An Epidemiological Investigation of the Diphtheria Outbreaks Reported in a District of Gujarat

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Abstract:

Introduction: Mortality and morbidity due to infectious disease have reduced in the last couple of decades. Diphtheria is one of the infectious diseases which can be preventable with a complete immunization. **Objective :** To understand trends and identify factors affecting the outbreak of diphtheria in Banaskantha district of Gujarat. **Method :** A retrospective study based on the available case records for the years 2019, 2020 and 2021(till June). The study was conducted after the reported diphtheria cases in a district. The study was a public health response and intended to provide specific geographical recommendations to the district. The data was recorded from the reported case record and immunization registers. The data were analyzed for defined variables. **Results :** Out of the 366 cases identified during years 2019-2021. Almost 74% cases have occurred during 2019, with a 7.7% mortality rate. Total 48% of cases were among the age group of 5-10 years, with an increasing number of cases during August-December in specific geographical distribution. Among all the cases, 164 (44.5%) have never taken any vaccine in their lifetime or are unaware of the vaccination status, and 87.9% of cases have not taken third dose of DPT or Pentavalent Vaccine, which is associated statistically with the mortality. **Conclusion :** The prevalence of diphtheria cases was high in children who have not taken all three doses of DPT or Pentavalent vaccine. These have shown an essential role of immunization, focusing on the vaccine for all doses and need to create a customized awareness communication plan.

Keywords: Diphtheria, DPT Vaccine, Epidemiology, Immunization, Pentavalent Vaccine

Introduction:

Diphtheria is a severe bacterial infection caused by Corynebacterium diphtheria which may involve many body organs if remains untreated. The Greek meaning of the name suggests "Leather," which points towards the pseudo membrane, the critical feature of the disease.[1] It gets manifested within two to five days of exposure with any contaminated surfaces or through air droplets. It will get symptoms from mild sore throat and fever with grey or white discoloration of the throat to grave multisystem failure on the release of toxins in the body.

Diphtheria was one of the primary causes of mortality before introducing vaccines among children.[1] Despite the strengthening of the universal immunization program, diphtheria remains endemic

in India. A total incidence of 22,986 diphtheria cases was reported globally during the year 2019. India has the highest proportion of 41.9% (n=9622) reported worldwide during 2019.[2,3] Developed countries have successfully controlled the spread of disease. However, it remains a concern for developing countries as most cases were reported through developing nations. Vaccination proves an effective tool in reducing and preventing diphtheria cases among children aged < 15 years. Children with at least three doses of diphtheria, pertussis (whooping cough), and tetanus (DPT) vaccine have shown approximately 50% efficacy against diphtheria and with more than two booster doses have shown 91% efficacy.[4] India had overall 87% coverage for the third dose of DPT vaccine with 63.2% (n=445) districts out of 704 reported above or equal to 80% coverage.[3,5] Only 61% of children in India aged 12-23 months are fully vaccinated even after more than 40 years of vaccination campaign.[6] Gujarat shows the coverage of 86.1% for the third dose of pentavalent vaccine, and Banaskantha, a district of Gujarat, having 64.1% coverage.[7,8] Multiple factors play an essential role in diphtheria cases among the community, i.e. vaccination coverage, poverty, education, hygiene and cleanliness, migration, social stigma and beliefs for vaccination etc. Borders of the states are commonly affected by diphtheria cases due to frequent to and fro movement and loss of follow-up during vaccine campaigns.[1]

Present study was conducted to understand the trends of diphtheria cases in Banaskantha district of Gujarat. Factors affecting the outbreak of diphtheria were also identified. District-specific recommendations are provided based on the available information which will be helpful in preparing the prevention plan in future.

Method:

The present record-based retrospective study was conducted on 336 confirmed diphtheria patients reported from a district of Gujarat. The records were taken from the line listing of cases with selected variables screened and identified by health staff during surveillance of vaccine preventable diseases. In June 2021, the team was formed at state health department with group of experts; and investigation was carried out with the sole objective of finding out epidemiological linkages and recommending necessary actions to control the outbreaks. The investigation team has coordinated with health department of Banaskantha district and requested all the available data of diphtheria cases of previous years. The team was provided with line list of patients identified during the diphtheria outbreaks in Banaskantha District in 2019, 2020 and 2021(till June). Variables like the number of cases, mortality rate, age group-wise bifurcation, month-wise number of cases reported, vaccination status, and correlation with mortality were identified andanalyzed. Geographical periodic year-wise analysis was also carried out to identify the distribution and identification of cases.

Case Definition:

Clinical Identification: Symptoms characterized with fever, sore throat, headache and particular greyish or whitish discoloration in the throat.[2]

Case Classification : As per the available district records, all field level staffs were trained for primary screening and identification of cases with diphtheria. All private medical practitioners (including AYUSH) were sensitized to strengthen the liaison between private and public health facilities for early referral and management. Cases with severe illness were referred at Sub District Hospital (SDH) Tharad, and those in need of a ventilator were referred to tertiary level medical college. The training and sensitization activities were carried out in February 2019 during roll out of surveillance system of Diphtheria, Pertussis and Neonatal Tetanus cases by the district health officers.

Data collection and Analysis : The yearly reports for the disease outbreak were the source of data, and due efforts were made to conceal the identity of patients. The data collection was carried out from secondary data of the case record registers, which

contains demographic, programmatic information of patients, and clinical parameters of patients filled up by health staff.

Inclusion Criteria : All cases registered by the District Health Staff.

Exclusion Criteria : Cases missed by the health staff to identify and register and cases with inadequate information.

Ethical Permission : This study was conducted as an the emergency response to outbreak and designed to provide information on to the public health response. The investigation was aimed at achieving public good

(beneficence) and collective welfare (solidarity); no harm was done to any individual (nonmaleficence); fair, honest, and transparent (accountability and transparency); and participants' data were de-identified before analysis (confidentiality).

The trend of identification of diphtheria cases at Banaskantha District was described based on the data collected from the district health team. Statistical analysis was carried out for proportions and chi-square test to identify the relationship between cases, immunization status and associated variables using Statistical Package for the Social Sciences (SPSS) version 16.

Table 1: Age group and year-wise number of cases & mortality due to Diphtheria at Banaskantha (BK) district (n=366)

Age Group	Year 2019 No. (%)	Year 2020 No. (%)	Jan- June 2021 No. (%)	Total No. (%)
< 2 Years	13.00 (4.8)	7 (9)	4 (22.22)	24 (6.6)
2 – 5 Years	32 (11.9)	16 (20.5)	2 (11.11)	50 (13.7)
5 – 10 Years	130 (48.2)	36 (46.15)	9 (50.0)	175 (47.8)
10 – 16 Years	83 (30.7)	16 (20.5)	3 (16.7)	102 (27.9)
> 16 Years	12 (4.4)	3 (3.9)	0 (0.0)	15 (4.10)
Total	270 (100)	78 (100)	18 (100)	366 (100)

Figure 1: Month-wise number of cases identified for Diphtheria at Banaskantha district (n=366)
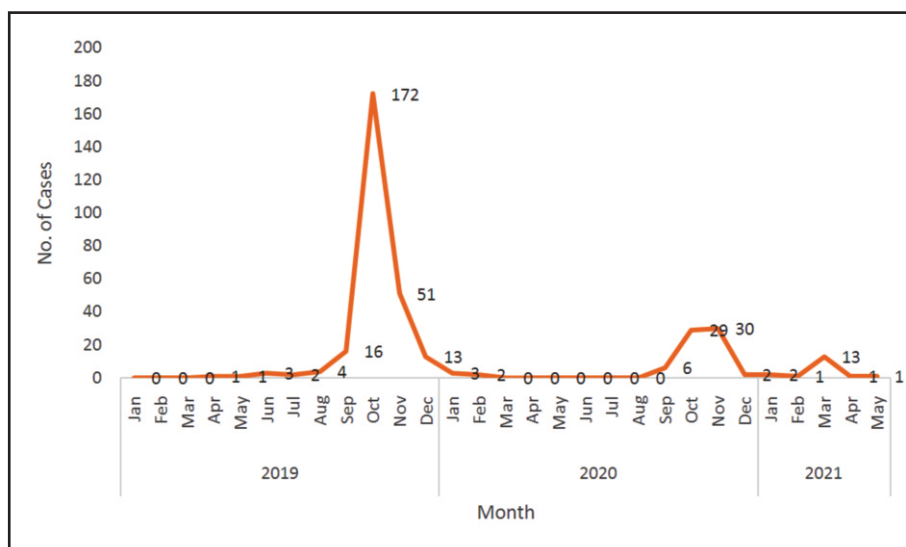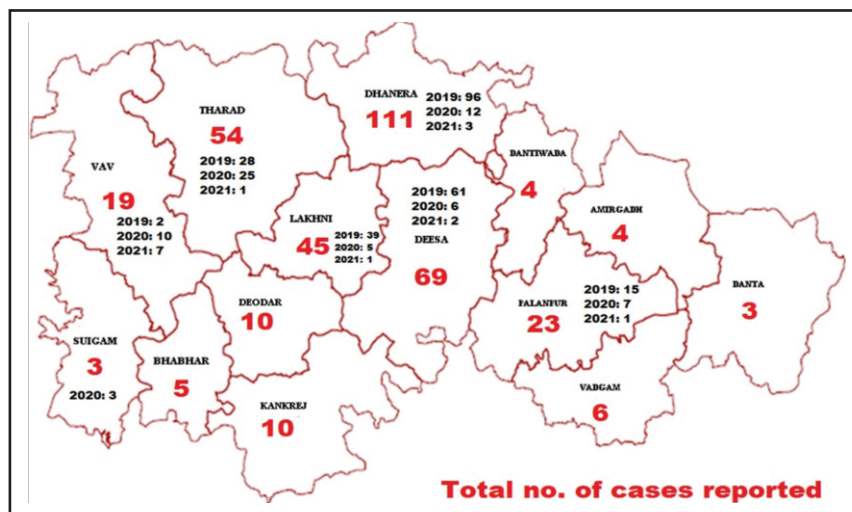
Figure 2: Block-wise distribution of Diphtheria cases for last three years in Banaskantha district (n=366)

Results:

Data for the total 366 cases identified for diphtheria during the last three years at Banaskantha (BK) district was available, out of which 73.77% was during 2019. The distribution showed that maximum cases identified during 2019 (n=270, 73.77%) followed by 2020 (n = 78, 21.3%) and 2021 (n =18.5%). Total 33 (9.01%) deaths took place, 20 (58.3%) in 2019. 10 (30.3%) in 2020 and 3 (9.09%) in 2021. Analyzing the age-wise distribution of identified cases, around half of the children (47.81%) were in the age group of 5 – 10 years, followed by 10-16 years (27.87%), 2 – 5 Years (13.66%), < 2 years (6.56%) and > 16 years (4.10%). (Table1)

Most of the cases were reported during the Sept-Dec period majority, but the last trend was observed in March 2021 with a report of three cases. (Figure1) Geographically, four blocks were commonly affected and had a maximum number of cases for diphtheria during the last three years, i.e., Deesa, Dhanera, Lakhani and Tharad.(Figure2)Out of 215 villages, 22 (10.23%) villages had been affected more than once during the previous three years in a district. This may be correlated with the migratory tribal population; and working as a laborer in big farms for all crop seasons left uncovered during the catch-up round of vaccination scheduled near Holi festival days. The tribal migratory population usually celebrates the Holi festival in their native places, so the active in and out migration would have affected the campaign.

Table 2 showed the variables; gender, high-risk establishments, brick kilns, nomads, farm laborers, construction sites, and the recent history of travel since last month. Their vaccination status was statistically associated with the reported deaths of diphtherial disease. Out of 366 reported cases, only 70 (19.1%) cases had not received any vaccine during their lifetime, and 94 (25.7%) cases did not aware of their complete immunization status. 15 (21.4%) out of 70 cases reported deaths who have not taken any vaccine. That was associated with mortality due to diphtheria. The district immunization records showed that the third dose of diphtheria toxins containing vaccine was associated with mortality. The study found that a total of 12 (3.3%) cases had taken the third dose of vaccine, and 29 (87.9%)reported deaths had not taken the vaccines. The association was statistically significant with an adjusted odds ratio of 5.6 (95% CI 1.59 – 19.73). There was no history of taking booster doses at 10 and 16 years of age among the reported cases.

Discussion:

The current study suggests that most of the cases were reported during 2019, and then subsequent decreases over time. Mortality was also reported high during the same year. Almost half of

Table 2: Variables associated with the deaths due to diphtheria among the reported cases in Banaskantha district (n=366)

Variables			Death due to diphtheria n = 33	Survived n=333	Total Reported Cases n=366	Chi-square p value
			n (%)	n (%)	n (%)	
Age Groups (Years)		< 2	5 (15.2%)	19 (5.7%)	24 (6.6%)	13.760 (0.0081)
		2 – 5	9 (27.3%)	41 (12.3%)	50 (13.7%)	
		5 – 10	15 (45.5%)	160 (48.0%)	175 (47.8%)	
		10 – 16	4 (12.1%)	98 (29.4%)	102 (27.9%)	
		> 16	0 (0.0%)	15 (4.5%)	15 (4.1%)	
Gender		Male	18 (54.5%)	172 (51.7)	190 (51.9)	0.1007 (0.750969)
		Female	15 (45.5%)	161 (48.3%)	176 (48.1%)	
High Risk Population		Yes	7 (21.2%)	48 (14.4%)	55 (15.0%)	1.086 (0.297242)
		No	26 (78.8%)	285 (85.6%)	311 (85.0%)	
History of recent travel		Yes	3 (9.1%)	42 (12.6%)	45 (12.3%)	0.096 (0.7567)
		No	30 (90.9%)	291 (87.4%)	321 (87.7%)	
History of receiving any Vaccines in lifetime		Yes	15 (45.5%)	187 (56.2%)	202 (55.2%)	17.657 (0.000146)
		No	15 (45.5%)	55 (16.5%)	70 (19.1%)	
		Unknown	3 (9.1%)	91 (27.3%)	94 (25.7%)	
History of 3rd dose of DPT or Pentavalent Vaccine		Yes	4 (12.1%)	8 (24.0%)	12 (3.3%)	8.943 (0.02785)
		No	29 (87.9%)	325 (76.0%)	354 (96.7%)	

the cases were reported in the age group of 5-10 years, which shows a shift in the prevalence of diphtheria cases from under 5 years to 5-10 years. Similarly, a studies conducted in central India and Indonesia have reported 55.32% of cases in the 5-12 years age group and 40.22% among the 5-9 age group.[1,10]

The majority of cases (76%) in the study were geographically reported from the blocks at the district boundary with to and fro migration in other states. The study in Europe has also highlighted the role of migration from the epidemic areas and by unvaccinated people leads to the spread of diphtheria across the different geographical regions.[9]

During a particular period, the rise of diphtheria cases may form a base for assuming several causes related to migration, epidemiological dynamics, etc. The present study has shown an increase in the number of cases during the August to December months. A study in Rajkot and Indonesia has also reported the rise in diphtheria cases from August to October and from September to December due to several environmental factors and seasonal changes making people more susceptible to infectious disease.[10,12] The talukas, which had reported more cases over the period, were border districts to Rajasthan State. The socio-cultural aspects and care-seeking behavior of these reported pockets should be the next level of assessment that can guide the health team for a local customized awareness campaign.

Immunization plays an influential role in preventing diphtheria in different countries, especially in developing countries like India. The study has shown half of the cases identified (55%) were aware of the immunization status or any vaccine taken during their lifetime. Three-fourths (77%) of cases have never taken the DPT 3 or Penta 3 vaccine. A study conducted at Hyderabad has reported vaccine efficacy among the population with three DPT doses (49%; 95% CI 0-80) and upto five DPT doses(91%, 95% CI 68-98) as compared with two DPT doses (0%, 95% CI 0-63).[4] A systemic review has suggested a 60% reduction in transmission of diphtheria among people if vaccinated with DPT 3 and interruption of transmission by 28% through vaccination among the outbreak settings.[11] In the study at Rajkot, 65% of identified cases have not received a single dose of DPT, revealing the importance of immunization status for reducing diphtheria cases.[12]

The study had few limitations as it is dependent on the records available with the district health team. The more constructive intensified surveillance activity with proper data collection format would yield better results for further analysis. However, this study showed that the characteristics of the cases identified have similar findings with other studies conducted in different parts of the world.

Conclusion:

The study concludes that most of the diphtheria cases were identified in 2019 at Banaskantha District. Diphtheria was more commonly identified among the age group of 5-10 years, during August to September months. The deaths were reported among the cases with no history of completed DPT or petavalent vaccine, in blocks located at the borders of Banaskantha District with frequent migration. These findings may be significant in designing a strategy to cover the maximum number of children for the diphtheria vaccine. Also, a structured database must be maintained for individual child regarding their vaccination status across their lifecycle to monitor the dropouts and left outs.

Recommendations:

The findings suggest that active screening and case findings of diphtheria among the community should be ensured through the meticulous follow up national guideline, surveillance of diphtheria, pertussis and neonatal tetanus. Immunization is essential for reducing diphtheria cases, so the efforts are to be made to cover the maximum number of children, especially in remote areas and who are frequently missed due to system side or beneficiary side reasons. A catch-up campaign for the vaccination should be scheduled for drop outs and left outs children to ensure at least three and booster doses of DPT or pentavalent vaccine. The staff should be provided refresher training of guideline; universal immunization program (UIP) guideline and district has to ensure that as per the guideline norms; a line

list for all eligible children up to aged 16 years for vaccination under UIP is to be maintained with their immunization status for effective vaccination coverage. Concentrated efforts are to be made to cover the migratory population sites and high-risk groups (settlements/hamlets/hard-to-reach areas) for diphtheria and vaccine-preventable diseases. A locally customized awareness campaign should be driven for those who don't have a clear vaccination history and push for social mobilization to ensure complete immunization as per the national immunization schedule norms.

Declaration:

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Conflict of Interest: Nil

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