



## A Behind The Scenes Look At The Worst Lead Poisoning Outbreak On Record

Last month we reported on an investigation of an unprecedented lead poisoning outbreak in Nigeria (Epi Monitor April 2011) which won the Singal award at CDC's recent Epidemic Intelligence Service Conference in Atlanta. Since then the Epi Monitor has learned that the organizations investigating and responding to the outbreak have been named the 2011 winners of the Green Star awards for "environmental heroes working in disasters and emergencies" (see related article). What remained unclear from that initial report are the details of how the outbreak was actually detected, a topic of special interest to epidemiologists and others conducting disease surveillance.

### Assumptions

Whenever outbreaks happen they are by definition a departure from the usual rate at which disease occurs and thus may be readily detected or reported via routine surveillance activities, perhaps by an observant clinician, or by members of the affected population. And the events in this outbreak were certainly unusual since the death rate was as high as 30% of all children under five years of age in some villages, according to [Jane Greig](#) from Médecins Sans Frontières (MSF) or Doctors Without Borders.

In fact, it appears that none of these pathways produced an early or effective alert, and the behind the scenes story of how the outbreak came to be detected and the response carried out reveals much about the incredibly harsh conditions and complex public health problems in some poorer areas of developing countries.

The following account has been pieced together from documents and interviews with MSF epidemiologists [Jane Greig](#) and [Todd Swarthout](#), and fact checked with other MSF staff working on the outbreak ([Lauren Cooney](#) (health advisor for the emergency desk), [Natalie Thurtle](#) (current health advisor for the project), and [Leslie Shanks](#) (medical director). MSF was the first group of public health professionals to identify and respond to the outbreak which the British Medical Journal called the worst heavy metal contamination incident on record worldwide.

### Origins

The outbreak came to attention of MSF at the end of March 2010 when a team doing regular "emergency surveillance" for meningitis visited villages in the area of northern Zamfara state. These teams are fielded regularly by MSF looking for early signs of epidemic-prone diseases such as meningococcal meningitis. The team was informed of sick children, and a large number of deaths were reported to them, however, the symptoms did not fit clearly with likely local causes of illness such as meningitis or malaria, and the onset of cases predated the usual onset date of the seasonal meningitis cases. Furthermore, treating the sick children for these conditions had no impact.

### More MSF Investigation

MSF and Ministry of Health (MoH) teams provided 24hr medical care in the villages from the start of April, and on April 8, an MSF epidemiologist, medical coordinator and assistant medical coordinator visited two villages, saw children at the local health posts, and talked with villagers. Investigators began to suspect the illnesses were linked to the observed crushing and grinding of rock going on in village households as part of mining activities in the area, with heavy metal poisoning a strong differential diagnosis. Suspicion centered initially on mercury poisoning since it is used in the process of gold mining and inhabitants doing the mining had evidence of mercury on their hands. In agreement with the MoH, the investigators took blood samples which had to be sent to a laboratory in Germany for heavy metal testing. Although mercury poisoning was considered, the clinical picture pointed more to lead intoxication. The blood test results, which



were delayed for days because of ash clouds over Europe from a volcano in Iceland, showed that lead was clearly the problem, with all samples having levels far exceeding the threshold for urgent treatment.

### **Important News**

The diagnosis of lead poisoning was important news because the team now knew that chelation therapy is an effective medical intervention. However, it was not readily available in this part of the world, so all that the MSF physicians could provide at this early stage was supportive care for symptoms such as fever and convulsions. In effect, they were working long hours, but only buying time for children who were likely to die until chelation therapy could be obtained. And this was hard on the doctors, said Greig and Swarthout.

### **A New Mission**

Discussions within MSF headquarters ensued about what should be the MSF response. The organization has an "Emergency Desk" to manage the critical phase of emergency interventions, and this clearly was a situation where more children would die without treatment. However, what to do was not an easy decision. MSF had never provided such therapy before and knew little about it. The advice of organizations such as CDC / WHO and toxicologists would be critical to making an effective response. However, MSF knew that no other organization was likely to respond quickly enough nor have the operational ability to work in such a difficult environment, so they decided they had to do it. In early May, MSF worked out what scope their response should have.

As soon as MSF had results, they sought, and encouraged the Nigerian Ministry of Health to seek support from the USA Centers for Disease Control and the World Health Organization. Chelation therapy was sourced and the Ministry of Health had to give permission to import the drug into Nigeria.

### **Logistics**

MSF has strong logistics capacity, but the challenges involved in providing such therapy under the harsh conditions found in the villages were daunting. For example, MSF could not administer treatment in the villages where the patients lived since these dwellings were still contaminated and would result in ongoing exposure to lead. So they had to set up special treatment centers in 2 local government hospitals in areas provided by the local government in the big towns nearest the first 2 villages found to be affected. MSF had to resolve issues of providing adequate power and water, finding additional staff and adequate housing for them, and obtaining food and accommodations for the caregivers and other siblings who accompanied the sick children to the therapy site.

### **Testing and treatment**

CDC was able to bring in portable machines to test blood lead levels of children in large numbers locally. They also brought a team from TerraGraphics who confirmed the source and extent of the exposure, as well as provided emergency plans for remediation, which is a key contributor to recovery of children. Some of the initial blood levels were "astronomically" high, according to Greig. This provided an extra challenge to in-field testing, since almost all levels were above the upper limit of the portable machines capacity, so a dilution protocol had to be devised and validated by the field team and experts at CDC headquarters. In Europe, children might get 4-5 rounds of treatment for much lower lead levels over a course of a couple of years. In Nigeria, some of the children have needed more than 10 rounds of treatment already, in less than 1 year! And family support was required for many days since the initial course of treatment given by MSF was for 28 days as an inpatient. The magnitude of the challenge was considerable since essentially every child under five in the first-known affected villages was at risk, and there were hundreds of sick children to treat.

### **Rapid impact**



One positive aspect of the episode was the quick impact of treatment: some children came to the treatment center in a coma or no longer able to walk and showed rapid improvement with treatment, starting to walk again within just a few days. However, this posed additional challenges since it was a huge burden on families to send children to the treatment centers, and the caregivers wanted to return to their villages when children appeared much improved even though their treatment was not complete. However, some children remain with severe neurological sequelae.

### **New Protocols**

This challenge of maintaining patient compliance has been reduced since, in collaboration with an expert panel, MSF has been able to innovate and modify its treatment protocols from what they were in the early days. Inpatient treatment has been replaced largely by outreach teams that are able to go to the villages and give children oral tablets for a standard course of 19 days.

### **Data For Action**

During the early outbreak investigations, routine patient line lists were recorded to review symptoms of the unknown condition and develop a case definition, and “quick and dirty” survey data was collected to obtain a rough estimate of death rates, which even if somewhat inaccurate were still “ridiculously” high, according to Greig. Once the cause was identified and chelation therapy was available the death rates dropped dramatically. A database was set up to record treatment information, which has improved over time to meet changing project needs. Information about the personal characteristics of patients, treatment courses, and blood sample results at different times during treatment has been collected. With this information, MSF has been able to make informed decisions about patient management and protocol modifications. The data permit not only retrospective analysis, but help manage daily treatment and follow-up activities.

### **Current Status**

As of this point, the magnitude of the problem in Nigeria is unknown for sure, however, children in the seven villages first known to be affected have been screened, children who need treatment are offered it, and the environment has been remediated by teams led by the international organizations TerraGraphics & Blacksmith Institute. There remains at least one large village which has high environmental lead levels but has not yet been remediated.

### **Cause of the Outbreak**

The outbreak occurred because of very high lead content, sometimes >10% lead, in the rocks being crushed to extract gold, but the reasons the outbreak occurred last year and not earlier are not fully understood. It does appear that the problem happened quickly and thus could have been caused by a new gold strike or discovery in the area, a change in the source of rocks used for mining since the percent lead in these rocks varies, or some other precipitating factor. One thing that appears certain is that more grinding machines began appearing in the villages as more households took on mining activities late in 2009.

### **Long Term Solution**

Despite the encouraging aspects of the response to the outbreak itself, a solution to the longer term problem of preventing recontamination of the soil after villages have been remediated remains challenging. As long as a financial incentive to mine rock exists, then the risk of exposure will persist in the absence of safe mining practices. Villages themselves made efforts to move the mining activities out of the main area of the villages, but this presents other challenges of secure storage of equipment and travel distances. Implementation of safer mining practices is crucial to ensuring villages are no longer lead contaminated.