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African Case Studies in Public Health

Participants' Guide

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Response to an Unusual Outbreak in a High-risk Situation

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Abstract

In 2010, a series of lead poisoning outbreaks linked to artisanal gold processing killed at least 400 young children in Zamfara State in northwestern Nigeria. There were several efforts to respond to the outbreaks as they occurred. Subsequent recurrence of lead poisoning outbreaks within Zamfara and beyond suggested that there were no efforts to mitigate the outbreaks as recommended for disaster management. This case study, to be completed within 3 hours, is suitable for senior level public health officials and those training for such positions. It enables participants to review and apply epidemiological principles for managing disasters and suggest steps toward development of policy recommendations based on the context of environmental lead exposure. It will serve as a generic training module for managers/responders of other natural (floods, heat stroke) and man-made disasters (civil strife, conflict, insurgency) based on the general/standard principle of the complete disaster management cycle.

How to Use the Case Study

General instructions: This case study is designed for training 15-20 participants in a classroom setting. A facilitator leads the participants through the case study as participants take turns reading one or two paragraphs out loud and provides guidance as participants go through each discussion or exercise question. Instructor's notes are included with each question in the instructor's version of this case study with suggestions for facilitation and with background materials.

Audience: Senior level public health officials, public health officials responsible for policy and management, students of public health and/or field epidemiology, and practising (field) epidemiologists

Prerequisites: Before using this case study, case study participants should have received lectures or instruction in disaster management

Materials needed: Whiteboard or flip chart, markers

Level of training and associated public health activity: Intermediate - Disaster management

Time required: 2-3 hours

Language: English

Participant's Guide

Goal of Case Study: To review and apply epidemiological principles for managing disasters and develop policy recommendations based on the context of environmental lead exposure in Zamfara State, Nigeria, in 2010.

Learning Objectives - After completing this case study, the participant should be able to:

1. Identify and manage disasters
2. Revise epidemiological principles (summarise and interpret data, surveys and evaluation methods, implement monitoring and evaluation of public health interventions)
3. Describe formation and management of an emergency preparedness and response team
4. Understand the process of resource mobilisation and coordination
5. Develop and implement public health actions
6. Understand cause and management of lead poisoning
7. Critique public health actions/responses

Introduction – Outbreak in Zamfara State, February – June 2010

Zamfara State in northwestern Nigeria is mainly composed of agrarian and pastoral communities (Figure 1). In February 2010, a joint team from Zamfara State's Ministry of Health and Médecins Sans Frontières (MSF) identified more than 200 children under 5 years of age with convulsions in 4 villages while conducting routine meningitis surveillance. Approximately 40 of these children later died. Environmental causes were suspected because of a recent increase in gold ore processing activities in the region, an important alternative source of income for these pastoral families. A provisional diagnosis of lead poisoning was made by field workers [1].

Figure 1. Map of Nigeria with Zamfara State (39,762 km^2) highlighted. The projected population in 2009 was 3.6 million, of predominantly Hausa of Fulani ethnicity. (AFP/Graphics)

Lead poisoning is a medical condition caused by increased levels of the heavy metal lead in the body. Lead is ubiquitous in the environment and can be found in mining areas, batteries, pottery, plumbing works, gasoline, toys, paint, and traditional medicines [2–4]. In children, lead causes brain damage, behaviour and learning problems, and growth retardation. At high levels, it can cause convulsions and death. The Centers for Disease Control and Prevention (CDC) recommended threshold for public health action of blood lead in children was 5 µg/dl [5].

Diagnostic tests on eight symptomatic children revealed blood lead levels ranging from 168 to 370 µg/dl. Following this discovery, in May 2010, the Federal Ministry of Health (FMOH) constituted a multidisciplinary team comprising representatives from the CDC, World Health Organisation (WHO), Nigeria Field Epidemiology and Laboratory Training Program (NFELTP), and MSF to support outbreak investigation by Zamfara State public health officials [1]. The team selected Villages A & B, the two

villages with the highest number of cases found during the investigation where 37 and 20 child deaths were reported respectively between May 2009 and May 2010. The team conducted epidemiological, laboratory and environmental investigations [6].

As part of the epidemiological investigation, the team conducted a population survey by door-to-door visits in the two selected villages from 25th May to 4th June 2010. Information was collected from caregivers in each of the 119 compounds on signs and symptoms of lead poisoning in their children. Household participation in ore-processing activities was also documented (Figure 2) [6].

Figure 2. A flour mill was being used to process gold ore. Gold ore processing became an important source of income for the primary pastoral communities in Zamfara State.

To conduct laboratory investigations, venous blood was collected from 204 children less than five years of age to measure lead levels using a portable analyser – the Lead Care II machine. Soil samples were collected from areas where children played and/or ate in the surveyed compounds to determine levels of household contamination. Environmental lead levels were assessed using a x-ray fluorescence spectrometer (XRF), a real-time heavy metal analyser [6]. The findings from the investigation team were as seen in figures 3 – 4.

Figure 3. Epidemiological curve of the lead poisoning outbreak – Zamfara State, Nigeria, 2012 [6]

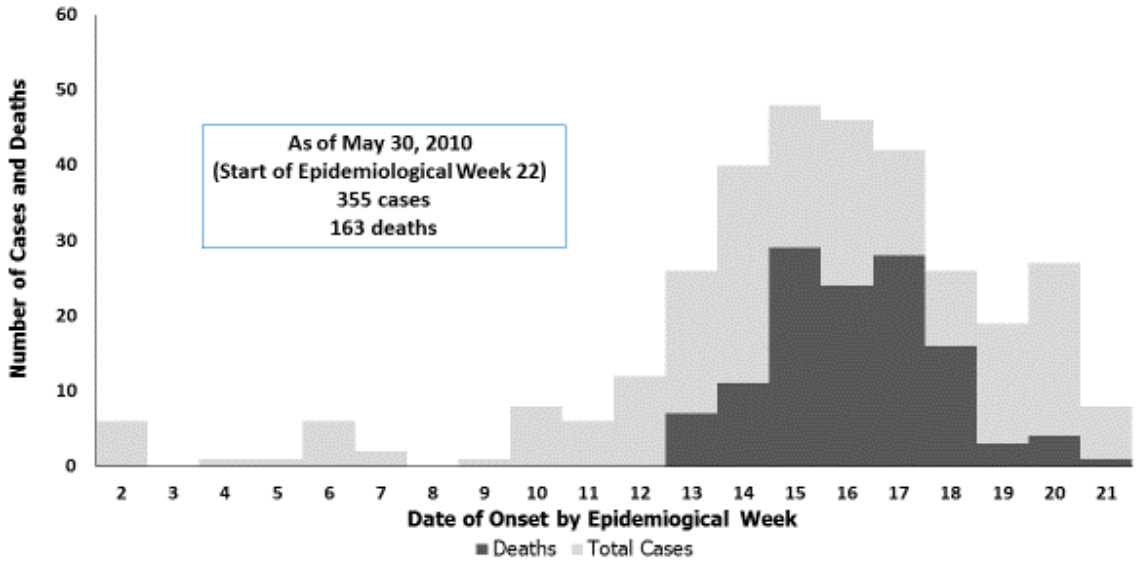
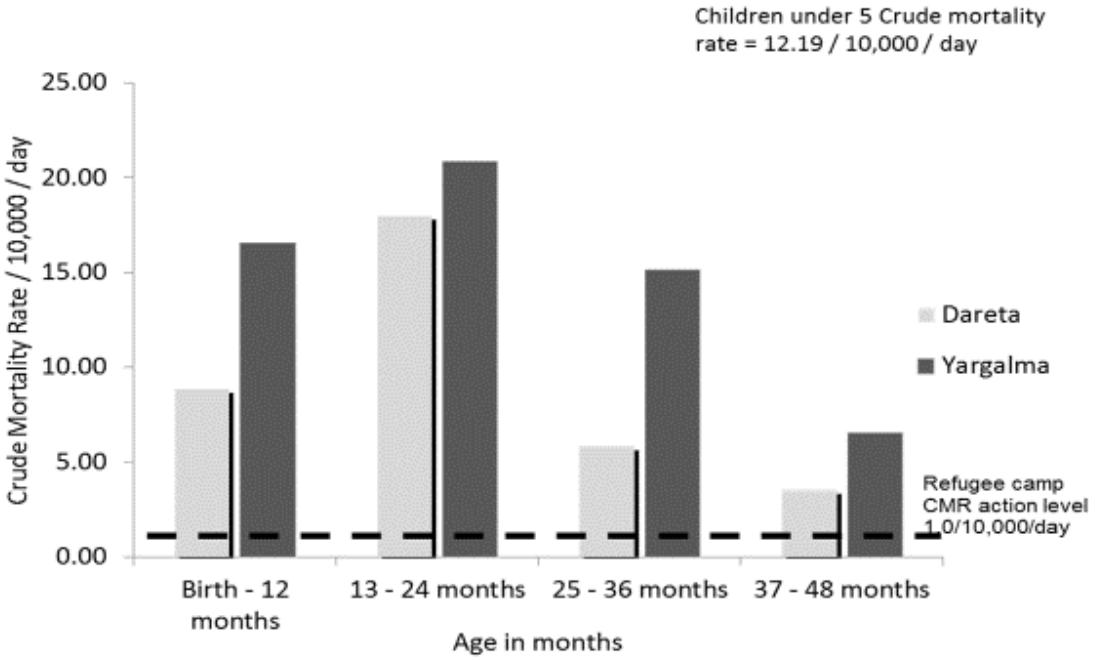


Figure 4. Age-stratified 6-month crude mortality rate/10,000 children/day in Villages A and B, Nigeria, 2010 [6]



The investigation team identified wells and open streams as sources of water. These water sources were unprotected from lead contamination and were shared with animals, leading to reports of significant die-offs among local poultry, goats, and sheep populations in addition to the human mortality shown in the figures above. Most of the soil and water samples were found to have high levels of lead [6].

Question 1. Would you consider this a disaster? Why or why not?

Question 2. What are key factors to measure and report to assess the magnitude and impact of a disaster?

Based on the outcome of their investigation, the team determined that this was the largest documented outbreak of fatal childhood lead poisoning associated with artisanal gold mining. An effective response would require coordination between federal, state ministries and international organisations with a multi-sectoral approach to address technological, medical, epidemiological, and social needs of the affected villages. With the limited resources in these communities and their dependence on mining as a means to augment income, the team focused on implementation of safe mining practices as a feasible strategy to prevent future outbreaks [6].

A multi-sectoral Emergency Preparedness and Response (EPR) team was raised to implement the investigation team's recommendations. The EPR team established an incident command centre to ensure effective coordination of the response. They also developed a protocol to guide implementation of their activities.

Question 3. Identify the goals and major components of a protocol for disaster management.

Question 4. What additional action should be taken to assess and address risk?

Question 5. Propose a list of appropriate members to be included in the EPR team for deployment to Zamfara State. Which roles might be included specifically for management of environmental lead?

Question 6. Describe the activities of an EPR team in terms of preparedness and response.

The multi-sectoral EPR team comprised representatives from federal, state, and international organisations. The team held daily meetings to review activities of the incident command centre and discuss technical and administrative aspects of the response. They provided solutions to logistics and security, as well as human and financial challenges.

In June 2010, the Nigerian FMOH granted approval for the therapeutic use of the oral chelating agent, meso-2,3-dimercaptosuccinic acid. Implementation of the therapy was coordinated jointly among all the stakeholders – oral chelation therapy was provided by MSF, remediation of lead-contaminated family compounds was provided by Terra Graphics, and public health messaging on lead poisoning and social mobilisation was conducted by UNICEF.

Question 7. Outline the steps of resource mobilisation for disaster management.

Part 1 – Outbreak in Zamfara State, August 2010

On 21st August 2010, the Zamfara State Ministry of Health reported another episode of unexplained deaths in children below five years in Village C and hypothesised that the fatalities were probably due to lead poisoning. Reports of gold mining activity within this community were unverified. Village C was not among the villages under surveillance for lead poisoning. A new EPR team was constituted to conduct epidemiological and environmental investigations.

Following the investigations, the team recommended environmental remediation, chelation therapy to treat affected children, and education against ore processing activities within the village boundaries (Figure 5). As long-term measures, the team also recommended adherence to safe mining practices and intensified soil lead surveillance.

Figure 5. Chief of Dareta halted the brick making process for homes in the village because the bricks made were highly contaminated with lead, contributing to the death of 58 children in 3 months.

Question 8. What are the key factors required for effective implementation of public health emergency response?

Question 9. How do you monitor the effectiveness of the interventions for lead exposure?

Part 2 – Outbreaks in Zamfara State, June-September 2010

Between June and September 2010, childhood lead poisoning was identified in five additional villages in Zamfara State. Public health professionals in Zamfara State continued to identify new villages with children having history of convulsions and deaths suggestive of lead poisoning, though evidence of lead poisoning was not laboratory confirmed. The FMOH requested the CDC and partners extend their investigations and response.

Question 10. Would you recommend the same approach as the earlier responses? Why or why not?

A rapid assessment was conducted to determine the geographical extent of the outbreak in Zamfara State and to guide implementation of appropriate interventions. Chain-referral sampling rather than random sampling was used to facilitate rapid identification of villages of interest, defined as villages suspected of participation in any gold ore-processing activity during the previous 12 months (October 2009–October 2010) in Zamfara State [7,8].

Question 11. What is a chain referral system?

Question 12. What are the strengths and weaknesses of the chain referral system?

For the lead poisoning response, traditional leaders were asked to provide a list of villages in their jurisdiction that likely participated in gold ore processing. These villages were visited and the villagers were asked to list other villages in their area that likely participated in the processing. These were added to the aggregate list, and the process was repeated in subsequent villages. The cycle was repeated during the 5-week operation period (15th October–18th November 2010) to compile a comprehensive list of villages of interest. The team considered one of three strategies for collecting information from identified villages of interest: a village-wide meeting, meeting with key stakeholders, or meeting with the village chief.

Question 13. Analyse the advantages and disadvantages of each approach for collecting information from villages of interest.

Teams of three to five members each were assigned to villages of interest to ask the village chief to convene an informal village-wide meeting. During the meeting, each team informed assembled villagers (predominantly male adults due to cultural norms) of the purpose of the visit and administered the questionnaire in the local language by interviewing villagers collectively, including the village chief. If villagers varied in their answer to a question, the interviewers asked for a consensus decision to record. Villages that reported gold ore processing activities were asked to indicate where the ore had been mined. Blood samples were collected from selected children, and environmental samples were collected from areas where children ate or slept, in addition to nearby ore processing sites.

The team concluded that childhood lead poisoning and environmental lead contamination were widespread in the three additional Local Government Areas (LGAs) of Zamfara State. Villages with a recent increase in gold ore processing activity were more likely to have childhood lead poisoning and lead contamination. Further investigations were conducted to identify villages requiring remediation and treat children with high lead level.

Part 3 – Niger State Outbreak, March 2015

In March 2015, the FMOH was notified of another confirmed lead poisoning outbreak with 65 cases and 28 deaths (CFR = 43%), in Niger State, North central, Nigeria. Investigations revealed that the incident was related to artisanal mining. Experience from the Zamfara outbreaks was used to implement a coordinated response.

Question 14. Describe the phases of a disaster management cycle.

Question 15. For each phase of the disaster management cycle, identify activities taken by Nigeria during their response to the recurrent outbreaks of lead poisoning. What steps could have been taken to improve the outcomes?

Question 16. Due to the recurrent discovery of illegal/uncontrolled mining-related lead poisonings, in August 2015 the President of Federal Republic of Nigeria stated that "illegal mining shall no longer be tolerated in Nigeria." Do you agree with the policy statement of the President? Highlight the possible implications of the policy statement.

Question 17. As a member of the investigation and response team, provide a recommendation to the president of short- and long-term strategies (public health actions) in terms of policy, advocacy and surveillance to mitigate exposures/outbreaks of lead poisoning in Nigeria.

Conclusion

The lead poisoning outbreak in Zamfara and Niger States resulted from artisanal and small-scale mining (ASM) that supplemented the income of agrarian communities. An estimated 100 million people worldwide rely directly or indirectly on ASM for their livelihood. These activities are driven by poverty and a lack of economic opportunities in rural communities, as seen in these outbreaks. The need to sustain this source of livelihood for millions globally should not compromise the need to ensure that it is done in a safer and less harmful manner.

In February 2016, a national symposium was conducted in Kano State, Nigeria to examine the issue of lead poisoning and provide immediate and long-term solutions. A national centre for heavy metal poisoning was approved to be established. Hopefully, the centre will be a focal point for research, policy, and advocacy for a comprehensive national disaster management program. This centre will manage future incidents of lead poisoning and other national and regional disasters.

Glossary

Chelating agent: Substance used to inactivate and/or remove harmful substances (e.g. heavy metals) from the body thereby rendering them inactive/harmless. An example is meso-2,3-dimercaptosuccinic acid. [9]

Disaster management: The range of activities designed to maintain control over disaster and emergency situations and to provide a framework for helping at risk persons avoid or recover from the impact of a disaster. The attempt to minimise the disruption caused by these adverse events and prevent as much additional damage as possible. [10]

Environmental remediation: Removal of pollution or contaminants from environmental media such as soil, groundwater, sediment, or surface water.

Meso-2,3-dimercaptosuccinic acid: See chelating agent.

Preparedness: Measures taken in advance to ensure effective response to the impact of disasters. Preparedness measures include effective evacuation infrastructures or the regular testing of warning systems. [10]

Rehabilitation & reconstruction: Refers to all activities aimed at recovery.

Response: "The set of activities implemented after the impact of a disaster in order to assess the needs reduce the suffering limit the spread and the consequences of the disaster open the way to rehabilitation." [11]

Therapeutic: Used for the purpose of treating a disease process.

Vulnerability – "The predisposition to suffer damage due to external events" [12]

Background Reading

Biya O, Gidado S, Haladu S, *et al.* Notes from the Field: Outbreak of Acute Lead Poisoning Among Children Aged <5 Years – Zamfara, Nigeria, 2010. *MMWR* 2010; 59(27): 846

Dooyema CA, Neri A, Lo Y-C, *et al.* Outbreak of fatal childhood lead poisoning related to artisanal gold mining in northwestern Nigeria, 2010. *Environmental Health Perspectives* 2012; 120(4): 601–7

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