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Diphtheria Outbreak in Serang City, Banten, Indonesia, 2024: Epidemiological Investigation and Response

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Abstract. Diphtheria is an infectious disease and often causes outbreak. Despite a significant global decrease in diphtheria cases due to effective vaccines, there's still a risk transmission for individuals who unvaccinated or incompletely vaccinated. A positive culture for Corynebacterium diphtheriae was reported in a diphtheria suspect in Serang City and an outbreak investigation was carried out. This study aimed to investigate the outbreak, identify risk factors, and recommend control measures. Data were collected through interviews and field observations to close contacts consist of household contacts, neighbors and school and we reviewed immunization coverage from the Public Health Center. Based on the investigation, it was shown that a 6 years-old male with signs and symptoms of Fever, Sore Throat, Swollen Neck, Pseudomembrane, difficulty swallowing, mouth ulcers, cough and vomiting, and positive results for toxigenic corynebacterium diphtheriae var intermedius. Risk factors for transmission are low immunization coverage, high population density, and mobilization. No additional cases were identified, but some close contacts were at risk of transmission due to unvaccinated. We recommend implementing Outbreak Response Immunization (ORI) as a critical measure to interrupt transmission.

Keywords: Diphtheria, Investigation, Immunization, Outbreak

1. Introduction

Diphtheria is an infectious disease caused by the toxin-producing bacteria *Corynebacterium Diphtheria.* The disease can spread from person to person when an infected person coughs or sneezes. The diphtheria toxin causes damage to the respiratory tract and can spread throughout the body. Common symptoms include fever, sore throat, and neck swelling. Diphtheria is a vaccine-preventable disease (VPD) it can affect anyone but is most common in children who have not been vaccinated.(Chin, 2000)

Diphtheria remains a serious public health issue, particularly in areas with suboptimal immunization coverage. In Indonesia, recurrent outbreaks highlight gaps in routine immunization programs regarding immunization service disruptions caused by the COVID-19 pandemic, which led to decreased DTP4 coverage below the national target of 95%. This situation underscores the urgent need to investigate the factors driving the outbreak and to develop targeted interventions.(Ministry of Health, 2023)

Previous studies have demonstrated that diphtheria outbreaks are commonly associated with low immunization coverage, population density, and increased mobility.(Alla Pavli, 2017; Nassar et al., 2022) Research from East Java and East Kalimantan, for instance, identified incomplete immunization and high-risk environments as significant factors contributing to outbreaks.(Muhamad Ramdan et al., 2018) Diphtheria outbreaks have been closely linked to

various epidemiological factors, with mobility being a significant contributor to the spread of the disease.

A study in Indonesia highlighted that mobility among children and parents increased the risk of diphtheria outbreaks, recommending restrictions on movement in areas with rising case numbers.(Muhamad Ramdan et al., 2018). The study from Ukraine found a positive association between diphtheria incidence and population density.(Alla Pavli, 2017) Additionally, incomplete vaccination remains a critical risk factor. Immunization status has a significant relationship and has the most dominant influence on the incidence of diphtheria.(Rahmadhani et al., 2019)

Diphtheria is preventable through vaccination; however, its incidence has increased in several regions, particularly in countries with low vaccination coverage. According to data from the World Health Organization (WHO, 2021), between 2021 and 2023, diphtheria cases in Indonesia have also increased, especially affecting children under the age of five. Diphtheria cases in Banten Province are still being reported, with DTP immunization coverage remaining below the national target of 95%. This condition can increase the risk of diphtheria outbreak transmission and need to gather information on case distribution, severity, immunization history, and risk of death in diphtheria patients to effectively plan and implement optimal prevention and control measures.(Fardani & Wahyono, 2023)

The epidemiological investigation aims to protect public health by identifying the source of the disease and implementing control measures to prevent the further spread of the disease. Information on the distribution of cases, severity levels, immunization history, and mortality risk among diphtheria patients is essential for guiding effective prevention and control measures for the disease.

2. Method

The investigation of the diphtheria outbreak was conducted following the 2023 Diphtheria Outbreak Guidelines from the Indonesian Ministry of Health. A cross-sectional investigation was conducted involving clinical case identification, laboratory confirmation, and contact tracing. Epidemiological data were collected through interviews and medical record reviews. Primary data were collected through interviews with 41 close contacts and oropharyngeal swabs consist of contacts at home, neighbors, and schools. Vaccination history and immunization coverage were assessed to identify immunity gaps. Environmental assessments and community surveys were also performed to evaluate risk factors for disease transmission.

3. Result

Patient is a male, aged 6 years-old. Based on the immunization history remembered by the case's parents, case had received DTP vaccination. The onset on February 1, 2024, and additional symptoms appeared including sore throat, swollen neck, pseudomembrane on tonsils, difficulty swallowing, mouth ulcers, cough, and vomiting on February 2, 2024. The case was referred by a private practice doctor with a suspected diagnosis in the Hospital on February 03, 2024.

On February 5, 2024, the patient was administered Ceftriaxone 1g via IV drip with NaCl 50 cc. Specimens, including a throat swab from the oropharynx, were collected from the patient and close contacts (including the mother) and sent to the Health Office for analysis. On February 6, 2024, the patient received 80,000 IU of Anti-Diphtheria Serum (ADS) and was prescribed additional medications: Dexamethasone 0.5 ml twice daily, Ketorolac 1 mg three

times daily, Erythromycin 1 tablet four times daily, Ondansetron 2 mg twice daily, and Paracetamol 200 mg three times daily.

The specimen was sent to the Laboratory and received on March 1, 2024, the results of the laboratory examination positive culture and PCR in the suspected case with the results of the examination of Corynebacterium diphtheriae var intermedius toxigenic. While in close contact (Mother) the test results were negative on March 14, 2024.

Specimens were collected from 41 close contact consisting of various groups, such as classmates, playmates, school vendors, teachers, families, and neighbors. The results of the analysis of the culture and PCR examination of Diphtheria showed that 41 close contacts were declared negative. The characteristics of close contacts based on gender indicated that 63% were male, while 37% were female. This finding demonstrated a higher proportion of male close contacts compared to females.

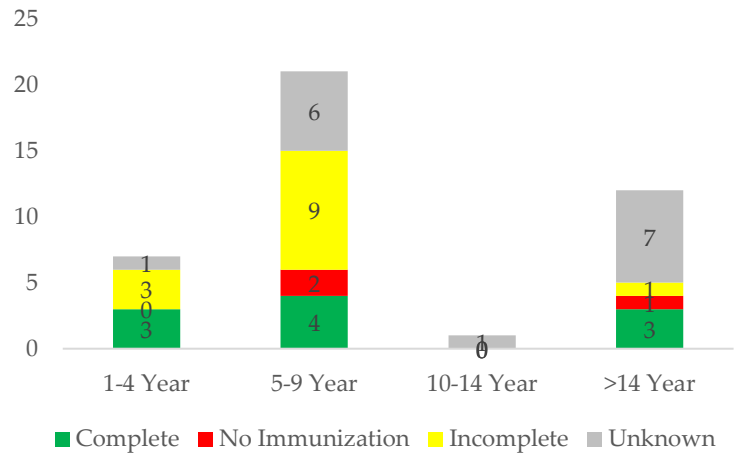

Figure 1. Characteristic of contacts by years and immunization

From this graph presenting that incomplete and unknown immunization statuses were predominant across all age groups, particularly in the 5-9 years and >14 years categories. The findings highlight a gap in immunization coverage, which poses a potential risk for disease transmission.

Coverage of DTP 3 and 4 in Serang City in 2023 DTP 3 was 98.9% and DTP 4 was 59.7%, still below the national target of 95%, while until April 2024 it had only reached 18.2% and 11.7%.

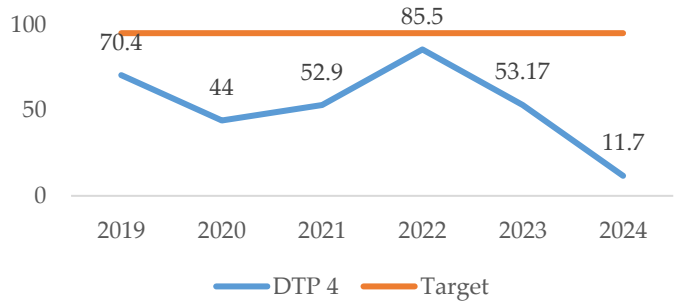

Figure 2. Immunization Coverage in Serang City, 2019-2024

Immunization coverage for DPT4 in Serang has consistently fallen below the 95% target over the past five years, with rates fluctuating from 70.4% in 2019 to a concerning 11.7% in 2024. The case resides in a densely populated area, with parents working outside the city and frequently traveling. The response to the diphtheria outbreak involved a comprehensive strategy to contain the spread and protect public health. Key measures included case management, contact tracing, advocacy and coordination for strengthening routine immunization and surveillance.

4. Discussion

The patient, a 6-year-old male, exhibited classical symptoms of diphtheria, including a sore throat, swollen neck, pseudomembrane on the tonsils, difficulty swallowing, mouth ulcers, cough, and vomiting. The pseudomembrane, a hallmark of diphtheria, appeared on February 2, 2024, shortly after the onset of initial symptoms. These findings are consistent with the literature, which highlights the rapid progression and severity of symptoms in toxigenic diphtheria cases.(Otshudiema et al., 2021) The early identification and clinical management, including the use of Anti-Diphtheria Serum (ADS), played a crucial role in mitigating the disease's severity. ADS is known to neutralize the diphtheria toxin, reducing complications and mortality. The prompt use of ADS, combined with antibiotics such as Ceftriaxone and Erythromycin, reflects adherence to established clinical guidelines for diphtheria management.(Chin, 2000; Otshudiema et al., 2021) cases are given ADS at the right dose and time and help protect cases from diphtheria toxin.

Specimens were collected from 41 close contacts, including family members, classmates, and neighbors, with all results returning negative for *Corynebacterium diphtheriae*. Although rare, it is possible that transmission of the causative bacteria may occur from healthy asymptomatic carriers (carriers), as chronic carriers can shed infectious organisms for up to six months or more.(WHO, 2018) The study found that 1.4% of the population were healthy carriers of *C. diphtheriae*. Two-thirds of them harbored nontoxigenic strains, which could be transmitted among human hosts asymptomatically.(Kitamura & etl, 2023) Furthermore the Diphtheria Outbreak in Switzerland reported that among individuals with positive throat tests, a high proportion (90.0%) were asymptomatic.(Brockhaus et al., 2024) This finding should raise concerns regarding the risk of carriers in diphtheria cases, so it is necessary to monitor the local area for at least 6 months.

Immunization coverage data reveals significant gaps, particularly for DTP 4, which fell to a concerning 11.7% in 2024, far below the national target of 95%. The incomplete immunization status, particularly in children aged 5-9 years and adolescents over 14 years, highlights a critical vulnerability. (Phan et al., 2018) In line with the results of the study, children under 15 years old are particularly vulnerable, with studies showing that most cases occur in this age group due to insufficient immunization.(Rintani et al., 2018) Studies indicate that partially vaccinated or unvaccinated individuals significantly increase the likelihood of disease transmission. Enhancing immunization programs, including catch-up campaigns and routine vaccination, is essential to address this gap and build herd immunity.

High population density and increased mobility are significant contributors to the transmission of diphtheria. Overcrowded living conditions create an environment that facilitates the rapid spread of infectious diseases due to close and frequent contact between individuals.(Alla Pavli, 2017; Nassar et al., 2022) Additionally, high mobility—such as travel to areas experiencing outbreaks—has been recognized as a critical risk factor for the resurgence of diphtheria. Studies show that child and parental mobility can increase the

likelihood of diphtheria outbreaks by more than eight times.(Muhamad Ramdan et al., 2018). Mobility of children is the main risk factor of diphtheria. It is recommended to forbid children/parents to visiting the area where a diphtheria outbreak is occurring, and to improve the condition of the child's nutritional status.(Muhamad Ramdan et al., 2018) This concern is particularly relevant in regions with populations that frequently migrate or travel for work, education, or other purposes, as such movement increases the risk of exposure to infected individuals and subsequent disease transmission. In line with the study, another risk factor is that the work of parents who carry out activities in the market is a place with high interaction between many people, which increases the risk of spreading infectious diseases, including diphtheria.

The outbreak response included case management, contact tracing, advocacy, and efforts to strengthen routine immunization and surveillance systems. These measures were critical in containing the outbreak and preventing further transmission. However, sustained efforts, including addressing gaps in immunization coverage and enhancing public health infrastructure, are necessary to prevent future outbreaks.

5. Conclusion

The study highlighted that low immunization coverage, particularly in high-density and highly mobile populations were factors that had led to resurgence of diphtheria transmission. Close contacts with incomplete or unvaccinated immunization status are at a higher risk. To address this, it is recommended to strengthen routine immunization programs, conduct catch-up vaccination campaigns, and improve surveillance systems to identify and manage vulnerable populations. Educating the public about the importance of diphtheria immunization and encouraging immediate reporting of suspected diphtheria cases to Public Health Centers are also critical measures.

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