# An outbreak of poliomyelitis, Republic of Congo, 2010

**Case study for the UK FETP / EPIET vaccinology module (3 hours)**

Version 8– 8 May 2013 (Corrected after use in the module)

## Objectives

- Define the objectives of the investigation of an outbreak of poliomyelitis
- Define the role of laboratory methods in supporting polio outbreak investigations
- Formulate an operational case definition during an outbreak
- Raise hypotheses about the determinants of an outbreak of vaccine preventable disease on the basis of:
    - Descriptive epidemiological data
    - An age-cohort analysis of the level of population immunity
- Investigate case fatality ratio during an outbreak
- Plan control measures for an outbreak of vaccine-preventable disease

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This case study is designed as a stand-alone and does not come with a facilitator's guide. The answers to all the questions for each section are provided as an introduction to the following section. To run this case study, it should be distributed one section at a time (i.e., one sheet at the time if the case study is printed out double-sided). Once the epilogue has been read, it is proposed to go back to the first page to read the objectives again. This re-iterates the acquisitions and provides additional opportunity to clarify what may have been misunderstood or not fully acquired.

## 1. The alert and the laboratory confirmation (25 m)

By late 2010, thanks to the effort of the Global Polio Eradication Initiative (GPEI), only four countries (Afghanistan, India, Nigeria and Pakistan) still had endemic transmission of wild-type poliovirus (WPV). However, that year, over 80% of the 1,291 WPV cases reported globally were from outbreaks in previously polio-free countries. These re-introductions of the virus in areas previously polio-free were a source of major international concern.

On 9 October 2010, a neurologist in Pointe Noire (PN), Republic of the Congo (ROC, Capital city: Brazzaville; 2010 population: 4,043,000), saw a 39-year-old man who reported 4 days of fever, headaches, myalgia, dysphagia, dyspnoea, and constipation, followed by acute, flaccid, asymmetric, lower extremity paralysis. The patient's vaccination history was unknown. The neurologist initiated treatment for Guillain-Barre* but the patient died the following day. The following week, the neurologist noted an unusual number of adults presenting with acute flaccid paralysis (AFP) and alerted health officials. Later in October, the Ministry of Health (MoH) heard about this cluster of AFP, raised the alarm and suspected polio (Box 1).

### *Questions*

- What are the potential implications of this cluster?
- What will be the most urgent step in the first 24 hours?
- How would you confirm the diagnosis? How would you collect and transport specimens?
- What other laboratory investigations may be needed in addition to the confirmation of the diagnosis?

**Box 1: Key facts and figures on poliomyelitis**

- **Agent:** Poliovirus, an enterovirus
- **Spread:** Most commonly from person to person via the faecal-oral route
- **Reservoir**: Exclusively human
- **Symptoms**: Many infected persons do not develop symptoms. Approximately 1 in 200 will go on to experience paralysis (Normally acute, flaccid, asymmetric and ascending)
- **Differential diagnoses:** Meningitis, brain abscess, leptospirosis and Guillain-Barre *
- **Case fatality ratio:** Normally, under 5%, but increases with age (High among adults)
- **Incubation period:** From 7 to 14 days for the paralytic form, but 3-35 days is possible
- **Infectivity:** Infected patients start shedding viruses 36-72 hours after exposure. The virus typically persists in the throat for about a week and in the faeces for 3-6 weeks
- **Age of infection:** With vaccination, mostly a disease of the young (less likely to be exposed to natural infection from the pre-vaccine era and at the highest risk for pathogens transmitted through the faecal-oral route)
- **Surveillance:** Surveillance activities to monitor polio eradication primarily look for acute flaccid paralysis (AFP)
- **Vaccine:** Different formulations of oral polio vaccine (OPV) target the three serotypes: 1, 2 and 3

* A rare nervous system disease characterized by loss of sensation and paralysis, usually symmetrical

## 2. Objectives of the investigation (20 m)

Due to the severe clinical presentation and age range of the initial patients, poliomyelitis was initially not strongly considered as the etiology of this outbreak. As a result, the adequate specimens needed for virological testing and confirmation (i.e., at least one thumb of stool, transported with reverse cold chain) were not obtained early. Instead, a wide variety of specimens (e.g., blood, cerebrospinal fluid (CSF), throat swabs) were distributed to various testing laboratories that were not accredited for polio by WHO. This delayed the diagnosis. [*]

On 2 November, the Centre International de Recherches Médicales de Franceville (CIRMF) received 15 rectal swabs, 14 throat swabs, and five CSF specimens from several patients. Of those, 13 rectal swabs (87%), 5 throat swabs (36%) and one CSF specimen (20%) were positive for enterovirus in a real-time RT-PCR. [†] The Institute of Virology of the University of Bonn Medical Centre (Germany) studied the genome. [‡] Poliovirus type 1 was identified in one specimen. [§] A portion of the genome [**] shared 94.8-96.3% identity with WPV 1 isolated recently in Angola, a neighbouring African country.

Given the major implication of this re-introduction of WPV in ROC, on 4 November 2010, the MoH, the World Health Organization (WHO), the United States Centers for Disease Control and Prevention (CDC), the United Nations Children's Fund (UNICEF) and Médecins Sans Frontières (MSF) initiated an extensive outbreak response.

### *Questions*

- What should be the objectives of the investigation?
- What key steps will you follow to address these objectives?
- How do we use and interpret the molecular genomic data for public health action?

[*] It is hard to confirm the diagnosis and distinguish serotypes without the right methodology, which is why only polio-certified laboratory results can be trusted.

[†] Targeting the 5'-noncoding region

[‡] Based on partial VP1 sequencing, 3D sequencing and 5'-UTR sequencing. The five prime un-translated region (5' UTR) can contain elements for controlling gene expression by way of regulatory elements.

[§] 100% amino acid identity to recent poliovirus strains of Indian genotype in 'typing' VP1 PCR

[**] The amplified 327nt sequence corresponding to genome positions 2,631 to 2,957 in WPV1 strain Brunhilde

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## 3. Case definition, case search and classification (25 m)

Investigators decided that the objectives of the investigation were to estimate the magnitude of the outbreak and to understand its determinants in order to stop transmission. The re-introduction is a critical event, but most importantly, the reasons of the secondary transmission must be understood. To achieve these objectives, they planned on following the usual ten steps of an outbreak investigation, adapted for vaccine-preventable diseases and polio. Using the global polio sequence database based on VP1 sequence held at US CDC, Atlanta, GA, USA, it was possible to identify the most recent closest related strain and to estimate the duration of circulation between the two isolates on the basis of the polio molecular clock. Such information helped investigating the exact source of re-introduction.

As they considered using the reference case definitions (Box 2), investigators observed that less than 20% AFP cases were investigated with specimens collected within two weeks of onset and 48 hours apart.

**Box 2: Case definition for notification of poliomyelitis due to WPV under the International Health Regulation (IHR, 2005)**

- A suspected case is defined as a child under 15 years of age presenting with AFP, or as any person at any age with paralytic illness if poliomyelitis is suspected.

- Under the IHR (2005), a notifiable case of poliomyelitis due to wild-type poliovirus is defined as a suspected case with isolation of wild poliovirus in stool specimens collected from the suspected case or from a close contact of the suspected case.

### *Questions*

- What are the practical options you could follow in terms of case definition given the difficulties to obtain adequate stool specimens?

- What would be the implications of using a case definition that would not include laboratory confirmation during this outbreak?

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## 4. Descriptive epidemiology (20 m)

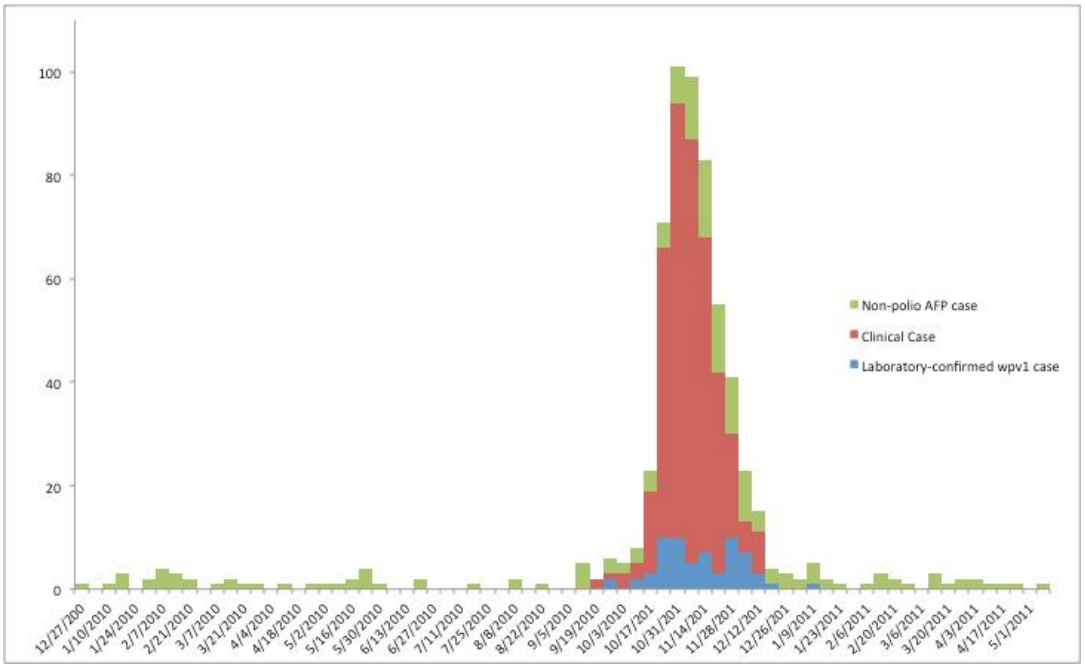
Collection of inadequate specimens, deaths and loss to follow-up limited laboratory confirmation and compromised the investigation. Therefore, investigators used an algorithm that the WHO African Region had been using in the 2000s. At the hypothesis raising stage of an outbreak investigation (descriptive epidemiology), the high frequency of disease increases the positive predictive value of the case definition, even in the absence of laboratory confirmation. *

1. The National Poliomyelitis Expert Committee (NPEC) used the algorithm to classify cases of AFP as per the categories below and plotted them by week of onset (Figure 1).

2. **Non-polio AFP cases** were patients with AFP with inadequate laboratory specimens and who did not have symptoms consistent with poliomyelitis as determined by the NPEC.
3. **Clinical poliomyelitis cases** were patients with AFP with inadequate laboratory specimens with a strong probability of having poliomyelitis (i.e., based on clinical presentation and residual paralysis at least 60 days after onset). This included all clinically diagnosed as well as clinically compatible cases (AFP case consistent with polio but isolated in a province were considered clinically compatible in the absence of epidemiological link).
4. **Laboratory-confirmed cases** were those for which WPV1 was isolated from adequate specimens.

Following passive case finding supplemented by active case search in selected hospitals, the distribution of cases in the country indicated a clustering around Pointe Noire (2007 population: 715,334; Figure 2). Table 1 summarizes the key characteristics of the clinical and laboratory confirmed cases that included a large proportion of young adults (Median age: 9 years, range: 0.9-54).

**Figure 1: Acute flaccid paralysis (AFP) cases by week of onset and confirmation status, Republic of Congo, 2010-2011 (n = 611)**




* Laboratory confirmed cases are preferred, however, at the stage of hypothesis testing / analytical epidemiology

**Figure 2: Laboratory-confirmed and clinical poliomyelitis cases by district of residence, * Republic of Congo. †**

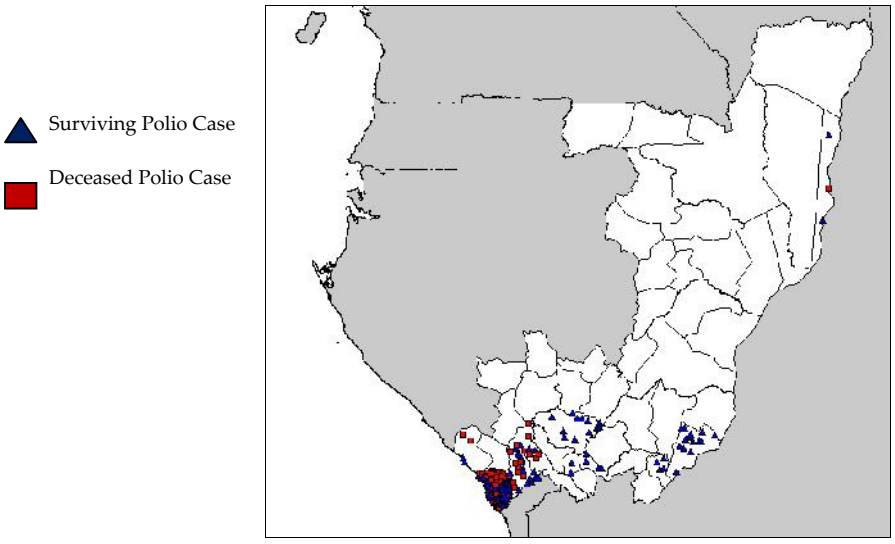



**Table 1: Characteristics of persons with laboratory-confirmed and clinical poliomyelitis, Republic of Congo (2010–2011)**

| | All poliomyelitis (n=445) | | Laboratory-confirmed (n=64) | | Clinical (n=381) | | |
|---|---|---|---|---|---|---|---|
| **Characteristics** | **Number Positive/Total** | **%** | **Number Positive / Total** | **%** | **Number Positive / Total** | **%** | **$\chi^2$ p value ‡** |
| Male | 301/440 | 68% | 43/63 | 68% | 258/377 | 68% | 0.97 |
| Diagnosed in Pointe Noire | 390/445 | 88% | 39/64 | 61% | 351/381 | 92% | <0.0001 |
| Clinical symptoms at time of presentation | | | | | | | |
| Fever at onset | 322/341 | 94% | 48/52 | 92% | 274/289 | 95% | 0.47 |
| Progression of paralysis within 3 days | 314/331 | 95% | 50/52 | 96% | 264/279 | 95% | 0.65 |
| Asymmetrical paralysis | 116/342 | 34% | 19/51 | 37% | 97/291 | 33% | 0.59 |
| Monoplegia | 76/359 | 21% | 7/53 | 13% | 69/306 | 23% | |
| 2 limbs paralyzed | 212/359 | 59% | 26/53 | 49% | 186/306 | 61% | 0.002 |
| Triplegia | 13/359 | 4% | 5/53 | 9% | 8/306 | 3% | |
| Quadriplegia | 58/359 | 16% | 15/53 | 28% | 43/306 | 14% | |
| Paralysis at >60 day after onset among survivors with follow-up | 91/99 | 92% | 21/22 | 95% | 70/77 | 91% | 0.68[a] |
| Death | 193/445 | 44% | 9/64 | 14% | 184/381 | 48% | <0.0001 |
| Missing data on OPV vaccination history | 348/445 | 78% | 36/64 | 56% | 312/381 | 82% | <0.0001 |
| OPV doses (by card or recall) | | | | | | | |
| Zero | 29/97 | 30% | 13/28 | 46% | 16/69 | 23% | |
| 1-2 | 25/97 | 26% | 8/28 | 29% | 17/69 | 25% | 0.03 |
| 3+ | 43/97 | 44% | 7/28 | 25% | 36/69 | 52% | |

[a] 2-tailed Fisher's exact p-value

## *Questions*

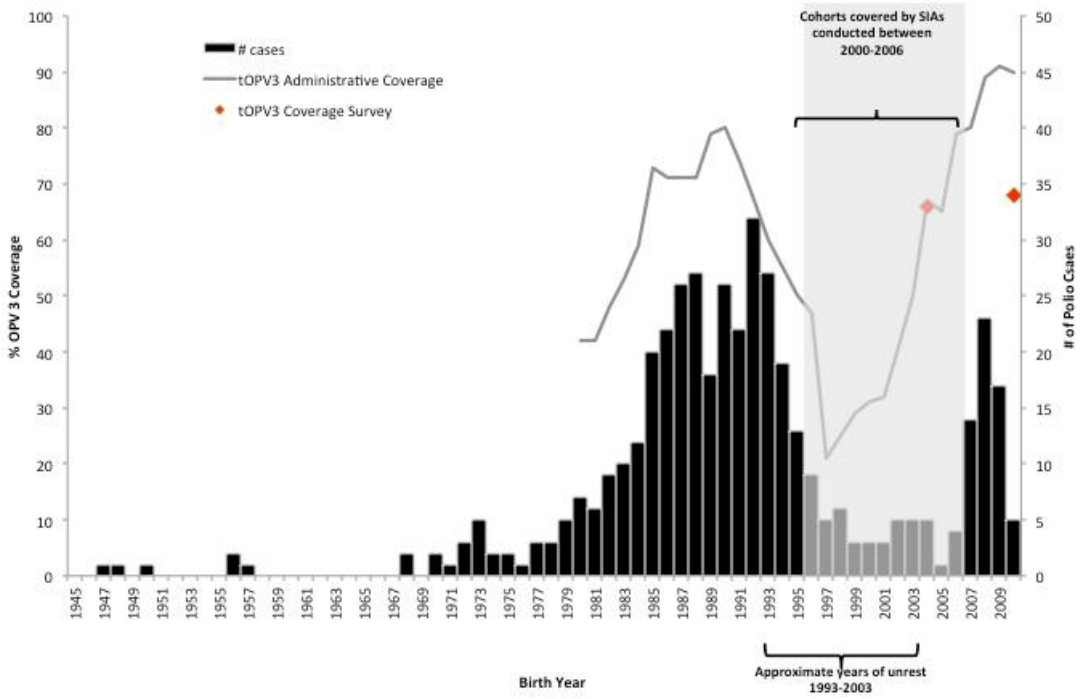
- What hypotheses could you generate from the time, place and person information with respect to the determinants of this outbreak? Do the data suggest vaccine failure or failure to vaccinate?
- What information could you obtain to examine these hypotheses?

* The cluster of surviving and deceased cases on the coast corresponds to the city of Pointe Noire
† Dots are placed randomly in districts and are not representative of the exact village of a given case
‡ Statistical test comparing clinical and laboratory-confirmed cases in terms of selected characteristics

## 5. Immunization history and population immunity (20 m)

The sharp epidemic curve and the clustering in Pointe Noire suggested a common source outbreak while the immunization coverage was not sufficiently high to lead the investigators to suspect vaccine failure. Investigators were concerned about the cases among young adults and wanted to understand what could have explained transmission in that age group. In an 'age-cohort' analysis, they plotted the number of cases by year of birth against the information regarding vaccination coverage that these age cohorts were exposed to (Figure 3). This included routine immunization and a number of supplemental immunization activities (SIAs) that were conducted between 2000 and 2006 at a time when the country's routine immunization programme suffered from the civil unrest. Administrative coverage [*]with trivalent oral polio vaccine (OPV3, that includes all three WPV serotypes), was obtained from the WHO/UNICEF Joint Reporting Form. Coverage survey data was obtained from the 2005 Demographic and Health Survey (DHS) and the 2009 Expanded Program on Immunization Coverage Survey.

**Figure 3: Laboratory-confirmed and clinical poliomyelitis cases (2010-11 outbreak) and coverage with 3 doses of trivalent oral polio vaccine (tOPV3) by birth year, Republic of Congo [†‡]**




### *Questions*

- Take the time to understand what the axis, bars, lines and points represent and describe the information on this graph.
- How can this information help you to refine the hypothesis of an immunity gap?
- What further information would you want to collect to evaluate this hypothesis?
- What additional studies could contribute to understand or describe an immunity gap?

[*] Administrative coverage is obtained by dividing the number of doses administered by the target population size
[†] Abbreviations: OPV, oral polio vaccine; SIAs, supplementary immunization activities
[‡] The red dots for tOPV3 coverage correspond to routine delivery and exclude SIAs

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## 6. Determinants of the outbreak from vaccination history and environmental conditions (20 m)

On the basis of the age cohort analysis using aggregated data, investigators formulated the hypothesis that the low coverage in routine immunization in the past led to immunity gap among younger adults. Given the geographical cluster and the narrow epidemic curve, they were also concerned about the environmental factors that could have led to large scale transmission in Pointe Noire. In theory, a sero-prevalence study could also have helped understanding the situation, but it was not adapted to the field conditions.

Investigators conducted a single-community rapid assessment of epidemiologic conditions potentially contributing to the outbreak, including vaccination coverage at the individual level. The survey was done in Mbota, a neighbourhood composed of four sectors, comprising 9.5% of the Pointe Noire population. This neighbourhood was selected using convenience / purposive sampling from Loandjili district in an effort to ensure socioeconomic representativity. Investigators collected information through face-to-face interviews in December 9–10, 2010 using a structured questionnaire. Questions included household demographics, water supply, and sanitary conditions. In addition, information for each person in the household was collected about vaccination history (routine and SIAs), any previous illness, and access to health care during the past three months.

Table 2 summarizes the findings in terms of vaccination coverage. In addition, tap water either from a neighbour's house (42%, 95% confidence interval [CI] 36%–48%) or within the house (31%, 95% CI 25%–36%) was the primary potable water source. Wells were also common (23%, 95% CI 18%–28%). When the primary source of potable water was unavailable, wells were the most frequently mentioned alternative source (38%, 95% CI 32%–44%).

### *Questions*

- Describe the information on Table 2.
- What do think of the validity of the information on vaccination status obtained from card and from recall?
- Interpret the information gathered up to now to propose explanations for this outbreak

**Table 2: Routine vaccination status against poliomyelitis by age and gender, Mbota, Pointe-Noire, Republic of the Congo, December 2010**

| Characteristics | | Vaccinated | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | According the card | | According to recall | | Card or recall | | Non Vaccinated | | Unknown | | |
| Age (years) | Gender | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | Total |
| <5 | M | 43 | (35) | 67 | (55) | 110 | (91) | 5 | (4) | 6 | (5) | 121 |
| | F | 54 | (36) | 72 | (48) | 126 | (84) | 9 | (6) | 14 | (9) | 149 |
| 5-9 | M | 26 | (25) | 53 | (52) | 79 | (77) | 10 | (10) | 13 | (13) | 102 |
| | F | 23 | (21) | 66 | (60) | 89 | (81) | 7 | (6) | 14 | (13) | 110 |
| 10-14 | M | 7 | (7) | 62 | (64) | 69 | (71) | 9 | (9) | 19 | (20) | 97 |
| | F | 16 | (16) | 51 | (51) | 67 | (67) | 7 | (7) | 26 | (26) | 100 |
| 15-19 | M | 4 | (4) | 39 | (42) | 43 | (47) | 9 | (10) | 40 | (43) | 92 |
| | F | 8 | (7) | 49 | (45) | 57 | (52) | 12 | (11) | 40 | (37) | 109 |
| 20-24 | M | 2 | (3) | 25 | (37) | 27 | (40) | 7 | (10) | 33 | (49) | 67 |
| | F | 4 | (3) | 61 | (48) | 65 | (51) | 14 | (11) | 48 | (38) | 127 |
| 25-29 | M | 2 | (2) | 37 | (43) | 39 | (45) | 12 | (14) | 35 | (41) | 86 |
| | F | 11 | (10) | 50 | (47) | 61 | (58) | 15 | (14) | 30 | (28) | 106 |
| >29 | M | 4 | (1) | 80 | (29) | 84 | (31) | 33 | (12) | 157 | (57) | 274 |
| | F | 11 | (4) | 84 | (32) | 95 | (36) | 30 | (11) | 135 | (52) | 260 |
| **Grand total** | | **215** | **(12)** | **796** | **(44)** | **1,011** | **(56)** | **179** | **(10)** | **610** | **(34)** | **1,800** |

## 7. Examining the case fatality ratio (20m)

According to the survey, estimates of routine vaccination coverage were low and decreased with age. In persons 15–29 years of age it varied between 46% and 52%. This survey confirmed the information obtained from the administrative programmatic source (Local public health authorities) that suggested a coverage ranging from 42% to 79% in those between 15 and 24 years of age. Civil conflicts in the 1990s undermined vaccination efforts, especially affecting those 10–20 years of age in 2010. The last WPV outbreak struck Pointe Noire in 1969. After 1969, some virus circulation may have occurred at endemic level until OPV was introduced in 1981. Progressively, the number of susceptible persons (i.e., those who were never infected and never vaccinated) accumulated. Once introduced from Angola, the virus spread quickly through this population. Flooding, poor to medium sanitation conditions, and common sources for water consumption potentially facilitated spread.

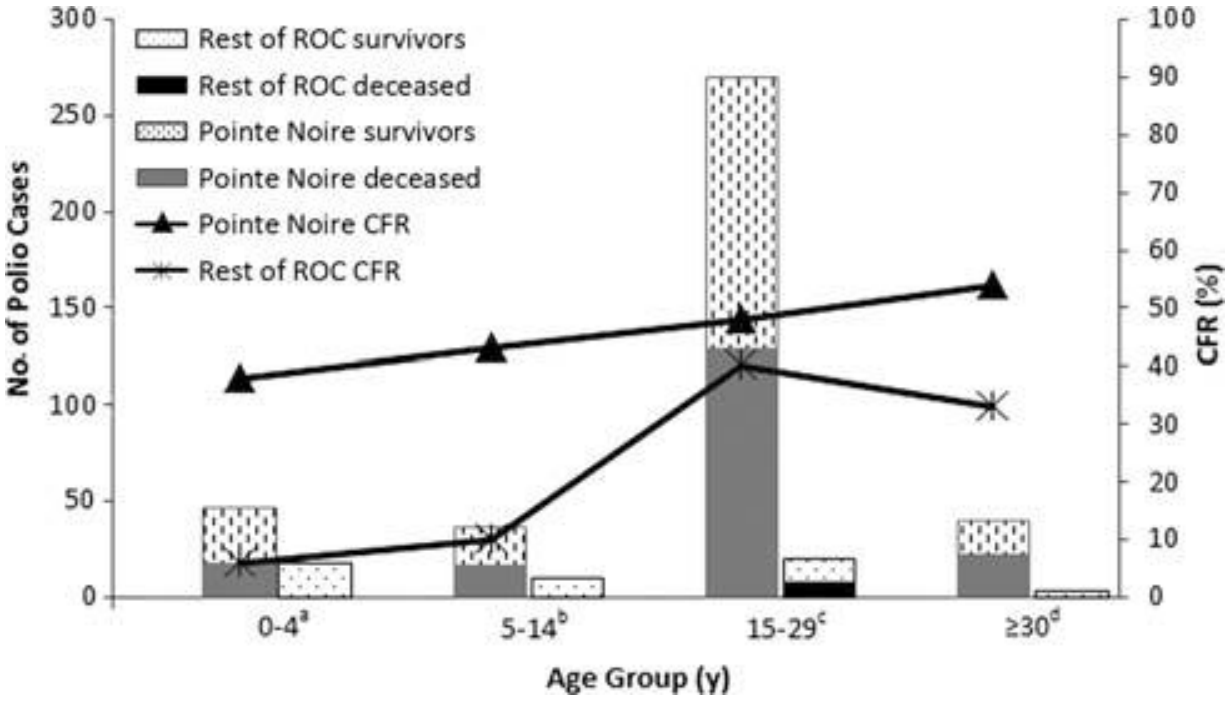
At this stage of the investigation, investigators were concerned with the high reported case fatality ratio. To understand the situation, they first compared data between Pointe Noire and the rest of the country (Table 3) and adjusted the comparison for the age group (Figure 4).

**Table 3: Characteristics of persons with poliomyelitis in Pointe Noire and in the rest of the Republic of Congo (2010–2011)**

| | Pointe Noire | Rest of ROC | $\chi^2$ p value |
|---|---|---|---|
| Number of poliomyelitis cases | 390 | 55 | |
| Number of deaths | 182 | 11 | |
| Case fatality ratio | 47% | 20% | 0.0002 |
| Median age in years (range) | 20 (0.6-63) | 9 (0.9-54) | <0.0001[a] |
| % Male | 69% | 65% | 0.61 |

[a] Wilcox rank-sum p-value

**Figure 4: Case-fatality ratio (CFR) among persons with poliomyelitis reported in Pointe Noire and in the rest of the Republic of Congo, stratified by age group, September 2010–January 2011.** *




## *Questions*

- Looking at the information on the table and on the graph, what are the factors that seem to influence the case fatality ratio?
- What additional investigation could be proposed to understand the case fatality ratio? What would be the operation research question that would require an answer? What would you compare with what in terms of what?

* P values provided compare CFR by geographic location within each age group. aCFR $\chi 2$ P = .02. bCFR 2-tailed Fisher exact P = .07. .07. cCFR $\chi 2$ P = .51. dCFR 2-tailed Fisher exact P = .60. Abbreviations: CFR, case-fatality ratio; ROC, Republic of Congo.

## 8. Additional investigations of the case fatality ratio (15m)

While older age explained the high case fatality ratio to some extent, the case fatality ratio was higher in Pointe Noire. Investigators explored factors associated with fatal outcomes among persons with poliomyelitis in Pointe Noire. * Data were obtained from medical records, hospital databases, AFP case investigation forms and, when possible, via interviews with persons with polio or surrogates using a standard questionnaire. Case-patients who died were compared those who survived in terms of several characteristics, including age, treatment received, crowding, socio-economic status and sources of water supply (Table 4).

### *Questions*

- How do you describe the information in the table?
- How do you interpret the information to answer the question at hand and identify factors associated with fatal outcomes?

**Table 4: Uni-variable and multi-variable analysis of variables associated with fatal outcome among persons with polio for whom interviews were conducted, Pointe Noire, ROC, 2010 (n=96)**

| Characteristics | | N | Died (n=52) No. (%) | Survived (n=44) No. (%) | Uni-variable Odds Ratio (95% CI) | Multivariable Adjusted Odds Ratio (95% CI) |
|---|---|---|---|---|---|---|
| **Age group** | < 15 years | **21** | **6 (29%)** | **15 (71%)** | **referent** | |
| | ≥ 15 years | **75** | **46 (61%)** | **29 (39%)** | **4.0 (1.4-11.4)** | **7.2 (1.6-32.6)** |
| **Rx before paralysis** | IV / IM injection | **38** | **22 (58%)** | **16 (42%)** | **1.3(0.6-2.9)** | |
| **Rx after paralysis** | Antibiotics | **34** | **19 (56%)** | **15 (44%)** | **1.02 (0.4-2.4)** | |
| | Vitamin B | **46** | **24 (52%)** | **22 (48%)** | **0.8 (0.3-1.8)** | |
| **Number of rooms in home** [b] | 1 or 2 | **49** | **31 (65%)** | **17 (35%)** | **2.6 (1.1-6.1)** | **3.9 (1.3-11.4)** |
| | > 2 | **43** | **18 (41%)** | **26 (59%)** | **referent** | |
| **Home ownership** | Yes | **58** | **38 (66%)** | **20 (34%)** | **3.2 (1.4-7.7)** | |
| | No | **38** | **14 (37%)** | **24 (63%)** | **referent** | |
| **Home material** [b] | Cement | **41** | **17 (41%)** | **24 (59%)** | **referent** | |
| | Not cement | **43** | **26 (60%)** | **17 (40%)** | **2.2 (0.9-5.2)** | |
| **Usual source of drinking water** [c] | Borehole | **17** | **8 (47%)** | **9 (53%)** | **0.7 (0.3-2.0)** | |
| | Bottle water | **23** | **13 (57%)** | **10 (43%)** | **1.1 (0.4-2.9)** | |
| | Covered well | **33** | **22 (67%)** | **11 (33%)** | **2.2 (0.9-5.3)** | |
| | Open well | **5** | **2 (40%)** | **3 (60%)** | **0.6 (0.1-3.4)**[d] | |
| | Home tap | **25** | **14 (56%)** | **11 (44%)** | **1.1 (0.4-2.8)** | |
| | Public tap | **49** | **27 (55%)** | **22 (45%)** | **1.1 (0.5-2.4)** | |
| **Drinking water source during shortage** [c] | Borehole | **20** | **10 (50%)** | **10 (50%)** | **0.8 (0.3-2.1)** | |
| | Bottle water | **26** | **14(54%)** | **12 (46%)** | **0.95 (0.4-2.4)** | |
| | Covered well | **46** | **32 (70%)** | **14 (30%)** | **3.3 (1.4-7.7)** | **5.1 (1.7-15.0)** |
| | Open well | **8** | **2 (25%)** | **6 (75%)** | **0.3 (0.1-1.3)**[d] | |
| | Home tap | **10** | **6 (60%)** | **4 (40%)** | **1.3 (0.3-4.8)**[d] | |
| | Public tap | **33** | **19 (58%)** | **14 (42%)** | **1.2 (0.5-2.7)** | |
| **Adequate water treatment** | Yes | **42** | **19 (45%)** | **23 (55%)** | **referent** | |
| | No | **54** | **33 (61%)** | **21 (39%)** | **1.9 (0.8-4.3)** | |
| **Toilet facilities** | Public pit | **40** | **28 (70%)** | **12 (30%)** | **3.1 (1.3-7.3)** | **NS** |
| | Other | **56** | **24 (43%)** | **32 (57%)** | **referent** | |

[a] Interview conducted with person with polio or appropriate representative
[b] Numbers total < 96 due to missing responses
[c] Numbers total > 96 due to interviewees being able to choose > 1 more response
[d] Calculated using Fisher's exact test
CI = confidence interval, NS = not significant

* Clinical poliomyelitis cases and laboratory confirmed poliomyelitis cases reported from 7 October to 7 December 2010

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## 9. Infectious dose and case fatality ratio (10m)

Compared with surviving polio cases, those who died were more likely to live in houses with less rooms and more likely to drink water from covered wells. This could suggest that an association between a higher infectious dose and a higher case fatality ratio, as reported for some other viral diseases (e.g., measles). Direct evidence for poliomyelitis infection via contaminated water is scarce. Indirect evidence for the role of contaminated water in polio transmission came from a detailed investigation of a 1952 outbreak during which 95% of the clinical cases in a community were concentrated in areas served by water of poorer quality. In a subsequent study, investigators found evidence suggesting that mode of transmission affected not only risk of infection but also severity of disease, possibly from exposure to large viral doses during repeated ingestion of contaminated water. Although evidence of a dose-response effect of poliovirus in humans has not been shown, Sabin demonstrated such an effect in a primate model of poliovirus infection.

### *Questions*

- What further investigations could be performed to explore the role of waterborne transmission of poliovirus in this outbreak?
- What control measures could be proposed to control this outbreak?

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## 10. Control measures and epilogue (5m)

Investigators discussed the possibility of environmental testing of water sources for WPV. The disruption of the water supply and flooding immediately before the outbreak could have led to faecal contamination of the potable water. This idea was finally not pursued because of technical issues (e.g., difficulties to of distinguish WPV from OPV in diluted specimens after a large campaign). WHO recommends environmental surveillance for poliovirus. * However, these methods are recommended to provide early warning signals before outbreaks. During an outbreak, the excretion of the virus by many case-patients makes it difficult to interpret positive results.

Overall, the finding on the case fatality ratio cannot be used directly for practical action, but they contribute to a better understanding of polio outbreaks.

A national SIA was conducted 12–22 November 2010 using the highly immunogenic monovalent OPV against WPV1, followed by three more rounds of national SIAs using bivalent OPV against WPV1 and WPV3 (bOPV). The first 3 national SIAs were synchronized with bordering regions of Angola and Democratic Republic of Congo (DRC). In April 2011, a sub-regional SIA targeting seven districts in southern ROC was conducted using bOPV (synchronized with Gabon, Angola, Namibia, and DRC). SIAs targeted the entire population of 4.5 million persons, including adults. Transmission was stopped <6 months after the first case with multiple coordinated SIAs.

Several lessons from this outbreak are applicable to other countries (Table 5).

1. Regions suffering from armed conflicts are at increased risk of immunization programmes failure. These may have consequences long after these conflicts.

2. In elimination and/or eradication programmes, countries that were successful in controlling a disease remain at risk for re-introduction, as long as the disease transmission persists in any country (Particularly if transmission is taking place in a neighbouring country). Appropriate measures, including increased surveillance and vaccination of non-immune populations must be conducted prophylactically.

3. In elimination and/or eradication programmes, molecular methods are increasingly important to follow up circulation and changes of the different strains.

4. A high index of suspicion for polio is required in the evaluation of all AFP cases, even among adults. Adequate specimen collection and laboratory diagnostics are vital to rapidly identifying the first cases of poliomyelitis in previously polio-free countries.

Outbreaks such as the one in the ROC undermine confidence and drain scarce resources. At this critical juncture in polio eradication, preventing importations by increasing population immunity in vulnerable countries is imperative. Heightened vigilance for WPV importation is critical to ending an outbreak quickly.

* http://whqlibdoc.who.int/hq/2003/WHO_V&B_03.03.pdf

**Table 5: Application of the 10 steps of an outbreak investigation during the 2010 outbreak of poliomyelitis, Republic of Congo**

| Steps | Traditional steps of an outbreak investigation | Application during the outbreak |
|---|---|---|
| **1** | **Confirm the nature of the outbreak** | Detection of an unusual cluster of AFP |
| **2** | **Confirm the diagnosis** | Isolation of VPW in a WHO-accredited laboratory |
| **3** | **Define a case** | WHO/AFRO case classification |
| **4** | **Conduct case finding** | Passive / active case finding |
| **5** | **Descriptive epidemiology to raise hypotheses** | Time: Narrow epidemic curve<br>Place: Cluster around Pointe Noire<br>Person: Young adults, low proportion of vaccination among cases<br><br>Age cohort analysis<br><br>Descriptive epidemiology for the high CFR |
| **6** | **Analytical epidemiology to test hypotheses** | (No vaccine effectiveness study: No data suggesting vaccine failure)<br>Comparison of surviving cases and deceased cases in terms of selected characteristics |
| **7** | **Conduct additional investigations** | Survey of environmental conditions in Pointe Noire |
| **8** | **Draw conclusions** | Introduction of WPV 1 from Angola<br>Accumulation of susceptible individuals among young adults<br>Rapid transmission in Pointe Noire because of environmental conditions<br>Age and higher virus dose may explain higher CFR |
| **9** | **Communicate findings** | IHR notification<br>Publications |
| **10** | **Enforce prevention measures** | SIAs until cessation of transmission |

## 11. References


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