Distribution Agreement

Signature: 4/21/2022

Jenna Buttolph

Increasing Global Workforce Capacity: A New Outbreak Investigation Curriculum

By

Jenna Buttolph
MPH

Hubert Department of Global Health

Deborah McFarland, Ph.D., MPH
Committee Chair

Increasing Global Workforce Capacity: A New Outbreak Investigation Curriculum

By

Jenna Buttolph
MPH

Bachelor of Science, Public Health Promotion
Miami University
2020

Thesis Chair: Deborah McFarland, Ph.D., MPH

An abstract of
a thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Global Health
2022

Abstract

Increasing Global Workforce Capacity: A New Outbreak Investigation Curriculum

By Jenna Buttolph

The current pandemic has shed light on the need to increase the efforts in the Global Health Security Agenda (GHSA), a regulation recognized globally and support by large health organizations, including the World Health Organization and the Centers for Disease Control and Prevention. A component of the GHSA includes increasing workforce capacity, both at country and regional levels to ultimately lead to a safer, more secure world in the field of public health. A key tool to expand workforce capacity includes outbreak investigation training. These trainings allow for public health professionals to learn how to communicate with other personnel in the health field, properly respond to public health emergencies of international concern, and perform appropriate laboratory diagnostics and surveillance measures. Based off previous outbreak investigation trainings conducted globally, there is a need to review and/or repeat similar trainings due to the lack of educational adherence to materials presented by the respective implementers. This special studies project was developed to engage participants with an outbreak that has not been previously taught with a higher emphasis on collaboration with other professionals in the audience for a more interactive experience. The curriculum also offers a tabletop exercise, which is utilized for enhanced participation through an outbreak investigation simulation. This project offers a new perspective on how to train public health professionals in various settings, with the overall intent to increase workforce capacity and expand the GHSA globally.

Increasing Global Workforce Capacity: A New Outbreak Investigation Curriculum

By

Jenna Buttolph
MPH

Bachelor of Science, Public Health Promotion
Miami University
2020

Thesis Chair: Deborah McFarland, Ph.D., MPH

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Global Health
2022

Acknowledgements

It is with immense gratitude that I acknowledge the support, advice, and mentorship from Dr. Deborah McFarland. I recognize her global health expertise and believe that her various international experiences assisted me with this special studies project.

I would also like to personally thank Mr. Nabil Ahmed, Director of Integral Global, Dr. Ziad Kazzi, Assistant Professor of Emory University School of Medicine's Emergency Department, and Dr. Benon Kwesiga, FETP and public health professional in Uganda. Without their permission and gracious feedback, this curriculum could not have been developed.

Finally, I would like to thank my mother and father, who showed unconditional love during the creation of my thesis project. They have always pushed me to expand my knowledge and have supported my travel to Georgia to conduct my first outbreak investigation training with Mr. Ahmed and Dr. Kazzi.

Table of Contents

Chapter 1- Introduction

1.1 Rationale and Problem Statement

Throughout the 21st century, infectious disease outbreaks have become a recurring, dangerous, and fearful issue globally. While it seems that the public health world has learned various lessons from each previous pandemic, a consistent problem has remained: the workforce, particularly in low-to-middle income countries, lacks effective and efficient experience in professional preparedness and management regarding infectious disease outbreak investigations. This is due, in part, to the fact that previously taught trainings continue to repeat similar material, with little support for different, educational approaches from implementers.

The most recent Coronavirus pandemic has shed light on the importance of global health security (GHS). Of the "core four" components of the global health security agenda (GHSA), which include laboratory diagnostics, emergency response operations centers, workforce capacity, and surveillance, workforce capacity is commonly underfunded with difficulty scaling-up an appropriate number of trained health professionals based on global demand (Lui et al., 2017). An underfunded global health workforce capacity will continue to delay preparedness and response to highly transmissible pathogens, and reduce the chances of getting to a sustainable, international public health system (Ferguson and Williams, 2021). While the other GHS components are just as important in reaching a more stable and secure global health system, it is vital to continue increasing public health personnel's education and understanding of outbreak investigations. Though various organizations and stakeholders have conducted workshops on a global scale, these sessions are often not effective, nor sustainable, to reach the outcomes for this component of the GHSA. One indicator that the global workshops have not hit the mark in terms of sustained training is that health professionals need similar, repeated content taught as a "review course" which creates imbalances in retained skills (Figueroa et al., 2019).

1.2 Purpose Statement

The purpose of this special studies project is to develop an outbreak investigation curriculum for project implementers including NGOs and consulting firms, building off a published case study not previously utilized as a training resource for public health professionals. Stakeholders have expressed the need for an original outbreak investigation curriculum that will preserve the knowledge learned from training, and further avoid the need for repeated trainings. This new curriculum includes basic epidemiology and biostatistics topics that relate to a specific published, and approved outbreak investigation case study. A tabletop exercise is an additional, engaging aspect of the original curriculum described in this special studies project. The intent for this additional component is for physicians, epidemiologists, and other public health officials to play a role in the designated outbreak. The sustainable impact of "hands-on" learning will allow the participants to be able to determine the best method of communication, detection, response, and future prevention techniques.

1.3 Objectives

Objective One:

Review the current GHSA report to determine the need for specific training techniques and tools that are needed on a global scale (Bell and Nuzzo, 2021). The curriculum should be in a universal format for multiple low-to-middle income countries to utilize for training more efficient and knowledgeable public health personnel when a real outbreak occurs.

Objective Two:

Conduct a literature review of current outbreak investigations curricula that are implemented on a global scale. The curricula should contain one or more of the following:

- Placed in a low-to-middle income country that impacts the GHSA
- Evidence-based findings that have hands-on activities
- Deeper understanding of how various medical professionals communicate and interact with one another

Objective Three:

With the support of the Uganda Ministry of Health, create a curriculum based on a case study that has not been previously taught about an outbreak that occurred in a small village in Uganda. The curriculum will also include a table-top exercise for participants to gain hands-on experience in the workshop.

1.4 Significance Statement

The need to expand public health professionals learning and understanding of outbreak investigations can decrease the amount of miscommunication and delay in proper response to diseases and infections that cause high mortality rates on a global scale. The ability for public health personnel to review/understand/evaluate examples of positive and negative outcomes of previous outbreaks gives them the opportunity to learn from mistakes, follow appropriate actions, and create new protocols/procedures on how best their respective country should respond to a public health emergency of international concern (PHEIC).

1.5 Relationship Between the GHSA and Outbreak Investigation Trainings

1.5.1 Understanding the Global Health Security Agenda

In order for countries to increase workforce capacity and better respond to outbreaks, international communication and collaboration enhance security matters globally. The International Health Regulations (IHR) of 2005 have provided a significant and valuable framework for countries to follow and key health organizations to emulate in their work. Out of the 196 countries that utilize the IHR framework, The World Health Organization (WHO) equips its 194[1] members states to reflect and serve the globe through the regulations (WHO, 2021). Countries are required to report public health events, some of which are PHEICs and need serious actions to be taken to avoid life-threatening challenges (WHO, 2021). One of the key monitoring and evaluating techniques included in the GHSA framework is the Joint External Evaluation (JEE). The JEE is an assessment to evaluate a country's infrastructure and current mechanisms to strengthen its health system (WHO Geneva, 2017). The current

[1] The IHR has 196 legally binding countries, of which 194 are WHO Member States (WHO, 2021).

approach of the JEE is a multisectoral process for which governments (e.g., representatives from health and other sectors, Ministries, etc.) can bring in subject matter experts (SMEs) in health security, management, and preparedness to assess its status in national and public health security (WHO EURO, 2021). This allows countries to receive the respective reporting scores and then allow them the opportunity to create or revise a national action plan to focus on key obstacles to better preparedness. For a more detailed explanation of the respective reporting scores, please see Appendix E.

Learning from previous and historic PHEICs, reform in WHO's strategies is necessary to avoid political, economic, and social consequences from international disease outbreaks (Moon et al., 2015). For example, the Ebola outbreak in 2013 highlighted the need of reform for preventing, detecting, and responding to diseases that had the magnitude in mortality seen in West Africa. Ten recommendations were made to improve the preparedness of governments for PHEICs, which included: creating a dedicated center for outbreak response with a technical workforce, developing standard operating procedures on how to react during an outbreak, and promoting early reporting for countries that can quickly and publicly share their data, etc. (Moon et al., 2015). The Ebola crisis highlighted the fact that West African public health personnel were not well-informed and educated on how to respond to infectious disease outbreaks. Another conclusion was that additional training workshops regarding infectious disease outbreaks would further increase workforce capacity to then benefit the entire region (Moon et al., 2015).

1.5.2 Current Data on Global Workforce Capacity

The WHO published the GHS Index for 2021 per country that are a part of the IHR. The index report describes the lack of workforce capacity, as only 25% of the IHR countries have an updated workforce strategy (Bell and Nuzzo, 2021). The fifth data category in the report discusses the percentage differences per country on "commitments to improving national capacity, financing plans to address gaps, and adherence to global norms," and the average, global score was 47.8 of 100 (Bell and Nuzzo, 2021). In order to address such gaps, new plans and courses could reduce the concern of national capacity and reach above the 50% mark. Additional studies have also shown that the need for public health personnel will increase at an exponential rate. In fact, certain projections highlight the need to better educate public health personnel, as the demand for the health workforce will rise to 80 million workers by 2030, resulting in a global shortage of approximately 15 million (Liu et al., 2017).

Other studies have reviewed country-specific issues related to workforce capacity and training, specifically for infectious disease outbreak investigations, and revealed that leaders are interested in new approaches to planning, management, and communication of the public health system (Kuhlmann et al., 2021). The high interest from country leaders supports the idea that new training concepts need to be developed and implemented globally in order to effectively transform the educational training to better increase and prepare workforce capacity when another pandemic evolves. Unique and sustainable outbreak investigation trainings will allow global health personnel to link the national public health system and security authorities, support more efficient and effective real-time surveillance and reporting, and communicate with various types of healthcare workers during a PHEIC, indicators that are heavily focused on in the GHS Index Report (Bell and Nuzzo, 2021).

1.5.3 The Case Study

In order to better understand the new curriculum, it is important to review essential information regarding the outbreak investigation case study from the Uganda Ministry of Health. In the Tororo District of Uganda, 3 students from Mukuju School died after eating chapatti bread from a local food stand (Kwesiga et al., 2019). The laboratory diagnosis, autopsies, and other students' medical symptoms after eating smaller doses of chapatti revealed that the cause of death was organophosphate poisoning, which is common in Uganda (Kwesiga et al., 2019). Toxicological poisoning is a prevalent problem in many low-to-middle income countries due to the nature of employment (e.g., farming) and the opportunity to purchase harmful chemicals at common, everyday stores for indoor spraying (Kwesiga et al., 2019). The case study will be further discussed and explained in greater detail in the curriculum PowerPoint (Appendix B).

1.5.4 Why This Case Study is Different

Leading organizations like the CDC have various outbreak investigations for public viewing on the Internet. While these resources are public for the use of curriculum-based training, many have been taught many times and in many training programs globally, which causes repetition in case studies and further disengagement from stakeholders that are interested in funding outbreak investigation trainings. I originally became inspired for this special studies project through the organization I work for, Integral Global[2]. The organization allowed me to make connections with various public health professionals not only in the Greater Atlanta area, but internationally as well. A successful collaboration for me at IG has been with Dr. Ziad Kazzi, Professor of Emergency Medicine at Emory University's School of Medicine. Dr. Kazzi is also the founder and president of the Middle East North African Toxicology Association (MENATOX), and his organization has had a long relationship with IG on various projects. For example, Dr. Kazzi and I previously worked on outbreak investigation curriculums, and we were intrigued by the idea of taking the comments and evaluations from previous workshops to create an original outbreak investigation curriculum that could be utilized worldwide for public health professionals. In 2019, IG and the MENATOX Association utilized aspects of a popular outbreak investigation, found on CDC's website (Argentinian "Matambre" Foodborne Outbreak), in a training workshop in Istanbul, Turkey. The participants were able to learn key concepts on how to communicate with different medical professionals during a public health emergency.

While the participants gained knowledgeable information on how to conduct an outbreak investigation, many were already aware of the Argentina Foodborne Outbreak, so the conclusions and activities were not of a surprise and/or learning opportunity for the participants. Therefore, both organizations expanded on the course and created different aspects that the participants did not see coming. In 2021, the updated version of the course was implemented in Tbilisi, Georgia, in collaboration

[2] Integral Global is an organization that works with international organizations, Ministries of Health, and consulting groups to develop and implement public health projects globally (https://www.integralglobal.net/home)

with the National Centers for Disease Control and Public Health (NCDC). Though this was a step in the right direction, both Dr. Kazzi and IG knew there would be an increase of interest in stakeholders if an original outbreak investigation was created, specifically with a case study that has not been previously utilized for public health training.

The Uganda Ministry of Health, specifically Benon Kwesgia[3], has given IG and Dr. Kazzi the approval to utilize the chapati outbreak investigation as a learning tool for future trainings on a global scale. The fact that this case study has not been utilized by any public health implementers or organizations before creates an appealing and attractive proposal for funders. The COVID-19 pandemic has shown that various countries are not prepared for actual PHEICs, so investing in a new and relevant curriculum is in the best interest for governments and funders to contribute to their country's readiness and preparedness of potential outbreaks.

[3] Leading author of the case study utilized for this special studies project

Chapter 2- Literature Review

2.1 Outbreak Investigation Curricula for Health Professionals that Relate to the GHSA

Teaching Outbreak Investigations with an Interactive Blended Learning Approach

An online outbreak investigation course was developed for participants to determine the mode of transmission for an infectious pathogen and its relationship to agriculture (Duckwitz et al., 2021). The case focused on the importance of veterinary public health and its relationship to potential outbreaks that are common with livestock (Duckwitz et al., 2021). The focus on zoonotic diseases creates an applicable tool for stakeholders to utilize in an international setting, as this type of infectious disease is a core topic in the GHSA (WHO, 2021). Participants learn key topics relating to laboratory diagnostics, epidemiology, and biostatistics through a module-based training course. The course did not allow for interpersonal discussion, as the online format is intended for individual completion (Duckwitz et al., 2021).

Case Study: Building a Microlearning Curriculum at WorldFish

Fish, a global and common food source, are susceptible to various diseases that impact people internationally (Wills et al., 2018). Therefore, WorldFish, a nonprofit research and innovation organization that relates research to water and its respective food systems, created a training curriculum regarding fish sampling and disease diagnostics (Wills et al., 2018). The target population, which includes fishers, researchers, students, and farmers can access the training modules globally. The curriculum covers key topics including foundations in fish disease sampling, bacteriology, blood sampling, and microbiome sampling (Wills et al., 2018). The online training is informational and helps numerous low-to-middle income countries determine potential outbreaks regarding fish diseases (Wills et al., 2018). This related to the GHSA because fish are a large, global import/export business and it is important for other countries to determine diseases in fish before moving into a different country/territory.

Clinical REsearch During Outbreak (CREDO) Training for Low and Middle-Income Countries

The CREDO Training, in collaboration with Special Program for Research and Training in Tropical Diseases (TDR), the WHO, the International Severe Acute Respiratory and Emerging Infections Consortium, and the United Kingdom Public Health Rapid Support Team created a curriculum with the intention to support clinical research for public health professionals, during a disease outbreak (Kayem et al., 2019). The training also had a specific interest in capacity building between professionals (11 medical doctors, 2 research nurses, 2 data managers, 1 clinical trial manager, 3 biomedical students) from four sub-Saharan African countries (Ethiopia, Ghana, Côte d'Ivoire, and Uganda) to better enhance communication between the fields (Kayem et al., 2019). The format of the CREDO training involved both online modules and three in-person workshops in different locations throughout Uganda. Key topics covered in the workshops include how to conduct a proper research study during an outbreak investigation and define epidemiological concepts of the disease outbreaks (Kayem et al., 2019). While the participants noted in their evaluations that they felt more confident in how to respond to a disease outbreak, the training itself had a higher focus on how to conduct research, rather than increasing communication and knowledge of outbreak investigations (Kayem at al., 2019). The training paused due to the COVID-19 pandemic and does not show any plans to repeat the courses.

2.2 Outbreak Investigation Evidence-Based Curricula that Have Hands-On Material

Teaching Epidemiology Concepts Experientially: A "Real" Foodborne Outbreak In the Classroom

This course offered public health students the ability to participate in a classroom exercise to learn specific information regarding necessary steps to be taken in an outbreak investigation, along with basic concepts of how to respond to an outbreak. This course was meant for students on an epidemiological track of the Master of Public Health degree. The concepts discussed in greater detail include: '"recall bias, measuring associations with small sample sizes, dealing with raw data, interviewing techniques, including what it is like to be an epidemiologist, and determining the likely etiology of a disease based on symptomology and incubation periods"' (Pogreba-Brown et al., 2021).

Students participated in a mock interview process and calculated essential information of the food outbreak (e.g., 2x2 table and attack rates). Communication and relationships to other public health personnel were not discussed.

Development of a Pandemic Awareness STEM Outreach Curriculum: Utilizing a Computational Thinking Taxonomy Framework

The Pandemic Awareness STEM Outreach Program Curriculum was utilized for a STEM-specific school based in North Carolina to teach students on the importance of epidemiological methods, and the relationship between science, mathematics, and outbreak investigation. The curriculum provided students with the ability to participate laboratory diagnostic exercises, engage in an outbreak simulation, and learn about disease prevention and vaccine development. Students learned similar biostatistics and epidemiological terms that health professionals in low-to-middle income countries learned in previously implemented outbreak investigation workshops, including calculating incidence, prevalence, utilizing 2X2 tables, and the r0 (Gilchrist et al., 2021). While this curriculum showcases the importance of teaching students the importance of epidemiology with math and science, there was not any discussion on how outbreak investigations are conducted in low-to-middle income settings.

Training for Foodborne Outbreak Investigations by Using Structured Learning Experience

An interactive training program utilizing play cards was created for outbreak investigations relating to foodborne illness (Burckhardt and Kissling., 2020). The participants become engaged in an outbreak event through the fictional playing cards to learn about basic principles of epidemiology (e.g., differential diagnoses, creating a case definition, performing statistical tests), while being able communicate with the other 15-25 participants (Burckhardt and Kissling, 2020). The training allows for facilitated, small-group discussions and gives participants the opportunity to relate back to their personal experiences with outbreaks they've worked on, if any (Burckhardt and Kissling, 2020).

South Africa Field Epidemiology Training Program: Developing and Building Applied Epidemiology Capacity, 2007-2016

The South Africa Field Epidemiology Training Program offers outbreak investigation curricula incorporated into the 2-year program. The teaching style differs from other trainings, as outbreak investigation workshops in the classroom account for only 25% of the time in the program, and the other 75% are comprised of field, hands-on activities (Reddy et al., 2019). While this program has had success in sustainability with local epidemiologists in-country, it continues to encounter problems in recruiting other medical professionals (Reddy et al., 2019). The SAFETP is addressing these needs by increasing awareness of employment opportunities in field epidemiology for laboratory specialists, veterinarians, and nurses. In addition, the residents of the SAFETP are required to complete three ongoing outbreak investigations that are included in the 75% field activities. Currently, the leaders of the program are working towards improving the quantity and quality of these outbreak investigations, as there has been criticism in the past that the three outbreak investigations are not assisting the residents in outbreak investigation competency; common criticism include lack of coordination between public health professionals and reporting of outbreak data (Reddy et al., 2019).

2.3 Outbreak Investigation Curricula with Specific Emphasis on Medical and Public Health Personnel Communication

Improvement of DVM Curriculum to Meet OIE Recommendations at Chattogram Veterinary and Animal Sciences University, Bangladesh

The Chattogram Veterinary and Animal Sciences University and Tufts Cummings School of Veterinary Medicine, with the support of the World Organization of Animal Health (OIE), enhanced previously taught animal disease outbreak curricula to a more relatable and inclusive training for veterinary personnel in Bangladesh (Ahasanul Hoque et al., 2020). The participants learned techniques to analyze livestock and their offspring (e.g., egg quality), while also gaining epidemiological skills (e.g., conducting disease survey and surveillance, and analyzing outbreak data using statistical software like STATA) to enhance the communication between veterinarians and public health officials (Ahasanul Hoque et al., 2020).

Most of the students learned from lecture-based materials and hands-on experience in some of the hospitals, but not all the students were able to attend the university hospitals that included different case studies. This was due to their “visiting status” as a student, and not being a direct enrolled student at the respective institution (Ahasanul Hoque et al., 2020). The curriculum also made future recommendations for the integration of medical fields, including “the expansion of veterinary schools teaching disease surveillance systems and prevention, chikungunya and its public health consequences, government veterinary-hospital based disease surveillance systems, and clinical procedures in small and large animals” (Ahasanul Hoque et al., 2020).

Training Ghanaian frontline healthcare workers in public health surveillance and disease outbreak investigation and response

The Field Epidemiology Training Program (FETP) is a well-known, global program that teaches beginning epidemiologists basic concepts regarding outbreaks, analyzing data from cases, and surveillance mechanisms that are used in the respective country (CDC, 2017). This course discussed the importance of strong communication measures between epidemiologists and laboratory personnel, as both are responsible for different aspects of an outbreak investigation (Ameme et al., 2016). The case study discussed the Ebola Virus epidemic in West Africa (2014-2016), which is extremely relevant to Ghanaians. This FETP course was designed for the third tier of frontline health workers that had little-to-no prior experience in outbreak investigations or communicating with other medical personnel, particularly veterinary specialists in the case of emerging, zoonotic diseases.

While FETP is becoming a more popular option for governments to increase their public health workforce capacity, the design and duration of the program is not effective for training public health professionals for an outbreak investigation. A standardized format utilized by FETP does not accommodate different educational levels for community health workers versus professionals with medical school training. Therefore, this training in Ghana tried to modify a typical FETP training program by making the courses shorter for district level staff so they then have the capacity to conduct an investigation at the sub-national level (Ameme et al., 2016). The consortium partners, including

University of Ghana School of Public Health, Ghana Health Service and Veterinary Service Department, World Health Organization and Centers for Disease Control and Prevention also tried to make the curriculum more user-friendly for different competency levels in-country.

Teaching Wildlife Disease Outbreak Response Through a Collaborative One Health Workshop

Colorado State University's Wildlife Disease Association hosted a one-day workshop where students and professionals in their respective medical field gathered on campus to conduct, examine, and respond to a wildlife disease outbreak simulation. Both students and public health professionals, including wildlife biologists, veterinarians, and epidemiologists, worked in a collaborative manner to systematically conduct the investigation and learn how to best work in a multidisciplinary field (Chiu et al., 2020) . The workshop included both lecture-based course instruction, along with the hands-on investigation. The purpose was for various responders in an outbreak investigation to learn about other respective fields' responsibilities and how to best collaborate with one another (Chiu et al., 2020).

2.4 Summary

In summary, the literature shows that there are curricula that have been offered and taught in various global settings to enhance outbreak investigation knowledge and trainings. Leading organizations, including the FETP, have achieved success in both enrollment and sustainability of trained field officers in various regions of the world. However, there is still a missing gap in communication, hands-on learning, and trainings that are offered in low-to-middle income countries. Most of the curricula described in published literature focus on two sides of the "optimal outbreak investigation training triangle" (1. offered in low-to-middle income countries; 2. has a hands-on experience; and 3. directly shows the interdisciplinary relationship in the medical field), but one side is often absent from the training and/or workshops.

In order to sustain knowledge taught to health professionals, future outbreak investigation curricula should have a hands-on learning opportunity, rather than training solely focused on lecture-based teaching. There also should be more of an emphasis on the importance of communication between various health professionals (specifically veterinarians, medical officers, and public health personnel) to avoid an increase in zoonotic disease outbreaks. The GHSA strongly supports the link between these medical professionals to avoid novel diseases caused by animals, along with new variants reaching different areas of the world, similar to the Delta and Omicron variants of COVID-19 (WHO, 2021). Lastly, low-to-middle income countries need to have the ability to access these trainings. This will further enhance their workforce capacity within their respective country. If all three sides of the triangle are met, then the opportunity for participants' knowledge is more likely to be sustained , while the need to repeat curricula previously taught is likely to diminish. Please see below for *Figure 1* of the "optimal outbreak investigation training triangle."

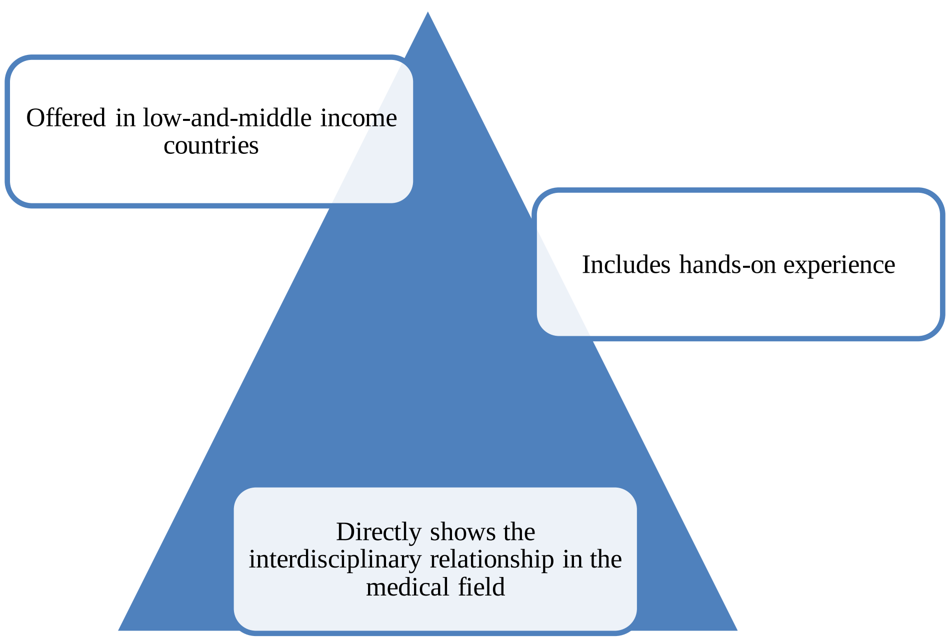


Figure 1: The relationship for an "optimal outbreak investigation training triangle" includes all three sides to enhance sustainable knowledge and increase workforce capacity (WHO, 2021).

Chapter 3- Methodology

While there were various curricula to utilize as examples and ideas for the design of my outbreak investigation course, I found myself making compare and contrast notes from previous published outbreaks on the Centers for Disease Control and Prevention's published documents and what I wanted this special studies' curriculum to accomplish. Based on the reputation and reliability the CDC has in the public health field, I knew that their easily accessible outbreak investigation documents were considered the "gold standard" for organizations that are interested in creating their own curriculum. Therefore, I reviewed the CDC cases and determined the missing links between their documents, along with the current literature on outbreak investigation curriculum to create a new course for global, public health professionals. The overall largest missing link was the fact that the published outbreak investigation curricula that had hands-on experience and engagement for participants did not have actual data or previous public health case studies included in the curriculum. Instead, the cases were fiction.

On the other hand, the documents from CDC's website regarding outbreak investigations were incredibly factual and non-fiction, yet still lacked participant engagement and/or educational tools for organizations to utilize as a reference (CDC, 2022). The list of outbreaks and their respective case information is useful for the public to review and analyze, but the section titled, "Education Materials" only offer communication handouts and flyers that discuss common outbreaks, like foodborne diseases (CDC, 2022). Therefore, it was important for the special studies project to highlight the need to have an interactive and factual training curriculum to best help public health personnel master key concepts that are associated with outbreak investigations (CDC, 2018). The goal is an increase in public health workforce capacity to strengthen the GHSA.

Furthermore, IG and Dr. Kazzi had experience creating and conducting outbreak investigation curricula to low and middle-income countries in the past three years, and I had the opportunity to gain insight on what should be further developed and implemented to have a successful, engaging training. In April of 2021, the director of IG asked me to review the previously conducted outbreak investigation curriculum that was implemented in Istanbul in 2020, the first teaching collaboration for IG and Emory University. I was instructed to review the curricula from an outside perspective and provide new ideas and suggestions for the next training that was planned for July 2021. Dr. Kazzi and I met on Zoom for months and came up with new formatting ideas for the same case study of the Argentina food outbreak of matambre, along with adding more information to provide additional aspects of the outbreak that were not originally in the case study (e.g., adding combined foods on the menu for the outbreak in Argentina). We rehearsed the training curriculum for weeks and finished our preparation, piloting the newly updated curriculum in Tbilisi, Georgia, in July of 2021.

The NCDC's collaboration with IG gave me the opportunity to travel and teach the updated curriculum to epidemiologists, emergency medicine physicians, nurses, and medical students. The participants were engaged throughout the curriculum by using worksheets and responding to open-ended questions and discussions. After the workshop ended, IG and Dr. Kazzi conducted an informal (call and respond) evaluation, giving the Georgian participants the ability to provide feedback on the updated Argentinian outbreak. While the participants enjoyed the discussions, they thought that the curriculum contained information that they were already aware of (e.g., every participant in the workshop knew of the Matambre outbreak). After the training, I knew that I wanted to expand on the concepts we taught in Tbilisi but utilize a case study that participants in various countries had not used before.

I returned from Georgia and met with Dr. Kazzi on Zoom to go over different case studies that we could use for subsequent outbreak investigation trainings. We reviewed 5 published outbreaks and concluded that we wanted to work with a newly published case study, the chapati outbreak in Uganda. We brought the case study to the director of IG who has connections with the one of the authors (Bao-Ping Zhu) who put us in touch with the lead author, Benon Kwesiga. Since the literature was published in collaboration with the CDC, the director of IG asked me to set up a meeting with the author from CDC and a previous colleague, Julie Harris. IG and Dr. Kazzi discussed our proposition to utilize this case study for an outbreak investigation curriculum with Dr. Harris and she was supportive of the idea.

Having reviewed key literature and deliberated with key stakeholders I started to work on creating a curriculum based on the chapati outbreak and expand on the basic principles of an outbreak investigation.

Chapter 4 – The Actual Curriculum

Before conducting the training, a pretest covers main ideas and topics that revolve around outbreak investigations. This allows the participants to determine their knowledge and competency before any materials are presented to them. The curriculum is separated into sections, based on CDC's guidelines regarding the steps to conduct an outbreak investigation.[4] Similar to other educational workshops, the goals and objectives of the training are described, followed by any additional questions or concerns from the participants before the educators start the training. The participants are walked through the chapatti case study and are informed of key epidemiological facts (e.g., descriptive epidemiology including person, time, place). While learning pieces of the case study, the participants are introduced to outbreak investigation steps, presented in a simulation format. For example, the case study explains that some other children in the village heard through word of mouth that an outbreak of organophosphate poisoning linked to chapati was underway which was impacting local market vendors. In order to keep the public health professionals ahead of miscommunication and panic from the population, the participants learn how to properly engage with the media by creating their own news report. This exercise will be given out on a worksheet, as this provides a cognitive break from the lecture component of the workshop.

The media report is one of many examples of how participants are able to engage with the lectures through worksheets and group discussions. The participants are given the ability to practice more advanced biostatistical methods (e.g., how to run a t test and go a step further than conducting a 2x2 table).[5] Another beneficial and informative component I included in the biostatistics aspect of the training is the easily accessible, free, and open-source epidemiological software provided by Emory University, Rollins School of Public Health: *OpenEpi* (Dean et al., 2013). OpenEpi allows participants to conduct various biostatistical and epidemiological equations through an online browser (Dean et al., 2013). This

---

[4] A page in the PowerPoint slide set includes a photograph taken of CDC's website showing these steps.
[5] This was a comment received previously from the Georgian participants that they would like to have more advanced biostatistical methods, including t tests, to be included in the training.

way, participants are able to utilize this tool during actual outbreak investigations, either as a direct computation or to check their answers via pen and paper.

For a more detailed explanation of the curriculum, please see Appendix B.

Chapter 5- Discussion, Conclusion and Recommendations

.

5.1 Discussion

A key strength of this special studies project is the opportunity I had to use a case study that has not been previously utilized for an outbreak investigation course. Since I was the first person, along with my colleagues at Integral Global and Emory University Department of Emergency Medicine (Dr. Ziad Kazzi), to receive permission from the Ugandan Ministry of Health to utilize the local chapati vendor outbreak for a training curriculum, this project will be the first educational tool with the case referenced. Future participants will have the ability to engage in new material and participate in a training with information that has not been previously taught in the global health field. Thus the curricula and supporting documentation can be made available for other training programs to use.

While it would have been extremely effective and beneficial to be able to pilot this special studies project at the Middle East and North Africa Clinical Toxicology Association, intended to showcase the curricula, the current status of the COVID-19 pandemic did not allow for travel and/or implementation of the course at the designated venue, Muscat, Oman. The Ministry of Health was not given permission to convene a large conference, as the Omicron variant was starting to rapidly spread at the time of the proposed conference dates. This is a limitation in the special studies project, as I was not able to pilot the original curriculum with health professionals from low-to-middle income countries. However, there will be other opportunities to conduct this workshop in the future (e.g., current discussion of this curriculum to be utilized at the 2023 MENATOX Conference in Abu Dhabi). The training next year will allow me to gain insight from the participants and make any necessary adjustments to the curriculum, based on their evaluations of the course.

5.2 Conclusions

Reported in a recent study conducted to determine what qualities make a good outbreak investigator, countries need to have public health personnel that are strong in communication and other interpersonal skills (Forbes et al., 2020). While it seems that various curricula in the past have mastered the technical framework of how to train public health professionals on outbreak investigations, there is a missing link in communication and teamwork, particularly when they need support from either other colleagues or professionals from a different medical field (Forbes et al., 2020).

Moving forward, the transition from lecture-based learning to hands-on, practical exercises are seen as beneficial before entering the field and conducting an actual outbreak investigation (Forbes et al., 2020). It is important to understand the value of how the information is being taught, rather than what information is included in the curriculum. Often, educators forget the role of participatory lessons and return to something more familiar: audio-based learning and long lectures.

During the process of creating this curriculum for my special studies project, I have worked closely with the director of Integral Global, who is very interested in utilizing the curriculum for further trainings and projects that receive funding. For example, IG has previously received funding from the Department of State (DoS) to conduct outbreak investigation trainings for various target audiences (e.g., Iraqi law enforcement and medical professionals). He has told me that some of the content may have to be tailored depending on the funder's goals and objectives for the respective fiscal year of implementation. I have also discussed the content of the curriculum with Dr. Ziad Kazzi. Dr. Kazzi has provided me with ideas and suggestions to modify the curriculum based on the country where future workshops will be held (e.g., changing the language based on English competency for participants that have a different first language). Dr. Kazzi has been extremely beneficial throughout the development of the curriculum, as he was able to verify the clinical toxicology content and questions that guide the participants throughout the workshop.

5.3 Recommendations

While this curriculum was developed to be utilized for a specific set of stakeholders, I realize that various stakeholders have different missions and objectives, based on the country of interest; modifications and edits are quite possible and easily adaptable if needed. The stakeholders that are interested in the curriculum will therefore make necessary adjustments that fit the scope of their own goals.

Due to the current pandemic, it is inevitable that other public health professionals will engage with different educational tools on outbreak investigation curricula. Therefore, personnel should consider and review the literature regarding successful implementation on outbreak investigation training, After reviewing studies regarding the various options of how to teach an outbreak investigation, and what technical pieces are already available on the Internet or has been taught by other organizations, newer curricula should cover:

- Case studies that have not already been published, to cover new, original outbreak investigation material.
- A variety of case studies that cover common public health issues, particularly in low-to-middle income countries.
- Diverse topics of PHEICs (e.g., zoonotic diseases, toxicological outbreaks, enteric diseases, etc.).
- New case studies that demonstrate the importance of communication between health fields, which enhances the GHSA.
- Participatory aspects of the curricula, like tabletop exercises, where participants can gain hands-on, classroom experience in how to conduct an outbreak investigation.

Furthermore, it would be beneficial to have the curriculum utilized in a training workshop in a country where the Ministry of Health and the stakeholder approve of its use to better educate participants of this global health topic. An evaluation document, along with a corresponding report, would be effective in determining the positive and negative aspects of the curriculum from the participants' perspectives. After reviewing and analyzing the data and participants' comments, the outbreak investigation curriculum can be adjusted to accommodate for any necessary modifications for future outbreak investigation trainings.

5.4 Closing Statements

In closing, it is important for stakeholders to utilize effective public health training courses that offer the opportunity for engagement and communication for participants. Increasing workforce capacity remains to be a top priority in the GHSA, which will ultimately protect and promote people's health globally (Ferguson and Williams, 2021). The current COVID-19 pandemic has brought to light the need for outbreak investigation training to improve the education and capabilities of countries' workforce in relation to PHEICs (Lui et al., 2017).

Sources

1. Ameme, D. K., Nyarko, K. M., Afari, E. A., Antara, S., Sackey, S. O., & Wurapa, F. (2016). Training Ghanaian frontline healthcare workers in public health surveillance and disease outbreak investigation and response. *The Pan African medical journal*, *25*(Suppl 1), 2. https://doi.org/10.11604/pamj.supp.2016.25.1.6179
2. Ahasanul Hoque, M., Ahad, A., Saifuddin, A. K. M., Warner, A. E., Debnath, N. C., & Sawkat Anwer, M. (2020). Improvement of DVM curriculum to meet OIE recommendations at Chattogram Veterinary and Animal Sciences University, Bangladesh. *Journal of Veterinary Medical Education*. https://doi.org/10.3138/jvme-2019-0107
3. Bell, J., Nuzzo, J. (2021). Global health security index: advancing collective action and accountability amid global crises. https://www.ghsindex.org/wp-content/uploads/2021/12/2021_GHSindexFullReport_Final.pdf
4. Burckhardt, F., & Kissling, E. (2020). Training for Foodborne Outbreak Investigations by Using Structured Learning Experience. *Emerging infectious diseases*, 26(1), 162–164. https://doi.org/10.3201/eid2601.190755
5. CDC. (2017). Field Epidemiology Training Program. *Global Health Protection and Security*. Centers for Disease Control and Prevention. https://www.cdc.gov/globalhealth/healthprotection/fetp/index.htm
6. CDC. (2018). Educational Materials. *Division of Foodborne, Waterborne, and Environmental Diseases*. Centers for Disease Control and Prevention. https://www.cdc.gov/ncezid/dfwed/multimedia.html
7. CDC. (2022). List of Selected Multistate Foodborne Outbreak Investigations. *Foodborne Outbreaks*. Centers for Disease Control and Prevention. https://www.cdc.gov/foodsafety/outbreaks/multistate-outbreaks/outbreaks-list.html
8. Chiu, E. S., Lee, J., Malmberg, J., Fagre, A., Dannemiller, N. G., Stuchin, M., Golas, B., & Huyvaert, K. P. (2020). Teaching wildlife disease outbreak response through a collaborative one health workshop. *Journal of Veterinary Medical Education*, *47*(4), 402–407. https://doi.org/10.3138/jvme.2018-0020
9. Duckwitz, V., Vogt, L., Hautzinger, C., Bartel, A., Reinhardt, J., Haase, S., Alter, T., Fulde, M., Bahramsoltani, M., Doherr, M. G. (2021). Teaching outbreak investigations with an interactive blended learning approach. Journal of Veterinary Medical Education. https://doi.org/10.3138/jvme-2020-0077
10. Ferguson, S., Williams, M. (2021). An underfunded public health workforce imperils global health. *Nursing Economics.* 39(5). http://www.nursingeconomics.net/necfiles/2021/SO21/251.pdf
11. Figueroa, C.A., Harrison, R., Chauhan, A. *et al.* (2019). Priorities and challenges for health leadership and workforce management globally: a rapid review. *BMC Health Serv Res* 19(1), 239. https://doi.org/10.1186/s12913-019-4080-7
12. Forbes, O., Davis, S., Dyda, A., Rosewell, A., Williams, S., Moffatt, C., & Viney, K. (2020). Expert Perspectives on Outbreak Investigation Training: A Quality Improvement Exercise. *Global Biosecurity, 2*(1). DOI: http://doi.org/10.31646/gbio.53
13. Gilchrist, P. O., Alexander, A. B., Green, A. J., Sanders, F. E., Hooker, A. Q., & Reif, D. M. (2021). Development of a Pandemic Awareness STEM Outreach Curriculum: Utilizing a Computational Thinking Taxonomy Framework. *Education Sciences*, 11(3), 109. MDPI AG. http://dx.doi.org/10.3390/educsci11030109
14. Kayem, N. D., Rojek, A., Denis, E., Salam, A., Reis, A., Olliaro, P., & Horby, P. (2019). Clinical REsearch During Outbreaks (CREDO) Training for Low- and Middle-

Income Countries. *Emerging infectious diseases*, *25*(11), 2084–2087. https://doi.org/10.3201/eid2511.180628

15. Kwesiga, B., Ario, A.R., Bulage, L., Harris, J., Zhu, B.P. (2019). Fatal cases associated with eating chapatti contaminated with organophosphate in Tororo District, Eastern Uganda, 2015: case series. *BMC Public Health* 19(767) https://doi.org/10.1186/s12889-019-7143-0
16. Kuhlmann, E., Dussault, G. and Correia, T. (2021), Global health and health workforce development: what to learn from COVID-19 on health workforce preparedness and resilience. *International Journal of Health Planning and Management.* 36(58). https://doi.org/10.1002/hpm.3160
17. Liu, J.X., Goryakin, Y., Maeda, A. *et al.* (2017). Global Health Workforce Labor Market Projections for 2030. *Hum Resour Health* 15, 11. https://doi.org/10.1186/s12960017-0187-2
18. Moon, S., Sridhar, D., Pate, M. A., Jha, A. K., Clinton, C., Delaunay, S., Edwin, V., Fallah, M., Fidler, D. P., Garrett, L., Goosby, E., Gostin, L. O., Heymann, D. L., Lee, K., Leung, G. M., Morrison, J. S., Saavedra, J., Tanner, M., Leigh, J. A., Hawkins, B., … Piot, P. (2015). Will Ebola change the game? Ten essential reforms before the next pandemic. The report of the Harvard-LSHTM Independent Panel on the Global Response to Ebola. *Lancet (London, England)*, *386*(10009), 2204–2221. https://doi.org/10.1016/S01406736(15)00946-0
19. Pogreba-Brown, K., Ernst, K., & Harris, R. (2012). Teaching epidemiology concepts experientially: a "real" foodborne outbreak in the classroom. *Public health reports (Washington, D.C. : 1974)*, *127*(5), 549–555. https://doi.org/10.1177/003335491212700512
20. Reddy, C., Kuonza, L., Ngobeni, H. Ngobeni, H., Mayet, N., Doyle, T., Williams, S. (2019). South Africa field epidemiology training program: developing and building applied epidemiology capacity, 2007–2016. *BMC Public Health*. 19(469). https://doi.org/10.1186/s12889-019-6788-z
21. Wills, A., Khor, L., Delamare-Deboutteville, J. (2018). Case study: Building a microlearning curriculum at WorldFish. *Learn.ink.* https://hdl.handle.net/20.500.12348/5015
22. WHO. (2021). International health regulations. World Health Organization. https://www.who.int/westernpacific/health-topics/international-health-regulations.
23. WHO EURO. (2021). Joint external evaluation. World Health Organization. https://www.euro.who.int/en/health-topics/health-emergencies/international-health-regulations/misc-from-old-ihr/monitoring-and-evaluation/joint-external-evaluation.

Appendix A: The Ugandan Case Study

Kwesiga *et al. BMC Public Health* (2019) 19:767
https://doi.org/10.1186/s12889-019-7143-0

BMC Public Health

RESEARCH ARTICLE Open Access

Fatal cases associated with eating chapatti contaminated with organophosphate in Tororo District, Eastern Uganda, 2015: case series

Benon Kwesiga[1*], Alex R. Ario[1], Lilian Bulage[1], Julie Harris[3] and Bao-Ping Zhu[2,3]

Abstract

Background: Few cases of organophosphate poisoning in developing countries have been investigated using clinical and epidemiological methods. On 30 October 2015, 3 students at Mukuju School, Tororo District, Uganda, died soon after eating chapatti (locally-made flat bread) from the same food stand. Ministry of Health investigated to identify the cause and recommend prevention measures.

Methods: We defined a case as onset during 30–31 October 2015 in a resident of Mukuju Town of ≥1 of the following symptoms: excessive saliva, profuse sweating, dizziness, low blood pressure, constricted pupils or loss of consciousness. We reviewed medical/police records and interviewed survivors, healthcare workers, and police officers. We collected samples of implicated food for toxicological analysis. Autopsies were performed on decedents to identify the cause of death.

Results: We identified 7 cases with 3 deaths (case-fatality ratio = 43%). Clinical manifestations included acute onset of confusion (100%), constricted pupils (43%), excessive saliva (43%), and low blood pressure (43%). All 7 cases had onset from 16:00–18:00 h on 30 October, with a point-source exposure pattern. Of the 7 cases, 86% (6/7) were men; the mean age was 24 (range: 20–32) years. The 3 decedents each ate a whole chapatti while the other 4 cases ate half or less. Autopsy findings of the 3 decedents indicated organophosphate poisoning. Toxicological analysis found high levels of malathion in leftover foods (266 mg/L in dough and 258 mg/L in chapatti) and malaoxon (a highly toxic malathion derivative) in decedents' postmortem specimens (mean levels of 19 mg/L in the blood and 22 mg/L in the gastric contents). There was a delay of 4 h before the patients received appropriate treatment. Police investigations revealed that flour used to make the chapatti was intentionally contaminated with an organophosphate pesticide.

Conclusion: This fatal outbreak of organophosphate poisoning was associated with consumption of roadside-vended chapatti made of flour contaminated with pesticide. Clinicians should be aware of symptoms of organophosphate poisoning and prepared to treat it quickly. Street vendors should carefully consider the source of their ingredients. An in-depth surveillance review of such poisonings in Uganda would guide policymakers in reducing access by criminals and accidental exposures for the public.

Keywords: Organophosphate, Poisoning, Pesticide, Uganda

* Correspondence: benon.kwesiga@musph.ac.ug
[1]Uganda Public Health Fellowship Program, Ministry of Health, P.O. Box 7272, Kampala, Uganda
Full list of author information is available at the end of the article

Background

Organophosphate poisoning results from exposure to organophosphates which cause the inhibition of acetylcholinesterase, a critical compound for nerve function [1–3]. The irreversible blockage of this enzyme causes acetylcholine accumulation in the body that can result in muscle overstimulation [3] and acute symptoms such as muscle weakness, fatigue, muscle cramps, fasciculation, vomiting, diarrhoea and paralysis [2]. Beyond this, people suffering from organophosphate poisoning can experience anxiety, headache, convulsions, ataxia, depression of respiration and circulation, tremor, general weakness, tightness in the chest, wheezing due to bronchoconstriction, increased bronchial secretions, increased salivation, lacrimation, sweating, peristalsis, urination, and potentially coma [2]. The onset and severity of symptoms, whether acute or chronic, depends upon the specific organophosphate, the route of exposure, the dose, and the individual's ability to degrade the compound [4]. Food contaminated by organophosphates might have a chemical smell and bitter taste although this depends on the amount of organophosphate.

Organophosphates are one of the commonest agents of poisoning worldwide: there are an estimated one million organophosphate poisonings per year worldwide, with several hundred thousand resulting in fatalities [5]. Organophosphates are frequently used in suicides and homicides [5]. Unintentional organophosphate poisoning most commonly occurs among agricultural workers or children [6–8]. Poisoning has also been caused by ingestion of contaminated flour as well as leafy vegetables on which the organophosphates were used [9, 10]. In the treatment of organophosphate poisoning, timely decontamination is key. Pralidoxime and anticholinergic drugs such as atropine counteract the effects of excess acetylcholine and reactivate acetylcholinesterase [5, 11]. Another treatment involves management of complications such as aspiration, coma, etc. as they arise [12]. Organophosphates can survive for long periods in the environment and can withstand high temperatures during cooking [13].

In Uganda, organophosphate poisoning is a common occurrence [14]. These chemicals are sold by animal drug shops, and shops that sell general merchandise. Pesticides are used in most homes, for indoor spraying, and on agricultural farms. In Uganda, organophosphate pesticides are available in both powder and liquid forms. A recent study reviewing pesticide poisoning cases treated in health facilities in Uganda found that organophosphate pesticides accounted for 73% of the poisonings [15]. This study also found that the case-fatality rate was higher in rural health facilities than in urban facilities because the urban health facilities provide better intensive care. It recommended restriction of pesticide availability, an intervention that has proven to be effective in low-income countries.

On 30 October 2015, 3 students at Mukuju Primary Teachers' College in Tororo District, Eastern Uganda, died, reportedly after eating chapatti (locally-made flat bread) from a roadside chapatti vendor near their school. Chapatti is flattened bread made by frying a paste made from wheat flour and water in oil. Within minutes of eating the chapatti, the students developed severe symptoms; all three died while being treated in a nearby health centre. In this case report, we used clinical and epidemiological investigations to ascertain the cause of death and inform public health actions to prevent future incidents. There are a few cases of organophosphate poisoning in developing countries that have been comprehensively investigated using both clinical and epidemiological methods [16–18].

Methods

We defined a suspected case as sudden onset of foaming at the mouth of saliva, low blood pressure, loss of consciousness, or constricted pupils in a resident of Mukuju village from 24 October 2015 onwards. We developed a questionnaire to guide the interviewers during data collection and it is attached as Additional file 1. We searched for additional cases at nearby health centres and district hospitals, at the school with the help of the school administrators, and, with the help of a village chief, among persons living near the chapatti vending area. We reviewed patient records at the hospital and postmortem results obtained from the police to verify the clinical characteristics of patients. Data collected for this investigation was not publicly available. However, being the Uganda ministry of health investigation team that was authorised to conduct this investigation, we were allowed access to this data. We were therefore granted access to all hospital and police records that were relevant to this emergency public health investigation.

We assessed whether a dose-response relationship existed by relating the number of symptoms each case-patient developed with the amount of chapatti eaten. On average, a chapatti made in Uganda has a diameter of 10 cm and weighs approximately 100 g.

The police surgeon undertook postmortem examination to determine the cause of deaths of the decedents and collected the decedents' blood and gastric contents for toxicological testing. With the help of the police, we also conducted an environmental assessment of the chapatti vending business to assess for possible sources of contamination, and collected leftover baking flour, cooking oil, chapatti and flour-dough specimens for toxicological examination. Toxicological testing was conducted at the Government Analytical Laboratory in Kampala

(Uganda's capital city); the laboratory used liquid chromatography triple quadrupole mass spectrometry [19] to determine the level of organophosphates in the specimens. Police conducted criminal investigations by interviewing identified suspects and survivors.

Results

We identified 7 suspected cases, with the onset of symptoms occurring between 16:00 h and 18:00 h on 30 October 2015 (Fig. 1). Three of the 7 case-patients died (case-fatality rate = 43%). Of the 7 suspected case-patients, six (86%) were men. The mean age was 24 (range: 20–32) years, and four (57%) case-patients (including all 3 deceased) were students. The other three case-patients were a chapatti vendor, a Boda-Boda (i.e., motorcycle taxi) driver, and a hair salon worker. All case-patients were from the same village, located near the roadside chapatti vending place which was just outside the school gate (Figs. 2, [20]. Students and other community members in the area often bought chapatti from this vendor.

This community had several chapatti vendors located at strategic trading points within its villages. Mukuju village, where the outbreak occurred, had only one chapatti vendor (Vendor A). Vendor A made and sold chapatti in Mukuju village every day. He would sell approximately 50 chapatti every day. During the morning of 30 October 2015, chapatti were sold from the vending place in the normal fashion, with no reported problems. However, in the afternoon, 4 students each bought a chapatti from Vendor A. Three ate the whole chapatti, while one ate only part of it because it 'tasted strange'; this student returned the chapatti to Vendor A. Upon hearing the student's complaint, Vendor A tasted the chapatti. All four students and Vendor A developed symptoms approximately 20 min after eating the chapatti. The initial symptoms included profuse sweating, foaming of saliva, confusion, vomiting, diarrhoea, and difficulty breathing, followed by more severe symptoms and signs; low blood pressure (< 90/60 mmHg), altered state of consciousness, and constricted pupils (Fig. 3). Severity increased with the amount of chapatti eaten (Table 1).

The students were rushed to nearby Mukuju Health Centre IV where they were initially administered intravenous fluids while health workers tried to identify the cause of illness. After approximately 4 h at this health centre with no clear diagnosis, three of the four students lost consciousness and were referred to the nearby Tororo Hospital. The clinician at Tororo Hospital who treated the students noticed a strange smell while examining the patients and suspected pesticide poisoning. The 3 students who had eaten a whole chapatti were all treated with atropine and pralidoxime to reverse the cholinergic effects of organophosphate poisoning on the body, but they died shortly after admission (Table 1). The student who had eaten only a portion of his chapatti recovered fully and left the hospital after 2 days. The other three case-patients, including Vendor A, a Boda-Boda ("motorcycle taxi") rider, and a hair-salon worker, each of whom ate part of a chapatti from Vendor A, made a full recovery (Table 1).

Autopsy records of the 3 decedents indicated that the gut contents had a strong organophosphate smell and evidence of multiple organ failure. The toxicological analysis found high levels of malathion in the leftover food specimens (266 mg/L in the dough and 258 mg/L in the chapatti). The United States Environmental Protection Agency has established a malathion acute reference dose

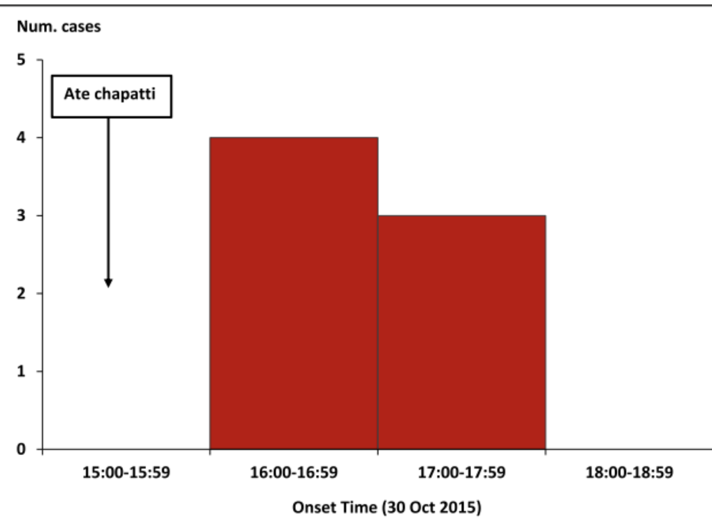


Fig. 1 Symptom onset of 7 cases of organophosphate poisoning: Mukuju Village, Tororo District, Uganda, 30 October 2015

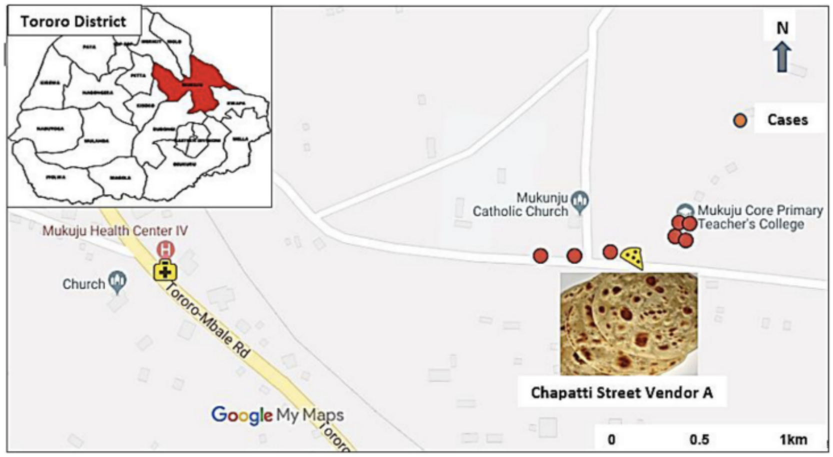


Fig. 2 Map showing place of residence of cases of organophosphate poisoning: Mukuju Village, Tororo District, Uganda, 3[20]0 October 2015. This map was drawn using Google maps, an online open-source software used for mapping purposes [20]

of 0.14 mg/kg/day [21]. We also found high levels of malaoxon, a highly toxic metabolic derivative of malathion, in the 3 decedents' postmortem specimens (average of 19 mg/L in the blood and 22 mg/L in the gastric contents) [22, 23].

Police investigations revealed that Vendor A occasionally accepted flour from his clients to make chapatti for them. On the day of the poisoning, Vendor A received approximately 1 kg of flour from one of his clients, which he then used to make the implicated chapatti. Police investigations identified the person who provided the contaminated flour to the vendor and concluded that the contamination was intentional. The individual was arrested and convicted of murder, and sentenced to prison for 14 years. Unfortunately, we were unable to obtain details of how the contamination actually occurred.

Discussion

This outbreak of organophosphate poisoning was caused by eating street-vended chapatti made from flour contaminated with pesticide powder. The symptoms of the patients, as well as findings of epidemiologic, laboratory, and environmental investigations were all consistent with malathion organophosphate poisoning. This outbreak investigation and response demonstrated that good collaboration between police and public health agencies during criminal outbreak investigations can

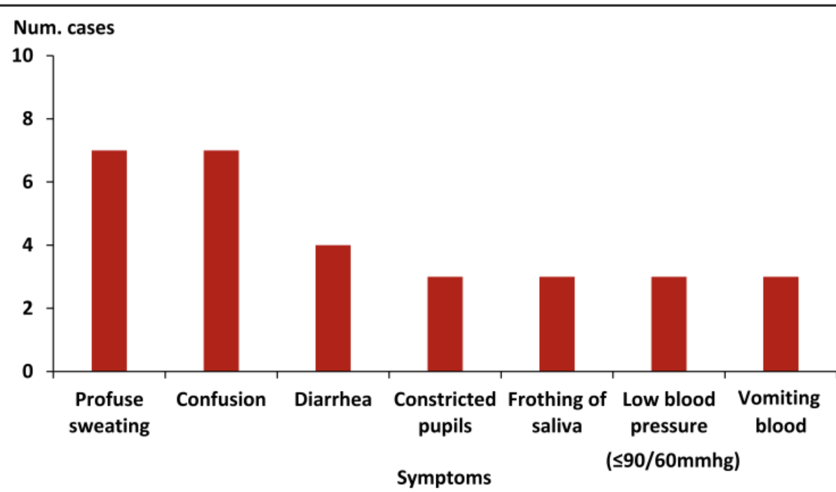


Fig. 3 Distribution of symptoms among 7 cases of organophosphate poisoning: Mukuju Village, Tororo District, Uganda, 30 October 2015

Table 1 Clinical presentation and outcome of 7 case-patients in relation to the amount of chapatti eaten during an outbreak of organophosphate poisoning: Mukuju Village, Tororo District, Uganda, 30 October 2015

Case No.	Age	Sex	Occupation	Amount of chapatti eaten	Symptoms and signs	Outcome
1	23	M	Student	1	Profuse sweating, foaming of saliva, vomiting blood, diarrhoea, constricted pupils, low blood pressure and coma	Died
2	20	M	Student	1	Profuse sweating, foaming of saliva, vomiting blood, diarrhoea, constricted pupils, low blood pressure and coma	Died
3	20	M	Student	1	Profuse sweating, foaming of saliva, vomiting blood, diarrhoea, constricted pupils, low blood pressure and coma	Died
4	26	M	Student	Part of a chapatti	Dizziness, Profuse sweating, confusion,	Recovered
5	24	M	Chapati Vendor	Part of a chapatti	Dizziness, profuse sweating	Recovered
6	25	M	Boda-Boda driver	Part of a chapatti	Dizziness, profuse sweating, diarrhoea	Recovered
7	32	F	Hair-salon worker	A little flour	Dizziness, profuse sweating	Recovered

benefit both sides and such collaboration reflects a core component of global health security.

Malathion is a common, broad-spectrum organophosphate pesticide used to control a variety of outdoor pests in both agricultural and residential settings [24]. It is readily available in Uganda and other developing countries as a pesticide for use in homes and agricultural farms. While malathion itself has low toxicity among humans, its metabolite malaoxon can be up to 20 times more toxic [23]. Malaoxon toxicity in humans is not a well-studied area. During a study on malathion and malaoxon toxicity in humans, autopsy samples from an individual who had ingested large quantities of malathion were analysed for malaoxon [25]. Malaoxon was identified at low levels in some tissues but the highest concentration was in fat (8.2 mg/l) [25]. Compared to our investigation, these malaoxon levels were less than half of the concentrations we found in blood and gastric contents of the 3 descents indicating a high level of toxicity in these cases. Although organophosphates are rarely associated with human outbreaks, a few documented outbreaks exist, including one in India (60 men ate chapatti containing malathion and 1 person died [3]) and another in two farming villages in Bangladesh, which resulted in 2 deaths [16]. Incidents of acute unintentional organophosphate poisoning (due to monocrotophos) after consumption of contaminated millet flour and oil have also been documented in India [26, 27]. There are few reports about organophosphate poisoning with criminal intent [28].

In this outbreak, the 4-h delay in receipt of appropriate treatment likely contributed to the high case-fatality rate among case-patients. Had health workers quickly confirmed the diagnosis and provided specific treatment or referred the patients to higher-level health facility sooner, the 3 students might have had a better outcome [17]. Public and clinical education about warning signs of organophosphate poisoning might have facilitated faster recognition of the syndrome. The easy availability of organophosphate compounds in Uganda could make this type of education particularly important in this setting.

Consumption of street-vended food is common in Uganda and in most developing countries. Street-vended food is often considered risky due to lack of regulation and the likelihood of contamination with foodborne bacteria and viruses. Although rare, our investigation revealed additional risks of eating food for which the ingredients have unknown provenance, including street food. Although police investigations concluded that the flour poisoning was intentional in this outbreak, we were unfortunately unable to obtain details of how the accused contaminated the flour. However, additional education to street food vendors that emphasizes only making food with ingredients that the vendor has purchased himself or herself may be warranted.

Despite the fact that greater volumes of pesticides are used in developed than in developing countries, developing countries suffer pesticide poisoning much more frequently, largely due to the lack of training on their use and the absence of regulatory laws [29]. Uganda is one of several African countries without a policy to regulate access to pesticides. While it is inappropriate to make specific public health recommendations in response to an atypical intentional event such as the one described in this paper, a more in-depth surveillance review of such poisonings in Uganda could help generate evidence of the linkage between intentional pesticide poisonings and access. Such evidence could guide policymakers to reduce pesticide access by criminals and accidental exposures for the public.

We conducted the investigation a few days after the incident. By the time of the investigation, most of the patients had already recovered and discharged, and clinical specimens were not taken for testing while they were hospitalized. We were, therefore, unable to test blood acetylcholinesterase levels for any of the patients, which could have confirmed organophosphate poisoning in their blood. Despite this, the clinical and epidemiological evidence, autopsy findings and testing of environmental samples provided sufficient evidence of organophosphate poisoning.

Conclusion

This fatal outbreak of organophosphate poisoning was associated with consumption of roadside-vended food (chapatti) made of flour contaminated with pesticide. Following the investigation, all chapatti-vending points within the village were closed for inspection. The Tororo District Health Team retrained health workers on early diagnosis and referral to prevent delays in such patients. The District health Team and Police cautioned roadside food vendors about accepting flour from clients and the dangers of organophosphate poisoning and advised them to only make food with ingredients they have purchased themselves. We recommend an in-depth surveillance review of such poisonings in Uganda to help guide policy-makers to reduce access by criminals and accidental exposures for the public.

Additional file

Additional file 1: Questionnaire guide for interviewer. Demographic characteristics, clinical information and food history of patients during a fatal food poisoning incident in Tororo District, Uganda, 2015. This tool was used to collect data for Table 1, and Figs. 1, 2 and 3. The questionnaire that was used to guide interviewers while collecting data about the patients' demographic characteristics, clinical presentation and food intake history on the day of the food poisoning incident (30 October 2015). (DOCX 18 kb)

Acknowledgements

We would like to thank the Tororo District Health Officer, Tororo District Health Team Members involved in this investigation, Tororo District Police and the toxicology team. We would also like to thank Mukuju community and the respondents in helping us conduct this challenging investigation. The team effort from all these stakeholders was extremely crucial during the investigation and response activities.

Authors' contributions

BK investigated the outbreak under technical guidance and supervision of ARA and B-PZ. BK, ARA, and B-PZ analysed, interpreted the data and drafted the manuscript. ARA, LB, JH and B-PZ critically reviewed the manuscript for intellectual content. BK is the guarantor of the paper. All authors participated in the writing, read and approved the final manuscript for publication.

Funding

This project was supported by the President's Emergency Plan for AIDS Relief (PEPFAR) through the United States Centers for Disease Control and Prevention (US CDC) Cooperative Agreement number GH001353–01, awarded to Makerere University School of Public Health to support the Uganda Public Health Fellowship Program, Ministry of Health of Uganda. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the US Centers for Disease Control and Prevention, the Department of Health and Human Services, Makerere University School of Public Health, or the Ministry of Health of Uganda. US CDC provided technical assistance in the design of the study, analysis, interpretation of data and writing the manuscript.

Availability of data and materials

All data generated and analyzed from this investigation are available upon reasonable request from the corresponding author.

Ethics approval and consent to participate

This investigation was authorised by the Uganda Ministry of Health in response to a public health emergency and was, therefore, determined to be exempt from institutional review. We sought verbal informed consent from respondents or their next of kin for the deceased. A verbal consent script was read out to the respondents in the local language and signed by the interviewer. We opted for verbal consent because the interviews had minimal risk to the respondents and only involved non-sensitive information for which consent is not normally sought. We also had a concern that, due to the fatal nature of the incident, participants may be wary of signing documents. We informed respondents that their participation was voluntary and refusal to participate would not result in any negative consequences. To protect confidentiality, we assigned a unique identifier which was used instead of names.

Consent for publication

Not applicable.

Competing interests

The authors hereby declare no competing interests.

Author details

[1]Uganda Public Health Fellowship Program, Ministry of Health, P.O. Box 7272, Kampala, Uganda. [2]United States Centres for Disease Control and Prevention, Kampala, Uganda. [3]Division of Global Health Protection, Center for Global Health, United States Centers for Disease Control and Prevention, Atlanta, GA, USA.

Received: 7 November 2018 Accepted: 10 June 2019
Published online: 17 June 2019

References

1. Chemical hazards. http://www.who.int/ceh/risks/cehchemicals2/en/index1.html#.
2. Vale A, Lotti M. Organophosphorus and carbamate insecticide poisoning. Handb Clin Neurol. 2015;131:149–68.
3. Chaudhry R, Lall SB, Mishra B, Dhawan B. A foodborne outbreak of organophosphate poisoning. BMJ. 1998;317(7153):268–9.
4. Malangu N. Acute poisoning at two hospitals in Kampala-Uganda. J Forensic Legal Med. 2008;15(8):489–92.
5. Clinical management of acute pesticide intoxication: prevention of suicidal behaviours. http://www.who.int/mental_health/publications/9789241596732/en/.
6. Litchfield MH. Estimates of acute pesticide poisoning in agricultural workers in less developed countries. Toxicol Rev. 2005;24(4):271–8.
7. Kang EJ, Seok SJ, Lee KH, Gil HW, Yang JO, Lee EY, Hong SY. Factors for determining survival in acute organophosphate poisoning. The Korean journal of internal medicine. 2009;24(4):362–7.
8. Nalwanga E, Ssempebwa JC. Knowledge and practices of in-home pesticide use: a community survey in Uganda. J Environ Public Health. 2011;2011:230894.
9. Diggory HJ, Landrigan PJ, Latimer KP, Ellington AC, Kimbrough RD, Liddle JA, Cline RE, Smrek AL. Fatal parathion poisoning caused by contamination of flour in international commerce. Am J Epidemiol. 1977;106(2):145–53.
10. Goh KT, Yew FS, Ong KH, Tan IK. Acute organophosphorus food poisoning caused by contaminated green leafy vegetables. Arch Environ Health. 1990;45(3):180–4.
11. Roberts DM, Aaron CK. Management of acute organophosphorus pesticide poisoning. BMJ. 2007;334(7594):629–34.
12. Sungur M, Guven M. Intensive care management of organophosphate insecticide poisoning. Crit Care. 2001;5(4):211–5.
13. Coulibaly K, Smith JS. Effect of pH and cooking temperature on the stability of organophosphate pesticides in beef muscle. J Agric Food Chem. 1994;42(9):2035–9.
14. Ssemugabo C, Halage AA, Neebye RM, Nabankema V, Kasule MM, Ssekimpi D, Jors E: Prevalence, circumstances, and Management of Acute Pesticide Poisoning in hospitals in Kampala City, Uganda. Environ Health Insights 2017, 11:1178630217728924.
15. Pedersen B, Ssemugabo C, Nabankema V, Jørs E. Characteristics of pesticide poisoning in rural and urban settings in Uganda. Environmental health insights. 2017;11:1178630217713015.

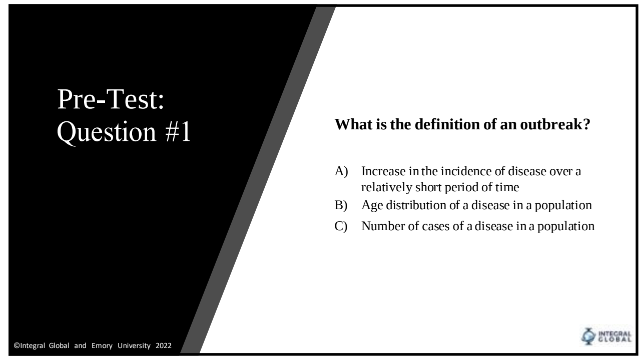
16. Martin CA, Schier J, Chang A, Gurley E, Hossain MJ, Rahman M, Luby S, Haider MS, Alamgir ASM, Homaira N, et al. Investigation of an outbreak of unintentional acute pesticide poisoning: assessment of exposure to carbamate and organophosphate insecticides, rural Bangladesh, 2009. Epidemiology. 2011;22(1):S115.
17. Kavalci C, Durukan P, Ozer M, Cevik Y, Kavalci G. Organophosphate poisoning due to a wheat bagel. Intern Med. 2009;48(2):85–8.
18. Jørs E, Neupane D, London L: Pesticide poisonings in low- and middle-income countries. Environmental health insights 2018, 12: 1178630217750876–1178630217750876.
19. Petrović M, Hernando MD, Díaz-Cruz MS, Barceló D. Liquid chromatography–tandem mass spectrometry for the analysis of pharmaceutical residues in environmental samples: a review. J Chromatogr A. 2005;1067(1–2):1–14.
20. Map of Mukuju Village, Tororo District, Uganda. https://www.google.co.ug/maps/@0.7459111,34.1827453,16z.
21. Gervias JA. malathion technical fact sheet. In: Edited by National Pesticide Information Center OSUES; 2009.
22. Buratti FM, D'aniello A, Volpe MT, Meneguz A, Testai E. Malathion bioactivation in the human liver: the contribution of different cytochrome P450 isoforms. Drug Metab Dispos. 2005;33(3):295–302.
23. PubChem Compound Database: Malaoxon. https://pubchem.ncbi.nlm.nih.gov/compound/15415.
24. Use of malathion for vector control. http://www.who.int/whopes/resources/9789241510578/en/.
25. Morgade C, Barquet A. Body distribution of malathion and its metabolites in a fatal poisoning by ingestion. J Toxicol Environ Health. 1982;10(2):321–5.
26. Krause K-H, van Thriel C, De Sousa PA, Leist M, Hengstler JG. Monocrotophos in Gandaman village: India school lunch deaths and need for improved toxicity testing. Arch Toxicol. 2013;87(10):1877–81.
27. Patel AB, Dewan A, Kaji BC: Monocrotophos poisoning through contaminated millet flour. 2012, 63(3):377.
28. De Letter EA, Cordonnier JACM, Piette MHA. An unusual case of homicide by use of repeated administration of organophosphate insecticides. Journal of Clinical Forensic Medicine. 2002;9(1):15–21.
29. Phung DT, Connell D, Miller G, Rutherford S, Chu C. Pesticide regulations and farm worker safety: the need to improve pesticide regulations in Viet Nam. Bull World Health Organ. 2012;90:468–73.

Publisher's Note

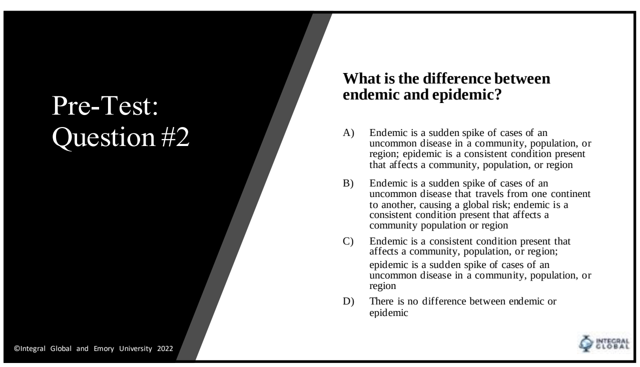
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Appendix B: The Outbreak Investigation Curriculum

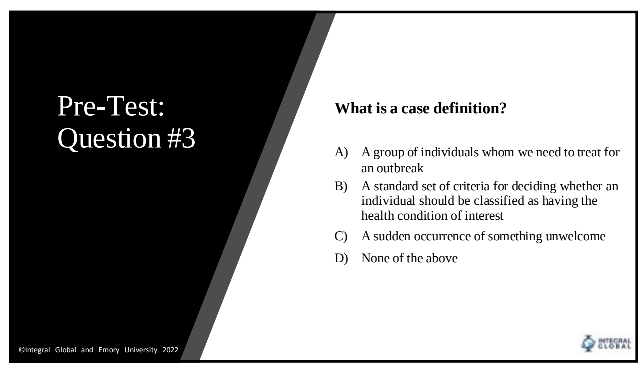
1



2



3



4

Pre-Test: Question #4

True or False:

A case definition cannot be changed once created.

A) True
B) False

5

Pre-Test: Question #5

What information should public health professionals NOT share with the media?

A) Clinical signs and symptoms of the specified disease/condition
B) Detailed demographic information, including names and addresses
C) Area where the outbreak was first discovered
D) Information that pertains to risk factors or risk behaviors

6

Pre-Test: Question #6

True or False:

Public health data can be gathered from vital records, surveys, environmental monitoring systems and animal health data.

A) True
B) False

7

Pre-Test: Question #7

Which of the following is NOT an important aspect of public health surveillance?

A) Determine the geographical distribution of a disease/condition
B) Appropriately estimate the size of a public health problem
C) Inform the media every fact known about a disease/condition present in an area
D) Facilitate emergency planning

8

Pre-Test:
Question #8

True or False:

There are 15 steps from the Center of Disease Control and Prevention's *Epidemiologic Steps of an Outbreak Investigation*, followed on a global scale.

A) True
B) False

9

Pre-Test:
Question #9

Why is preparing for field work important in an outbreak investigation?

A) It allows public health professionals to be independent of other medical fields, as they should know all aspects of the respective outbreak.
B) It allows public health professionals to create an action and communication plan, and establish relationships with others, including medical professionals, partners, andstakeholders.
C) It allows public health professionals to prepare for media coverage, before knowing the case definition or other key facts about the outbreak.
D) Preparing for field work is not important in an outbreak investigation.

10

Pre-Test:
Question #10

Which of the following correctly displays the roadmap for the data of the outbreak?

A) Data analysis-> Data interpretation-> Data collection and display-> Data dissemination-> Link to action
B) Data interpretation-> Data dissemination-> Data collection and display-> Data analysis-> Link to action
C) Link to action-> Data collection and display-> Data analysis-> Data interpretation-> Data dissemination
D) Data collection and display-> Data analysis-> Data interpretation-> Data dissemination-> Link to action

11

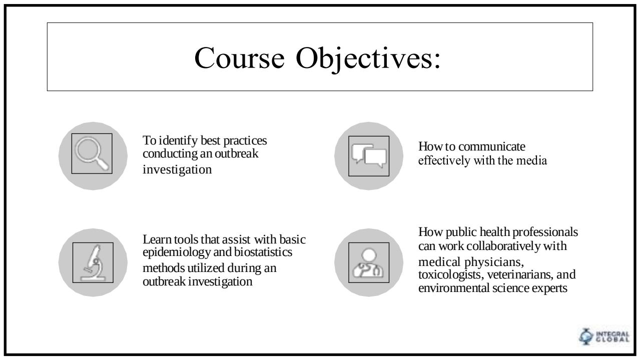
Introducing the Guest Lecturers:

Mr. Nabil Ahmed
Integral Global Consulting
nabil@integralglobal.net
www.integralglobal.net

Dr. Ziad Kazzi
Emory University
zkazzi@emory.edu
www.menatox.org

Ms. Jenna Buttolph
Integral Global Consulting
jenna@integralglobal.net

12


Course Objectives:
To identify best practices conducting an outbreak investigation
How to communicate effectively with the media
Learn tools that assist with basic epidemiology and biostatistics methods utilized during an outbreak investigation
How public health professionals can work collaboratively with medical physicians, toxicologists, veterinarians, and environmental science experts
INTEGRAL GLOBAL

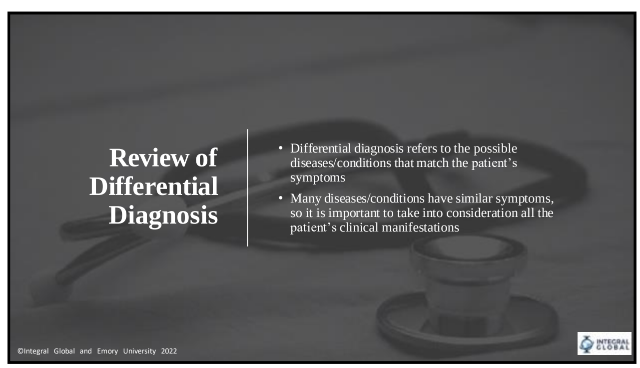
13


Review
Public Health Terms for Review:
©Integral Global and Emory University 2022
INTEGRAL GLOBAL

14


Review of Surveillance
Why is Public Health Surveillance Important?
Total Deaths
4.720
68.324
50.318 recovered
Hubei China
Determine
Determine the geographical onset of a disease/condition and decipher if an epidemic is present
Estimate
Estimate the size of a health problem
Facilitate
Facilitate emergency planning
Monitor
Monitor changes in infectious agents
Detect
Detect changes in health practices
INTEGRAL GLOBAL

15


Review of Differential Diagnosis
• Differential diagnosis refers to the possible diseases/conditions that match the patient's symptoms
• Many diseases/conditions have similar symptoms, so it is important to take into consideration all the patient's clinical manifestations
©Integral Global and Emory University 2022
INTEGRAL GLOBAL

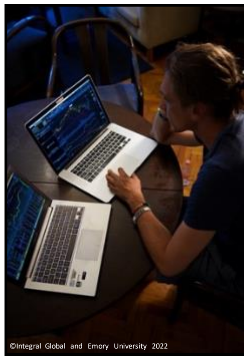
16

Review of Outbreak & Outbreak Investigation

- An outbreak is an epidemic limited to localized increase in the incidence of disease over a relatively short period of time
- When an outbreak is discovered, public health professionals conduct an outbreak investigation
  - An outbreak investigation helps identify ways to prevent further transmission of the disease/condition

Source: CDC, *Principles of Epidemiology in Public Health Practice*

17



Objectives of an Outbreak Investigation

3 main objectives of an outbreak investigation are:

1. Identify the etiologic agent OR the means of transmission
2. Find the source of infection by studying the occurrence of the disease among persons over location and time, as well as determining the specific risk and risk ratios.
3. Formulate recommendations and undertake actions to prevent further transmission

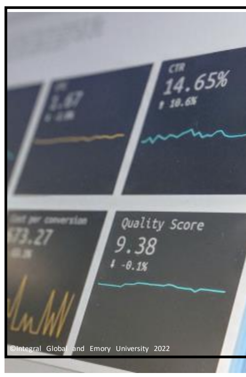
Source: CDC, *Principles of Epidemiology in Public Health Practice*

18

CDC's Table: Epidemiologic Steps of an Outbreak Investigation

1. Prepare for Fieldwork
2. Establish the Existence of an Outbreak
3. Verify the Diagnosis
4. Construct a Working Case Definition
5. Find Cases Systematically and Record Information
6. Perform Descriptive Epidemiology
7. Develop Hypotheses
8. Evaluate Hypotheses Epidemiologically
9. As Necessary, Reconsider, Refine, and Re-evaluate Hypotheses
10. Compare and Reconcile with Laboratory and/or Environmental Studies
11. Implement Control and Prevention Measures
12. Initiate or Maintain Surveillance
13. Communicate Findings

19



The Data Roadmap During an Outbreak Investigation:

Data collection and display
Data analysis
Data interpretation
Data dissemination
Link to action

20

The Case

21

On Friday October 30th, 2015...

- 3 students die at Tororo Hospital in Uganda after being transferred unconscious from the neighboring town Mukuju Health Center IV
- The patients, all male, had been cared for at Mukuju Health Center for 4 hours with intravenous fluids
- They had presented with sweating, vomiting, diarrhea, confusion, and difficulty breathing

22

Question #1

What is your differential diagnosis?

23

Differential Diagnosis for "Gastroenteritis"

Infectious	Toxic	Radiation

• Bacterial or viral gastroenteritis	• Ricin
	• Heavy metals
	• Pesticides
	  • Organophosphates
	  • Carbamates
	  • Nicotine
		• Acute radiation syndrome

24

More Information on the Case

- The 3 patients were students in Mukuju and had fallen ill in the afternoon. They attended school together during the morning session and had lunch together from a local street vendor.
- All students at the school, and family members were asked to report any similar illnesses.

Photo Credit: Sandra Aceng, Global Voices (2020)

25

Question #2

Are these deaths important? As a public health professional, do you need to worry about this? Why or why not?

26

Question #3

Is this event considered a public health outbreak? Why or why not?

27

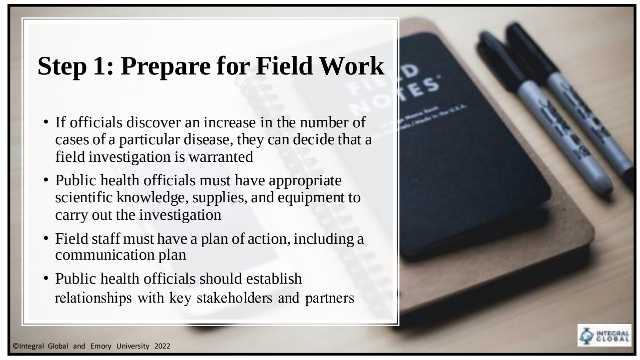
Review of CDC's Table: Epidemiologic Steps of an Outbreak Investigation

1. Prepare for Fieldwork
2. Establish the Existence of an Outbreak
3. Verify the Diagnosis
4. Construct a Working Case Definition
5. Find Cases Systematically and Record Information
6. Perform Descriptive Epidemiology
7. Develop Hypotheses
8. Evaluate Hypotheses Epidemiologically
9. As Necessary, Reconsider, Refine, and Re-evaluate Hypotheses
10. Compare and Reconcile with Laboratory and/or Environmental Studies
11. Implement Control and Prevention Measures
12. Initiate or Maintain Surveillance
13. Communicate Findings

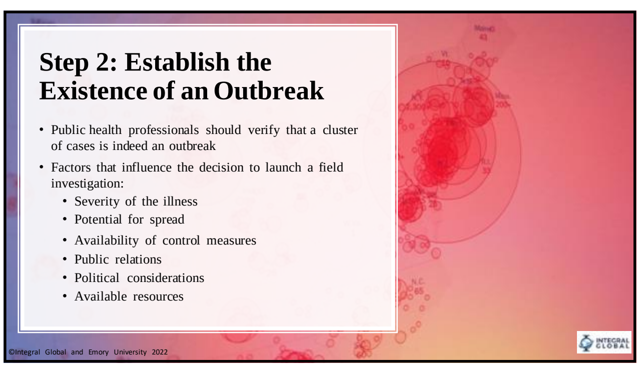
28


Starting the Outbreak Investigation
©Integral Global and Emory University 2022
INTEGRAL GLOBAL

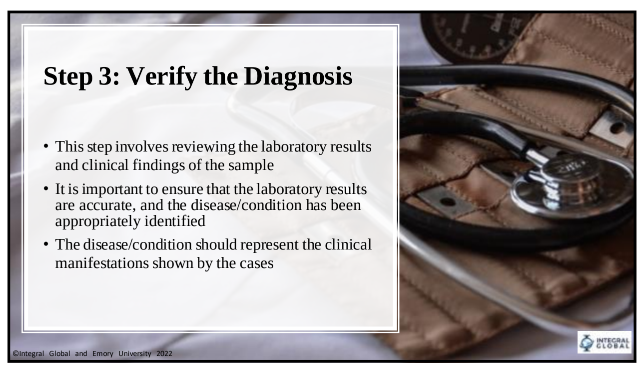
29


Step 1: Prepare for Field Work
• If officials discover an increase in the number of cases of a particular disease, they can decide that a field investigation is warranted
• Public health officials must have appropriate scientific knowledge, supplies, and equipment to carry out the investigation
• Field staff must have a plan of action, including a communication plan
• Public health officials should establish relationships with key stakeholders and partners
©Integral Global and Emory University 2022
INTEGRAL GLOBAL

30


Step 2: Establish the Existence of an Outbreak
• Public health professionals should verify that a cluster of cases is indeed an outbreak
• Factors that influence the decision to launch a field investigation:
• Severity of the illness
• Potential for spread
• Availability of control measures
• Public relations
• Political considerations
• Available resources
©Integral Global and Emory University 2022
INTEGRAL GLOBAL

31


Step 3: Verify the Diagnosis
• This step involves reviewing the laboratory results and clinical findings of the sample
• It is important to ensure that the laboratory results are accurate, and the disease/condition has been appropriately identified
• The disease/condition should represent the clinical manifestations shown by the cases
©Integral Global and Emory University 2022
INTEGRAL GLOBAL

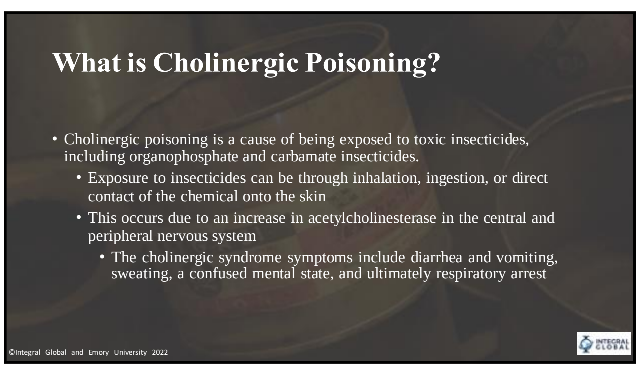
32


New Case Information
©Integral Global and Emory University 2022

33


After Reaching the Hospital
• The Tororo Hospital personnel suspected Cholinergic poisoning, and initiated treatment with medications atropine and Pralidoxime
• Unfortunately, the three patients died within hours after arrival due to cardiac arrest
©Integral Global and Emory University 2022

34


What is Cholinergic Poisoning?
• Cholinergic poisoning is a cause of being exposed to toxic insecticides, including organophosphate and carbamate insecticides.
• Exposure to insecticides can be through inhalation, ingestion, or direct contact of the chemical onto the skin
• This occurs due to an increase in acetylcholinesterase in the central and peripheral nervous system
• The cholinergic syndrome symptoms include diarrhea and vomiting, sweating, a confused mental state, and ultimately respiratory arrest
©Integral Global and Emory University 2022

35


Why is This Important to Our Case?
• Organophosphate poisoning is a common occurrence in Uganda
• Cases are usually suicidal/homicidal
• Organophosphates are easily accessible in-country
• Purchased at animal drug shops
• The uses include:
• Pesticides in most homes
• Indoor residual spraying against mosquitoes
• Agricultural farms
*This information was generously given by Dr, Benon Kwesiga, who brought this information to IGC & Emory from the Uganda Case Study
©Integral Global and Emory University 2022

36

Step 4: Construct a Working Case Definition

- A case definition is a standard set of criteria for deciding whether an individual should be classified as heaving the health condition of interest. It includes clinical criteria and- particularly in the setting of an outbreak investigation- restrictions by time, place and person
  - (e.g., clinical classification can be defined as "three or more loose bowel movements per day")

Source: CDC, Principles of Epidemiology in Public Health Practice

37

Step 4: Continued

- Case definitions can be categorized by:
  - Possible/suspect: a case that meets the clinical case definition and clinical manifestations
  - Probable: a suspected case that meets the clinical case definition, and has an epidemiological link to a confirmed case
  - Confirmed: a suspected or probable case with laboratory confirmation

Source: CDC, Principles of Epidemiology in Public Health Practice

38

Step 4: Continued

- A case definition can be restricted by:
  - Time (e.g., persons with onset of illness within the past 2 months)
  - Place (e.g., only workers in a certain specified village)
  - Person (e.g., people that have a history of breast cancer in the family)
- This should not include the exposure or risk factor

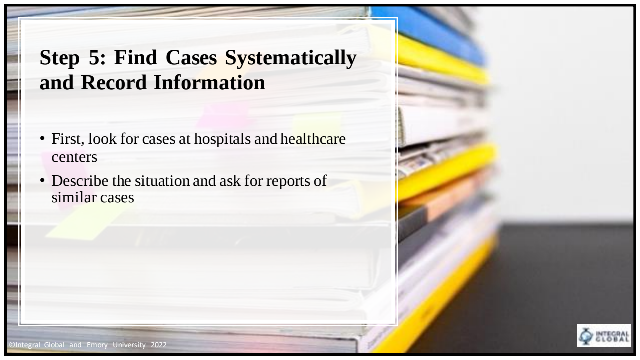
Source: CDC, Principles of Epidemiology in Public Health Practice

39

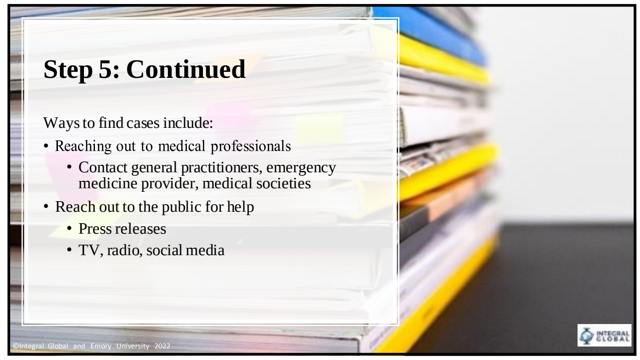
Question #4

As a public health professional, how do you look for additional cases to determine the geographic extent of the problem and size of the population at risk?

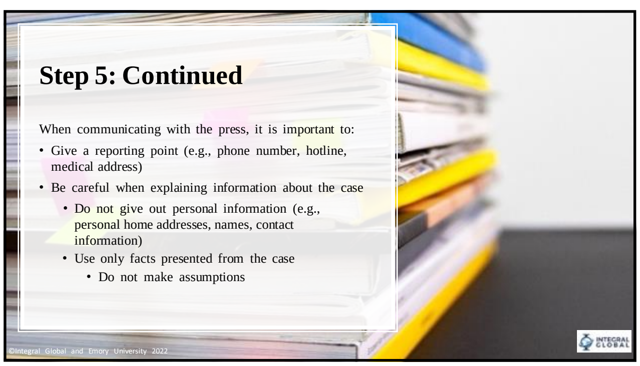
40


Step 5: Find Cases Systematically and Record Information
• First, look for cases at hospitals and healthcare centers
• Describe the situation and ask for reports of similar cases
©Integral Global and Emory University 2022

41


Step 5: Continued
Ways to find cases include:
• Reaching out to medical professionals
• Contact general practitioners, emergency medicine provider, medical societies
• Reach out to the public for help
• Press releases
• TV, radio, social media
©Integral Global and Emory University 2022

42


Step 5: Continued
When communicating with the press, it is important to:
• Give a reporting point (e.g., phone number, hotline, medical address)
• Be careful when explaining information about the case
• Do not give out personal information (e.g., personal home addresses, names, contact information)
• Use only facts presented from the case
• Do not make assumptions
©Integral Global and Emory University 2022

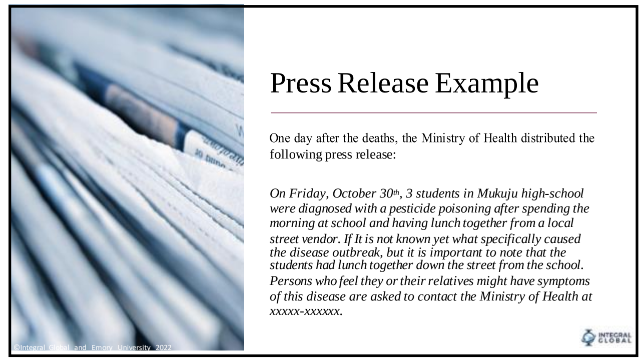
43


Individual Activity
Create a press release!
• Be mindful of what you decide to include
©Integral Global and Emory University 2022

44


Pair & Share
Share your press release with the person next to you and answer the following questions:
• What facts of the case did you both include in the press release?
• Were there any differences?

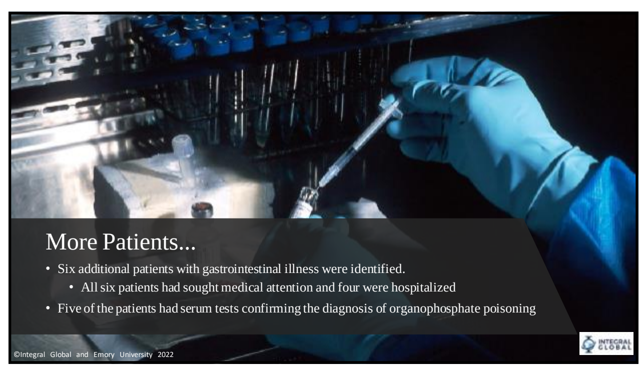
45


Press Release Example
One day after the deaths, the Ministry of Health distributed the following press release:
On Friday, October 30th, 3 students in Mukuju high-school were diagnosed with a pesticide poisoning after spending the morning at school and having lunch together from a local street vendor. If It is not known yet what specifically caused the disease outbreak, but it is important to note that the students had lunch together down the street from the school. Persons who feel they or their relatives might have symptoms of this disease are asked to contact the Ministry of Health at xxxxx-xxxxxx.

46


New Case Information
©Integral Global and Emory University 2022

47


More Patients...
• Six additional patients with gastrointestinal illness were identified.
• All six patients had sought medical attention and four were hospitalized
• Five of the patients had serum tests confirming the diagnosis of organophosphate poisoning
©Integral Global and Emory University 2022

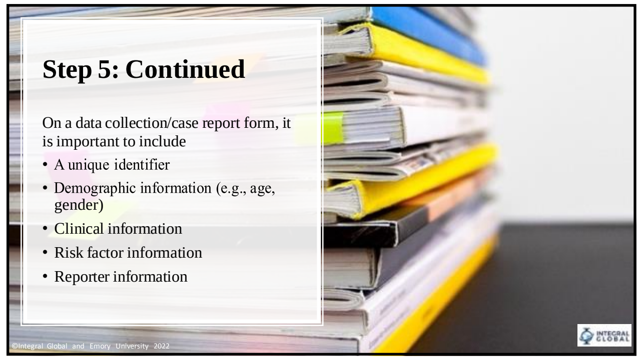
48

Questions #5 & 6

What questions do you ask these patients when you able to interview them?

What data do you want in the Case Report Form?

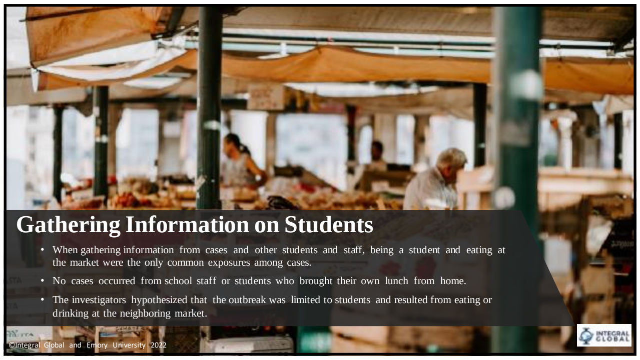
49



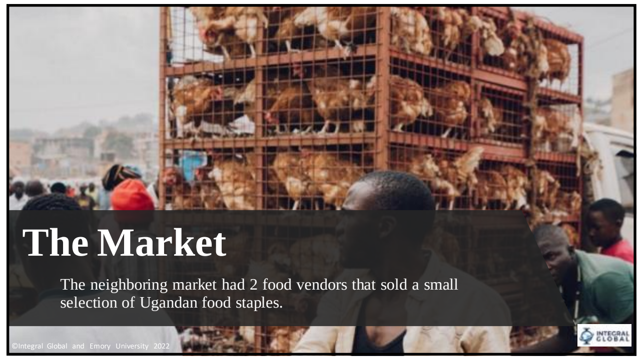
50

51

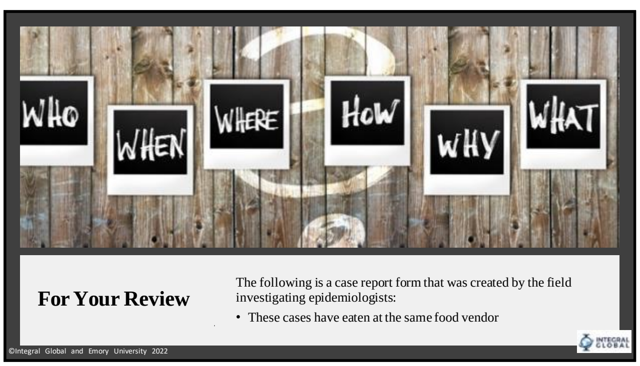
52



53



54



55

Unique ID	Age	Gender (M/F)	Occupation/Risk Factors	Symptoms	Reporting Information	Laboratory Test to Confirm Poisoning (Y/N)
1	15	M	Student at Mukuja HS	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 30th	Health Center Staff	Y (via autopsy)
2	15	M	Student at Mukuja HS	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 30th	Health Center Staff	Y (via autopsy)
3	15	M	Student at Mukuja HS	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 30th	Health Center Staff	Y (via autopsy)
4	16	M	Student at Mukuja HS	Vomiting & fatigue ; October 30th	Self-identified	N
5	14	M	Student at Mukuja HS	Sweating, diarrhea, confusion ; October 30th	Self-identified	Y
6	15	F	Student at Mukuja HS	Sweating, diarrhea, confusion ; October 30th	Self-identified	Y
7	16	M	Student at Mukuja HS	Sweating, diarrhea, confusion ; October 30th	Self-identified	Y
8	24	F	New Vendor/Seller	Sweating, diarrhea, confusion ; October 30th	Self-identified	Y
9	23	F	New Vendor/Seller	Sweating, diarrhea, confusion ; October 31st	Self-identified	Y
10	66	M	Taxi Driver	Diarrhea, stomach pain ; October 31st	Clinic Doctor	N
11	28	F	Pharmacist	Nausea, fever, stomach pain ; October 31st	Self-identified	Y
12	47	M	Taxi Driver	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Clinic Doctor	Y
13	35	F	Teacher at Mukuja HS	Vomiting & fatigue ; October 31st	Clinic Doctor	N

56

Unique ID	Age	Gender (M/F)	Occupation/Risk Factors	Symptoms & Date of Onset	Reporting Information	Laboratory Test to Confirm Poisoning (Y/N)
15	26	F	New Vendor/Seller	Diarrhea, stomach pain ; October 31st	Husband called the hotline	N
16	15	F	Student at Mukuja HS	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Father called the hotline	Y
17	17	F	Student at Mukuja HS	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Self-identified	Y
18	32	M	Local Trader	Diarrhea, stomach pain ; October 31st	Wife called the hotline	N
19	27	M	New Vendor/Seller	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Clinic Doctor	Y
20	55	M	Taxi Driver	Diarrhea, stomach pain ; October 31st	Clinic Doctor	N
21	43	F	Local Trader	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Husband called the hotline	Y
22	26	M	New Vendor/Seller	Sweating, diarrhea, confusion ; October 31st	Friend at the market called the hotline	Y
23	40	F	New Vendor/Seller	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Friend at the market called the hotline	Y
24	35	M	Teacher at Mukuja HS	Diarrhea, stomach pain ; October 31st	Self-identified	N
25	61	M	Taxi Driver	Sweating, diarrhea, confusion ; October 31st	Clinic Doctor	Y
26	57	M	Taxi Driver	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Wife called the hotline	Y
27	18	F	Student at Mukuja HS	Diarrhea, stomach pain ; October 31st	Self-identified	N

57

Unique ID	Age	Gender (M/F)	Occupation/Risk Factors	Symptoms	Reporting Information	Laboratory Test to Confirm Poisoning (Y/N)
28	24	F	New Vendor/Seller	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Husband called the hotline	Y
29	46	F	Local Trader	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Friend from the market called the hotline	Y
30	53	M	Taxi Driver	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; October 31st	Clinic Doctor	Y
31	20	M	New Vendor/Seller	Sweating, vomiting, diarrhea, confusion and difficulty breathing ; November 1st	Friend from the market called the hotline	Y
32	28	F	Teacher at Mukuja HS	Sweating, diarrhea, confusion ; November 1st	Self-identified	Y
33	52	M	Taxi Driver	Sweating, diarrhea, confusion ; November 1st	Clinic Doctor	Y
34	40	M	Local Trader	Sweating, diarrhea, confusion ; November 1st	Wife called the hotline	Y
35	17	M	Student at Mukuja HS	Sweating, diarrhea, confusion ; November 1st	Self-identified	Y

58

The Data Roadmap for Outbreak Investigation

Once you have the data:

- Display it visually
- Perform descriptive epidemiology
- Draw an epidemic curve (histogram)

59

Step 6: Perform Descriptive Epidemiology

- **Descriptive Epidemiology:** the aspect of epidemiology concerned with organizing and summarizing data regarding the persons affected (the characteristics of those who became ill), time (when they became ill), and place (where they might have been exposed to the cause of illness).
- **Epidemic Curve (Epi Curve):** a histogram that displays the course of an outbreak or epidemic by plotting the number of cases according to the time of onset

60

Why is Descriptive Epidemiology Important?

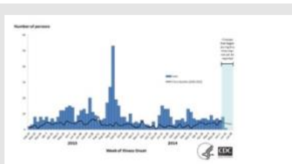
- Summarizes the key demographic variable to characterize an outbreak (age, sex, race)
- Identifies or infers the population at risk for the disease
- Provides clues about etiology, source and modes of transmission
- Describes the "where" and "whom" of the disease, allowing for intervention and prevention measures to begin
- Early & continuing analysis of descriptive data with familiarization, helping identify and correct errors.

61

Descriptive Epidemiology: Time

62

Perform Descriptive Epidemiology: Epi Curves



Example of an epidemic (epi) curve during a multistate outbreak investigation of *Salmonella* Heidelberg infections, 2013-2014.

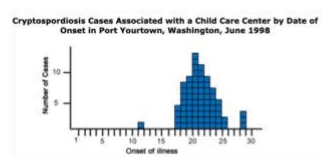
- Epidemic Curves graph the number of cases by date or time of onset of illness
- Epidemic curves are highly informative
- First step in interpreting an epidemic curve is to consider its overall shape

Source: CDC, National Center for Emerging and Zoonotic Infectious Diseases, Division of Foodborne, Waterborne, and Environmental Diseases

63

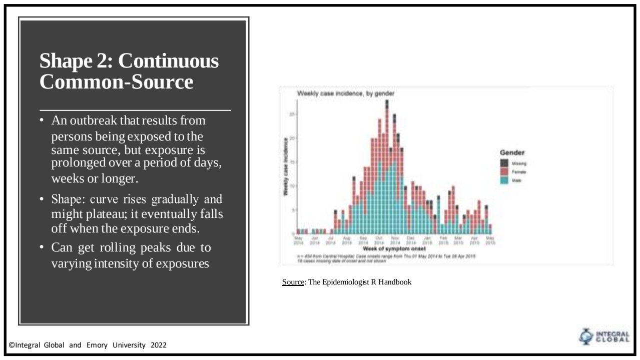
Shape 1: Point-Source Epidemic

- Persons are exposed over a brief time to the same source, such a single meal or an event
- Shape: number of cases rise rapidly to a peak and fall gradually
- Most of the cases within one incubation period of the disease
- Usually, these epidemics do not tend to affect many people, but they can if a lot of people are exposed.

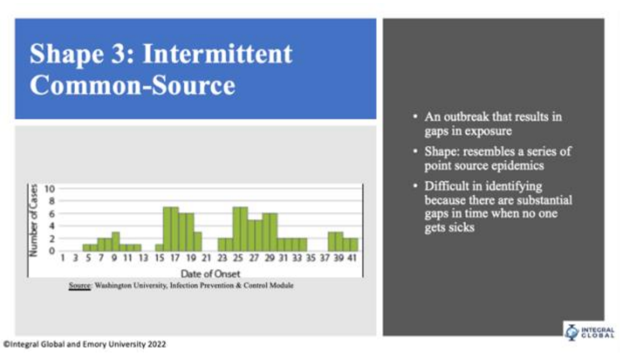


Source: CDC, Training Module 4, Mode of Spread

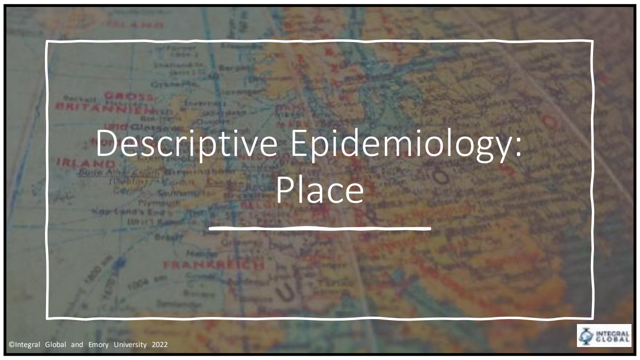
64


Shape 2: Continuous Common-Source
• An outbreak that results from persons being exposed to the same source, but exposure is prolonged over a period of days, weeks or longer.
• Shape: curve rises gradually and might plateau; it eventually falls off when the exposure ends.
• Can get rolling peaks due to varying intensity of exposures
Weekly case incidence, by gender
Week of symptom onset
Gender
Source: The Epidemiologist R Handbook
©Integral Global and Emory University 2022

65


Shape 3: Intermittent Common-Source
Number of Cases
Date of Onset
Source: Washington University, Infection Prevention & Control Module
• An outbreak that results in gaps in exposure
• Shape: resembles a series of point source epidemics
• Difficult in identifying because there are substantial gaps in time when no one gets sicks
©Integral Global and Emory University 2022

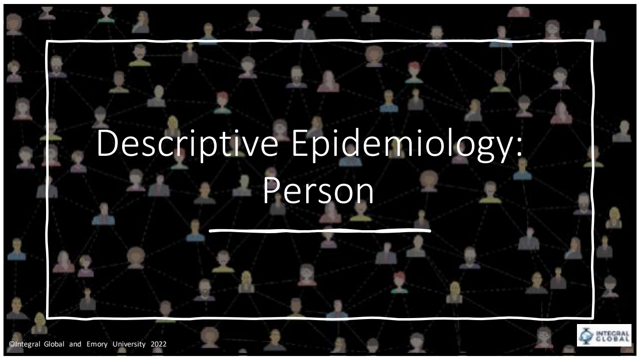
66


Descriptive Epidemiology: Place
©Integral Global and Emory University 2022

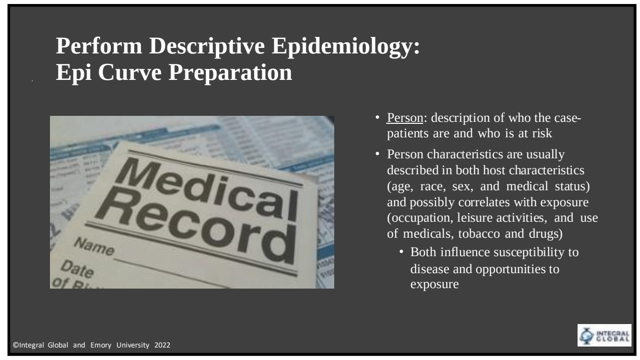
67


Where are the cases? Spot Mapping
JOHN SNOW
• Assessing an outbreak by place provides information on geographic extent and demonstrates clusters or patterns that illustrate important etiologic clues
• Spot Map
• Useful for demonstrating cases within a geographic area, but do not take the size of the underlying population into account
©Integral Global and Emory University 2022

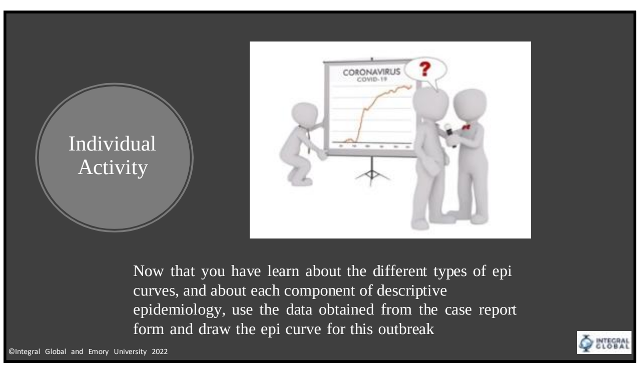
68


Descriptive Epidemiology:
Person
©Integral Global and Emory University 2022

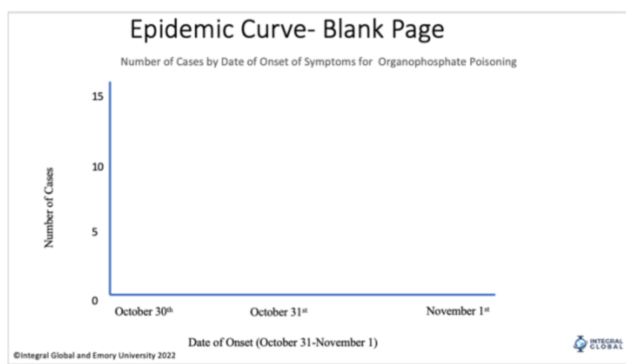
69


Perform Descriptive Epidemiology:
Epi Curve Preparation
Medical
Record
Name
Date
• Person: description of who the case-patients are and who is at risk
• Person characteristics are usually described in both host characteristics (age, race, sex, and medical status) and possibly correlates with exposure (occupation, leisure activities, and use of medicals, tobacco and drugs)
• Both influence susceptibility to disease and opportunities to exposure
©Integral Global and Emory University 2022

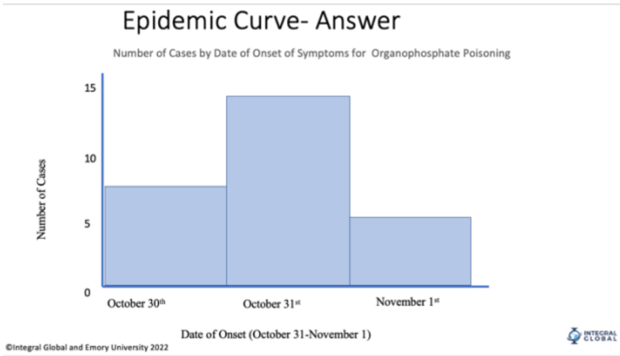
70


Individual Activity
CORONAVIRUS
COVID-19
?
Now that you have learn about the different types of epi curves, and about each component of descriptive epidemiology, use the data obtained from the case report form and draw the epi curve for this outbreak
©Integral Global and Emory University 2022

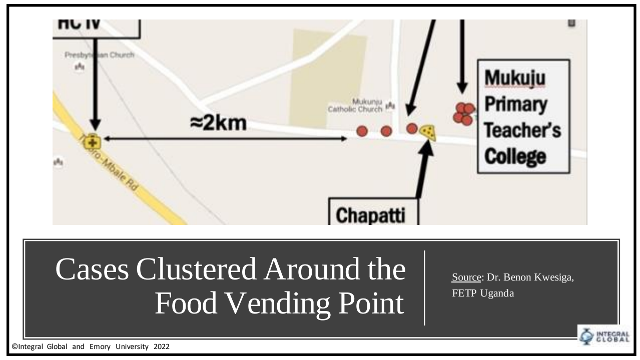
71


Epidemic Curve- Blank Page
Number of Cases by Date of Onset of Symptoms for Organophosphate Poisoning
Number of Cases
15
10
5
0
October 30th
October 31st
November 1st
Date of Onset (October 31-November 1)
©Integral Global and Emory University 2022

72


Epidemic Curve- Answer
Number of Cases by Date of Onset of Symptoms for Organophosphate Poisoning
Number of Cases
15
10
5
0
October 30th
October 31st
November 1st
Date of Onset (October 31-November 1)
©Integral Global and Emory University 2022

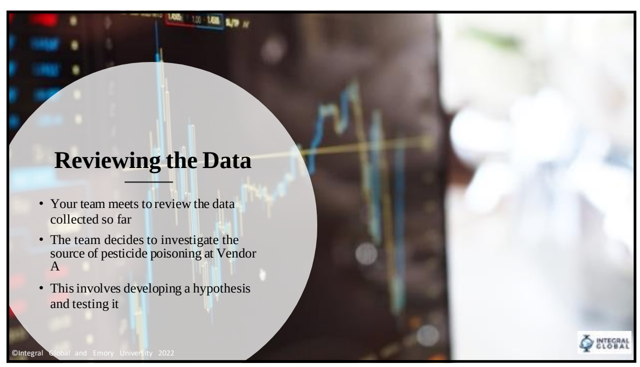
73


HC IV
≈2km
Mukuju Primary Teacher's College
Chapatti
Cases Clustered Around the Food Vending Point
Source: Dr. Benon Kwesiga, FETP Uganda
©Integral Global and Emory University 2022

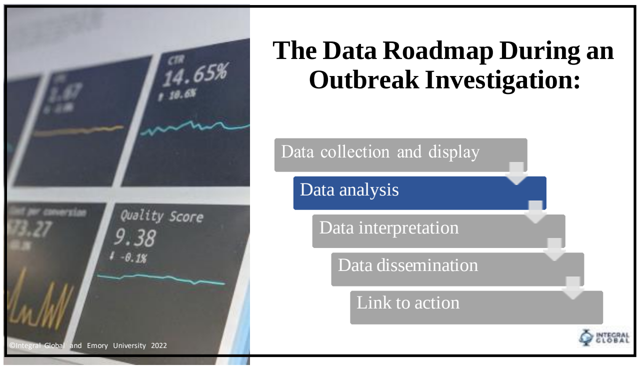
74


New Case Information
©Integral Global and Emory University 2022

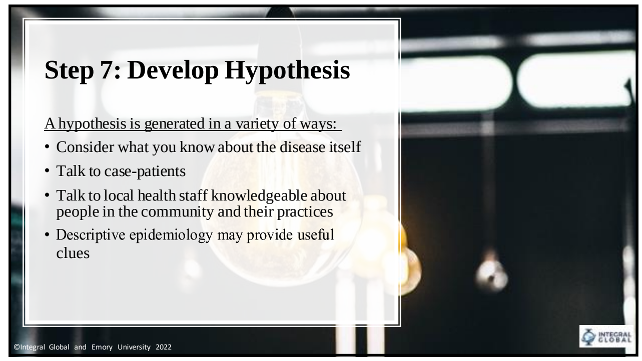
75


Reviewing the Data
• Your team meets to review the data collected so far
• The team decides to investigate the source of pesticide poisoning at Vendor A
• This involves developing a hypothesis and testing it

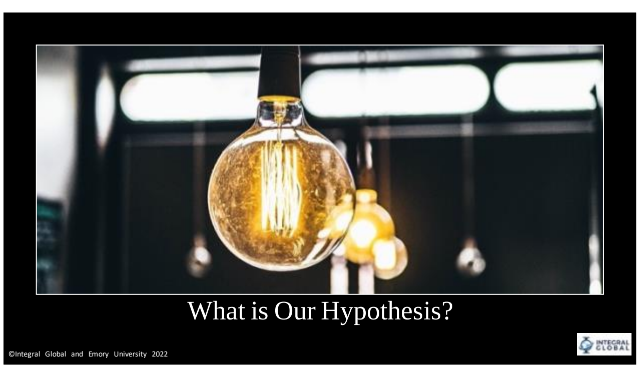
76


The Data Roadmap During an Outbreak Investigation:
Data collection and display
Data analysis
Data interpretation
Data dissemination
Link to action
©Integral Global and Emory University 2022

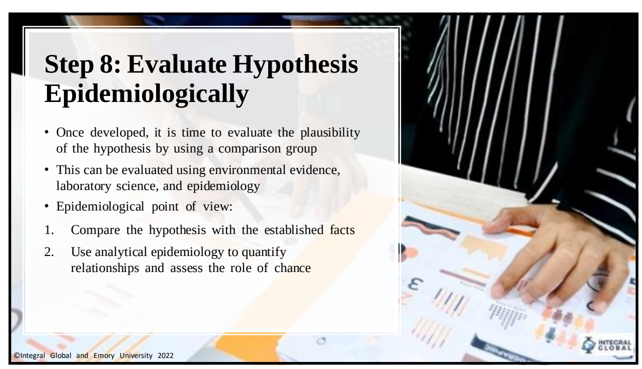
77


Step 7: Develop Hypothesis
A hypothesis is generated in a variety of ways:
• Consider what you know about the disease itself
• Talk to case-patients
• Talk to local health staff knowledgeable about people in the community and their practices
• Descriptive epidemiology may provide useful clues
©Integral Global and Emory University 2022

78


What is Our Hypothesis?
©Integral Global and Emory University 2022

79


Step 8: Evaluate Hypothesis Epidemiologically
• Once developed, it is time to evaluate the plausibility of the hypothesis by using a comparison group
• This can be evaluated using environmental evidence, laboratory science, and epidemiology
• Epidemiological point of view:
1. Compare the hypothesis with the established facts
2. Use analytical epidemiology to quantify relationships and assess the role of chance
©Integral Global and Emory University 2022

80

Individual Activity

Based off the group's hypothesis, review and ensure that the hypothesis does not have to be refined

81

Step 9: As Necessary, Reconsider, Refine and Re-evaluate Hypothesis

- In certain investigations, the circumstances may not be as straightforward, and information from the series of cases may not display compelling or convincing evidence to create a sufficient hypothesis
  - In such investigations, epidemiologists use analytic epidemiology (using a comparison group) to compare the pattern among case-patients with the expected pattern among cases or unexposed persons
- In this scenario, we do not need to refine our hypothesis

82

Step 10: Compare and Reconcile with Laboratory and Environmental Studies

- While epidemiology can implicate vehicles and guide appropriate public health action, laboratory evidence can confirm the findings
- Environmental studies are equally important in some settings and can be helpful in explaining why an outbreak occurred

83

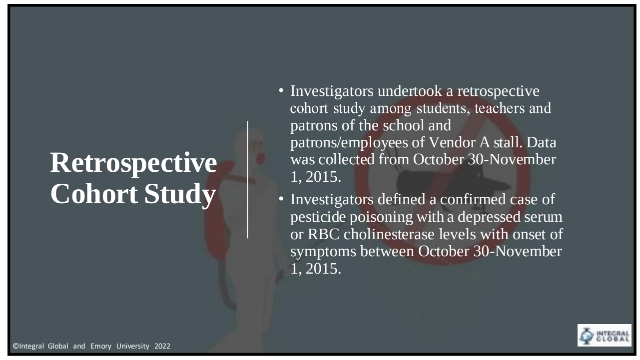
Possible Study Designs

- Perspective cohort
- Retrospective cohort
- Case-control study
- Animal Study

84


New Case Information
©Integral Global and Emory University 2022

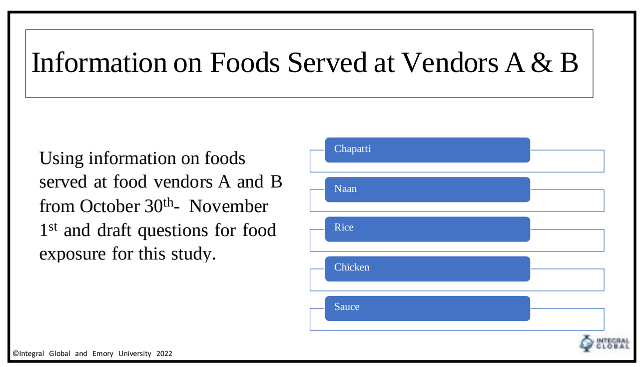
85


Retrospective Cohort Study
• Investigators undertook a retrospective cohort study among students, teachers and patrons of the school and patrons/employees of Vendor A stall. Data was collected from October 30-November 1, 2015.
• Investigators defined a confirmed case of pesticide poisoning with a depressed serum or RBC cholinesterase levels with onset of symptoms between October 30-November 1, 2015.
©Integral Global and Emory University 2022

86


Detailed Case Information
• The comparison group consisted of all students, employees of the school and vendor stalls of their patrons
• After consultation with the local health department, investigators developed a structured questionnaire for the epidemiologic study.

87


Information on Foods Served at Vendors A & B
Using information on foods served at food vendors A and B from October 30th- November 1st and draft questions for food exposure for this study.
Chapatti
Naan
Rice
Chicken
Sauce
©Integral Global and Emory University 2022

88

Questionnaire

Did you eat or drink any foods at Vendors A or B between October 30 and November 1st?

- Yes
- No
- I don't know

If NO, you are done with the investigation

If YES, please finish the questionnaire and prepare for additional questions from the public health staff

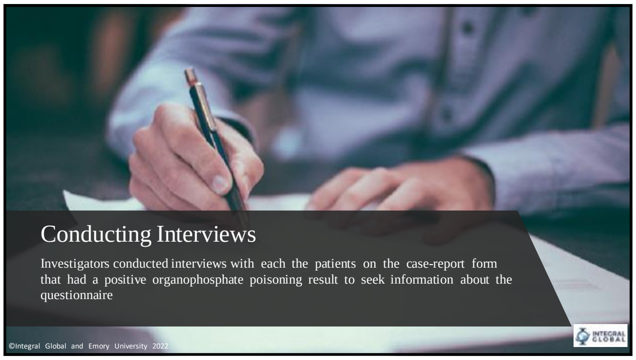
89

Additional Information on the Questionnaire

Food Source	If yes, please circle	If no, please circle	If I don't know, please circle
Chapatti	YES	NO	I DON'T KNOW
Naan	YES	NO	I DON'T KNOW
Rice	YES	NO	I DON'T KNOW
Chicken	YES	NO	I DON'T KNOW
Sauce	YES	NO	I DON'T KNOW

90

91



92

Food Exposure Information

- Of the 35 patients on the case-report form, 26 had a positive organophosphate poisoning result, making the new total for the cases 26
- The 26 cases were asked to fill out what they ate at Vendor A (none of the cases ate at Vendor B)
- Data was then tabulated using a 2 by 2 table for every food item on the menu (exposure)

93

Biostatistical Equations Important for an Outbreak Investigation

- An attack rate was calculated for every food item on the menu (exposure)
- A relative risk was calculated for every food item on the menu (exposure)

94

2X2 Table- Any Exposure

	Outcome		
Exposure	*Yes*	*No*	**Total**
Yes	a	b	**a+b**
No	c	d	**c+d**
Total	a+c	**b+d**	**a+b+c+d**

95

2X2 Table- Chapatti

	Pesticide Poisoning		
Ate Chapatti	*Yes*	*No*	**Total**
Yes	18	2	**20**
No	1	5	**6**
Total	**15**	**11**	**26**

96

Attack Rate- Chapatti

Attack Rate = *# of new cases of a disease* **/** *Total # of people at-risk in the population*

Attack Rate = A / A+B

18/(18+2) = 90%

97

Relative Risk- Chapatti

- RR = Relative Risk <u>or</u> Risk Ratio (Same thing!)
- RR = *Risk in the Exposed* **/** *Risk in the Unexposed*
- RR= *A/(A+B)* / *C/ (C+D)*

RR= (*18/20*) / (*1/6*)
RR= .90 / .17
RR= 5.3

The Risk Ratio indicates that people who ate chapatti are 5.3 times more likely to develop organophosphate poisoning than the people who did not eat chapatti

98

Fisher's Exact Test

- The Fisher's Exact Test is used to determine the p-value for the measure of association calculation
- P-values are used to determine what the odds of getting the same results from chance are (as opposed to from the exposure)
- 0.05 is usually the cut-off for a significant value

99

A Useful Tool!

Created by Emory University, the website www.openepi.com is a tool that public health professionals can utilize to compute biostatistical formulas necessary for an outbreak investigation

100

2x2 Table- Sauce

	Pesticide Poisoning		
Ate Sauce	*Yes*	*No*	**Total**
Yes	3	2	**5**
No	8	13	**21**
Total	**17**	**9**	**26**

101

Attack Rate- Sauce

Attack Rate = *# of new cases of a disease / Total # of people at-risk in the population*

Attack Rate = A / A+B

3/(3+2) = 60%

102

Relative Risk- Sauce

- RR = Relative Risk or Risk Ratio (Same thing!)
- RR = *Risk in the Exposed / Risk in the Unexposed*
- RR= *A/(A+B) / C/ (C+D)*

RR= *(2/5) / (8/21)*
RR= .6 / .38
RR= 1.6

The Risk Ratio indicates that people who ate the sauce are 1.6 times more likely to develop organophosphate poisoning than the people who did not eat the sauce.

103

Other Food Items

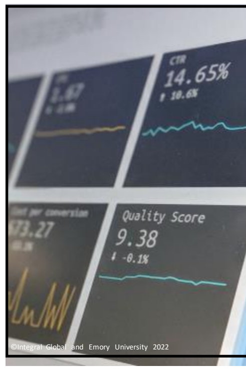
Food Item	Ate Item		Did Not Eat Item	
	Ill	Well	Ill	Well
Naan	1	7	1	12
Rice	3	5	2	11
Chicken	5	12	1	3

104

Calculate the Measures of Association for Remaining Foods

Food	Attack Rate of Exposed (ate the food)	Relative Risk	Fisher's Test
Chapatti	90%	5.3	0.003527
Sauce	60%	1.6	0.6913
Naan	12.5%	1.7	>0.9999
Rice	37.5%	2.4	0.5243
Chicken	29.4%	1.2	>0.9999

105



The Data Roadmap During an Outbreak Investigation:

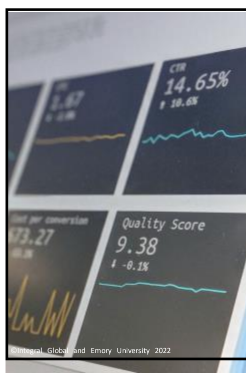
- Data collection and display
- Data analysis
- **Data interpretation**
- Data dissemination
- Link to action

106

Interpret the Results

- Of the people that were interviewed with everything ate the market, the common denominator was that chapatti was a part of each meal (e.g., cases that were sick and ate sauce also ate the chapatti with the sauce).
- The cases that did not eat the chapatti but ate at Vendor A did not get sick.

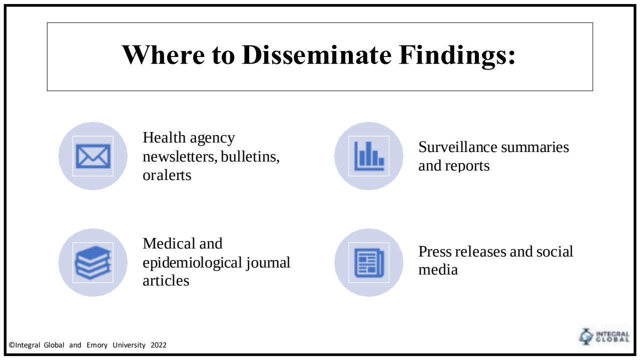
107



The Data Roadmap During an Outbreak Investigation:

- Data collection and display
- Data analysis
- Data interpretation
- **Data dissemination**
- Link to action

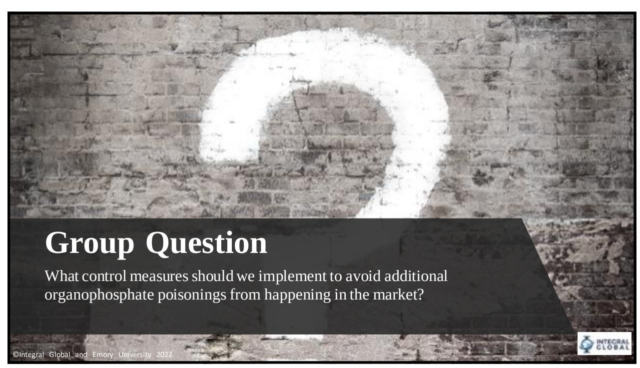
108



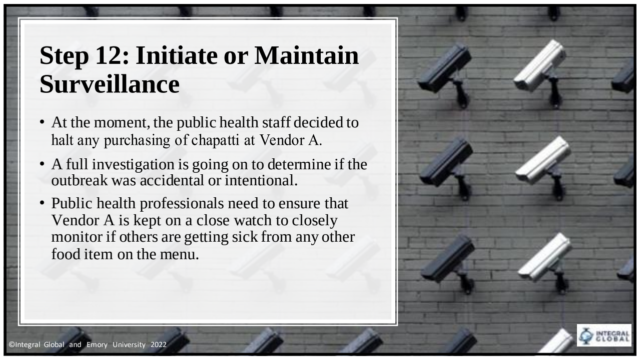
109

110

111



112



113

114

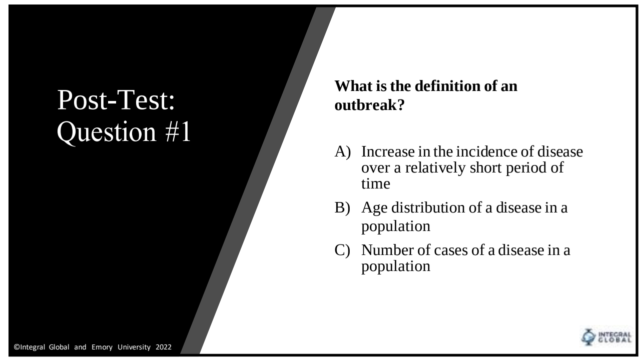
115

Step 13: Communicate the Findings

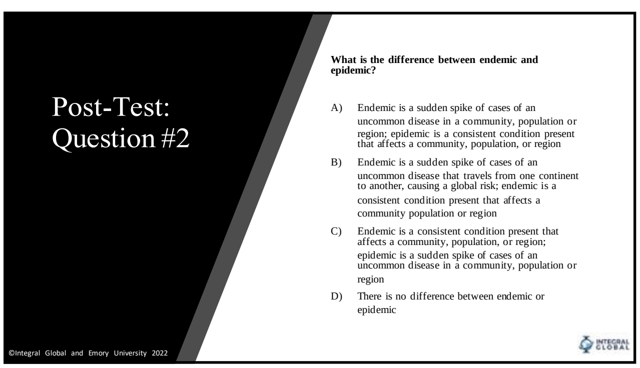
Oral Briefing	Written Report
Present finding in a clear manner	Usual scientific format (introduction, background, methods, results, discussion, and recommendations)
Provides justifiable recommendations for action	Provides a blueprint for action and a reference for future similar situations
Gives the opportunity to describe what investigators did, what they found, and what they think should be done	Contributes to the knowledge base of epidemiology and public health

116

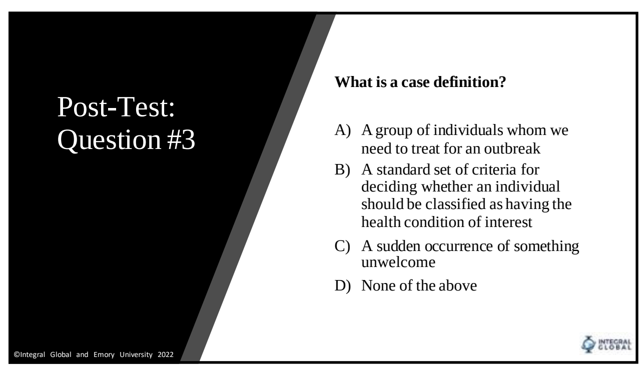
117



118



119



120

Post-Test: Question #4

True or False:

A case definition cannot be changed once created.

A) True
B) False

121

Post-Test: Question #5

What information should public health professionals NOT share with the media?

A) Clinical signs and symptoms of the specified disease/condition
B) Detailed demographic information, including names and addresses
C) Area where the outbreak was first discovered
D) Information that pertains to risk factors or risk behaviors

122

Post-Test: Question #6

True or False:

Public health data can be gathered from vital records, surveys, environmental monitoring systems and animal health data.

A) True
B) False

123

Post-Test: Question #7

Which of the following is NOT an important aspect of public health surveillance?

A) Determine the geographical distribution of a disease/condition
B) Appropriately estimate the size of a public health problem
C) Inform the media every fact known about a disease/condition present in an area
D) Facilitate emergency planning

124

Post-Test: Question #8

True or False:

There are 15 steps from the Center of Disease Control and Prevention's *Epidemiologic Steps of an Outbreak Investigation*, followed on a global scale.

A) True
B) False

125

Post-Test: Question #9

Why is preparing for field work important in an outbreak investigation?

A) It allows public health professionals to be independent of other medical fields, as they should know all aspects of the respective outbreak.
B) It allows public health professionals to create an action and communication plan, and establish relationships with others, including medical professionals, partners and stakeholders.
C) It allows public health professionals to prepare for media coverage, before knowing the case definition or other key facts about the outbreak.
D) Preparing for field work is not important in an outbreak investigation.

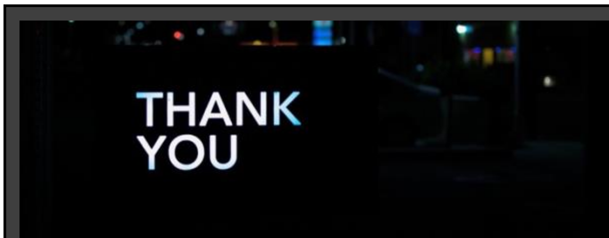
126

Post-Test: Question #10

Which of the following correctly displays the roadmap for the data of the outbreak?

A) Data analysis-> Data interpretation-> Data collection and display-> Data dissemination-> Link to action
B) Data interpretation-> Data dissemination-> Data collection and display-> Data analysis-> Link to action
C) Link to action-> Data collection and display-> Data analysis-> Data interpretation-> Data dissemination
D) Data collection and display-> Data analysis-> Data interpretation-> Data dissemination-> Link to action

127



Acknowledgements

Thank you to the U.S. Centers for Disease Control and Prevention (US- CDC) and Dr. Benon Kwesiga, MBChB, MPH of Uganda

128


Contact Information:
Jenna- jenna@integralglobal.net
Nabil- nabil@integralglobal.net
Ziad- zkazzi@emory.edu
©Integral Global and Emory University 2022

129

Appendix C: The Tabletop Exercise

Infectious disease outbreaks continue to pose a global threat. Outbreaks can stem from viral droplets to food-borne incidents. Today, Integral Global will be leading you through a technical tabletop exercise to simulate a real outbreak investigation. The purpose of the exercise is to determine and assess the knowledge gained from the workshop curriculum, and use the concepts described in a simulation. The exercise will focus on the collaboration between various health professionals to coordinate and strengthen the health system in a time of public health concern.

In groups of four participants, each member will choose a role to play in the outbreak investigation simulation. Below are the roles, and their respective responsibilities.

Epidemiologist: To track surveillance measures of the outbreak and lead the effort in the field for the outbreak- The epidemiologist will be present in the community and communicate with the local population about the outbreak.

Laboratory Technician: To perform key laboratory diagnostics tests and work with the medical personnel on determining the proper disease in the simulation. The technician will communicate with the medical personnel throughout the investigation, specifically during the differential diagnosis portion.

Medical Officer: To speak with the infected patients in the case and help determine the root cause of the outbreak, based off clinical findings. The medical officer will lead the efforts in clinical examinations and will be in charge of speaking to the other public health officers regarding the patients.

Data Analyst- To track the data collected, perform statistical analyses, and disseminate the findings with the rest of the public health personnel part of the simulation. The data analyst will follow the "Roadmap for Data" discussed in the workshop curriculum to guide them through each step of the investigation.

The tabletop exercise is meant to be very broad, allowing the teams to explore the information gained during the workshop, while also bringing in their own pervious experiences in public health to investigate the outbreak. Good luck!

Scenario Portion 1: On June 4th, 2022, you and your team are attending a public health training conference in Da Nang, Vietnam, when you all suddenly have alerts on your phone explaining that you need to return to Hoi Ann, Vietnam because of a potential outbreak. It appears the outbreak is happening in the local street market in Hoi Ann, located in the agricultural district. At this time, three patients, two men and one woman, have experienced severe respiratory distress after visiting the market. The clinical symptoms include coughing/wheezing, running nose, and a fever ranging from 101-103 degrees Fahrenheit.

For the next 10 minutes, discuss with your team on how to answer the three questions below:

1. Who are the designated people each role need to contact first (e.g., who should the medical officer reach out to first)?
2. What are potential changes that are occurring in the local community (e.g., are people still in the market, are the hospitals experiencing an influx in patients)?
3. What are the positive and negative outcomes of contact other organizations or departments for further assistance?

Scenario Portion 2: The next day, your team gets back to Hoi Ann and realize that 12 more people are in the hospital experiencing the same symptoms. One of the patients from yesterday, the woman- age 64 years old- has died due to pneumonia. It is now the medical officer and the laboratory technician to assess the clinical findings.

For the next 5 minutes, determine with your team potential, differential diagnoses.

Scenario Portion 3: After receiving the clinical findings from the laboratory technician and discussing with the medical officer about the signs and symptoms, the confirmed diagnosis is a novel type of influenza. Some of the patients are starting to develop worse symptoms, while the younger population is recovering at a faster rate with proper hydration and a Vietnamese medication similar to Tamiflu. The epidemiologist and the data analyst are aware of the confirmed diagnosis and are now visiting the local market to speak with the vendors and propose proper regulations to avoid more of a spread of the new influenza throughout the city.

For the next 10 minutes, work together to determine what are they key questions the epidemiologist should ask the vendors, and if the agricultural district should be shut-down.

Scenario Portion 4: The epidemiologist and the data analyst discuss with the vendors in the agricultural district and determine that the only difference was that a new vendor, selling exotic chicken from a different Southeast Asian country, started opening up the shop two days ago. After testing one of the chickens in the laboratory, it was discovered that the vendor was the culprit of the outbreak and should not have started the shop in the market, with unknown sources of chicken.

For the next 30 minutes, discuss with your group the following:

1. What are some protocols that should be in place globally for selling and distributing meat?
2. Who else should be notified of vendors bringing exotic meat into a different country?
3. How would your team as a public health professional best communicate with the respective partners and medical personnel involved in the outbreak investigation?

Thank you for participating in the simulation discussion today. For the next hour, we will talk as a large group regarding your thoughts and experiences of the tabletop exercise. We will also be reviewing the questions from the last small group discussion.

Appendix D: Photographs from the Outbreak Investigation Training at the National Centers for Disease Control and Public Health (NCDC) in Tbilisi, Georgia