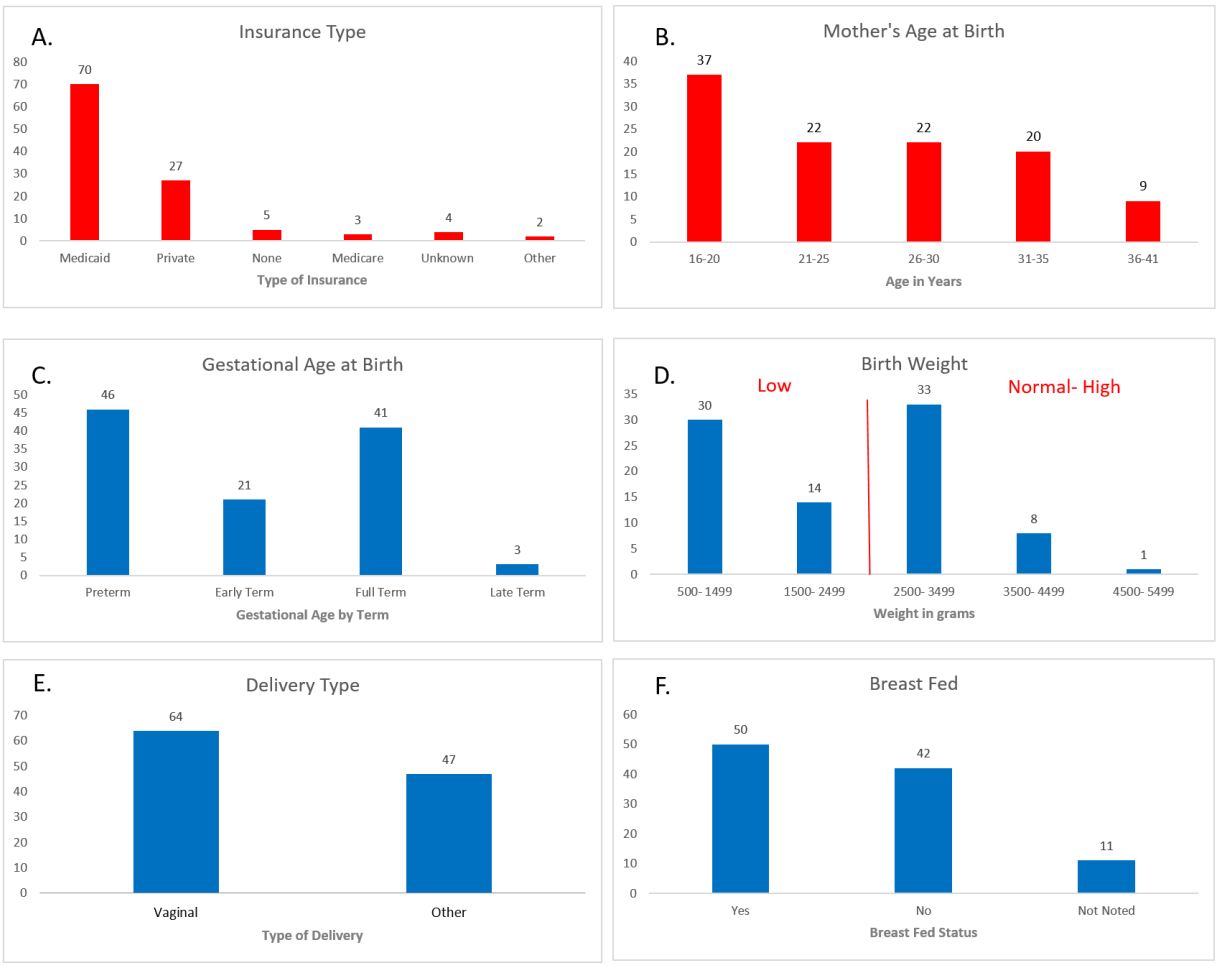


Figure 3.3: The breakdown of insurance type (A), Mother's age at birth (B), gestational age at birth where (C), Birth weight in grams (D), type of delivery E, and whether or not the neonate was fed breastmilk (F) for Late onset Group B *Streptococcus* cases in Tennessee from 2010-2014.

For individual level socioeconomic data, the incidence rates for both male and female neonates were similar at 4.34 (95% CI = 3.2-5.65) and 4.47 (95% CI = 3.73-5.31) per 10,000 population, respectively. The incidence in black neonates (8.82 per 10,000 population, 95% CI = 7.38-10.27) was higher than in white (2.45/10,000 population, 95% CI = 1.63-3.27). Table 3.2 shows the individual and neighborhood level characteristics featured in this project. As shown within the table, incidence rates did not vary numerically within each neighborhood level variable. The lowest incidence of disease was found in areas with ≥700 people per square mile (urban demographic) with 4.76 cases per 10,000 population (95% CI = 0.7-8.82), and the highest was found in areas with 200-699 people per square mile (suburban) with an incidence of 7.15 cases per population (95% CI = 5.21-9.09). For people living below poverty the incidence rates

ranged from 5.99 per 10,000 population (95% CI = 3.82- 8.15) in areas where 10.0-19.9 percent of people lived below poverty level to 6.96 per 10,000 population (95% CI = 6.28-7.64) in areas where ≥20 percent of the population lived below poverty level. The rate ratio for the two categories of percent of population employed was 0.85 (95% CI = 0.57-1.27). The higher of the two rates occurred in the category where <50% of people were employed with 6.93 cases per 10,000 population (95% CI = 6.52-7.33), and the lower rate was 5.88 per 10,000 population (95% CI = 3.18-8.58) where 50-65.9% of the population was employed. This would support the idea that living in a population with a higher percentage of people employed would be protective against LO GBS. For percent of population with a female head of household, the highest rate ratio was 1.17 (95% CI (0.57-1.88). The reference for this was <20 percent of the population with female heads of household and the comparison was with census tracts that had 20-39.9% female heads of household. While the vast majority of cases belong to a category where greater than 40% of the population received a college education, the incidence was actually the lowest with 6.33 (95% CI = 5.63-7.04) per 10,000 per population. This is in comparison to 7.63 (95% CI = 0-16.8) and 7.43 (95% CI = 4.93-9.73) per 10,000 population for 15-24.9 percent and 25-39.9 percent receiving a college education, respectively.

Table 3.2: Average annual incidence rates, relative rates, and rate differences of late onset group B *Streptococcus* in Tennessee from 2010-2014.

Characteristic	Cases, no.(%)	Incidence*	95%CI	Rate Ratio	95% CI	Rate Diff.	95%CI
Individual-level Data	Total N=111						
Sex							
M	56 (50.45)	4.34	(3.2-5.65)	Ref		Ref	
F	55 (49.55)	4.47	(3.73-5.31)	1.03	(0.71-1.49)	0.13	(-1.23-1.36)
Race							
White	42 (37.8)	2.45	(1.63-3.27)	Ref		Ref	
Black	63 (57.8)	8.82	(7.38-10.27)	3.64	(2.47-5.38)	6.37	(4.71-8.03)
Other	6 (5.4)	6.58	(2.5-10.67)	2.69	(1.14-6.28)	4.13	(-.05-8.31)
Neighborhood-Level Data	Total N=109						
% Below Poverty							
<5.0	12 (11.01)	6.21	(1.79-10.64)	Ref		Ref	
5.0-9.9	20 (18.35)	6.44	(3.80-9.08)	1.04	(0.51-2.12)	0.23	(-4.92-5.39)
10.0-19.9	22 (20.18)	5.99	(3.82-8.15)	0.96	(0.48-1.94)	-0.22	(-4.89-4.47)
≥20	55 (50.46)	6.96	(6.28-7.64)	1.12	(0.77-1.63)	0.75	(-4.17-5.67)
% College Educated							
15.0-24.9	2 (1.83)	7.63	(0-16.8)	Ref		Ref	
25.0-39.9	25 (22.94)	7.34	(4.93-9.74)	0.96	(0.23-4.05)	-0.29	(-9.77-9.19)
≥40	82 (75.23)	6.33	(5.63-7.04)	0.83	(0.56-1.33)	-1.3	(-10.50-7.90)
%Employed							
<50	75(68.8)	6.93	(6.52-7.33)	Ref		Ref	
50.0-65.9	34(31.2)	5.88	(3.18-8.58)	0.85	(0.57-1.27)	-1.05	(-3.78-1.68)
≥66	0 (0)	-	-	-		-	
%Female HH							
<20.0	21 (19.23)	5.96	(3.57-8.36)	Ref		Ref	
20.0-39.9	34 (31.19)	6.95	(4.09-9.81)	1.17	(0.68-2.00)	0.99	(-2.74-4.72)
40.0-59.9	22 (20.18)	6.31	(4.72-7.9)	1.06	(0.57-1.88)	0.35	(-2.52-3.23)
≥60.0	32 (29.36)	6.91	(6.06-7.75)	1.16	(0.67-2.00)	0.95	(-1.59-3.49)
Population Density							
0-<200	39 (35.78)	6.848	(5.09-8.60)	Ref		Ref	
200-699	54 (49.54)	7.149	(5.21-9.09)	1.04	(0.69-1.57)	0.301	(-2.31-2.92)
≥700	16 (14.68)	4.76	(0.7-8.82)	0.70	(0.29-1.24)	-2.088	(-6.51-2.33)

*per 10,000 population

Discussion

Despite prevention efforts, late onset group B *Streptococcal* incidence rates have remained stable since the 1970's when it, along with early onset GBS, emerged as the leading cause of neonatal sepsis. Consequently, with the decrease in EO GBS incidence rate, the proportion of late onset to early onset cases has risen. Therefore, it is important to elucidate the risk factors of LO GBS to lower the incidence rate. Having a better understanding of the risk factors for this disease will help to increase education and better inform policy which can work

to lower the incidence. This project was a preliminary step to a larger data analyses to address this problem.

We chose the abbreviated time period of 2010-2014 for three reasons. First, the CDC guidelines changed in 2010 and we did not want to compare across guidelines. Another change that happened in 2010 was an increase in surveillance population for the ABCs. We started this project intending to use 2015 data, but unfortunately, the Tennessee Department of Health had to delay the release of live birth data from the beginning of May to the beginning of August.

To help decide what risk factors to study, case counts and frequency data were assessed for different characteristics. From this, we found that there was a higher proportion of black neonates, young mothers, and Medicaid recipients with LO GBS in our sample. This indicated that lower socioeconomic status could be a risk factor for the development of LO GBS. One of the few known risk factors for LO GBS is being of black race. This was confirmed in our study with the IR in black neonates being 3.64 (95% CI = 2.47-5.38) times higher than in white neonates.

One interesting phenomenon in our data is that 82 (75%) of the cases occurred in a population where greater than 40% of the population is college educated; yet 75 (68.8%) of the cases resided in an area where less than 50% are employed. While minute, an increasing trend in incidence rates is demonstrated as the percent of population living below poverty increases. The rate ratio of $\geq$20% of the population compared to the reference of <5.0% is 1.12 (95% CI = 0.77-1.63). This indicates that high poverty has 1.12 times higher rate of LO GBS than low poverty.

Because of the small sample size, a risk factor analysis was not carried out within this project. Instead, we chose to focus on descriptive statistics. Another limitation of this study is that the variables were assessed independently and their relationship was not taken into account.

With a low average national incidence level of 0.28 cases per 1,000 live births, I would recommend conducting a retrospective case-control study in the future (Centers for Disease Control, 2014). To gain enough power, the study should utilize data from all 10 EIP sites starting from 2010. For the control population, the EIP has access to outpatient data, and I would match on age, time, and county and set a ratio of four controls per one LO GBS case. The controls would be selected based on illnesses that do not include infections, possibly acute conditions like gastrointestinal upset. Because the study would be based off of secondary data, I would probe into the same readily available factors that were investigated in this study with the addition of

insurance type (Medicaid, private, other). To analyze the data, I would utilize a logistic regression, compare odds ratios and test for statistical significance between baseline and models that incorporate our measures of socioeconomic disparities

Currently, there is very limited knowledge regarding risk factors of LO GBS. The aim of our study was to analyze Tennessee's data in hopes to elucidate socioeconomic disparities within LO GBS cases. However, this analysis provided an insight into the limitations of the small number of Tennessee's cases, and, instead, can serve as a pilot for a larger, EIP wide study of LO GBS.

Chapter 4 - Conclusion

My field experience at the Tennessee Emerging Infections Program gave me a great insight into how population surveillance is conducted. During this experience, I learned many difference facets of collection, management, and maintenance of databases. On my first day with the program, I was able to attend an annual CDC Flu team site visit, which provided me an extensive introduction, not only to Flu-Surv, but also to all sections of the program. It was very interesting to see how much of a collaborative spirit there is in the CDC/EIP site relationship. In addition to a federal level perspective, I was also able to shadow at the state level and attend surveillance meetings with state and local public health agents. Towards the end of my field experience, my role changed from listening in meetings to leading them. For both of my projects and the Flu-Surv poster, I was leading small group meetings to discuss progress and future directions.

The database audit project taught me how to create a functional database. I also learned how to conduct quality control of datasets, which is extremely important for obtaining clean and accurate data. However, I believe the most important revelation to me during the database audit was that each of the numbers shown in a table corresponds to real a person. I spent many hours exploring case report forms, and I was shaken up every time I read about a person not surviving an infection. Prior to this, it was very easy to overlook the fact that these data points are people who have experienced one of these diseases.

My LO GBS work primarily functioned to set the EIP site up for larger future. This enabled us to visualize the raw data and what types of questions could be answered from it. Through this project, I learned how to clean and present summarized data for reports, work in SAS 9.4, and apply measures such as incidence rates. The TN EIP site plans to propose a study utilizing data from all 10 sites. Future studies on the risk factors for this disease will hopefully guide policy and provide education that can lead to a decrease in the incidence of LO GBS.

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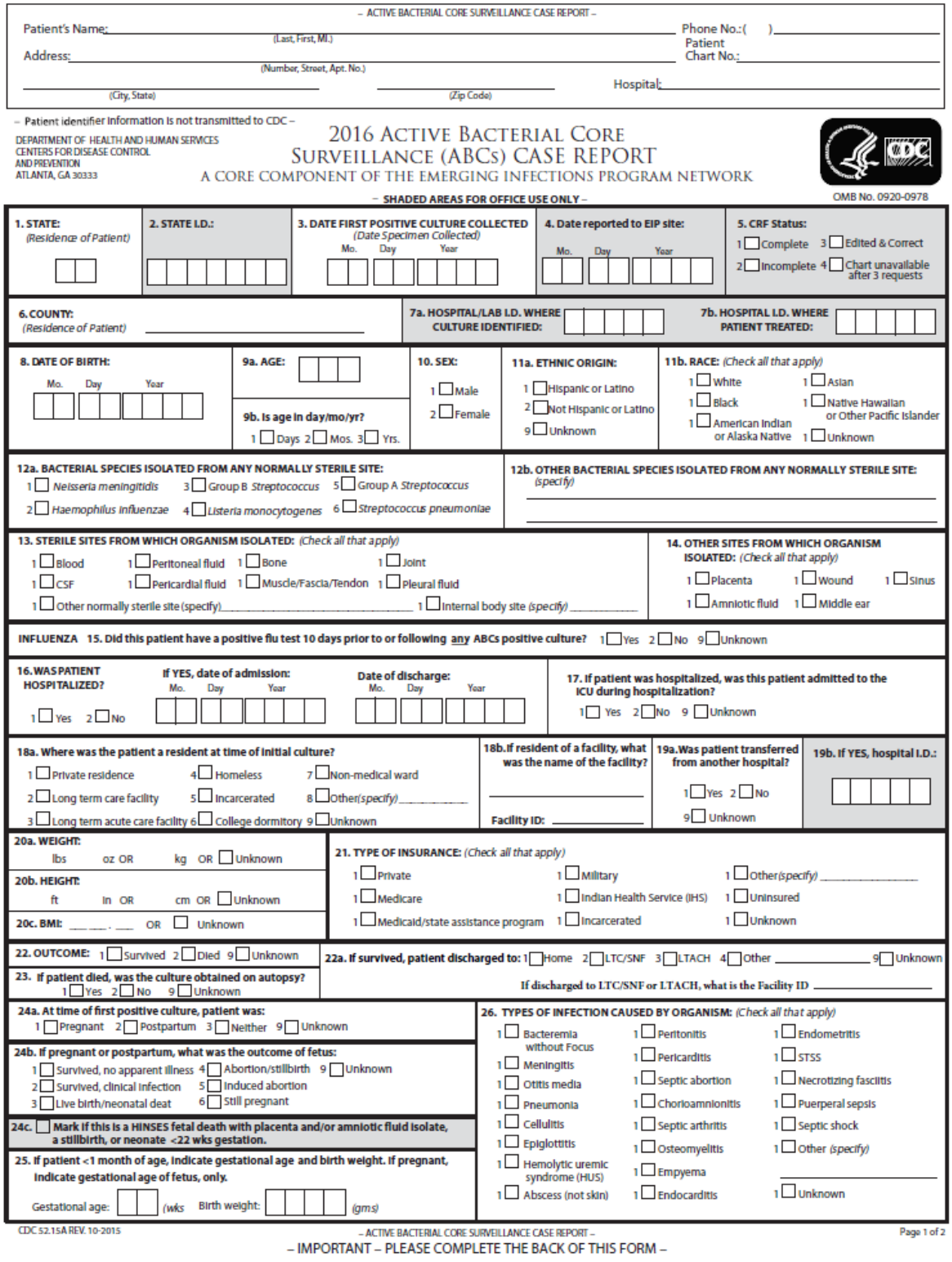
Appendix

Appendix A: Active Bacterial Core Surveillance Sample Case Report Form



– ACTIVE BACTERIAL CORE SURVEILLANCE CASE REPORT –

Patient's Name: _____ (Last, First, MI.) Phone No.:( ) _____

Address: _____ (Number, Street, Apt. No.) Patient Chart No.: _____

_____ (City, State) _____ (Zip Code) Hospital: _____

– Patient identifier information is not transmitted to CDC –

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION
ATLANTA, GA 30333

2016 ACTIVE BACTERIAL CORE SURVEILLANCE (ABCs) CASE REPORT

A CORE COMPONENT OF THE EMERGING INFECTIONS PROGRAM NETWORK

OMB No. 0920-0978

– SHADED AREAS FOR OFFICE USE ONLY –

1. STATE: *(Residence of Patient)* ☐☐

2. STATE I.D.: ☐☐☐☐☐☐

3. DATE FIRST POSITIVE CULTURE COLLECTED *(Date Specimen Collected)* Mo. ☐☐ Day ☐☐ Year ☐☐☐☐

4. Date reported to EIP site: Mo. ☐☐ Day ☐☐ Year ☐☐☐☐

5. CRF Status: 1 ☐ Complete 2 ☐ Incomplete 3 ☐ Edited & Correct 4 ☐ Chart unavailable after 3 requests

6. COUNTY: *(Residence of Patient)* _____

7a. HOSPITAL/LAB I.D. WHERE CULTURE IDENTIFIED: ☐☐☐☐☐

7b. HOSPITAL I.D. WHERE PATIENT TREATED: ☐☐☐☐☐

8. DATE OF BIRTH: Mo. ☐☐ Day ☐☐ Year ☐☐☐☐

9a. AGE: ☐☐☐

9b. Is age in day/mo/yr? 1 ☐ Days 2 ☐ Mos. 3 ☐ Yrs.

10. SEX: 1 ☐ Male 2 ☐ Female

11a. ETHNIC ORIGIN: 1 ☐ Hispanic or Latino 2 ☐ Not Hispanic or Latino 9 ☐ Unknown

11b. RACE: *(Check all that apply)* 1 ☐ White 1 ☐ Black 1 ☐ American Indian or Alaska Native 1 ☐ Asian 1 ☐ Native Hawaiian or Other Pacific Islander 1 ☐ Unknown

12a. BACTERIAL SPECIES ISOLATED FROM ANY NORMALLY STERILE SITE:
1 ☐ *Neisseria meningitidis* 3 ☐ Group B *Streptococcus* 5 ☐ Group A *Streptococcus*
2 ☐ *Haemophilus influenzae* 4 ☐ *Listeria monocytogenes* 6 ☐ *Streptococcus pneumoniae*

12b. OTHER BACTERIAL SPECIES ISOLATED FROM ANY NORMALLY STERILE SITE: *(specify)* _____

13. STERILE SITES FROM WHICH ORGANISM ISOLATED: *(Check all that apply)*
1 ☐ Blood 1 ☐ Peritoneal fluid 1 ☐ Bone 1 ☐ Joint
1 ☐ CSF 1 ☐ Pericardial fluid 1 ☐ Muscle/Fascia/Tendon 1 ☐ Pleural fluid
1 ☐ Other normally sterile site (specify) _____ 1 ☐ Internal body site *(specify)* _____

14. OTHER SITES FROM WHICH ORGANISM ISOLATED: *(Check all that apply)*
1 ☐ Placenta 1 ☐ Wound 1 ☐ Sinus
1 ☐ Amniotic fluid 1 ☐ Middle ear

INFLUENZA 15. Did this patient have a positive flu test 10 days prior to or following any ABCs positive culture? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown

16. WAS PATIENT HOSPITALIZED? 1 ☐ Yes 2 ☐ No
If YES, date of admission: Mo. ☐☐ Day ☐☐ Year ☐☐☐☐
Date of discharge: Mo. ☐☐ Day ☐☐ Year ☐☐☐☐

17. If patient was hospitalized, was this patient admitted to the ICU during hospitalization? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown

18a. Where was the patient a resident at time of initial culture?
1 ☐ Private residence 4 ☐ Homeless 7 ☐ Non-medical ward
2 ☐ Long term care facility 5 ☐ Incarcerated 8 ☐ Other *(specify)* _____
3 ☐ Long term acute care facility 6 ☐ College dormitory 9 ☐ Unknown

18b. If resident of a facility, what was the name of the facility? _____
Facility ID: _____

19a. Was patient transferred from another hospital? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown

19b. If YES, hospital I.D.: ☐☐☐☐☐

20a. WEIGHT: lbs oz OR kg OR ☐ Unknown

20b. HEIGHT: ft in OR cm OR ☐ Unknown

20c. BMI: ___.___ OR ☐ Unknown

21. TYPE OF INSURANCE: *(Check all that apply)*
1 ☐ Private 1 ☐ Military 1 ☐ Other *(specify)* _____
1 ☐ Medicare 1 ☐ Indian Health Service (IHS) 1 ☐ Uninsured
1 ☐ Medicaid/state assistance program 1 ☐ Incarcerated 1 ☐ Unknown

22. OUTCOME: 1 ☐ Survived 2 ☐ Died 9 ☐ Unknown

22a. If survived, patient discharged to: 1 ☐ Home 2 ☐ LTC/SNF 3 ☐ LTACH 4 ☐ Other _____ 9 ☐ Unknown
If discharged to LTC/SNF or LTACH, what is the Facility ID _____

23. If patient died, was the culture obtained on autopsy? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown

24a. At time of first positive culture, patient was: 1 ☐ Pregnant 2 ☐ Postpartum 3 ☐ Neither 9 ☐ Unknown

24b. If pregnant or postpartum, what was the outcome of fetus:
1 ☐ Survived, no apparent illness 4 ☐ Abortion/stillbirth 9 ☐ Unknown
2 ☐ Survived, clinical infection 5 ☐ Induced abortion
3 ☐ Live birth/neonatal deat 6 ☐ Still pregnant

24c. ☐ Mark if this is a HINSES fetal death with placenta and/or amniotic fluid isolate, a stillbirth, or neonate <22 wks gestation.

25. If patient <1 month of age, indicate gestational age and birth weight. If pregnant, indicate gestational age of fetus, only.
Gestational age: ☐☐ *(wks* Birth weight: ☐☐☐☐ *(gms)*

26. TYPES OF INFECTION CAUSED BY ORGANISM: *(Check all that apply)*
1 ☐ Bacteremia without Focus
1 ☐ Meningitis
1 ☐ Otitis media
1 ☐ Pneumonia
1 ☐ Cellulitis
1 ☐ Epiglottitis
1 ☐ Hemolytic uremic syndrome (HUS)
1 ☐ Abscess (not skin)
1 ☐ Peritonitis
1 ☐ Pericarditis
1 ☐ Septic abortion
1 ☐ Chorioamnionitis
1 ☐ Septic arthritis
1 ☐ Osteomyelitis
1 ☐ Empyema
1 ☐ Endocarditis
1 ☐ Endometritis
1 ☐ STSS
1 ☐ Necrotizing fasciitis
1 ☐ Puerperal sepsis
1 ☐ Septic shock
1 ☐ Other *(specify)* _____
1 ☐ Unknown

CDC 52.15A REV. 10-2015 – ACTIVE BACTERIAL CORE SURVEILLANCE CASE REPORT – Page 1 of 2

– IMPORTANT – PLEASE COMPLETE THE BACK OF THIS FORM –

27. UNDERLYING CAUSES OR PRIOR ILLNESSES: *(Check all that apply OR if NONE or CHART UNAVAILABLE, check appropriate box)* 1 ☐ None 1 ☐ Unknown

- 1 ☐ AIDS or CD4 count <200
- 1 ☐ Alcohol Abuse, Current
- 1 ☐ Alcohol Abuse, Past
- 1 ☐ Asthma
- 1 ☐ Atherosclerotic Cardiovascular Disease (ASCVD)/CAD
- 1 ☐ Bone Marrow Transplant (BMT)
- 1 ☐ Cerebral Vascular Accident (CVA)/Stroke/TIA
- 1 ☐ Chronic Kidney Disease
- 1 ☐ Chronic Liver Disease/cirrhosis
- 1 ☐ Current Chronic Dialysis
- 1 ☐ Chronic Skin Breakdown
- 1 ☐ Cochlear Implant
- 1 ☐ Complement Deficiency
- 1 ☐ Connective Tissue Disease (Lupus, etc.)
- 1 ☐ CSF Leak
- 1 ☐ Deaf/Profound Hearing Loss
- 1 ☐ Dementia
- 1 ☐ Diabetes Mellitus
- 1 ☐ Emphysema/COPD
- 1 ☐ Heart Failure/CHF
- 1 ☐ HIV Infection
- 1 ☐ Hodgkin's Disease/Lymphoma
- 1 ☐ Immunoglobulin Deficiency
- 1 ☐ Immunosuppressive Therapy (Steroids, Chemotherapy, Radiation)
- 1 ☐ IVDU, Current
- 1 ☐ IVDU, Past
- 1 ☐ Leukemia
- 1 ☐ Multiple Myeloma
- 1 ☐ Multiple Sclerosis
- 1 ☐ Myocardial Infarction
- 1 ☐ Nephrotic Syndrome
- 1 ☐ Neuromuscular Disorder
- 1 ☐ Obesity
- 1 ☐ Other Drug Use, Current
- 1 ☐ Other Drug Use, Past
- 1 ☐ Parkinson's Disease
- 1 ☐ Peptic Ulcer Disease
- 1 ☐ Peripheral Neuropathy
- 1 ☐ Peripheral Vascular Disease
- 1 ☐ Plegias/Paralysis
- 1 ☐ Premature Birth (specify gestational age at birth) ☐☐ (wks)
- 1 ☐ Seizure/Seizure Disorder
- 1 ☐ Sickle Cell Anemia
- 1 ☐ Smoker (current)
- 1 ☐ Solid Organ Malignancy
- 1 ☐ Solid Organ Transplant
- 1 ☐ Splenectomy/Asplenia
- 1 ☐ Other prior illness (specify): _____

– IMPORTANT – PLEASE COMPLETE FOR THE RELEVANT ORGANISM –

HAEMOPHILUS INFLUENZAE

28a. What was the serotype? 1 ☐ b 2 ☐ Not Typeable 3 ☐ a 4 ☐ c 5 ☐ d 6 ☐ e 7 ☐ f 8 ☐ Other *(specify)* _____ 9 ☐ Not Tested or Unknown

28b. If <15 years of age and serotype 'b' or 'unknown' did patient receive *Haemophilus Influenzae* b vaccine? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown **If YES, please complete the list below.**

DOSE	DATE GIVEN Mo.	Day	Year	VACCINE NAME	MANUFACTURER	LOT NUMBER
1						
2						
3						
4						

28c. Were records obtained to verify vaccination history? *(<5 years of age with Hib/unknown serotype, only)*

1 ☐ Yes 2 ☐ No

If YES, what was the source of the information? *(Check all that apply)*

1 ☐ Vaccine Registry

1 ☐ Healthcare Provider

1 ☐ Other *(specify)* _____

NEISSERIA MENINGITIDIS

29. What was the serogroup? 1 ☐ A 2 ☐ B 3 ☐ C 4 ☐ Y 5 ☐ W135 6 ☐ Not Groupable 8 ☐ Other _____ 9 ☐ Unknown

30. Is patient currently attending college? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown

31. Did patient receive meningococcal vaccine? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown **If YES, complete the table**

DOSE	TYPE	DATE GIVEN Mo.	Day	Year	NAME	MANUFACTURER	LOT NUMBER
1							
2							
3							
4							
5							
6							

Type Codes: 1= ACWY conjugate (Menactra, Menveo, MenHibrix) 2= ACWY polysaccharide (Menomune) 3= B (Bexsero, Trumenba) 9= Unknown

STREPTOCOCCUS PNEUMONIAE

1 ☐ Yes 2 ☐ No 9 ☐ Unknown

If YES, please note which pneumococcal vaccine was received: *(Check all that apply)*

1 ☐ Prevnar®7-valent Pneumococcal Conjugate Vaccine (PCV7)

1 ☐ Prevnar-13®, 13-valent Pneumococcal Conjugate Vaccine (PCV13)

1 ☐ Pneumovax®, 23-valent Pneumococcal Polysaccharide Vaccine (PPV23)

1 ☐ Vaccine type not specified

If between ≥2 months and < 5 years of age and an isolate is available for serotyping, please complete the Invasive Pneumococcal Disease in Children expanded form.

31b. If survived, did patient have any of the following sequelae evident upon discharge? (check all that apply) 1 ☐ None 1 ☐ Unknown

1 ☐ Hearing deficits 1 ☐ Amputation (digit) 1 ☐ Amputation (limb) 1 ☐ Seizures 1 ☐ Paralysis or spasticity 1 ☐ Skin Scarring/necrosis 1 ☐ Other *(specify)* _____

GROUP A STREPTOCOCCUS *(#33–35 refer to the 14 days prior to first positive culture)*

33. Did the patient have surgery or any skin incision? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown

If YES, date of surgery or skin incision: Mo. ☐☐ Day ☐☐ Year ☐☐☐☐

34. Did the patient deliver a baby *(vaginal or C-section)*?

1 ☐ Yes 2 ☐ No 9 ☐ Unknown

If YES, date of delivery: Mo. ☐☐ Day ☐☐ Year ☐☐☐☐

35. Did patient have:

1 ☐ Varicella 1 ☐ Surgical wound *(post operative)*

1 ☐ Penetrating trauma

1 ☐ Blunt trauma 1 ☐ Burns

If YES to any of the above, record the number of days prior to the first positive culture *(If > 1, use the most recent skin injury)*

1 ☐ 0-7 days 2 ☐ 8-14 days

36. COMMENTS: _____

37. Was case first identified through audit? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown

38. Does this case have recurrent disease with the same pathogen? 1 ☐ Yes 2 ☐ No 9 ☐ Unknown **If YES, previous (1st) state I.D.:** ☐☐☐☐☐☐☐☐

39. S.O. Initials _____

Submitted By: _____ Phone No.: ( ) _____ Date: ____/____/____

Physician's Name: _____ Phone No.: ( ) _____

Appendix B: Expanded Neonatal Surveillance form

NEONATAL GROUP B STREPTOCOCCAL DISEASE PREVENTION TRACKING FORM

Infant's Name: _____ (Last, First, M.I.) Infant's Chart No.: _____

Mother's Name: _____ (Last, First, M.I.) Mother's Chart No.: _____

Hospital Name: _____ Culture date: _____

*Patient identifier information is NOT transmitted to CDC *

ACTIVE BACTERIAL CORE SURVEILLANCE (ABCs)
NEONATAL GROUP B STREPTOCOCCAL DISEASE PREVENTION TRACKING FORM

STATEID __ __ __ __ __ __ __ **HOSPITAL ID** (of birth; if home birth leave blank) __ __ __ __ __

Infant Information **Were labor & delivery records available? ☐ Yes (1) ☐ No (0)**

1. Date of Birth: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits))
   Time of birth: __ __ __ __ (times in military format) ☐ Unknown (1)

2. Did this birth occur outside of the hospital?
   ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
   IF YES, please check one: ☐ Home Birth (1) ☐ Birthing Center (2) ☐ En route to hospital (3) ☐ Other (4) ☐ Unknown (9)

3. Gestational age in completed weeks: __ __ (do not round up)

4. Birthweight: ___ lbs ___oz OR __ __ __ __ grams

5. Date & time of newborn discharge after birth: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits)) __ __ __ __ (time) ☐ Unknown (1)

6. Outcome: ☐ Survived (1) ☐ Died (2) ☐ Unknown (9)

7. Readmitted to the same hospital: ☐ Yes (1) ☐ No (0)
   IF YES, date & time of readmission: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits)) __ __ __ __ (time)

8. Admitted from home to different hospital: ☐ Yes (1) ☐ No (0)
   IF YES, hospital id: __ __ __ __ __ __ **AND date & time admission:** __ __ / __ __ / __ __ __ __ (month / day / year (4 digits)) __ __ __ __ (time)

9. Infant discharge diagnosis:
   ICD9-1 __ __ __.__ __ ICD9-2 __ __ __.__ __ ICD9-3 __ __ __.__ __

10. Did the baby receive breast milk from the mother? (*for late-onset cases only*) ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
    IF YES, did the baby receive breast milk before onset of GBS infection (eg, date of first positive neonatal culture): ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

Maternal Information

11. Maternal admission date & time: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits)) __ __ __ __ (time) ☐ Unknown (1)

    Maternal age at delivery (years): __ __ years Maternal blood type: ☐ A (1) ☐ B (2) ☐ AB (3) ☐ O (4)

12. Did mother have a prior history of penicillin allergy? ☐ Yes (1) ☐ No (0)
    IF YES, was a previous maternal history of anaphylaxis noted? ☐ Yes (1) ☐ No (0)

13. Date & time membrane rupture: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits)) __ __ __ __ (time) ☐ Unknown (1)

14. Was duration of membrane rupture ≥18 hours? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

15. If membranes ruptured at <37 weeks, did membranes rupture before onset of labor? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

16. Type of rupture: ☐ Spontaneous (1) ☐ Artificial (2)

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Maternal Information *(continued)*

17. Type of delivery: *(Check all that apply)*
☐ Vaginal (1) ☐ Vaginal after previous C-section (1) ☐ Primary C-section (1) ☐ Repeat C-section (1)
☐ Forceps (1) ☐ Vacuum (1) ☐ Unknown (1)
If delivery was by C-section: Did labor or contractions begin before C-section? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
Did membrane rupture happen before C-section? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

18. Intrapartum fever (T ≥ 100.4 F or 38.0 C): ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
IF YES, 1st recorded T ≥ 100.4 F or 38.0 C at: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits)) __ __ __ __ (time)

19. Did mother receive prenatal care? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

20. Was prenatal record (even partial information) in labor and delivery chart? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
IF YES: No. of visits: __ __ First visit: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits)) Last visit: __ __ / __ __ / __ __ __ __ (month / day / year (4 digits))

21. Estimated gestational age (EGA) at last documented prenatal visit: ___ ___ . ___ ___ (weeks)

22. GBS bacteriuria during this pregnancy? ☐ Yes (1) ☐ No (0)
IF YES, what order of magnitude was the colony count?
☐ 0 (1) ☐ <10,000 (2) ☐ 10k–<25,000 (3) ☐ 25k–<50,000 (4) ☐ 50k–<75,000 (5) ☐ 75k–<100,000 (6)
☐ ≥100,0000 (7) ☐ Unknown (9)

23. Previous infant with invasive GBS disease? ☐ Yes (1) ☐ No (0)

24. Previous pregnancy with GBS colonization? ☐ Yes (1) ☐ No (0)

25a. Was maternal group B strep colonization screened for BEFORE admission (in prenatal care)?
☐ Yes (1) ☐ No (0) ☐ Unknown (9)
IF YES, list dates, test type, and test results below:

Test date (list most recent first):	Test type:	Positive culture (Do not include urine here!)
1. __ __ / __ __ / __ __ __ __	☐ Culture (1) ☐ Rapid pcr (2) ☐ Rapid antigen (3) ☐ Other (4) ☐ Unknown (9)	☐ Yes (1) ☐ No (0) ☐ Unknown (9)
2. __ __ / __ __ / __ __ __ __	☐ Culture (1) ☐ Rapid pcr (2) ☐ Rapid antigen (3) ☐ Other (4) ☐ Unknown (9)	☐ Yes (1) ☐ No (0) ☐ Unknown (9)

25b. If the *most recent* test was GBS positive, was antimicrobial susceptibility performed? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
IF YES, Was the isolate resistant to clindamycin? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
Was the isolate resistant to erythromycin? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

26a. Was maternal group B strep colonization screened for AFTER admission (before delivery)? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)
IF YES, list date of *most recent* test, test type and test results below:

Test date (list most recent first):	Test type:	Positive culture (Do not include urine here!)
__ __ / __ __ / __ __ __ __	☐ Culture (1) ☐ Rapid pcr (2) ☐ Rapid antigen (3) ☐ Other (4) ☐ Unknown (9)	☐ Yes (1) ☐ No (0) ☐ Unknown (9)

Maternal Information *(continued)*

26b. If the *most recent* test was GBS positive, was antimicrobial susceptibility performed? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

IF YES, Was the isolate resistant to clindamycin? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

Was the isolate resistant to erythromycin? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

27. Were GBS test results available to care givers at the time of delivery? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

Intrapartum Antibiotics

28. Were antibiotics given to the mother intrapartum? ☐ Yes (1) ☐ No (0) ☐ Unknown (9)

IF YES, answer a-b and Question 29-30

a) Date & time antibiotics 1st administered: (before delivery) __ __ /__ __ /__ __ __ __ (month / day / year (4 digits)) __ __ __ __ (time)

b) Antibiotic 1: _____ ☐ IV (1) ☐ IM (2) ☐ PO (3) # doses given before delivery: _____

Start date: __ __ /__ __ /__ __ __ __ Stop date (if applicable): __ __ /__ __ /__ __ __ __

Antibiotic 2: _____ ☐ IV (1) ☐ IM (2) ☐ PO (3) # doses given before delivery: _____

Start date: __ __ /__ __ /__ __ __ __ Stop date (if applicable): __ __ /__ __ /__ __ __ __

Antibiotic 3: _____ ☐ IV (1) ☐ IM (2) ☐ PO (3) # doses given before delivery: _____

Start date: __ __ /__ __ /__ __ __ __ Stop date (if applicable): __ __ /__ __ /__ __ __ __

Antibiotic 4: _____ ☐ IV (1) ☐ IM (2) ☐ PO (3) # doses given before delivery: _____

Start date: __ __ /__ __ /__ __ __ __ Stop date (if applicable): __ __ /__ __ /__ __ __ __

Antibiotic 5: _____ ☐ IV (1) ☐ IM (2) ☐ PO (3) # doses given before delivery: _____

Start date: __ __ /__ __ /__ __ __ __ Stop date (if applicable): __ __ /__ __ /__ __ __ __

Antibiotic 6: _____ ☐ IV (1) ☐ IM (2) ☐ PO (3) # doses given before delivery: _____

Start date: __ __ /__ __ /__ __ __ __ Stop date (if applicable): __ __ /__ __ /__ __ __ __

29. Interval between receipt of 1st antibiotic and delivery: ___ ___ ___ (hours) ___ ___ (minutes)

30. What was the reason for administration of intrapartum antibiotics? (*Check all that apply*)

☐ GBS prophylaxis (1) ☐ C-section prophylaxis (1) ☐ Mitral valve prolapse prophylaxis (1)

☐ Suspected amnionitis (1) ☐ Other (1) ☐ Unknown (1)

Comments: _____

_____

_____

_____

_____