What do we know about plague epidemiology that is critical for planning vaccine trials?

Elisabeth Carniel

Centre Pasteur du Cameroun
Geographical distribution of human plague cases
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Why would a plague vaccine be useful?

- Number of cases
  - DRC: ≥100 cases/year
  - Madagascar: ≥300 cases/year

Andrianaivoarimanana et al. (2013)
Why would a plague vaccine be useful?

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- **Occurrence of outbreaks**
Democratic Republic of Congo

- 2005  DRC  Pneumonic plague, mine  
114 cases (54 deaths)

- 2006  DRC  Pneumonic plague, 
1,174 suspected cases

- 2007  Uganda  Pneumonic & bubonic plague  
(2008)  200 cases
Plague outbreaks, Madagascar 2017

The plague today: Where the ancient disease is still spreading and how to protect yourself
Après avoir disparu pendant dix ans, la peste touche à nouveau l'île de Madagascar, où 138 cas suspects ont été recensés depuis le mois de janvier, dont 47 mortels. Les quartiers insalubres de la capitale, Antananarivo, sont les plus touchés.

L'Organisation mondiale de la santé (OMS) a annoncé vendredi 21 novembre l'apparition de cas de peste à Madagascar, le premier mortel ayant été enregistré dans un village le 31 août. Dans un communiqué, elle indique avoir été notifiée le 4 novembre par les autorités sanitaires malgaches du développement de cette maladie.
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- **Remote areas**
  - DRC: Ituri
  - Madagascar
Bunia (Ituri, DRC) 2010

War between Hema and Lendu ethnic groups
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- Occurrence of outbreaks:

- Remote areas:
  - DRC: Ituri, war between Hema and Lendu ethnies
  - Madagascar:
Madagascar
2013-2014
Mandritsara
37 cases, 20 deaths

2016-2017
Befotaka
68 cases, 27 deaths

“Upon our arrival after almost 1.5 days of walking, rapid diagnostic tests for plague were carried out”

"However, after collecting some samples, treating some people and starting pest control efforts, the team’s mission had to be cut short because of insecurity and direct threats to team members."
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Electronic access to treatment sometime very difficult or impossible
Bubonic plague

50-70% (≤ 1 week)
Pneumonic plague

High fatality rate
Extremely acute infection

Need for a rapid and efficient treatment

Bubonic plague
Synanthropic rodent
Wild rodent
Flea (Xenopsylla cheopis)
Aerosols

≈100% (≤ 3 days)
Antibiotic resistant strains

Streptomycin

Guiyoule et al. (2001)

Sm, Tet, Cm, Su
Mn, Sp, Ap, Km

Galimand et al. (1997)

Tetracycline

Cabanel et al. (2018)
Int. J. Antimicrobial Agents
Vaccine useful for human populations in plague endemic areas:

Epidemiological characteristics to take into account

- Highly acute infection
  ➤ highly protective vaccine
  ➤ active against both bubonic and pneumonic plague
  ➤ rapid onset of protection

- Remote places
  ➤ single dose
  ➤ long lasting
  ➤ not to depend on a stringent cold chain

- Countries with limited resources
  ➤ cheap vaccine
  ➤ easy administration (non parenteral)
Characteristics of the vaccine

- *Yersinia pestis*: very limited genetic variation
  - Active against most strains worldwide

- Antigenic targets
  - F1: the most potent target but F1- strains in Central Asia
  - V (Virulence plasmid)
  - EV76: live attenuated *Y. pestis* strain.
    - Strong side effects and genetically unstable.
  - Safe and stable.
  - Multiple targets would increase the efficiency and duration of protection.
Endemic plague

Plague outbreak

- Usefulness of a vaccine?
  - Rapid onset of protection
  - Stocks with long term storage (cheap)
  - Vaccine easy and fast to produce in case of need for large quantities in an emergency situation
Thank you!