

Diphtheria Outbreak Investigation in Florida

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MPH 717- Epidemiology of infectious Disease – Dr. Taylor

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Summary of Respiratory Diphtheria Outbreak Investigation in Lee County Florida

2022 Investigation Introduction:

On October 6, 2022, the Florida Department of Health was notified of multiple clinically diagnosed cases of *Corynebacterium diphtheriae* (c. diphtheriae) infection in individuals displaced by hurricane Ian. The US Centers for Disease Control and Prevention (CDC) were subsequently notified. All the infected individuals were temporarily housed at Hertz Arena in Estero and were unvaccinated or under vaccinated. A total of 507 individuals were housed at this facility over an 11-day period beginning on September 29, 2022. The first two patients developed symptoms on October 2, 2022 and received a medical diagnosis of diphtheria on October 4, 2022 due to the presence of a grey pseudo-membrane in the larynx which is indicative of diphtheria infection. Both cases were later laboratory confirmed. The ages of these patients were 12 months and 3 years, neither of which had received the recommended DTaP vaccinations appropriate to their ages.

After notification on October 6, 2022 an outbreak investigation by the Florida Dept of Health began at 3:00pm that afternoon under the direction of the CDC. The primary objectives of this investigation were to verify the existence of a respiratory diphtheria outbreak, determine the scope of infection, to take appropriate steps to slow or halt the spread of diphtheria and to prevent spread to other regions. During the investigation 43 individuals presented with flu like symptoms and consented to be tested for diphtheria, SARS-COV-2, influenza. 13 laboratory cases were discovered between October 5-11, 2022. By October 10, 2022 the Hertz Arena was emptied, cleaned, and disinfected in preparation of a concert taking place on October 14, 2022 of that month. An external infection linked to the Hertz Arena outbreak was discovered in Pensacola, FL on October 13, 2022 from an individual who spent 2 days at the arena and

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moved on to stay with family, all of whom were up to date on vaccination and voluntarily quarantined for the requisite 5 days post exposure (International Federation of Red Cross [IFRC], 2022).

There is no evidence to confirm whether the *C. diphtheriae* bacterium was introduced to the area from international importation or originated in the area. Further investigation will be needed for that determination and is outside of the scope of this investigation. However, the infection was able to take hold in the unhoused population due to cramped living quarters, environmental humidity, and the current low vaccine uptake in the region. The last two years have shown lower DTaP vaccine uptake infants and children. Tdap boosters in adults is also low in this region (Florida Health, 2022). This resulted in two hospitalizations and no deaths.

Background:

Corynebacterium diphtheriae (*C. diphtheriae*) is a gram-positive bacillus bacterium of which some strains can produce a toxin that will result in a diphtheria infection in susceptible individuals. This illness is generally seen in regions with disrupted vaccination programs and is exceedingly rare in industrialized nations. Attack rate in a completely susceptible population is 50-100 per 100,000 and a case fatality rate of 5 to 10% with treatment (IFRC, 2022). *C. diphtheriae* causes a respiratory illness which often presents with a grey pseudo-membrane in the nose, pharynx, tonsils, or larynx (U.S. Centers for Disease Control and Prevention [CDC], 2022). Other symptoms include general malaise, fever, sore throat, difficulty with swallowing and a loss of appetite. Complications can occur including myocarditis neuritis, otitis media and respiratory insufficiency (CDC, 2022). This infection is spread person to person through the respiratory droplets of infected individuals. Heat and humidity can increase the rate of disease transmission. There is an average incubation period of 2-5 days, but this can last up to 10 days (Truelove et al, 2020). Infected individuals have an average infectious period of 2 weeks;

however, this can be shortened through the use of antibiotics, at which point the infectious period may end within 48 hours of the first administered dose. Antibiotics are the generally needed to clear the infection. In some number of cases, diphtheria anti-toxin is also required and must be administered within a specified amount of time in order to be effective (CDC, 2022). In a susceptible population, the reproductive number of respiratory diphtheria is between 2-4, however, due to wide availability of vaccination, infection is rare in the United States. The most susceptible populations are unvaccinated individuals under the age of 5 and over the age of 45 or unvaccinated individuals of any age with one or more chronic conditions or an autoimmune disorder. Failing to receive the recommended booster each decade of adulthood is considered under vaccination and can leave an individual susceptible to disease. Vaccinated individuals will see a marked decrease in diphtheria toxoid antibodies between 2- and 6-years post vaccination with antibody status reverting to pre-vaccine status in many individuals after 6 years (Gao et al, 2022).

Investigation Methods:

Diphtheria is a reportable disease on a state and federal level. Any case discovered requires action (IFRC, 2022). Two cases from the same location with a large, unhoused population increased the likelihood of an outbreak and required a full outbreak investigation (CDC, 2022). The Merlin system, Florida's disease surveillance system, notified the Florida Department of Health to the two clinically diagnosed cases of diphtheria in Lee County at 8am October 6, 2022. The outbreak investigation began at 3:00pm on October 6, 2022, with a case-finding site visit. Informational interviews were conducted with adults experiencing symptoms, and individuals acting as caregivers to those experiencing symptoms. Basic case information was obtained, as well as vaccination status. Interviews were followed by testing of consenting individuals experiencing symptoms as well as asymptomatic care takers. Both infected individuals and their care takers were prescribed either erythromycin or penicillin (CDC, 2022).

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Rapid antigen SARS-CoV-2 and rapid antigen influenza testing via nasopharyngeal swab was completed on all consenting individuals concurrently with pharyngeal mucosal swabs to be lab tested for diphtheria. All mucosal swab samples were sent to the CDC lab in Atlanta, GA for Elek in vitro immunoprecipitation assay testing (CDC, 2022).

After the site visit was completed, the Florida Department of Health followed up with 8 individuals via telephone who were known to have spent time at Hertz Arena but had left by the time of the outbreak investigation site visit. This was done to determine potential transmission outside of the arena and local area. A line list of cases and vaccine status was created along with a map of the outbreak and an epidemic curve. Temperature and humidity testing was completed inside the main floor of the arena.

Case definition: The CDC case definition was utilized in this investigation which is: “Upper respiratory tract illness with an adherent membrane of the nose, pharynx, tonsils, or larynx and the Isolation of *C. diphtheriae* from any site and confirmation of toxin-production by Elek test” (CDC, 2022). All cases in this investigation were Elek tested in the CDC laboratory, including the two initial clinically diagnosed cases.

Results:

A total of 13 cases were discovered during the case-finding site visit. A 14th case was discovered in Pensacola, FL that was traced back to the Hertz Arena outbreak. No cases have been discovered outside of these two regions at this time, nor have any other cases been found in Pensacola. 8 pediatric cases were discovered with a median age of 2 years and 6 adult cases were discovered with a median age of 48.5 years. The cases began in two children and spread to other children and then adults. 12 of the 14 cases presented with a grey pseudo-membrane that is indicative of a diphtheria infection. Males made up 71% of all cases discovered. All

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cases included individuals who were unvaccinated or under vaccinated. A total of 7 individuals had comorbidities that are thought to have increased their susceptibility to infection. The first symptoms were experienced on October 2, 2022 and clinical diagnosis was given two days later on October 4, 2022. No cases have been diagnosed since October 13, 2022. Indoor temperature was 78 degrees with a humidity level >50% indicating an increase in risk for respiratory droplet transmission.

Figure 1: Epidemic Curve of Diagnosis Date

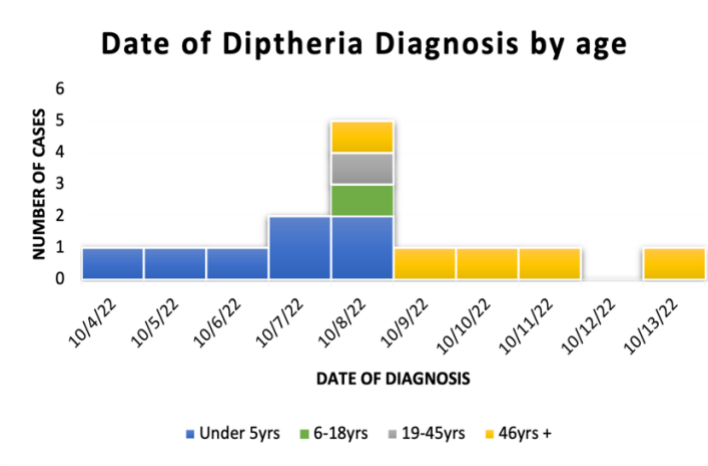


Figure 2: Breakdown of Infection by Sex

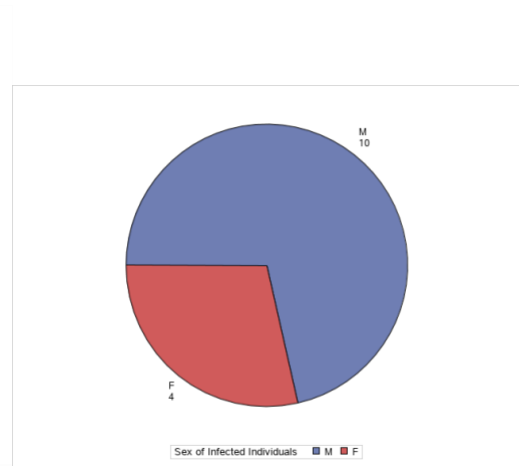


Table 1: Line listing of Key Outbreak Information

Diphtheria Outbreak Key Information Line List										
Obs	SymptomOnset	Age	DiagnoseDate	Sex	Membrane	Comorbidities	Vaccinated	Displaced	VaccineUTD	Hospitalization
1	10/02/2022	1	10/04/2022	M	Y	0	N	Y	N	N
2	10/02/2022	3	10/05/2022	M	Y	0	N	Y	N	N
3	10/03/2022	2	10/06/2022	F	Y	0	N	Y	N	N
4	10/04/2022	1	10/07/2022	M	Y	0	N	Y	N	N
5	10/06/2022	4	10/07/2022	F	Y	2	N	Y	N	N
6	10/05/2022	2	10/08/2022	M	Y	0	N	Y	N	N
7	10/05/2022	1	10/08/2022	M	Y	0	N	Y	N	N
8	10/07/2022	11	10/08/2022	M	Y	0	N	Y	N	Y
9	10/05/2022	44	10/08/2022	M	N	4	N	Y	N	N
10	10/04/2022	48	10/08/2022	M	Y	1	N	Y	N	N
11	10/07/2022	46	10/09/2022	F	Y	2	N	Y	N	N
12	10/06/2022	68	10/10/2022	M	Y	1	N	Y	N	Y
13	10/08/2022	49	10/11/2022	M	N	1	N	Y	N	N
14	10/05/2022	52	10/13/2022	F	Y	2	N	Y	N	N

Strengths & Limitations:

The primary strength of this investigation is that all cases discovered were confirmed in the laboratory by an Elek in vitro immunoprecipitation assay which has a diagnostic sensitivity of 99%. It is further supported by the fact that if any other cases present to a medical facility in the state, they will be reported, and the Florida Dept of Health will be notified through the Merlin system. The study was limited by the requirement for consent to be tested and the ability of potentially ill people to opt out.

Discussion and Conclusions:

An outbreak of respiratory diphtheria in Lee County Florida was reported on October 6, 2022. Upon investigation a total of 14 cases linked to the Hertz Arena were discovered. The epidemic curve shows that the infection began in children who went on to infect susceptible older adults. Young children are less able to cover coughs and or take any infection prevention measures making the spread to fellow children likely. Adults over 45 are more susceptible to diphtheria infection and are also less likely to seek medical treatment at the first sign of symptoms (CDC, 2022). This is demonstrated in the line list, where it is seen the time from onset of symptoms to the time of diagnosis was longer in infected adults. The most affected populations were those under 5 and those over 45 which is keeping with what is known about diphtheria susceptibility. The epidemic curve also indicates quick transmission and then a waning of infection once treatment and isolation for infected individuals were given and the unvaccinated human reservoir was no longer available. Multiple diagnoses on October 8, 2022 are due to the results of the testing campaign done on the first day of the outbreak investigation returning from the CDC lab. Male infection rate was 2.4 times greater than female. Adult males are less likely to seek out routine medical care, including vaccinations, leaving this group more susceptible than their female counterparts (Thompson et al, 2016). All infected individuals were unvaccinated or

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under-vaccinated which left them susceptible to infection. This indicates a need to strengthen the Tdap and Dtap vaccination program in Florida. While vaccination will not completely stop infection and colonization of bacteria, it does reduce symptomatic infection and transmission should infection occur (Truelove et al, 2020). At present, Florida has vaccine programs for both children and adults (Florida Health, 2022).

In the wake of this outbreak, it is vital to increase awareness of diphtheria to the general public, and medical practitioners across the state. Community education is important at this time. All individuals who stayed at Hertz Arena during the period of Sept 29-Oct 10 should be made aware of their possible exposure and should quarantine for a period of 5 days from the date they left the facility (IFRC, 2020). Anyone with symptoms should reach out to their primary care physician or the local health department and isolate until a time that a diagnosis can be ruled in or out. Mobile vaccine clinics should be considered in Lee County, and surrounding counties as well as in Escambia County to facilitate increased vaccine uptake and prevent the further spread of diphtheria in the region. More research should be done on vaccine hesitancy in the area, and strategies should be developed to further lessen hesitancy in the region.

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