Maternal Immunization: Current Status and Future Directions

Event ID: 4157352

September 18, 2019
Maternal Vaccination Against Influenza and Pertussis

CAPT Amy Parker Fiebelkorn, MSN, MPH

Vaccine Task Force Deputy, Adult and Influenza Immunization Team
Office of the Director, Immunization Services Division
National Center for Immunization and Respiratory Diseases
Influenza

Pregnant women are at risk for serious complications from flu:

- Severe illness
- Pneumonia
- Hospitalization
Pregnant women are at increased risk of influenza-related hospitalization compared with the general population

Risk of influenza-related hospitalization increases later in pregnancy

gis.cdc.gov/grasp/fluview/FluHospChars.html
Impact of Influenza Among Infants

Infants aged <6 months:

- Highest rate of influenza-related hospitalizations and deaths of all pediatric age groups

- Five times as likely to be hospitalized and twice the incidence of death vs. children aged 6–23 months

Pertussis (Whooping Cough)

- Highly contagious, bacterial respiratory infection that can be deadly for infants
- Rapid, high-pitched whoop followed by vomiting and exhaustion
- Infants can have atypical symptoms
- Poorly controlled, despite high vaccination coverage
Infants aged <2 months have the **highest incidence rate** of pertussis.

Approximately 67% of infants aged <2 months with pertussis need treatment in the **hospital**.
Pertussis Deaths by Age Group, United States, 2000–2017

CDC. National Notifiable Diseases Surveillance System, 2017
The Advisory Committee on Immunization Practices (ACIP) recommends that all women:

- who are pregnant during flu season receive influenza vaccine (at any time during pregnancy)
- receive tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccine during each pregnancy (preferably during the early part of gestational weeks 27–36)
## Effectiveness of Influenza Vaccines Given During Pregnancy

- Reduces risk of influenza in pregnant women by about 50%, and is 40% effective against influenza-associated hospitalization during pregnancy.
- Reduces antibiotic use, medical visits, loss of work days.
- Reduces risk of laboratory-confirmed influenza and influenza hospitalization among infants during the first several months of life.

---

Nunes et al. *Human Vaccines & Immunotherapeutics* 2018, 14(3);758-66.
Effectiveness of Tdap Vaccines Given During Pregnancy

Tdap during third trimester of pregnancy is 78% effective in preventing pertussis in infants <2 months of age.

Infants with pertussis born to vaccinated mothers less likely to be hospitalized or admitted to ICU.

References:
Two systematic reviews of influenza vaccination show no increased risk for spontaneous abortion, fetal death, or congenital malformations.

Tdap in pregnancy does not increase the risk of adverse reactions for the mother or infant.

No association between vaccination with either vaccine during pregnancy and risk of infant hospitalization or death in first 6 months of life.

www.cdc.gov/vaccinesafety/index.html
Influenza and Tdap Vaccination Coverage Among Pregnant Women, 2013-14 through 2017-18 Influenza Seasons, United States

Healthy People 2020 target for Influenza vaccination: 80%

Disparities in Maternal Vaccination Coverage

Influenza Vaccination Coverage Among Pregnant Women, by Race and Ethnicity, United States, 2017-2018

Disparities in Maternal Vaccination Coverage

Influenza and Tdap Vaccination Coverage Among Pregnant Women, by Race and Ethnicity, United States, 2017-2018

16% lower

Vaccination in Pregnant Women by Provider Offer or Recommendation of Vaccine, United States, 2017-2018

Provider Vaccine Recommendation

Provider Vaccine Offer
Influenza Vaccination in Pregnant Women by Provider Offer or Recommendation of Vaccine, United States, 2017-2018

67% offered influenza vaccination
- 64% vaccinated

15% recommended influenza vaccine without offer
- 38% vaccinated

19% had no recommendation or offer of influenza vaccine
- 9% vaccinated

Tdap Vaccination in Pregnant Women by Provider Offer or Recommendation of Vaccine, United States, 2017-2018

67% offered Tdap vaccination → 74% vaccinated

12% recommended Tdap vaccine without offer → 38% vaccinated

21% had no recommendation or offer of Tdap vaccine → 2% vaccinated


Tdap: tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine
Both influenza and pertussis are serious diseases for infants. Influenza is also a serious disease for pregnant women.

Maternal vaccination is effective and safe and can reduce complications, but vaccination coverage is too low.

HCP offering vaccines is strongly associated with vaccination.
Founded in 1951, ACOG is the professional organization dedicated to the improvement of women’s health.

In 2005, ACOG called together a Task Force on Immunization.
Impact of H1N1 Pandemic on Maternal Vaccination

- 2009 H1N1 pandemic
  - Pregnant women were at high risk of influenza-related complications and death

- H1N1 influenza vaccination rates for pregnant women increased from 15% to 50%
  - First significant increase
ACOG Immunization Program Timeline Since the H1N1 Pandemic

2010
Immunization Expert Work Group convened to continue momentum from H1N1 pandemic of immunizing pregnant women.
  - Awarded several multimillion dollar, multiyear immunization grants.

2011
ACOG’s Immunization for Women website developed:
www.immunizationforwomen.org

2015
ACOG partnered with CDC, which resulted in development of immunization tool kits from first round of grants.
ACOG Efforts to Improve Adult Immunization Rates: Tool Kits (2011-2018)
Immunization Resources for Obstetrician-Gynecologists: A Comprehensive Tool Kit*

Promotes immunization assessment, recommendation, administration and documentation as routine part of ob-gyn practice.

Distribution 2013:
- All 35,000 Ob-Gyns in practice in U.S.
- Residents and Residency Directors
- ACOG District Leadership
- State Maternal and Child Health Directors
- Key CDC Staff
- Partner Organizations

*Funding for distribution of this tool kit was provided by CDC, ASTHO, and Merck. ACOG does not allow companies to influence ACOG's programs, publications, or advocacy positions.
Ob/Gyn Survey on Vaccination Practices (n= 331)

Attitudes of Ob/Gyn Providers on Vaccinating Pregnant Patients

- It is safe to give the Tdap vaccine to pregnant women (99% CI 97–100)
- It is safe to give the influenza vaccine to pregnant women (98% CI 96–99)
- Pregnant women are at greater risk of severe influenza disease than nonpregnant women (95% CI 91–97)
- Tdap vaccination administered during pregnancy is effective in preventing pertussis in infants (79% CI 74–83)
- It is my responsibility to make sure my pregnant patients receive recommended vaccines, even if they get them somewhere else (76% CI 70–80)
- The influenza vaccine administered during pregnancy is effective in preventing influenza in pregnant women (70% CI 65–75)
- It is my responsibility to stock and administer all recommended vaccines for pregnant women (52% CI 47–58)
- The influenza vaccine administered during pregnancy is effective in preventing influenza in infants (45% CI 39–51)
- I prefer that women receive the Tdap vaccine after delivery rather than during their pregnancy because they can get it in the hospital (2% CI 1–4)
- I prefer that women receive the influenza vaccine after delivery rather than during their pregnancy because they can get it in the hospital (1% CI 0–2)
Barriers Identified to Vaccinating Pregnant Patients

Ob/Gyn Survey on Vaccination Practices (n= 331)

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Percentage</th>
<th>Major or somewhat of a barrier</th>
<th>Not at all a barrier</th>
<th>Minor barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other health issues taking precedence over discussion of vaccine risks and benefits</td>
<td>32%</td>
<td>37%</td>
<td>31%</td>
<td></td>
</tr>
<tr>
<td>The amount of time it takes</td>
<td>29%</td>
<td>45%</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>My belief that I am unlikely to change patients’ minds about their vaccination decision</td>
<td>8%</td>
<td>19%</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>Not knowing how to communicate with patients about risk</td>
<td>8%</td>
<td>17%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Not wanting to take the time to discuss a vaccine</td>
<td>7%</td>
<td>19%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Not knowing enough about existing evidence regarding vaccine safety</td>
<td>6%</td>
<td>35%</td>
<td>58%</td>
<td></td>
</tr>
<tr>
<td>Not feeling well prepared to address unanticipated questions that patients raise about vaccines</td>
<td>5%</td>
<td>20%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Not being knowledgeable enough about the severity of vaccine-preventable diseases</td>
<td>3%</td>
<td>15%</td>
<td>81%</td>
<td></td>
</tr>
<tr>
<td>My concern that the discussion will make patient worry that vaccines are not safe</td>
<td>3%</td>
<td>15%</td>
<td>81%</td>
<td></td>
</tr>
</tbody>
</table>
## Table 1. Summary of Maternal Immunization Recommendations

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Indicated During Every Pregnancy</th>
<th>May Be Given During Pregnancy in Certain Populations</th>
<th>Contraindicated During Pregnancy</th>
<th>Can Be Initiated Postpartum or When Breastfeeding or Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inactivated influenza</td>
<td>X&lt;sup&gt;1,3,5,7&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;7&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tetanus toxoid, reduced diphtheria toxoid and acellular pertussis (Tdap)</td>
<td>X&lt;sup&gt;2,3,4&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pneumococcal vaccines</td>
<td>X&lt;sup&gt;5,8&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;5,8&lt;/sup&gt;</td>
</tr>
<tr>
<td>Meningococcal conjugate (MenACWY) and Meningococcal serogroup B</td>
<td>X&lt;sup&gt;1,7&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;1,7&lt;/sup&gt;</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>X&lt;sup&gt;1,9&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;9&lt;/sup&gt;</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>X&lt;sup&gt;2,10&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;10&lt;/sup&gt;</td>
</tr>
<tr>
<td>Human papillomavirus (HPV)**</td>
<td>X&lt;sup&gt;*a, 11,12&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;*a, 11,12&lt;/sup&gt;</td>
</tr>
<tr>
<td>Measles—mumps—rubella</td>
<td>X&lt;sup&gt;11,13,14&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;11&lt;/sup&gt;</td>
</tr>
<tr>
<td>Varicella</td>
<td>X&lt;sup&gt;11,13,14,15,16&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;11&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*An 'X' indicates that the vaccine can be given in this window. See the corresponding numbered footnote for details.

1. Inactivated influenza vaccination can be given in any trimester and should be given with each influenza season as soon as the vaccine is available. The Tdap vaccine is given at 27–28 weeks of gestation in each pregnancy, preferably as early as the 27–30 week window as possible. The Tdap vaccine should be given during each pregnancy in order to boost the maternal immune response and maximize the passive antibody transfer to the newborn. Women who did not receive Tdap during pregnancy and have never received the Tdap vaccine should be immunized once in the immediate postpartum period.

2. Vaccination during every pregnancy is preferred over vaccination during the postpartum period to ensure antibody transfer to the newborn.

3. There are two pneumococcal vaccines: 1) the 23-valent pneumococcal polysaccharide vaccine (PPS23) is recommended in reproductive-age women who have heart disease, long disease, sickle cell disease, and diabetes as well as other chronic illnesses; 2) the 13-valent pneumococcal vaccine (PCV13) is recommended for reproductive-aged women with certain immunocompromised conditions, including human immunodeficiency virus (HIV) infection and asplenia. The PCV13 vaccine should be deferred in pregnant women unless the woman is at increased risk of pneumococcal disease and after consultation with her health care provider the benefits of vaccination are considered to outweigh the potential risks.

4. Quadrivalent conjugate meningococcal vaccine is routinely recommended for adolescents aged 11–18 years, along with individuals with HIV infection, complement component deficiency (including esculinabsorb), functional or anatomic asplenia (including sickle cell disease), exposure during a meningococcal disease outbreak, travel to endemic or hyperendemic areas, or work as a microbiologist routinely exposed to Neisseria meningitidis. If indicated, pregnancy should not preclude vaccination. The serogroup B vaccine should be deferred in pregnant women, unless the woman is at increased risk of serogroup B meningococcal disease and, after consultation with her health care provider, the benefits of vaccination are considered to outweigh the potential risks.
Ob/Gyn Perceptions on Why Women Refuse Vaccines

Ob/Gyn Survey on Vaccination Practices (n= 331)

Perceptions
(percentage reporting 'a lot' [95% CI])

- Belief that the influenza vaccine makes them sick (48 [42–54])
- Belief that they are unlikely to get a vaccine-preventable disease (38 [32–43])
- General worries about vaccines without specific concern (32 [27–38])
- The desire to maintain a natural pregnancy (31 [26–37])
- Concern that their child could develop autism as a result of receiving a vaccination during pregnancy (25 [20–30])
- Concern that their fetus or newborn will suffer long-term complications if they receive a vaccine in pregnancy (24 [19–29])
- Belief that vaccine-preventable diseases are not severe enough to warrant vaccination (19 [14–24])
- Concern that their fetus will suffer immediate, shorter term effects from vaccines (15 [11–20])
- Belief that vaccines are not very effective (14 [10–18])
- Belief that the Tdap vaccine makes them sick (10 [7–14])
- Belief that vaccination recommendations are driven by profit considerations of drug companies (7 [4–10])
- Religious objections to vaccination (1 [0–2])

Percentage

<table>
<thead>
<tr>
<th>Perceived level of contribution to vaccine refusal</th>
<th>A lot</th>
<th>Some</th>
<th>A little</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belief that the influenza vaccine makes them sick</td>
<td>48</td>
<td>37</td>
<td>13</td>
</tr>
<tr>
<td>Belief that they are unlikely to get a disease</td>
<td>38</td>
<td>44</td>
<td>16</td>
</tr>
<tr>
<td>General worries about vaccines without specific</td>
<td>32</td>
<td>45</td>
<td>21</td>
</tr>
<tr>
<td>The desire to maintain a natural pregnancy</td>
<td>31</td>
<td>33</td>
<td>25</td>
</tr>
<tr>
<td>Concern that their child could develop autism</td>
<td>25</td>
<td>39</td>
<td>27</td>
</tr>
<tr>
<td>Concern that their fetus or newborn will suffer</td>
<td>24</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>Concern that vaccines are not very effective</td>
<td>19</td>
<td>47</td>
<td>26</td>
</tr>
<tr>
<td>Belief that vaccine-preventable diseases are not</td>
<td>15</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>Concern that their fetus will suffer immediate,</td>
<td>14</td>
<td>50</td>
<td>27</td>
</tr>
<tr>
<td>Concern that vaccines are not very effective</td>
<td>10</td>
<td>22</td>
<td>39</td>
</tr>
<tr>
<td>Belief that vaccination recommendations are driven</td>
<td>7</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>Religious objections to vaccination</td>
<td>1</td>
<td>36</td>
<td>9</td>
</tr>
</tbody>
</table>
Next Steps to Promote Maternal Immunization

- Continue to emphasize risk for disease to the fetus or newborn to increase vaccine uptake

- Continue to educate about risk of maternal disease complications such as preterm birth, ICU admission for influenza-related morbidity

- Introduce education about both maternal and childhood immunization earlier in pregnancy

- Partner with others to decrease vaccine hesitancy and refusal
How Grady Memorial Hospital Works to Promote and Increase Maternal Immunization

Denise Jamieson, MD, MPH

James Robert McCord Professor and Chair
Department of Gynecology and Obstetrics
Emory University School of Medicine
Grady Health System

- One of the largest public health systems in the U.S.
- Safety net institution for medically underserved patients in Atlanta
- Approximately 3,000 deliveries per year
  - 88% Medicaid-eligible
  - 68% non-Hispanic black
  - 23% non-native English speakers
  - 44% inadequate prenatal care utilization
    - Defined by an index that includes when prenatal care began, and the number of prenatal visits from when prenatal care began until delivery (Kotelchuk index)
Maternal Vaccination Promotion at Grady

- Universal provider recommendation
- Routine assessment of immunization status
- Standing orders
- All sites stock influenza and Tdap vaccines
- Vaccines provided at no additional charge
ACOG Strategies for Effectively Integrating Immunizations into Routine Obstetric-Gynecologic Care

1. Administer routinely discussed and recommended vaccines.

2. Create a culture of immunization by educating and involving all staff in immunization processes.

3. Develop a standard process for assessing, recommending, administering, and documenting immunization status of patients.

4. Use existing systems and resources to conduct periodic assessments of immunization rates among patients to determine if and where progress is needed.
Assessing Maternal Immunization Rates at Grady

- Infectious Diseases in Pregnancy (IDPREG) study: Maternal Infections and Outcomes at Grady Memorial Hospital

- Retrospective cohort study of around 3,700 deliveries between July 1, 2016 and June 30, 2018

- Documented demographic and clinical characteristics of patients, including influenza and Tdap vaccination
IDPREG: Influenza and Tdap Vaccination Coverage by Race and Ethnicity, Grady Hospital, July 2016-June 2018

Unpublished data
IDPREG: Influenza and Tdap Vaccination Coverage by Prenatal Care Utilization, Grady Hospital, July 2016-June 2018

Unpublished data
IDPREG Conclusions

- Rate of receiving both Tdap and influenza vaccination is higher than national average (43% vs 33%).

- Hispanic women have highest rates of receiving both influenza and Tdap vaccination.

- Vaccination coverage declines with decreasing rates of prenatal care utilization.
  - >40% of women at Grady had inadequate prenatal care use.
“Yellow Sheet” Project

**Goals**

- Prospectively track influenza vaccine acceptance in Grady OB/GYN clinic.
- Identify reasons for refusal.
- Develop interventions to improve vaccine coverage.

**All patients seen in clinic from 9/18/2018 through 4/8/2019**
Preliminary Results – Influenza Vaccination of Pregnant Women at Grady Hospital, 9/2018 through 4/2019

Unpublished data
Top Five Reasons for Influenza Vaccine Refusal Among Pregnant Women

Unpublished data

- Don't normally get vaccine
- Heard bad things about vaccine
- Don't think I'm at risk for flu
- Don't like shots
- Worried about side effects for me

Percent reporting reason for declining vaccination

Non-Hispanic white | Non-Hispanic black | Hispanic | Other
Preliminary Results – Influenza Vaccination

Overall vaccination rate for pregnant women at Grady Hospital for the 2018-2019 flu season was 55% (a 5% increase from the previous two seasons)
Keys to Success in Increasing Maternal Immunization

Champions
Incentives
Education
Feedback
Celebration
Our Grady Team

Sheree Boulet
Jenna Adams
Hope Biswas
Miah Davis
Kamini Doraivelu
Emily Goggins
Lisa Haddad
Tess Kim
Mumu Rahman
Michelle Saums
Rachel Williams
Roland Matthews
Franklyn Geary

OB/GYN Focuses on Fighting Flu

At the start of last year’s flu season, Grady’s OB/GYN Clinic implemented the “Yellow Sheet Project” that aims to collect data on why patients refuse the flu vaccine. The project uses a bright yellow sheet of paper to track whether patients accept or decline the flu vaccine during each visit. If a patient declines the shot, her reasons for declining are also collected. The information from the yellow sheets is then entered into a database and used to track vaccination rates and commonly reported reasons for refusing the vaccine.

“Our intention is to increase vaccination rates, especially in pregnant women, and identify barriers to vaccinations for future flu seasons,” said Dr. Denise Jamieson, Emory’s associate chief of OB/GYN at Grady.

According to data collected from September 18 to December 15, 2018, only 51% of eligible pregnant patients seen at Grady’s OB/GYN clinic received the flu vaccine. Influenza is particularly dangerous in pregnant women given their immunocompromised state, Jamieson said.

“Vaccination not only protects the mother, but also the baby up to six months of age. Even though the vaccine is safe at any stage of pregnancy, nationally vaccination rates in pregnant women have plateaued at 50% for about the past ten years. We are working hard to beat the national average and protect more of our patients.”

Providers counsel patients on the benefits of the vaccine, fill out the yellow sheet, and if given the green light, nurses administer the vaccines. For those who refuse the vaccine, medical students from Emory University School of Medicine prepare and collect yellow sheets documenting reasons for refusal, and then input the data.

“The overarching goal is to improve the quality of care for patients by collecting information on why they refuse the vaccine, which will enable providers to better target their messages in a way that resonates with patients,” Jamieson said.

Patients who refuse the shot often base their decision on habitually skipping the vaccine every season, and a belief that it will make them sick.

“There are a lot of myths and misconceptions about the flu vaccine. The information collected in the Yellow Sheet Project will help us understand patient concerns so we can better counsel patients on the risks and benefits of flu vaccination.”
Accelerating Progress with New Maternal Vaccines

Saad B. Omer, MBBS, MPH, PhD

Director, Yale Institute for Global Health
Professor of Medicine, Yale School of Medicine

Susan Dwight Bliss Professor of Epidemiology of Microbial Diseases, Yale School of Public Health
General Infant Immunization Schedule

After Birth

Birth

2 months
(6 weeks)

4 months
(10 weeks)

6 months
(14 weeks)
In 1990, 2.5 million children under age 5 died of vaccine-preventable diseases.

In 2013, only 750,000 died.

GBD Collaborators, Lancet; 2015
Role of Maternal Immunization in Protecting Neonates

Pregnancy

- Pre-partum

After Birth

- 6 weeks (2 months)
- 10 weeks (4 months)
- 14 weeks (6 months)

Some infections more dangerous in pregnancy (e.g., influenza, hepatitis E)

3 million deaths (0-27 days)

<table>
<thead>
<tr>
<th>Vaccination Status</th>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine in development that could be used by pregnant women</td>
<td>Group B Streptococcus</td>
<td>For pregnant women, live vaccines are contraindicated and inactivated vaccines are not currently recommended.</td>
</tr>
<tr>
<td>Vaccine licensed; not routinely recommended for pregnant women</td>
<td>Respiratory syncytial virus</td>
<td>For pregnant women, live vaccines are contraindicated and inactivated vaccines are not currently recommended.</td>
</tr>
<tr>
<td>Vaccine licensed; can be given to pregnant women but not routinely recommended</td>
<td>Cytomegalovirus (CMV)</td>
<td>For pregnant women, live vaccines are contraindicated and inactivated vaccines are not currently recommended.</td>
</tr>
<tr>
<td>Vaccine licensed; routinely recommended for pregnant women</td>
<td>Pertussis**</td>
<td>For routine vaccination of pregnant women, recommended in some high-income countries including the United States.</td>
</tr>
<tr>
<td>Vaccine licensed; routinely recommended for pregnant women</td>
<td>Influenza**</td>
<td>For routine vaccination of pregnant women, recommended in some high-income countries including the United States.</td>
</tr>
</tbody>
</table>

* Live vaccine contraindicated for use in pregnancy; inactivated vaccine has been developed but is not currently recommended for use
** Recommended for routine vaccination of pregnant women in some high-income countries including United States
Group B Streptococcus (GBS) Vaccine
Invasive Group B Streptococcus Disease in Infants

- Early-onset Group B Streptococcus (EOGBS) occurs before age 7 days
  - sepsis (80%-95%)
  - pneumonia (10%-15%)
  - meningitis (5%-10%)

- Late-onset GBS (LOGBS) occurs in infants aged 7 to 89 days old
  - Meningitis more frequent (21%-35%)
    » 30% of infants have permanent complications
    (e.g., hearing loss, developmental delay)
Pregnancy Outcomes Among Women with Invasive GBS

- Active, population-based surveillance in 10 U.S. states
- Identified 409 invasive GBS infections in pregnant women
Epidemiology of GBS Infection in Pregnant Women in Select U.S. Areas

Figure 2. Incidence of Invasive Group B Streptococcal Disease Among Infants (<90 Days) and Pregnant Women in Select US Areas, 1999-2005

Universal screening

No decrease in late-onset disease in infants, or disease in pregnancy

Trivalent Type Ia, Ib and III vaccine to prevent GBS infection (Novartis®)

Purified capsular polysaccharide conjugated to CRM197 (nontoxic version of diphtheria toxin, used to make polysaccharides more immunogenic)

Phase I and II trials

- Phase I: small groups of people receive the trial vaccine
- Phase II: vaccine is given to people who have characteristics similar to those for whom the new vaccine is intended

www.cdc.gov/vaccines/basics/test-approve.html
Trade name shown for identification purposes only
Respiratory Syncytial Virus (RSV) Vaccine
Infants Under 6 Months and Premature Infants at High Risk for Hospitalization Due to RSV

Figure 2. Odds Ratios for Potential Risk Factors in Patients with and Those without Respiratory Syncytial Virus (RSV) Infection, According to Treatment Site.

According to multiple logistic-regression analyses, the only risk factors associated with RSV illness requiring hospitalization were an age of less than 2 years (especially under 6 months) and a history of prematurity. For age groups, the reference group is patients between the ages of 24 months and 59 months. Horizontal lines indicate 95% confidence intervals.
Large Numbers of Global Neonatal and Infant Deaths Due to RSV, 2010

# RSV Vaccine and mAb Snapshot

<table>
<thead>
<tr>
<th>Preclinical</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Market Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Live-Attenuated/Chimeric</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Codagenis, LID/NAAD/NH</td>
<td>LID/NAAD/NH</td>
<td>LID/NAAD/NH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RV5</td>
<td>RV5</td>
<td>RV5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxis Vaccines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Whole-Inactivated</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue Willow Biologics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RV5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Particle-Based</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agi/Van</td>
<td>Pauweteef</td>
<td>Virobits</td>
<td>Novavax</td>
<td>Novavax</td>
</tr>
<tr>
<td>VLP</td>
<td>VLP</td>
<td>VLP</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subunit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instituto de Salud Carlos III</td>
<td>University of Georgia</td>
<td>University of Massachusetts</td>
<td>Novavax</td>
<td>Novavax</td>
</tr>
<tr>
<td>VSV F Protein</td>
<td>VSV F Protein</td>
<td>VSV F Protein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solagen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSV F Protein</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nucleic Acid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CureVac</td>
<td>Biontech Pharmaceuticals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mRNA</td>
<td>DNA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recombinant Vectors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BioNTech</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Immunology-Prophylaxis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artesia</td>
<td>Pentavac</td>
<td>UCB, mAbxience</td>
<td>MedImmune</td>
<td>Syngene</td>
</tr>
<tr>
<td>Anti-F mAb</td>
<td>Anti-F mAb</td>
<td>Anti-F mAb</td>
<td>Anti-F mAb</td>
<td>Anti-F mAb</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Target Indication:** "P" = Pediatric  "M" = Maternal  "E" = Elderly

**Updated:** April 5, 2019

http://vaccineresources.org/details.php?id=1562
Ethics of Maternal Vaccination
Risk vs. Benefit
“...legitimacy of a mother’s interests in the welfare of her fetus/infant ...”
Characteristics of an Interests-based Approach

- Mother’s self-determination front and center
- Inclusion of women in decision-making
- Limits options for mandatory maternal immunization

Priorities when Vaccinating Among 601 Pregnant Kenyan Women

When deciding to get a vaccine, whose benefit do you prioritize first (the mother or the baby)?

- 66% prioritize the mother
- 34% prioritize the baby

MVAC study (unpublished data)
Overall Summary and Conclusions

- Maternal vaccinations are important for protecting pregnant women and their babies.

- With the support of professional organizations and local immunization champions, vaccination coverage of pregnant women has improved over the course of the past decade, but there is a long way to go.

- As new vaccines for pregnant women are being developed, continuous improvement in vaccination coverage can prevent more disease.