Infection Prevention in the NICU

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Objectives

• Discuss the mainstays of Infection Prevention practices, particularly as they pertain to the unique NICU setting.

• Identify other areas of interest in preventing infection in young infants, including vaccination of healthcare personnel as part of a “cocoon” vaccination strategy.

• Highlight pertinent cultural and linguistic factors.

Disclosures

• Speakers’ bureau for Sanofi Pasteur
**Nosocomial Infection Definition**

- An infection in the neonate that develops more than 48 hours after delivery, whether from mom, a visitor, or the hospital environment.
- Monitoring provides information regarding:
  - unusual problems
  - clusters of infection
  - risks associated with certain procedures or techniques
  - success of specific preventive measures

**Infection Prevention in the NICU**

- Hand hygiene
- Care bundles
- Antibiotics and prophylaxis

**Hand Hygiene**

- Either traditional soap & water or alcohol based hand rubs/sanitizer.
- Very important - must be strictly enforced and monitored.
- “Bare Arms” – nothing from fingertips to the elbow.
- Fingernails should be natural and short (1/4 inch or less from palmar side). If there is polish present it must be fresh and not chipped.
Best Practice to Prevent CLABSI

- **Central line insertion bundle** – maximal sterile barriers (cap, mask, sterile gown, sterile gloves, large sterile drape), CHG skin prep, minimize attempts
- **Dressing change bundle** – CHG skin prep, biopatch, occlusive dressing
- **Daily Goals Bundle**
  - Daily review of “Can the central line can be removed?"
  - Access technique/hub scrub
  - Reduce manipulation of line/batch labs

Antibiotics

- Starting is not a problem…it’s stopping!
- Prophylaxis (fluconazole)?
- Antibiotic stewardship program
- NICU pharmacist
- Institutional antibiograms
- ID people are your friends - please consult us!

Isolation and Cohorting

- Contact – MRSA, VRE, ESBL, RSV
- Droplet – Influenza, Pertussis
- Airborne (rarely) – Chickenpox or Measles

- Place in single room or Cohort (two or more babies in isolation who have the same germ)
- Requirements for MRSA screening – upon admission and weekly when an increase of healthcare associated MRSA occurs in the NICU.
Environmental Control

- Environmental cleaning – regular schedule for cleaning
- Cleaning and disinfecting patient care equipment such as IV poles, pumps, monitors, thermometers, dynamap, incubators, bassinets, etc.
- Nebulizers, water traps, respiratory support equipment
- Other (laryngoscopes, eye speculums, etc.)
- Laundry – outside vendor who maintains records for CDPH required water temperatures.

Health Standards for Personnel

- Personnel should be screened for immunity to measles, mumps, rubella, VZV, hepatitis B
- Personnel should receive Tdap and seasonal Influenza vaccine
- TB screening (ppd)
- Ideally, individuals with a respiratory, cutaneous, or GI infection should not have direct contact with neonates

- Personnel with exudative skin lesions or weeping dermatitis should refrain from all direct patient care.
- Transmission of HSV from infected personnel is rare. Those with cold sores should cover lesions and observe careful handwashing. Personnel with herpetic whitlow should not participate in patient care until lesions have healed.
- Transmission of CMV to healthcare personnel can be prevented by Standard Precautions.
Vaccination of HCP

• Neonatal diseases can be bad...
  – Pertussis
  – Influenza

Influenza

What is the difference between the influenza virus and a fax machine?

Influenza

One makes facsimiles, the other makes sick families!
Complications of Pertussis in Infants
United States, 2000-2004

<table>
<thead>
<tr>
<th>Age</th>
<th>Reported Cases</th>
<th>Apnea</th>
<th>Hospitalizations</th>
<th>Pneumonia</th>
<th>Seizures</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12 Months</td>
<td>12,174*</td>
<td>5464</td>
<td>6114</td>
<td>1063</td>
<td>146</td>
<td>92</td>
</tr>
</tbody>
</table>

The total number of reported cases is lower than the total complications because some infants had more than 1 complication.

- From 2000 to 2004, over 12,000 cases of pertussis were reported among infants younger than 12 months
- Almost half of them were hospitalized
- 90% of pertussis deaths occurred in infants under 6 months of age


Tdap Vaccination of Adults

- ACIP recommends adult (19-64 yrs) receive a single dose of Tdap if >10 yrs since Td (shorter intervals considered)
- Adults with close contact with infants <12mos
- Women should receive Tdap in the immediate postpartum period
- Adults should receive Tdap as part of wound management
- Adults with a history of pertussis should receive Tdap according to routine recommendations

Key Contacts Recommendation

“Adults who have or who anticipate having close contact with an infant aged <12 months (e.g., parents, grandparents aged <65 years, child-care providers, and HCP [health-care personnel]) should receive a single dose of Tdap at intervals <10 years since the last Td to protect against pertussis if they have not previously received Tdap. An interval as short as 2 years from the last dose of Td is suggested to reduce the risk for local and systemic reactions after vaccination; shorter intervals may be used.”

ACIP Adult Recommendations
Health-care Personnel Recommendation

“HCP [health-care personnel] in hospitals or ambulatory care settings who have direct patient contact should receive a single dose of Tdap as soon as feasible if they have not previously received Tdap. These HCP include but are not limited to physicians, other primary-care providers, nurses, aides, respiratory therapists, radiology technicians, students (e.g., medical, nursing, and other), dentists, social workers, chaplains, volunteers, and dietary and clerical workers.”

References:

Estimated Duration of Immunity After Infection or Vaccination

<table>
<thead>
<tr>
<th>Source of Immunity</th>
<th>Duration</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural infection</td>
<td>15 years</td>
<td>Wirsing von König et al, 1995</td>
</tr>
<tr>
<td>Whole-cell vaccine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>6 years</td>
<td>Jenkinson, 1988</td>
</tr>
<tr>
<td>Finland</td>
<td>6 years</td>
<td>He et al, 1994</td>
</tr>
<tr>
<td>Germany</td>
<td>&gt;6 years</td>
<td>Lugauer et al, 2002</td>
</tr>
<tr>
<td>Acellular vaccine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>6 years</td>
<td>Salmaso et al, 2001</td>
</tr>
<tr>
<td>Germany</td>
<td>&gt;6 years</td>
<td>Lugauer et al, 2002</td>
</tr>
</tbody>
</table>


Reports of Pertussis in the U.S.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 yr</td>
<td>4000</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
<td>8000</td>
</tr>
<tr>
<td>1-4 yrs</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
<td>5000</td>
</tr>
<tr>
<td>5-9 yrs</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
<td>5000</td>
<td>6000</td>
</tr>
<tr>
<td>10-19 yrs</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
<td>8000</td>
<td>9000</td>
</tr>
<tr>
<td>20+ yrs</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
<td>5000</td>
</tr>
</tbody>
</table>

Average Number of Cases / Year

18.8 fold
15.5 fold
Infant Pertussis Hospitalizations

Pertussis Deaths: Youngest Infants Are at Greatest Risk

California Epidemiology

- Pertussis declared epidemic in California 6/18/2010
- As of 1/7/2011, 8383 pertussis cases have been reported in 2010 for a state rate of 21.4 cases/100,000.
- 2010 has the most cases seen in 63 years
California Epidemiology

- 198 (55%) of hospitalized cases infants < 3mos old
- 253 (70%) < 6 mos old (of 43% with hosp info)
- 10 deaths; 9 infants < 2 mos (no vaccines); 1 ex-preemie who had rec’d one dose of vaccine (1.5%)
- Rates are highest in infants <6 mos of age (417.8 cases/ 100,000)
- 190 (75%) of hospitalized infants <6mos with known ethnicity were Hispanic. 9 (90%) of deaths were Hispanic infants
- as of 1/7/11

Local Epidemiology

- OC
  - 2005: 120 cases
  - 2006: 58 cases
  - 2007: 24 cases
  - 2008: 37 cases
  - 2009: 81 cases
  - 2010: 476 cases (as of 1/7/11)

Pertussis Summary

- Reports of pertussis, which have increased dramatically in recent years, represent only fraction of actual cases
- Largest increases in reported cases are among adolescents and adults
- Pertussis immunity, following disease or vaccination, wanes over time
- Disease in adolescents and adults associated with significant morbidity and complications, and with transmission to infants
- Infant pertussis is often severe, leading to hospitalization and mortality; deaths continue to increase among infants too young to be fully vaccinated
**Tdap for HCW Prevents Nosocomial Pertussis in the NICU**

- Simplified, stochastic simulation model of a NICU (based on Toronto Sick Children’s) used to examine the impact of different Tdap vaccination strategies on the probability and size of a nosocomial outbreak.
- Outbreak probability with an infected HCW went from 49% with no vaccine intervention, down to 2% when 95% of HCW were vaccinated.
- Increasing vaccination also resulted in smaller outbreak sizes.
- 100% boosting of family caregivers did not result in a significant reduction in probability of HCW or pt outbreaks.


**Tdap Vaccination of HCW**

- Studies have documented transmission of pertussis from
  - HCW to patients
  - Patients to HCW
- Investigation and control of exposures in health care settings is labor intensive, costly and disruptive
- Vaccination of HCW is recommended, with a benefit-cost ratio of 2.38

**Tetanus and Pertussis Vaccination Coverage in US Adults**

- CDC analyzed data from the National Health Interview Survey for 1999 and 2008
- Self-reported tetanus coverage in the preceding 10 y was 61.6% in 2008.
- Tdap coverage estimated 5.9%.
- Of those who rec’d tetanus vaccination 2005-08, 52% reported receiving Tdap.
- Tdap coverage among adults with infant contact was 5%.
- Among HCP was 15.9%.

MMWR 2010;59:1302-06.
How do treatments for avian flu and swine flu differ?

For avian flu you get a “tweetment”, but for swine flu you get an “oinkment”!

CLEARLY PREVENTION IS A BETTER ANSWER…

Excess Hospitalizations in Healthy Children <6 Months and Adults ≥65 Years

For the elderly, the smaller bar represents the average for A/H1N1 and B seasons and the taller bar represents the average for A/H3N2 seasons.

**Vaccination of Health Care Workers (HCW)
Influenza**

- Most professional societies now advocating mandatory HCW influenza vaccination (IDSA, SHEA).
- Rates of HCW influenza vaccination part of the data publicly reported for hospitals, and considered a measure of quality.

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**Cocoon Vaccination**

“The strategy of vaccinating contacts of persons at high risk to reduce disease and therefore transmission is used with influenza. Influenza vaccine is recommended for household contacts and out-of-home caregivers of children aged 0-59 months, particularly infants aged 0-6 months, the pediatric group at greatest risk for influenza-associated complications. A similar strategy for Tdap is likely to be acceptable to physicians.”

– ACIP

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**The Challenges**

- Infants are vulnerable to certain vaccine-preventable diseases in the first few months of life, before they have completed their primary immunization series
- Infants are at high risk for life-threatening complications, hospitalization, and death due to pertussis and influenza
- Infants who develop pertussis or influenza are most likely to acquire it from a family member
- Adults and adolescents have low rates of immunization against pertussis and influenza
Go Get Your Flu Vaccine!

Top 10 Reasons for not getting influenza vaccine:
• #10 – No time
• #9 – Too inconvenient
• #8 - It doesn’t work anyway
• #7 – I never get the flu anyway
• #6 – I have a (true) medical contraindication
• #5 – I rely on homeopathic medications
• #4 – I avoid medications in general
• #3 – Needle phobia
• #2 – I don’t like the infection control posters

Go Get Your Flu Vaccine!

• #1 – I always get the flu from the flu shot (!)

Safety of TIV: Low Rate of Systemic Side Effects*

<table>
<thead>
<tr>
<th>Side Effect</th>
<th>1990 Elderly Vaccine side effects (%)</th>
<th>Placebo side effects (%)</th>
<th>1990 Healthy Adults Vaccine side effects (%)</th>
<th>Placebo side effects (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>5.7</td>
<td>4.2</td>
<td>6.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Headache</td>
<td>6.3</td>
<td>7.5</td>
<td>10.8</td>
<td>14.4</td>
</tr>
<tr>
<td>Malaise</td>
<td>7.2</td>
<td>6.3</td>
<td>16.0</td>
<td>17.5</td>
</tr>
<tr>
<td>Myalgia</td>
<td>4.8</td>
<td>4.2</td>
<td>6.2</td>
<td>5.7</td>
</tr>
</tbody>
</table>

* Rates are estimated using the method of adjusted odds ratios. Reduced rates of symptoms in 1990 may be due to a greater use of antiviral therapies in 1990.
Solution: Be A Vaccine Champion

- Parents and other family members may not be aware that they pose a risk of infecting their babies
- They need to know they can reduce that risk by getting vaccinating themselves
- They trust their pediatrician’s advice on how best to protect and care for their babies
- Regular office visits offer you opportunities to deliver important disease prevention messages
Vaccination of Parents in the NICU

- A study of immunization practices in families with NICU infants at NYU found that 23.2% of parents sought immunization in the time prior to delivery. Of those not immunized, 94.5% received vaccination when offered the opportunity in the NICU.
  

- Programs need to take many considerations into account:
  - Financial planning
  - Practical considerations (who, what, where)
  - Ethical and Legal planning
  

Pregnancy and Influenza

- Pregnant women in the 3rd trimester are as likely to be hospitalized for heart and lung problems during flu season as women with serious chronic health conditions who were not pregnant.
- The risk increases during pregnancy and is 5X higher for healthy women at 37-42 weeks gestation compared with the first six months.
- Pregnant women with asthma are at particularly high risk for hospitalization during the flu season.

<table>
<thead>
<tr>
<th>Condition</th>
<th>General US Pop</th>
<th>Prevalence, General US Pop</th>
<th>Prevalence, Hospitalized H1N1 Patients</th>
<th>Prevalence, Novel H1N1 Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>0%</td>
<td>7%</td>
<td>15%</td>
<td>17%</td>
</tr>
<tr>
<td>COPD</td>
<td>5%</td>
<td>2%</td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td>Diabetes</td>
<td>17%</td>
<td>5%</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>Chronic CVD</td>
<td>10%</td>
<td>2%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Morbid Obesity</td>
<td>15%</td>
<td>6%</td>
<td>8%</td>
<td>10%</td>
</tr>
<tr>
<td>Neurocognitive Dis</td>
<td>15%</td>
<td>2%</td>
<td>3%</td>
<td>4%</td>
</tr>
<tr>
<td>Neuromuscular Dis</td>
<td>20%</td>
<td>1%</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>Pregnant</td>
<td>25%</td>
<td>1%</td>
<td>2%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Underlying conditions among those hospitalized and those who have died from 2009 H1N1 compared to general population.
The Case for Maternal Immunization

• Protects Mom and the baby…(Why not protect Mom while we are at it?)

• Offers the possibility to protect the infant from birth until immunity is achieved by active vaccination…
• Recognized more than 120 years ago. In 1879, Burckhardt reported that infants born to mothers who had “Jennerian vaccination” during pregnancy were protected from the vaccinia virus during the first days of life.
• In the early 1900’s, it was clear that common infections such as diphtheria, polio, scarlet fever and measles did not manifest in the first few months of life because of passively acquired maternal ab.
• Highly successful since the 1970’s for tetanus.

Pregnancy and Influenza

Randomized controlled trial conducted in Bangladesh;

– Provided flu vaccination to pregnant women during the third trimester while the control group received PPV23
– Demonstrated a 29% reduction in respiratory illness with fever in moms
– 36% reduction in respiratory illness with fever among their infants during the first 6 months after birth
– Infants born to vaccinated women had a 63% reduction in laboratory-confirmed influenza illness during the first 6 months of life. All women in this trial breastfed their infants (mean duration: 14 weeks).

Maternal Influenza Vaccination

- 1160 mother-infant pairs on Navajo and Apache reservations born during 1 of 3 influenza seasons
- Infants (<6 mos old) of vaccinated mothers had 41% reduction in laboratory-confirmed influenza and 39% reduction in ILI hospitalization compared to infants born to unvaccinated mothers
- Infants born to vaccinated mothers had significantly higher hemagglutinin inhibition antibody titers at birth and at 2 to 3 months of age for all 8 influenza strains tested


Maternal Influenza Vaccination

- Infants hospitalized at Yale 2000-2009 with laboratory confirmed influenza (91 cases), age and time matched with controls negative for flu (156)
- Vaccine effectiveness calculated by matched odds ratios
- Mothers of 2 (2.2%) of cases and 31 (19.9%) of controls <6 mos were vaccinated during pregnancy
- Effectiveness in preventing hospitalization for flu in the first 6 mos of life = 91.5%
- Not powered for > 6mos, but probably neutral
- Increasing vaccine rates with time (35% in 2009)


Information for Health-Care Professionals

- NNII (www.immunizationinfo.org)
- VEC (www.vaccine.chop.edu)
- IAC (www.immunize.org)
- CDC/NIP (www.cdc.gov/nip)
- AAP (www.aap.org)
- AAFP (www.aafp.org)
- IVS (www.vaccinesafety.edu)
- Vaccine Page (www.vaccines.org)
- Every Child by Two (www.ecbt.org)