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A Broad Look at Childhood Immunizations: Haemophilus Influenzae Type B and Tetanus

0.25 CREDIT HOURS

Pete Kreckel, RPh
Director of Clinical Services, Nickman's Drug Store

PHARMACIST OBJECTIVES

1. Indicate the frequency and dosing parameters for *Haemophilus influenza* type B and tetanus vaccines

PHARMACY TECHNICIAN OBJECTIVES

1. Indicate the frequency and dosing parameters for *Haemophilus influenza* type B and tetanus vaccines

OVERVIEW

Micro-learning opportunities were created in response to evidence that learning is maximized when delivered in short and focused 'bursts.' In this session, common childhood vaccines are examined, including vaccines for *Haemophilus influenzae* type B and tetanus

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TARGET AUDIENCE

Pharmacist, Pharmacy Technician

AUTHOR DISCLOSURE

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My sister, Mary Kreckel Fritz, is a registered nurse who graduated from Philipsburg State Hospital School of Nursing in 1980 and has vast experience in the area of pediatrics. When I told her I planned to write on *Haemophilus influenzae* Type B, she had this to offer:

> "We had several kids with epiglottitis. They were either intubated or had a tracheotomy. They [needed] one-on-one nursing care because, if they pulled out their tubes, you lost their airway. The endo tube and trach tube stayed for a few days until the swelling in the epiglottis went down.
>
> These kids were easily diagnosed because they would lean forward with constant drooling with respiratory distress. I would have to comfort them by hugging them while they were restrained from pulling out their tubes.
>
> The last two pediatricians that I worked with were amazed that I had actually taken care of Hib epiglottitis patients.
>
> When parents in the pediatrician's offices were reluctant to give vaccines, I always told them how epiglottitis has been eradicated because of the vaccines. I also had significant experience treating Hib meningitis."

A special thanks to Mary for providing her first-hand experience, may we never have to face these diseases again!

Haemophilus influenzae Type B

- The organism was given the name Haemophilus by Charles-Edward Winslow, et al. in 1920
    - Later, in 1933, researchers discovered that influenza was caused by a virus and that *H. influenzae* was a cause of secondary infection
- *H. influenzae* type b was the leading cause of invasive bacterial disease among children in the United States prior to licensing of Haemophilus b conjugate vaccines in 1987
    - The bacterium also causes pneumonia, meningitis, epiglottitis arthritis, cellulitis, and blood infections
    - Centers for Disease Control and Prevention (CDC) now estimate that *H. influenzae* type b disease in children under the age of 5 years has been reduced by 95%
- *Haemophilus influenzae* is an aerobic, gram-negative bacteria with a polysaccharide capsule with six different serotypes (a-f) of polysaccharide capsule
- *H. influenzae* enters the body through the nasopharynx
    - Organisms colonize the nasopharynx and may remain only transiently or for several months in the absence of symptoms (asymptomatic carrier)
    - This bacterium does not survive on inanimate surfaces
    - Hib could be isolated from the nasopharynx of 0.5% to 3% of healthy infants and children, but was uncommon in adults
- Before effective vaccines were introduced, it was estimated that 1 in 200 children developed invasive *H. influenzae* type b disease by 5 years old
- In children under 5 years old, the mortality rate for invasive *H. influenzae* type b disease ranged between 3% and 6%.

Meningitis

- In more than 60% of infected children, meningitis was the clinical syndrome and permanent sequelae
    - Ranged from mild hearing loss to mental retardation
    - Affected 20% to 30% of all survivors

Epiglottitis

- Swelling of the cartilage covering the windpipe
    - Can block the flow of air into the lungs
- The demographics, causative organisms, and natural history of epiglottitis changed substantially in the Hib vaccination era
- Routine Hib vaccination for infants has made epiglottitis rare in children
    - Now more common in adults – truly an example of "herd immunity"

Vaccine history

- A pure polysaccharide vaccine was licensed for use in the United States in 1985
    - Used until 1988
    - The vaccine had low efficacy and is no longer available in the United States
- The first Hib conjugate vaccine was licensed in 1987
    - Conjugation is the process of chemically bonding a polysaccharide to a more effective protein carrier
    - This process changes the polysaccharide from a T-independent to a T-dependent antigen and greatly improves immunogenicity, particularly in young children

Dosage of available vaccines

- Vaccines are interchangeable and should follow a 3-dose schedule if more than 1 brand is used
- Hib vaccines should be given at the same visit as other recommended vaccines

Monovalent vaccines

- ActHIB
    - 4-dose series
    - 3-dose primary series at age 2, 4, and 6 months, followed by a booster dose* at age 12–15 months
- Hiberix®
    - 4-dose series
    - 3-dose primary series at age 2, 4, and 6 months, followed by a booster dose* at age 12–15 months
- PedvaxHIB®
    - 3-dose series
    - 2-dose primary series at age 2 and 4 months, followed by a booster dose at age 12–15 months

Combination vaccines

- Pentacel®
    - DTaP-IPV/Hib
    - 4-dose series
    - 3-dose primary series at age 2, 4, and 6 months, followed by a booster dose* at age 12–15 months
- Vaxelis®
    - DTaP-IPV-Hib-HepB
    - 4-dose series
    - 3-dose primary series at age 2, 4, and 6 months, followed by a booster dose* at age 12–15 months
    - *Vaxelis® (DTaP-IPV-Hib-HepB) is not recommended for use as a booster dose. A different Hib-containing vaccine should be used for the booster dose.

Vaccination rates

- Among children born during 2016–2017:
    - 92.2% had received the Hib vaccine primary series (at least 2 or 3 doses, depending on product)
    - 79.9% had received the full series (primary series and booster; at least 3 or 4 doses, depending on product type) by age 24 months

Hib secular trends in the United States

- About 20,000 cases of Hib annually before vaccine
- Incidence of Hib has declined 99% since the pre-vaccine era
- Clinical efficacy has been estimated at 95% to 100%
    - Invasive Hib disease is uncommon in children who are fully vaccinated
- From 2009-2018, 36 reported cases of Hib in patients younger than age 5 years
- Secondary cases of Hib are rare (illness occurring 1-60 days following contact with an ill person)

Tetanus

- Caused by bacteria known as *Clostridium tetani*
    - Anaerobic bacteria found in the soil
    - Resides in the gut of mammals
    - *C. tetani* spores can survive autoclaving at 249.8˚F (121˚C) for 10 to 15 minutes
- When the bacteria invade the body, they produce a toxin called tetanospasmin
    - Causes painful muscle contractions and stiffness, usually all over the body
    - Occurs by the tetanus toxin entering adjacent inhibitory interneurons, where it blocks neurotransmission by its cleaving action on the membrane proteins involved in exocytosis of the nerve cell.
    - One of the cardinal features of tetanus: intense, painful spasms of the masseter muscles, and an inability to open the mouth, known as trismus or, more commonly, “lockjaw”
    - Can lead to tightening of muscles in the head and neck, so you can’t open your mouth, swallow, or sometimes even breathe

    - Patients have facial paralysis called “Risus Sardonicus” or “the smile of the devil”
- Kills about 1 out of 10 people who are infected, even after receiving the best medical care
- Rare in the US, thanks to our vaccine efforts.

“Help, I stepped on a rusty nail!”

- A clean nail will cause tetanus just as efficiently as a rusty nail
- Other opportunities for entry of tetanus include:
    - Gunshot wounds
    - Compound fractures
    - Burns
    - Unsterile intramuscular or subcutaneous injections (that often occur in injection drug users)
- What needs to happen for tetanus to occur is:
    - Any injury that penetrates the skin, resulting in the inoculation of *C. tetani* spores
        - Any foreign body increases the risk
    - Other bacteria present, creating a mixed-wound infection
    - Tissue breakdown
    - Localized ischemia
- The incubation period is usually about 8 days, with a usual range of 1 to 3 weeks
- Other opportunities for tetanus infection includes:
    - Infection of the umbilical stump in neonates
    - Obstetric patients (after septic abortions)
    - Bowel flora growth in post-op patients
    - Animal or insect bites
    - Dental abscesses
    - Diabetics with mixed-wound infections on the extremities
    - Injection drug users – *C. tetani* spores can be found in contaminated heroin

Clostridium family reunion

- Clostridia are gram-positive anaerobic bacilli
    - Grow best when there is no oxygen
- We health care practitioners are very familiar with the “star” of the clostridium family, *C. difficile*. However, there are other members of this family we need to avoid as well:
    - *Clostridium botulinum*:
        - Can produce botulinum toxin in food or wounds and can cause botulism
        - Can cause muscle paralysis
        - *Clostridium botulinum* can form spores that are very, very heat resistant
        - Even hours in the boiling water canner will not kill it
            - (source: www.foodsafety.gov)

- *Clostridiodes difficile* can flourish when other gut flora bacteria are killed during antibiotic therapy, leading to superinfection and potentially fatal pseudomembranous colitis (a severe necrotizing disease of the large intestine)
- *Clostridium perfringens* causes a wide range of symptoms, from food poisoning to cellulitis, fasciitis, and gas gangrene
- *Clostridium sordellii* can cause a fatal infection in exceptionally rare cases after medical abortions
    - No oxygen

Treatment

- Tetanus immune globulin (TIG) is recommended for persons with tetanus to remove unbound tetanus toxin
    - Toxin bound to nerve endings is unaffected by TIG
    - A single intramuscular dose of 500 units is generally recommended for children and adults, with part of the dose infiltrated around the wound, if it can be identified
- Intravenous immune globulin (IVIG) contains tetanus antitoxin and may be used if TIG is not available
- Antibiotic therapy is of little value unless debridement is done in an aggressive manner

Vaccination

- The development of tetanus toxoid occurred in 1924
- First widely used during World War II
- After the 1940s, tetanus declined steadily
- Since the mid-1970s, about 50-100 cases have been reported annually in the United States
- More recently, from 2009–2018, an average of 29 cases were reported per year, thanks to our vaccination efforts

WaTcH YoUr ShIfT KeY!!!

- When discussing Tetanus vaccines:
    - Td contains reduced amounts of diphtheria toxoid compared with DT
    - DTaP and Tdap contain the same acellular pertussis components, but Tdap contains a reduced quantity of some pertussis antigens and diphtheria toxoid. Boostrix® contains a reduced quantity of tetanus toxoid compared to Infanrix®.
    - Children younger than age 7 years should receive DTaP vaccine or DT vaccine (if not covering pertussis)
    - Persons age 7 years or older should receive Td vaccine or Tdap vaccine, even if they have not completed a series of DTaP or DT (Tdap would be off-label for children age 7 through 9 years, but is still recommended by ACIP)
    - Tdap (Boostrix® by GSK) is approved for persons age 10 years or older to any age
    - Tdap (Adacel® by Sanofi-Pasteur) is approved for persons age 10-64 years old
        - Note: Either vaccine administered to a person age 65 years or older is immunogenic and would provide protection

    - A dose of either vaccine would be considered valid
- For complete immunization schedule consult CDC
- Tetanus antitoxin levels decrease with time, so boosters are recommended every 10 years
- Small percentage of individuals are unprotected before 10 years, so booster for wound needed if more than 5 years have elapsed since last dose.
- Further reading: https://www.cdc.gov/vaccines/pubs/pinkbook/tetanus.html#epi

--Have a great day on the bench!!

Activity Test

A Broad Look at Childhood Immunizations: Haemophilus Influenzae Type B and Tetanus

Activity tests must be completed online at www.freeCE.com.
A passing grade of 70 or higher and completion of an online activity evaluation are required to earn credit.

1. **Tdap vaccines, such as Boostrix® and Adacel®, are approved for use at the starting age of:**
   A. 6 months
   B. 4 years
   C. 10 years
   D. 18 years

2. **Three-dose series *Haemophilus influena* type b monovalent vaccines, such as PedvaxHIB®, are recommended to be dosed at:**
   A. 2 and 4 months, followed by a booster dose at age 12-15 months
   B. 18 and 24 months, followed by a booster dose at 7 years
   C. 2, 4, and 6 months, with no need for a booster dose
   D. 18, 24, and 36 months with no need for a booster dose