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Whooping Cough: A Pharmacist's Role in an Emerging Endemic

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Abstract

Pertussis is an acute infectious disease caused by the organism *Bordetella pertussis* and characterized by a "whooping cough." Incidence of the disease had declined since the development of a vaccine, but is now increasing in reported cases. This increase has been attributed to both an increased awareness but also surmised to be related to a decrease in vaccinations. The pertussis vaccine is given in conjunction with tetanus and diphtheria vaccines to children before the age of 6 in five separate injections over the course of four to six years. A booster is now recommended for the older child and adults due to the declining protection of the vaccine over time. Pertussis is highly contagious and early treatment with a macrolide antibiotic is recommended to limit the severity and prevent transmission. It can be deadly in infants, which is why prevention via immunizations is so important. The pharmacist can assist with advising individuals of the importance of vaccination.

Introduction

Pertussis, also known as whooping cough, is an acute infectious disease caused by the organism *Bordetella pertussis* that has a history of being a common preventable yet fatal childhood disease. Since the development of the pertussis vaccine in the 1940s, the incidence rate has decreased by at least 75 percent among children. But recently, the number of reported cases of pertussis has increased. The Centers for Disease Control and Prevention (CDC) believes that this increase could be due to heightened awareness and improvement in clinicians' ability to diagnose pertussis, but they also believe that a large portion of the disease goes unreported or unrecognized.¹ According to the Council on Foreign Relations, since 2008 there have been 65,457 reported pertussis outbreaks around the world with an astonishing 56.4 percent of those cases happening in the United States.² Due to rapid spread of disease, these outbreaks usually occur in clusters. Over the years, these clusters of outbreaks experience peaks of incidence every three to five years and continue to follow this same pattern.³ With the use of patient education on signs and treatment of pertussis as well as prevention and vaccination, this recent spike in incidence rate can be controlled.

Disease State

Bordetella pertussis is a gram-negative bacteria that produces many biologically active products, most notably the pertussis toxin (PT). Pertussis toxin modifies inhibitory G proteins rendering them unable to inhibit adenylyl cyclase, an enzyme that plays an essential role in transmitting signals to secondary messengers. Thus, PT forces other activated G proteins into continuous signaling, leading to various unwanted consequences such as immune suppression, which would promote bacterial colonization and potentially in-

crease transmission of the disease.⁴ Physiologically, *Bordetella pertussis* attaches to the cilia of respiratory epithelial cells and paralyzes them. This causes pulmonary secretions to be inadequately cleared and leads to inflammation in the respiratory tract.¹

This very contagious disease is spread from person to person, most commonly by inhalation of droplets from a cough or a sneeze.⁵ Symptoms usually start to occur within seven to 10 days of initial transmission. These symptoms start off as cold-like with a runny nose and mild cough along with a low-grade fever. This can develop into a severe cough or apnea, a pause in breathing pattern that is very common in infants. This severe cough can become so violent and rapid that all the air from the lungs is expelled and the patient is forced to inhale, which results in the characteristic "whooping" sound. These severe coughs can cause young children to vomit and become extremely lethargic.⁶ Complications that occur in infants and children include pneumonia, convulsions, severe apnea, encephalopathy or even death. In teens and adults, complications can include weight loss, loss of bladder control, passing out or even rib fractures from severe coughing.⁷ Infants develop the most severe complications of pertussis because their immune systems are not fully developed at birth and cannot offer full protection against the disease. Although receiving vaccines helps infants fight certain diseases, they are still vulnerable to disease until their immune system is fully developed. If left untreated, these complications can lead to hospitalization of young children and infants in which one to two out of 100 infants will die due to pertussis.⁷ Diagnosis of pertussis involves evaluation of symptoms, a physical exam and a laboratory test of respiratory secretions. These secretions are taken from the back of the throat through the nose and are further evaluated for the presence of *Bordetella pertussis*.⁸

Prevention

The recommended form of prevention for pertussis is through immunizations.⁹ Two vaccines providing pertussis protection are available; Pediatric Diphtheria, Tetanus, and acellular Pertussis vaccine (DTaP) and Adult Tetanus, diphtheria, and acellular pertussis vaccine (Tdap). The use of the upper-case letters in the abbreviations designate the doses of tetanus (T) and diphtheria (D) toxoids, and pertussis (P) vaccine are full-strength. Reduced doses of diphtheria and pertussis are represented by the lower-case "d" and "p" in the adult vaccination. The lowercase "a" in both vaccines represents "acellular" which means only part of the pertussis organism is present.¹⁰ The DTaP is administered to children 6 years and younger in five separate doses usually occurring at ages 2 months, 4 months, 6 months, 15 to 18 months and 4 to 6 years. The Tdap is recommended for children ages 7 to 18

if they have not been fully vaccinated which means they have not received all five doses of DTaP. If they have not received either the DTaP or Tdap vaccines before, adults ages 19 and older should receive a dose of Tdap as soon as possible to protect themselves.¹¹

Along with first time protection, Tdap is also employed as a booster available for older children and adults ages 11 to 64 years, and is especially recommended for patients when coming into contact with infants. Adults may receive Tdap instead of their next scheduled tetanus booster shot, which are usually administered every 10 years. This dose of Tdap can be given before the next 10-year mark.¹¹ Recent studies have shown that the immunity generated by these vaccines, especially DTaP, decreases over time. This waning immunity has led to numerous outbreaks affecting previously immunized individuals. One report studied a population of children between ages 4 and 12 and placed them into groups based on if they possessed pertussis. It was found that every year after receiving their fifth dose of the DTaP vaccine, the children had a 42 percent increased probability in obtaining pertussis.¹² This means the DTaP vaccine would only be 71 percent effective five years after administration when it was 95 percent effective initially.¹³ The results of this study highlight the need for children to receive boosters of the Tdap vaccine in order to stop this waning immunity.

Special considerations about receiving the Tdap vaccine are made for pregnant women, health care professionals and the elderly. During each pregnancy, a woman should receive a dose of Tdap at 27 to 36 weeks to transfer pertussis antibodies to her baby and to protect herself. These antibodies provide the newborn with protection until they begin receiving DTaP vaccines after birth. If the mother has not received Tdap, it is recommended she receive the vaccine in the postpartum period, up to six weeks after birth. Adults 65 years or older should receive a single dose of the Tdap vaccine.¹¹ Health care personnel, such as pharmacists, who work in close contact with patients and have not previously been administered the Tdap vaccine should receive it to prevent spreading pertussis to their patients.

Of course, if a child or adult is moderately or severely ill or allergic to any ingredients, they should not receive either vaccine.¹⁴ In general, the ingredients of purified DTaP/Tdap vaccines administered in the United States contain reduced pertussis toxin, trace amounts of mercury and an aluminum adjuvant.¹⁵ The mechanism of action of these vaccines to prevent pertussis is not fully known, but an immune response is stimulated and protective antibodies are formed. Along with vaccines, prevention using post-exposure prophylaxis in at-risk individuals who have come in contact with a contaminated person can be avoided with the use of prophylactic antibiotics including azithromycin, clarithromycin and erythromycin.¹⁶ These antibiotics are known as macrolides which have bacteriostatic activities.¹⁷

As the most accessible health care professionals, pharmacists are able to play a large role in the prevention of pertussis. In most states, pharmacists are able to administer the Tdap vac-

cine to patients ages 10 and older who have a prescription.¹⁸ This places pharmacists at the center of pertussis prevention. Since retail pharmacists are in constant contact with patients, it proposes the chance to ask high-risk populations, pregnant women and elderly, if they have received their Tdap vaccines. Plus, by examining prescriptions and communicating with patients, pharmacists can recognize if someone is being treated for pertussis. This provides the pharmacist with an opportunity to counsel the patient about the danger of pertussis to infants and ways to minimize the spread of pertussis like good hand washing. Overall, pharmacists possess the ability to educate their communities about pertussis prevention while also administering the Tdap vaccine.

Acute Treatment

Even though multiple prevention techniques against pertussis exist, in 2012, the United States experienced 48,277 cases of pertussis reported to the CDC.¹⁹ Although prophylactic antibiotics are used to prevent the development of pertussis in at-risk individuals, these antibiotics are mainly used to treat those already afflicted by the illness. Antibiotics including azithromycin, clarithromycin and erythromycin are commonly employed treatment medications. Because erythromycin and clarithromycin have a higher propensity to cause gastrointestinal irritation, azithromycin is the preferred antibiotic to be used in pertussis treatment. When used in patients 6 months and older, a 10 mg/kg single dose is given on day 1 and then a 5 mg/kg single dose is administered days 2 through 5. The second-line option is clarithromycin given as two divided doses of 15 mg/kg/day to patients over 1 month old for seven days. A doctor can also prescribe erythromycin for pertussis treatment which is typically given as four divided daily doses of 40 to 50 mg/kg/day administered for 14 days to patients over 1 month old. At least five days of treatment are required before the patient should leave isolation, and it is important for the patient to complete the drug schedule fully.²⁰ Since this disease is highly contagious, those with pertussis should stay isolated and avoid contact with other people, especially the unimmunized and infants. Early treatment is necessary to stop pertussis from spreading, and if the medications are administered before coughing fits begin, the severity can be decreased. These medications only reduce the person's infectivity and do not alter the disease's clinical course. Once the individual has been infected with pertussis for three weeks, the medications are not useful because the bacteria is now absent from the body.⁸

Along with antibiotics, simple adjustments can aid the treatment of pertussis and stop its spread. Those individuals suffering from pertussis should drink plenty of fluids to avoid dehydration. Plus, minimizing irritants such as smoke and dust along with using a cool mist vaporizer helps alleviate an ill person's cough. A key way to stop the spread of pertussis is as simple as good hand washing. Overall, the treatment options for pertussis stop the spread and decrease the severity of pertussis. More serious cases of pertussis may require hospitalization, especially in infants.³ Since pharmacists are very accessible, counseling patients on these treatment points is convenient and beneficial to the community.

Special Populations

There are many special populations who are strongly advised to get the pertussis vaccine. The first population is infants and children, in which the highest incidence rate of pertussis occurs. Along with the vaccine, parents should be advised to keep their children away from anyone with cold symptoms or anyone coughing. The second population is caregivers of infants, who should get the vaccine and practice good hygiene in order to prevent them from spreading pertussis to children. Caregivers can collectively include parents, babysitters and other adults who have close contact frequently with young children. Another population that is recommended to get the vaccine is pregnant women or anyone around a pregnant woman or newborn. This is also a prevention measure taken to protect the child from contracting pertussis soon after birth. A more general population is anyone above preteen age who has not had a booster vaccine. This is solely for prevention of any future pertussis infection and to ensure that the individual has the maximum protection available. This is especially stressed in the elderly population in which immune systems are not as strong. Finally, international travelers should be especially cautious about hygiene and being up to date on the vaccine. Traveling to other countries that have outbreaks of pertussis can put a traveler at great risk to contract that disease, and it also heightens the risk that the traveler will bring the disease back to their country and cause an outbreak there.⁹

Disease Epidemiology

Even with vaccinations available to protect a majority of the population, pertussis is still considered as endemic within the United States.³ Since 2003, pertussis has been on the rise in the Midwest and California.²¹ Reported cases of pertussis across the country jumped to 48,277 cases in 2012, from 18,719 cases in 2011. A general increase in reporting is to blame for a portion of the jump, but the doubling in reported cases is troubling given that pertussis is easily preventable. While most cases of pertussis can be treated with little to no lasting sequelae, cases in infants can be especially severe, with high mortality rates.²² The importance of herd immunity has emerged over the years while the number of reported pertussis cases continues to climb.

In 2010, the United States saw its largest pertussis outbreak since 1947, in a Californian community. With 9,120 reported cases and 10 deaths, this outbreak was one of the first to be studied in relation to vaccination rates. Atwell et al. studied the rate of pertussis spread among clusters of nonmedical exemptions (NME) in kindergartners. Californian parents obtained NMEs if vaccines were seen to be against their religious or philosophical beliefs. Using the Californian Department of Health's reported pertussis data and Kulldorff spatial scans, Atwell et al. found statistically significant higher rates of pertussis among communities with higher rates of NMEs. This study provides health care professionals with a strong correlation between vaccinations and pertussis prevention.²¹

In describing the importance of vaccinations to the prevention of pertussis to patients, a term commonly used is "herd immunity." Herd or community immunity is defined by the

National Institute of Allergy and Infectious Disease as immunizing a critical portion of the population against a disease, thereby preventing an outbreak and protecting a smaller portion of the population which may not be able to receive vaccinations due to health or other rationale.²³ Childhood diseases such as polio and measles are essentially unheard of in first world countries due to the high vaccination rates among the children able to receive vaccinations. This high vaccination rate and immunity protects patients who may not be able to receive vaccinations due to disease states that may leave them immunocompromised or resistant to vaccination. As the number of people opting out of vaccinations grows, the herd immunity of communities within the United States weakens. This is especially troubling due to the disease's severe threat to infants. By informing patients of this concept while promoting vaccinations, high-risk populations can be easily protected until they are able to receive the vaccination themselves.

Conclusion

Pharmacists are one of the most readily available health care professionals and can therefore play an important role in counseling patients on the pertussis vaccination. When counseling patients about important vaccinations, pharmacists may run into patients hesitant to vaccinate due to many different reasons. The most common reasons include a belief that the vaccine-prevented disease no longer poses any risk, a doubt in the safety of the vaccine or a belief that the vaccine may overload a child's immune system or be linked to autism (which has been proven to be incorrect in multiple peer-reviewed studies). Conservative forms of Islam, Judaism and Christianity have reasons against vaccinations, often because of the production or contents of the vaccine. When counseling parents who are vaccine-hesitant, Dr. John Harrington outlines eight points that health care professionals should keep in mind. First, health care professionals should begin having vaccination conversations early (such as an infant's first pediatrician visit), and pharmacists can distribute vaccine information sheets often to promote questions and conversations. While counseling, it is important to take the time to listen to all questions without patronizing the patient. Health care professionals should never offend the patient or become offended by earnest questions. Acknowledging possible peer-reviewed risks, using clear, patient-friendly language, and respecting a patient's authority in decision-making allows for open conversations with patients about vaccinations. Pharmacists can also explain the reduction of pain for children receiving vaccinations through the use of sucrose or swaddling.²⁴ Community pharmacists can play a role in many of these steps by being available for patients with questions. Taking extra time to explain vaccinations or distribute educational material to the patient who has become a new parent, will add on to the information many parents will be receiving from their child's pediatrician. By educating vaccine-hesitant patient populations, pharmacists can help increase pertussis vaccination rates and help reverse the outbreak trend.

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