Outbreak Investigation

Outbreak investigations are key competencies in public health and preventive medicine. They must be done and all stakeholders expect that PM-PH professionals will be skilled in doing them.

Step 1 – Verify the diagnosis and identify the agent

Initial problem and symptoms	Outbreaks are detected when patients present with symptoms. Sometimes only one patient is enough to alert providers that an outbreak is beginning, and other times multiple cases are required.
Working diagnosis	For example, diarrhea with fever in a gastrointestinal disease outbreak
Agent tentatively identified	Often identified through clinical laboratory testing
Case definition	This is not the same as a clinical diagnosis but establishes consistent clinical criteria to identify cases before definitive diagnosis is available. The definition should favor sensitivity over specificity. Investigators must adhere to the case definition throughout the investigation.

For example, during the 2014-2015 Ebola outbreak, the case definition from the US CDC was as follows:

Person Under Investigation (PUI)	A person who has both consistent signs or symptoms and risk factors as follows should be considered a PUI: 1. Elevated body temperature or subjective fever or symptoms, including severe headache, fatigue, muscle pain, vomiting, diarrhea, abdominal pain, or unexplained hemorrhage; AND 2. An epidemiologic risk factor within the 21 days before the onset of symptoms.
Confirmed Case	Laboratory-confirmed diagnostic evidence of Ebola virus infection

Step 2 – Confirm that an outbreak exists

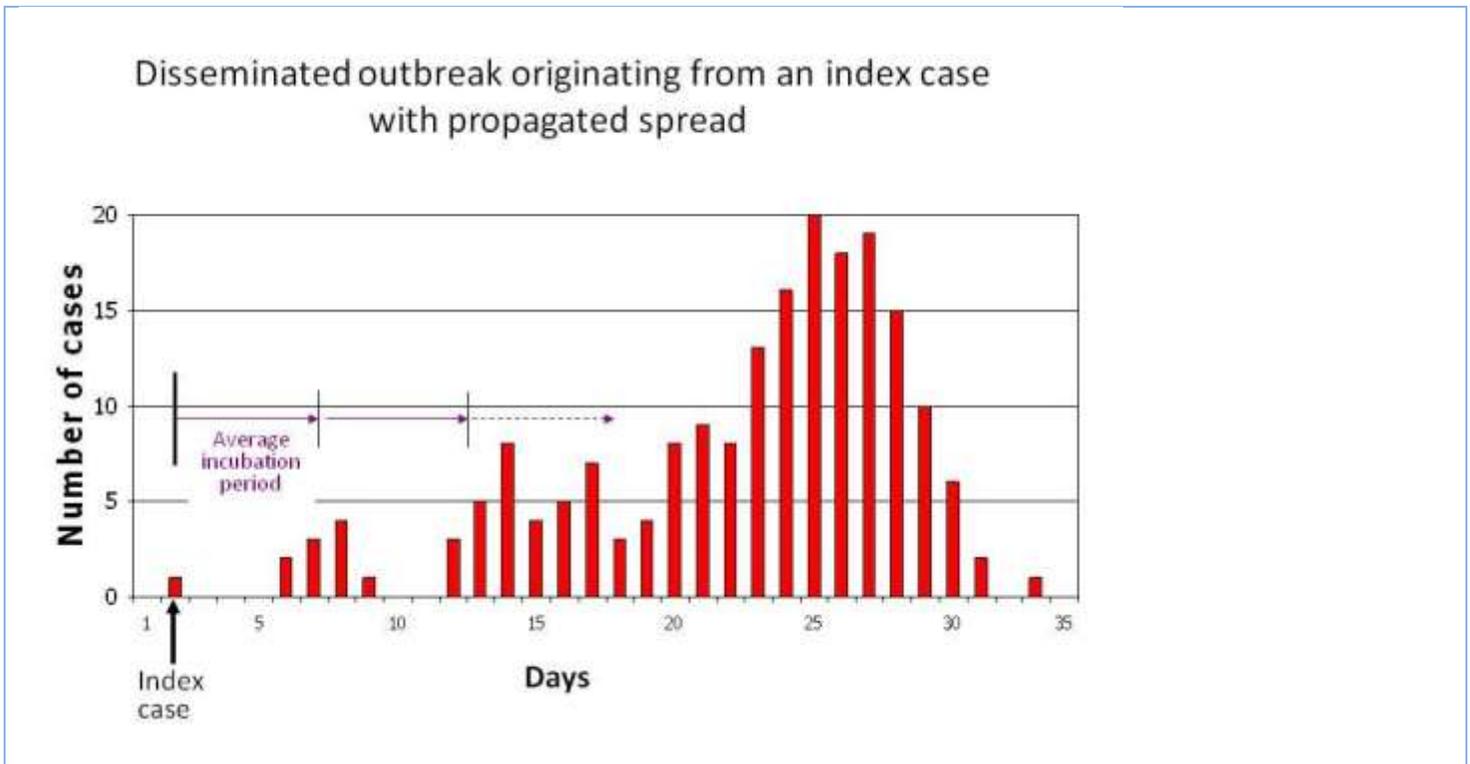| Use the case definition to identify all cases	How many cases exist in this outbreak?
Calculate the "at-risk" population	This should include people who could have reasonably been exposed to the pathogen, either through a common source or a disease case (if person to person transmission is possible)
Does the rate of disease cases exceed the baseline rate in this population/area? If so, an outbreak exists	For example, if the baseline rate of diarrheal disease in a group is 1/1000 and the rate has increased to 10/1000 now, an outbreak exists. Attack rate = # of new cases of a disease/number of persons exposed in a particular outbreak.
Preliminary reporting to higher level public health authorities	Local, state, CDC, military, other Federal

Step 3 – Seek additional cases

Alert health care facilities and encourage immediate reporting of patients meeting the case definition	They will be on the lookout for more cases and the information you provide may help guide their clinical care. For example, the presence of the anthrax epidemic in 2001 heightened clinical suspicion for anthrax among providers. This probably improved survival (through early detection and treatment) among those who were later infected).
Search for other cases	Retrospective chart review, lab reports, and the like

Step 4 – Characterize the cases by person, place and time

Name	Demo (age, sex, PMH)	Symptom Date	Symptoms	Medical Care Date	Laboratory	Epidemiologic Link to other cases	Outcome

Step 5 – Draw an epidemic curve (case numbers plotted against time) – example below

Disseminated outbreak originating from an index case with propagated spread

Step 6 – Form a tentative hypothesis

Reservoir	
Source	
Mode of Transmission	

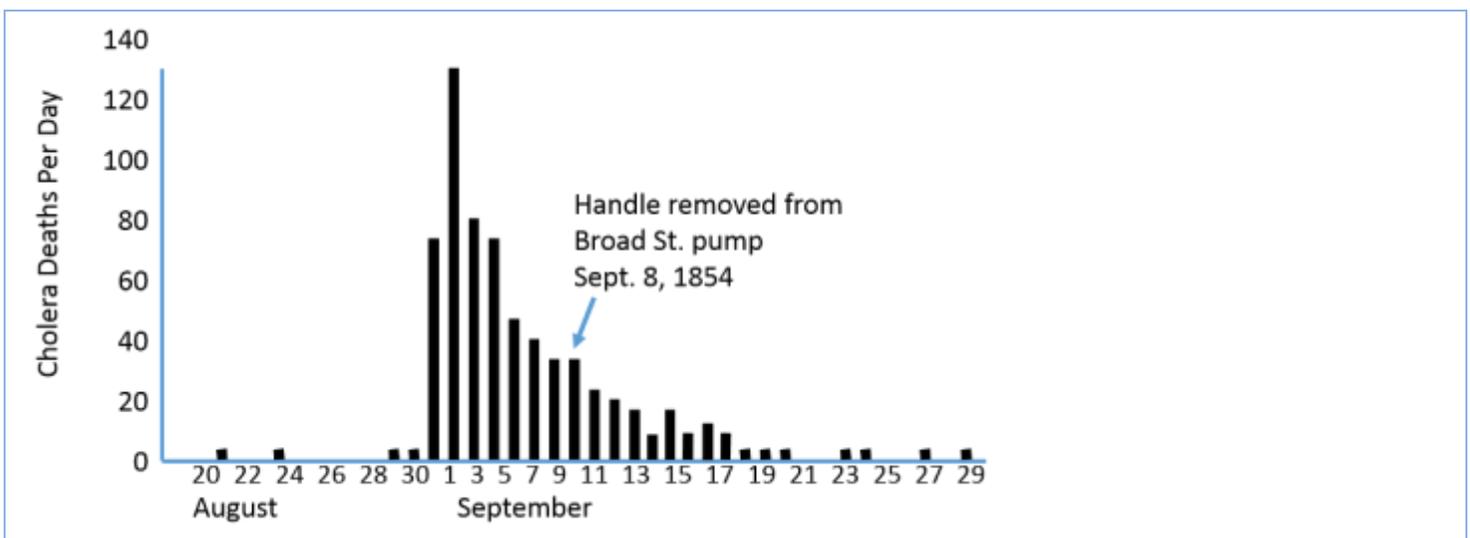**Step 7 – Institute preliminary control measures**

Patient care	In outbreaks of rare or highly lethal diseases, all health care personnel, including PM-PH should ensure that cases get the best possible outcomes
Outbreak control	Measures like hand washing, sanitation, isolation, quarantine, social distancing, masks, etc.
Educate at-risk population	Educating the group affected by the outbreak, cases and non-cases
Educate stakeholders	Educating government, public service, and other groups
Public Affairs	Educating the public to limit anxiety and encourage healthy habits

Step 8 – Test the Hypothesis (from step 6)

Simple outbreak investigations are done with cases and the at-risk population, but the best investigations are done as case-control studies. People who had been exposed to the disease (a case or a common source) are either cases or controls. By constructing a formal study, investigators can use odds ratios and other statistical measures to test their hypotheses about what is causing the outbreak.

Step 9 – Refine, monitor and evaluate the control measures

Noting how the outbreak progresses after the intervention helps investigators know if their preliminary control measures had been effective. From the graph below, it is clear that London cholera deaths improved before John Snow had the Broad Street pump handle removed, but removing the handle was still an effective intervention.

Step 10 – Prepare a final report