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Title: SWAP Applications to the 2014 Ebola Outbreak

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Intended for: Information regarding utility of our tools intended for potential users of the tools.

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70 YEARS OF CREATING TOMORROW

Los Alamos NATIONAL LABORATORY

SWAP Applications to the 2014 Ebola Outbreak

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NNSA National Nuclear Security Administration

SWAP Overview:

SWAP Purpose: **enhance situational awareness** during an infectious disease outbreak by providing the **historic context** of disease outbreaks

Disease	Status
1. Foot and Mouth Disease (FMD)	Added to SWAP
2. Cholera	Added to SWAP
3. Dengue	Added to SWAP
4. Novel Influenza – Avian and Swine	Added to SWAP
5. Q fever (acute)	Added to SWAP
6. Norovirus	Added to SWAP
7. Plague	Added to SWAP
8. Meningococcal disease	Added to SWAP
9. Tularemia	Added to SWAP
10. Ebola virus disease	Added to SWAP
11. Measles	Added to SWAP

SWAP library contains;
224 outbreaks in 43 countries

Goals of this exercise:

- Trying to understand the following:
  1. How are/ were the 2014 Liberia, Guinea and Sierra Leone outbreaks similar to and different from historical outbreaks?
  2. Are there similar outbreaks that could have provided useful information?
  3. With the information that would have been available in the SWAP during the bulk of the outbreaks, would we have been able to meaningfully contextualize data?

Evaluation: Methods

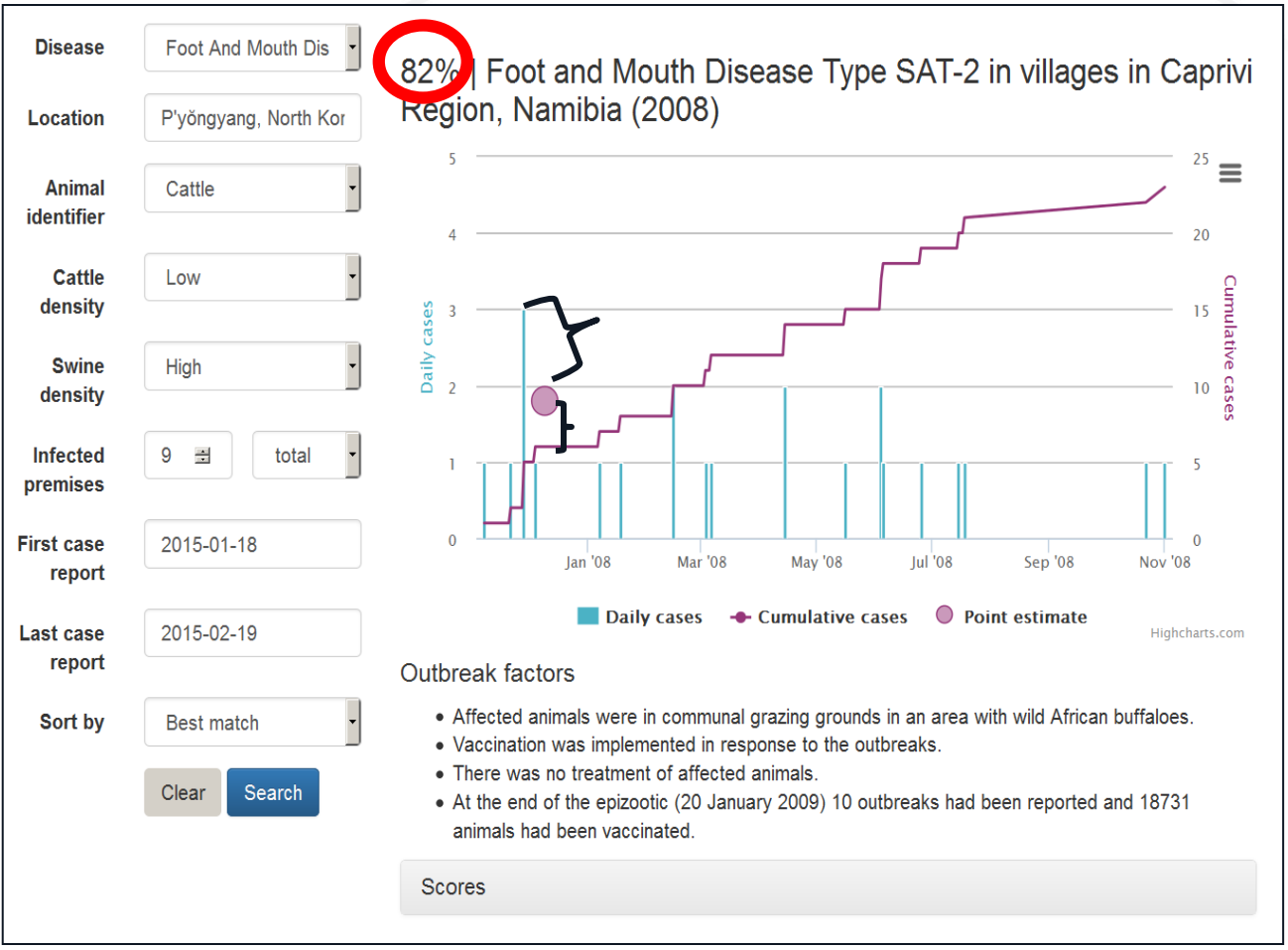
World Health Organization

- Selected data from the WHO and CDC for Liberia, Guinea and Sierra Leone outbreaks in 2014
  - *Liberia and Guinea outbreaks are already in the SWAP. They were excluded from analysis to avoid artificial inflation of evaluation parameters*
- Collected case counts, time points, parameter information

Put this data into the SWAP as though the outbreak were occurring in real time.

Note: Selected 3-4 time points from 1) early outbreak, 2) peak of outbreak and 3) post peak. This was to get a good understanding of SWAP response throughout the outbreak.

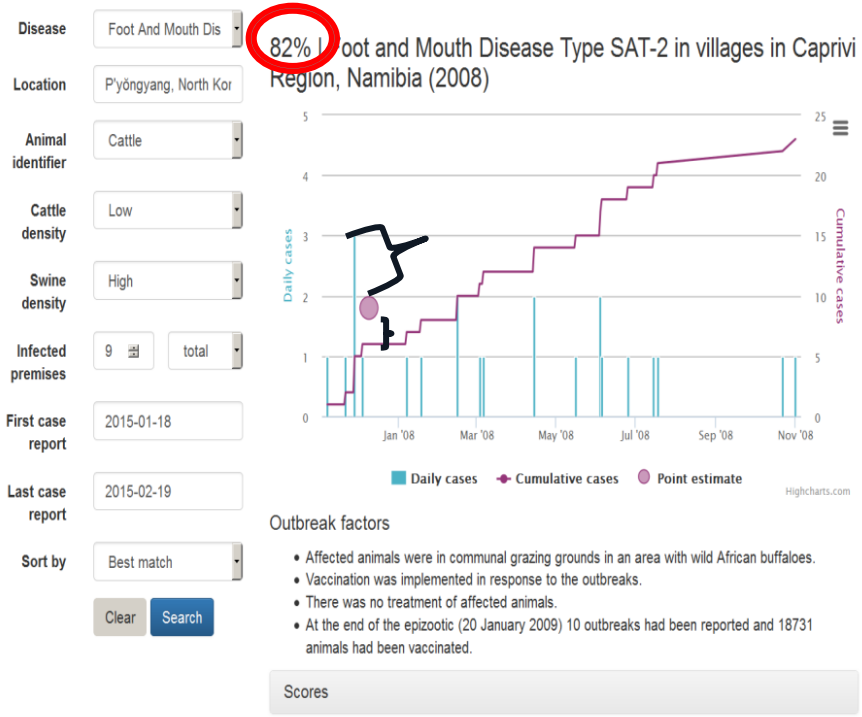
Evaluation: Methods



For each point in the "test" outbreak collect:

- Top **4** outbreak matches and similarity scores
- Nearest historical point
- Point estimate relation to peak
  - 'Before', 'after' or 'at'?

Internal evaluation: Methods

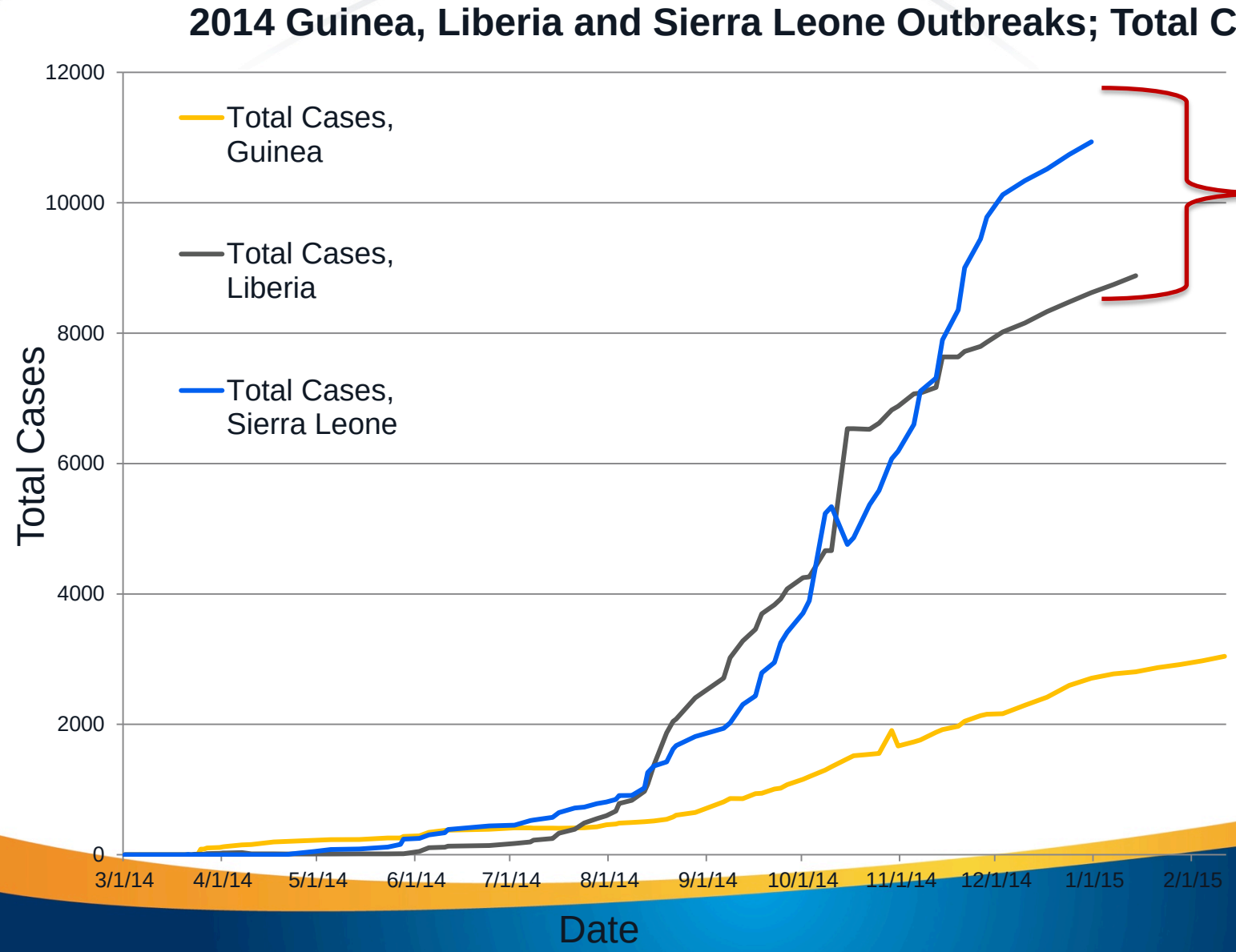


Do this for every time point available for the unfolding outbreak

- **Average over all unfolding outbreak data points to understand error in point estimate placement per disease**

$$Error = \frac{|Actual - Historical|}{Actual}$$

Results



These two outbreaks are more similar

We see this reflected in the SWAP! (see next slide)

Liberia & Sierra Leone Similarities

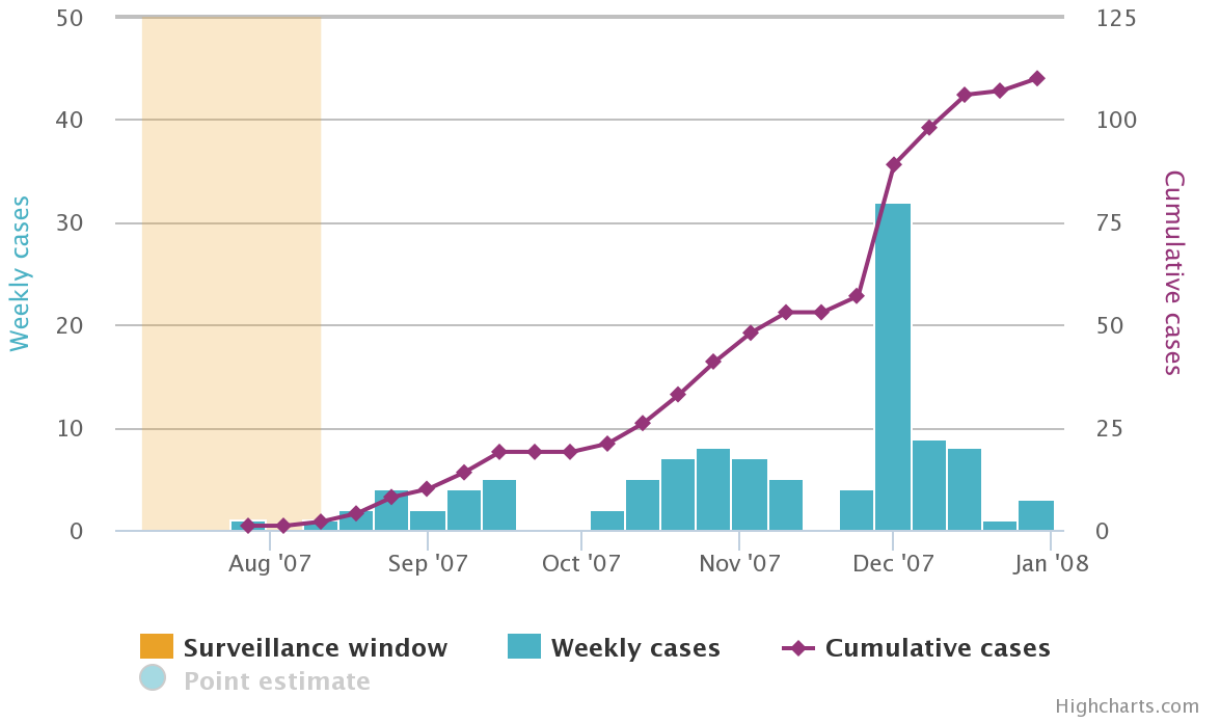
- When using the Sierra Leone outbreak as the “test”, Liberia was in the top 4 outbreaks 14 out of 14 times (**100%)**
  - Top response 12 out of 14 time points (**86%**)
  - Outbreaks that occurred ONLY in 2014 had highest similarities 13 out of 14 time points (**93%**)
- This is showing that our algorithm is producing “expected results”

BUT, none of the 2014 outbreaks would have been in the SWAP at the start of the West Africa epidemic. Would the SWAP still have been useful?

Non-2014 outbreaks

- Most commonly returned outbreaks, prior to 2014, for all 3 West Africa epidemics were:
  - Kabango, Uganda 2007
  - Gabon-Congo 2001 to 2002
  - Gulu, Uganda 2000
  - Mbomo, Republic of Congo 2003
- Consistently reported as <50% similar
  - This indicates that similarity is not high
  - Investigated these outbreaks further to see if there was useful historical information we could have learned early on

Kabango, Uganda 2007



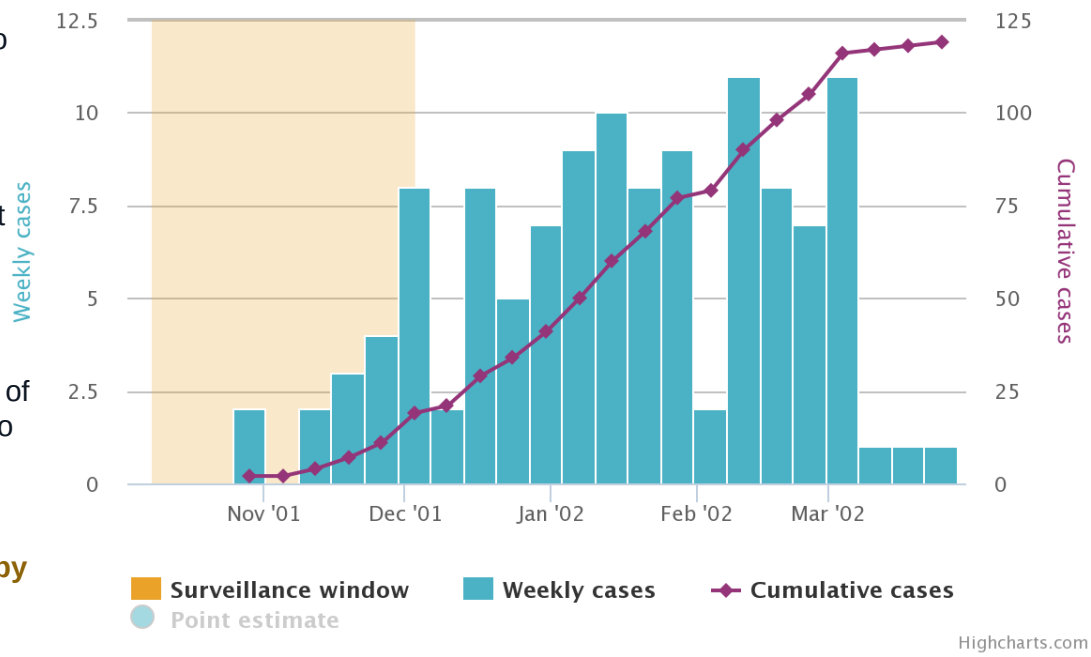
Outbreak factors

- Species was Bundibugyo
- **Case fatality rate was 36%**
- The putative index patient was a 26-year-old woman from Kabango village, Kasitu subcounty, in Bundibugyo district.
- **Laboratory confirmation lagged behind outbreak verification** by 3 months.
- The median incubation period was 7 days (range 2–20 days).
- **Transmission occurred due to participation in funeral rituals, family close contact, and hospital contact.**
- Likely source of transmission was wildlife in Semliki Naitonal park

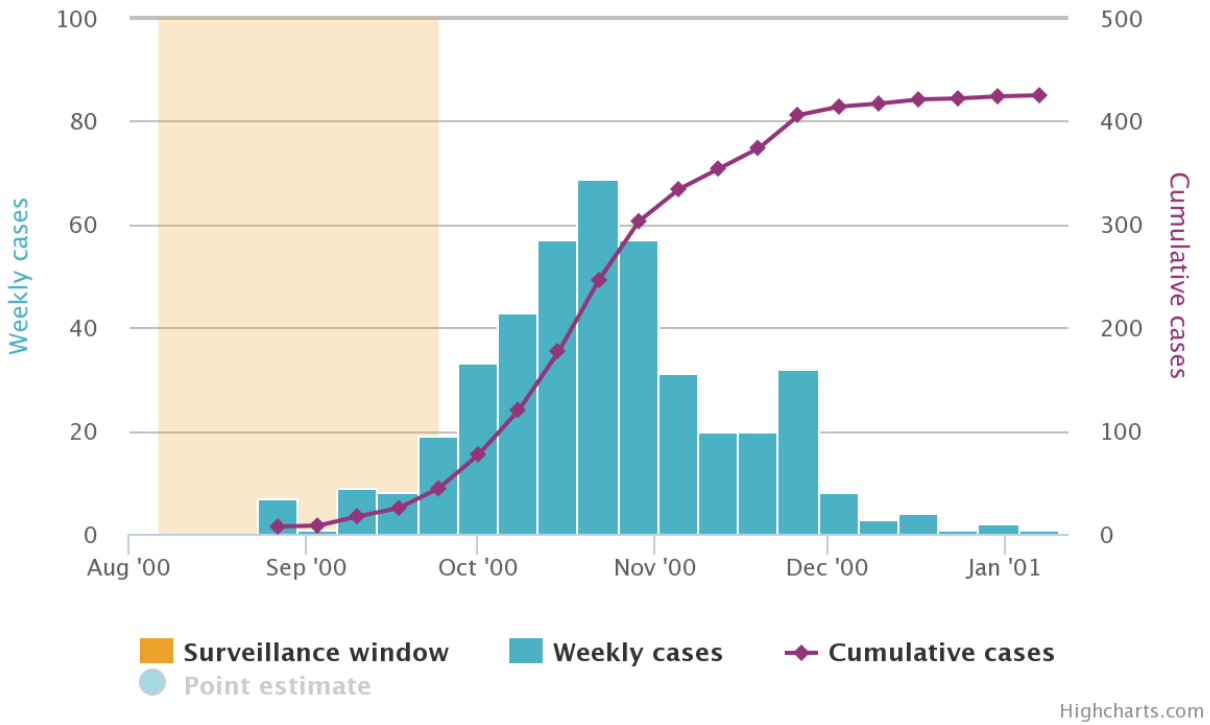
Gabon-Congo 2001-2002

Outbreak factors

- Species was ZEBOV
- **Case fatality rate was 78%**
- Outbreak started in Mendemba, Gabon in October due to a hunting event.
- A cluster of five deaths was reported to regional health authorities by medical personnel at Mékambo Medical Centre in the La Zadié health district bordering the Congo
- An unusually high number of animals, mainly non-human primates found dead in the rainforest of the same district.
- **There is high mobility of the population across the border between the two countries.**
- There was epidemiologic evidence of at least six different introductions (four in Gabon and two in Congo) of Ebola virus into human communities during this epidemic, each related to a hunting episode.
- Ebola virus was detected in the carcass of a gorilla butchered by one of the index cases shortly before onset of illness. This was the only case for which it was possible to demonstrate Ebola virus in the incriminated animal.
- **The vast majority of secondary cases were related to community-based transmission**
- **Control efforts in Congo and Gabon were hampered by the remoteness of the affected areas**, making efficient communication difficult to establish, as well as lack of transport for personnel, and insufficient materials for barrier nursing.
- On 6 May, 2002, 48 days after the death of the last registered case, the outbreak of EHF in Gabon was declared over by the Minister of Health.



Gulu, Uganda 2000



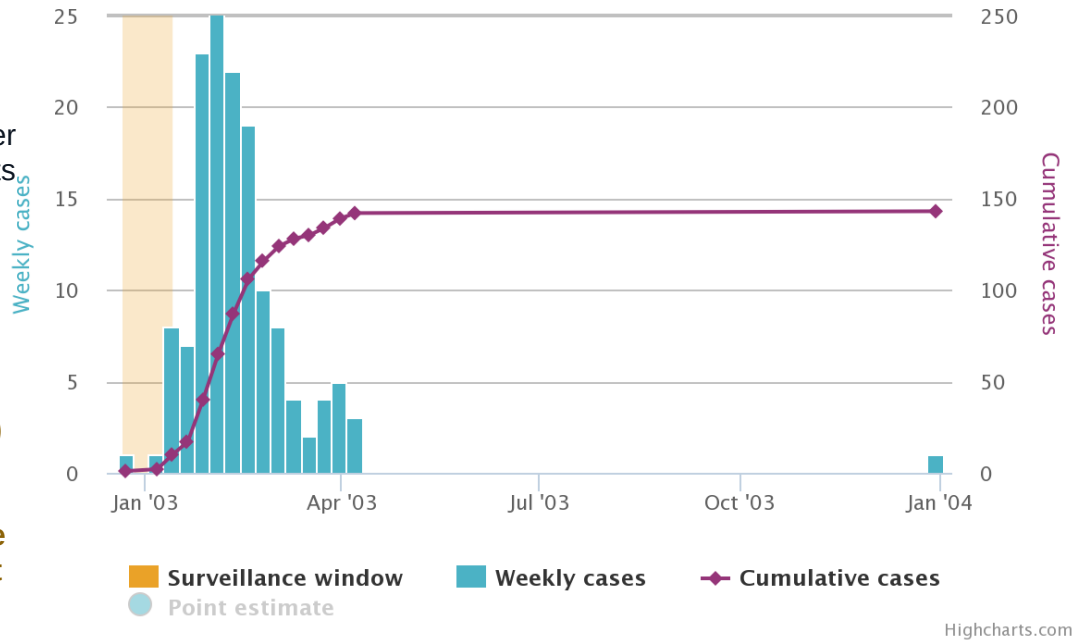
Outbreak factors

- Species was SEBOV
- **Case fatality rate was 53%**
- Index case not identified, the first presumptive case was on August 30th. A cluster on October 8th resultied in health alert and lab samples being taken.
- Lab confirmation on Oct 8th (RT-PCR, ELISA, viral antigen)
- Reservoir unknown, mean incubation period was 8-12 days
- **Three most important means of transmission were funeral attendance of presumptive cases, intrafamilial and nosocomial.**
- 60% of residents lived in camps because of insecurity. Health care had also deteriorated at the time.
- **Response strategies included: active surveillance and contact tracing, public education and community mobilization, isolation of cases, infection control through universal precaution and safe burial of the dead using trained burial teams.**

Mbomo, Republic of Congo, 2003

Outbreak factors

- Species was ZEBOV
- **Case fatality rate was 89%**
- In early December 2002, villagers and nongovernmental wildlife organizations reported having found a large number of dead animals, particularly non-human primates in forests in the districts of Kéllé and Mbomo
- Alerts issued early in January cautioned people to risks of contagion with bushmeat.
- **Control activities focused on: (i) social mobilization campaigns to encourage the adoption of practices capable of interrupting community disease spread; (ii) humane case management in the isolation units; (iii) ensuring the observance of safe methods of burial while maintaining respect for customs; (iv) active case detection and daily monitoring of contacts throughout the maximum incubation period.**
- Epidemiological evidence found for at least three independent introductions of Ebola virus into human communities during this epidemic, all related to a hunting episode.
- **Most secondary cases were related to intra-family transmission.**
- Outbreak declared over on June 05, 2003 by MOH.



Relevant lessons from historic outbreaks

- High case fatality
  - Kabango, Uganda 2007: 36%
  - Gabon-Congo , 2001-2002: 78%
  - Gulu, Uganda 2000: 53%
  - Mbomo, Republic of Congo 2003: 89%
- Common transmission themes:
  - Funeral/ burial rituals (Gulu, Uganda 2000; Kabango, Uganda 2007)
  - Community/ Intra-family (Mbomo, Republic of Congo 2003; Gulu, Uganda 2000; Kabango, Uganda 2007; Gabon-Congo , 2001-2002)
- Control measures (Gulu, Uganda 2000; Mbomo, Republic of Congo 2003):
  1. Social mobilization campaigns to encourage the adoption of practices capable of interrupting community disease sprea
  2. Case Management/ Infection control
  3. Ensuring safe methods of burial while maintaining respect for customs
  4. Active case detection and daily monitoring of contacts

Contextualizing data using the SWAP

- Like our internal evaluation, we wanted to see if the SWAP could correctly place a point estimate in relation to the peak, and how often.
- Results:
  - If all of the top 4 responses are utilized, the SWAP can correctly place the point estimate in relationship to the peak **56%** of the time.
  - If only pre-2014 responses are utilized: **58%**

Answers

1. How are/ were the Liberia, Guinea and Sierra Leone 2014 outbreaks similar to and different from historical outbreaks?
   - Most similar to the following outbreaks:
     - Kabango, Uganda 2007
     - Gabon-Congo 2001 to 2002
     - Gulu, Uganda 2000
     - Mbomo, Rep of Congo 2003
   - Similarity was consistently $\leq$ 50%
2. Are there similar outbreaks that could have been useful early on in the 2014 outbreaks?
   - Similarities with high case fatality and routes of transmission
   - Control measures used in previous outbreaks would have proven useful in the 2014 outbreaks, but there were barriers to implementation[1]
   - This may indicate that comparisons to historic outbreaks could have proven useful early on in the 2014 outbreaks (???)
3. With the information that would have been available in the SWAP during the bulk of the outbreaks, would we have been able to meaningfully contextualize data?
   - When using only pre-2014 data, still able to contextualize point estimates relative to the peak **about 60%** of the time.
   - It is clear early on in the outbreaks that historical curves are quite different.
     - This could have provided some use in identification of the anomaly.

Final Thoughts

- Please do not hesitate to email with questions/ comments/ concerns
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