Pneumonic plague outbreak investigation in India

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Section 1: Background

- Pneumonic plague is an infectious disease caused by the bacterium *Yersinia pestis*.
- The infection can be caused by directly by the inhalation of aerosolised plague bacteria, or due to septicaemic plague spreads into lung tissue from the bloodstream.
- Pneumonic plague can be vector-borne and spread due to contact with infected rodents or cats. The spread can also be through contact with infected person.
- Clinical manifestations include headache, fever, difficulty in breathing, chest pain and coughing often with hemoptysis.
- If not treated the disease can progress and cause respiratory failure, then shock and later death.
- The incubation period is 3-7 days.
- Diagnosis by isolation of the agent from the blood, sputum, or fluid from a lymph node.

Section 2: Methodology

The outbreak investigation should include the following:

1. *Verification of the diagnosis* The diagnosis of the disease was confirmed by serologic tests for all cases.
2. *Confirm the existence of an outbreak* From November 7, 2019 to December 15, 2019, confirmed, suspected and probable cases of pneumonic plague were reported, and this shows the existence of an outbreak.
3. *Identify and count cases* -

a. Establish case definition

- Possible fever (>37.5 oC) and at least two other symptoms compatible with pneumonic plague (headache, cough, chest pain, and/or haemoptysis) in an individual who did not have another proven etiology.
- Confirmed case: the above criteria and laboratory confirmation.

b. Case finding

- Hospital records from November 7, 2019 through December 15, 2019 were reviewed for the areas surrounding the epicenter of the outbreak hospitals.
- In addition, healthcare workers physicians in the area were contacted and asked to report patients seen in the last month with clinical features like the case patients.
- Patients with similar features were contacted, interviewed and asked to submit specimen samples for laboratory test.
- The case definition includes information on the person, place and time. It also uses clinical and laboratory criteria.

For this investigation, a line list of the cases was prepared to estimate the probable incubation period, secondary attack rate and case—fatality rate.

Section 3: Results

Figure 1 shows the incidence of confirmed, suspected and probable cases of pneumonic plague per week. The peak of the disease was in week 48 of 2019. Week 48 was also the last week with a confirmed case. The outbreak was for six weeks.

computing the incidence

```
library(haven)
plague_5 <- read_dta("C:/Users/olatunji/Desktop/plague_5.dta")
View(plague_5)

library('incidence')
library('ggplot2')

# compute weekly stratified incidence
i.7.group <- incidence(plague_5$onsetdate, interval = 7, groups = plague_5$status)

# print incidence object
i.7.group
```

```
## <incidence object>
## [66 cases from days 2019-11-04 to 2019-12-09]
## [66 cases from ISO weeks 2019-W45 to 2019-W50]
## [3 groups: "confirmed", "probable", "suspected"]
##
## $counts: matrix with 6 rows and 3 columns
## $n: 66 cases in total
## $dates: 6 dates marking the left-side of bins
## $interval: 7 days
## $timespan: 36 days
## $cumulative: FALSE
```

```
# plot incidence object
my_theme <- theme_bw(base_size = 12) +
  theme(panel.grid.minor = element_blank()) +
  theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust = 0.5, color = "black"))
plot(i.7.group, border = "white") +
  my_theme +
  theme(legend.position = c(0.8, 0.75))
```

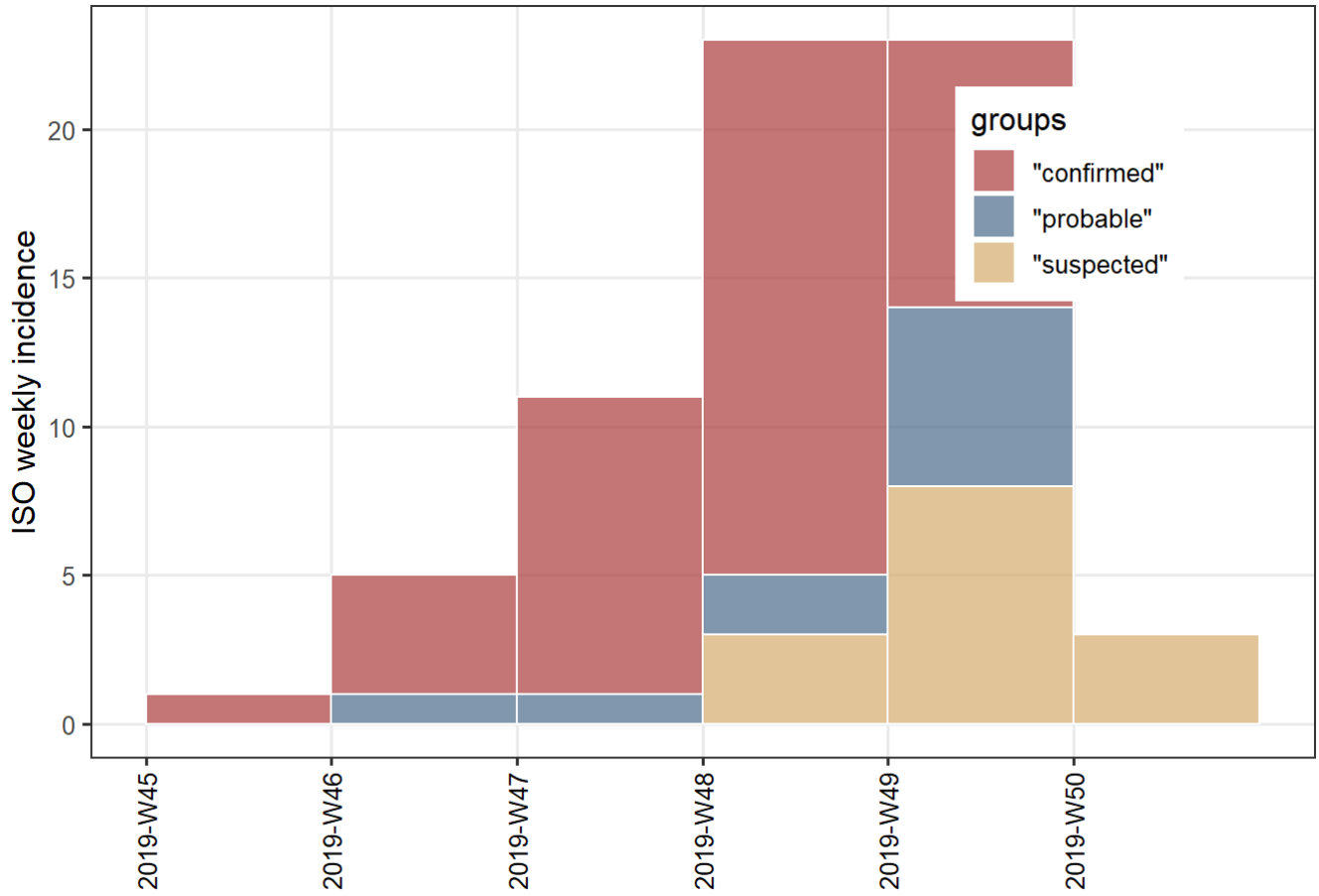

Figure 1 The weekly incidence of pneumonic plague outbreak

Only the 42 patients met the definition of a confirmed case. Ten other individuals detected by case finding methods met the definition of a probable case and fourteen were suspected cases.

Incubation period and duration of symptoms could not ascertain because of missing information like exposure date and recovery dates.

```
library("EpiCurve")
```

```
## Loading required package: dplyr
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
## Loading required package: ISOweek
```

```
## Loading required package: scales
```

```
## Loading required package: timeDate
```

```
EpiCurve(plague_5,
         date = "onsetdate",
         cutvar = "status",
         period = "day",
         ylabel="Number of cases",
         xlabel=sprintf("From %s to %s", min(plague_5$onsetdate), max(plague_5$onsetdate)),
         title = "Figure 2 Epidemic Curve of Pneumonic Plague Outbreak in India",
         note = "Daily epidemic curve")
```

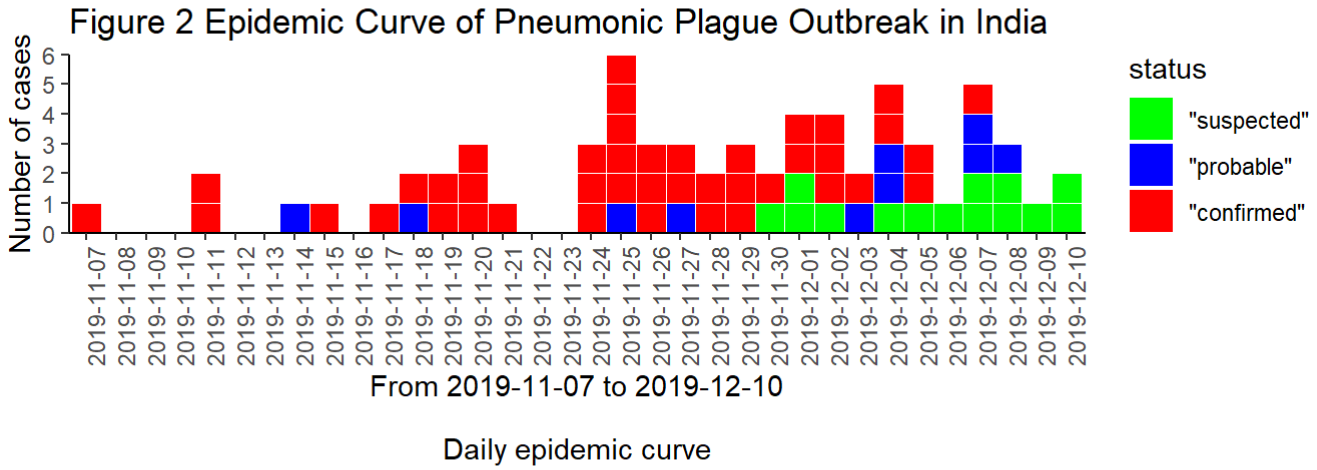

Figure 2 shows the epidemic trend of the outbreak. On November 7, 2019, the index case started showing symptoms of pneumonic plague and this was only reported on November 15, 2019. The outbreak period was from November 7, 2019 till December 15, 2019 when the last case was reported. The peak of this outbreak was on November 25, 2019.

Calculating attack rate

Attack rate (AR) = No of people who became ill/No of people at risk for the illness

```
66/201*100
```

```
## [1] 32.83582
```

The attack rate was 32.8%

Calculating case-fatality rate

Case fatality rate (CFR) = No of deaths from a specified disease/No of individuals diagnosed with the disease

```
13/66*100
```

```
## [1] 19.69697
```

The CFR was 19.7%

References

1. Dennis, DT, Gage KL, Gratz N, Poland JD, and Tikhomirov E. (Principal authors). Plague Manual. World Health Organization. Geneva, Switzerland. 172 pp., 1999.
2. Gross, L. How the plague bacillus and its transmission through fleas were discovered: reminiscences from my years at the Pasteur Institute in Paris.Proc Natl Acad Sci U S A. 1995 August 15; 92(17):7609–7611.
3. Plague. World Health Organization. September 2016. Accessed 16 January 2020. https://www.who.int/en/news-room/fact-sheets/detail/plague (https://www.who.int/en/news-room/fact-sheets/detail/plague)