

Investigation of an outbreak caused by an unknown infectious pathogen in rural Zola

Authors: Fortress Yayra Aku¹, Dinara Beisembekova², Nurudeen Ayobami Adebisi³, Eva Mertens^{4,5,*}, Lea Wende^{7,8}, Sayed Mahdi Marashi⁶, Janine Dywicki^{7,8}

1. Department of epidemiology and biostatistics, School of Public Health, University of Health and Allied Sciences, Hohoe campus, Ghana
2. Nazarbayev University, University Healthcare Department, Nur Sultan, Kazakhstan
3. Department of Chemical Pathology, University College Hospital, Ibadan, Oyo State, Nigeria
4. Bernhard Nocht Institute for Tropical Medicine Hamburg, Department of Infectious Disease Epidemiology, Bernhard-Nocht-Strasse 74, 20359 Hamburg, Germany
5. Global Partnership Initiated Biosecurity Academia for Controlling Health Threats (GIBACHT), Hamburg (Germany)
6. Tehran University of Medical Sciences, School of Public Health, Department of Virology, Tehran, Iran
7. Robert Koch Institute, Centre for International Health Protection, Preparedness and Operations Support, Nordufer 20, 13353 Berlin, Germany
8. Global Partnership Initiated Biosecurity Academia for Controlling Health Threats (GIBACHT), Berlin (Germany)

* Corresponding author, Email: info@gibacht.org

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Acknowledgements

The authors wish to acknowledge the Global Partnership Initiated Academia for Controlling Health Threats (GIBACHT) and their funding body, the German Federal Foreign Office, for their support in developing this case study.

Abstract

This case study was written as part of a fellowship in biosafety and biosecurity organised by the German Biosecurity Programme, namely the Global Partnership Initiated Biosecurity Academia for Controlling Health Threats (GIBACHT). Among other objectives, the fellowship focuses on equipping participants with the skills of developing their own country-specific case studies with focus on biosafety and biosecurity-related scenarios.

Upon completion of the underlying case study, participants should be able to identify some existing gaps with regards to early detection and investigation of outbreaks, describe the key steps in outbreak investigation, explain the role of communication and coordination among the various stakeholders in outbreak investigations and analyse epidemiological data obtained during outbreak investigations. They should also be able to suggest appropriate control and prevention measures for specific disease outbreaks with focus on foodborne outbreaks and to distinguish between biosafety and biosecurity.

How to use this case study

General instruction: This case study should be used as an add-on training and capacity-building resource for public health and epidemiology trainees meant to complement the theoretical aspects learned through lectures and/or other formats practically. Also, it can serve as a supplementary material in the context of in-service training activities for frontline public health professionals to refresh their knowledge and skills regarding the principles and concept of outbreak investigation and related biosafety as well as biosecurity matters.

Ideally, the case study should be led by 2 facilitators per group of around 5 participants each. To enhance interactivity, participants should read the subsequent paragraphs of the case study in turns. Discussions within the group during the conduction of the case study constitute a key element of the process and should be oriented towards the collective identification of an outbreak investigation strategy as a team. Respectively, facilitators should lead the discussion through guiding questions and further hints making use of materials such as flip charts. The integration of role plays as a facilitation method can also enhance the overall interactivity of the case study at hand.

Audience: The underlying case study targets a broad range of public health professionals working in outbreak prevention and control, especially disease control and surveillance officers, students of epidemiology training programs and other public health practitioners interested in the concepts highlighted.

Prerequisites: Prior to the use of this case study, participants should have basic background knowledge of the principles of outbreak investigation as well as biosafety and biosecurity issues related to the handling of samples in the context of outbreak investigations.

Materials required: Computer with MS Excel or other spreadsheet software, pen, notebooks, calculator, flip charts and markers.

Level of training and associated public health activity: Intermediate level in outbreak investigation

Time required: This case study is expected to take between 2,5 to 3 hours.

Language: English

Competing interest: The authors declare no competing interest.

Participant guide

Goal of the case study

To investigate an outbreak caused by an unknown infectious pathogen, identify the key steps of outbreak investigation alongside apparent gaps in outbreak investigation procedures as well as possible measures to mitigate them and discuss the role of biosafety and biosecurity in outbreak investigations.

Learning objectives

At the end of this case study, participants should be able to:

- Identify the apparent gaps in outbreak identification, investigation and control at the periphery of the healthcare and surveillance system
- Describe the key steps of an outbreak investigation
- Discuss the importance of communication and coordination among the various stakeholders in an outbreak situation
- Analyse and interpret epidemiological data in the scope of an outbreak investigation
- Implement effective control and prevention measures during outbreaks/an outbreak
- Discuss the importance of biosafety and biosecurity in the context of outbreaks and the difference between the two.

Case study description

This case study is based on fictitious events. Details and names have been modified to improve learning and support the instructional goal.

Part one: Sociodemographic characteristics of Zola community

Introduction

Zola is a community in the western part of Surulee county in country X. It is a rural community with a population of approximately 500 citizens. Members of the community usually engage in crop and animal farming as part of their economic activities. There is no health facility located within the borders of Zola and the community is facing frequent water supply shortages (although there is a pipe-borne water supply system), insufficient waste disposal and a lack of sanitary facilities such as latrines. On average, households in Zola community consist of 4 to 5 members.

However, there are adjoining communities with primary healthcare facilities which are accessible to Zola community members. The county health authority that oversees health needs across Surulee county regularly visits the communities within its jurisdiction. The county hospital, Surulee Hospital, is the only hospital that admits patients, performs basic laboratory tests and refers patients to the provincial level hospitals when the need arises.

While health facility consultations due to illnesses such as gastrointestinal tract infection, malaria, skin diseases, headache and typhoid among other illnesses are frequent, local health authorities have so far not reported a single outbreak in Zola community.

Surulee County, Bola Health Centre, May 9, 2018; 4:00 pm

A 13-year-old male (Yoti, case B) reported to the Bola Health Centre with complaints of fever, vomiting and abdominal pain. The community health nurse on duty upon interview with the patient gathered information that the boy fell ill 2 hours after eating a specific food at home. Interactions between the nurse and the boy revealed that Yoti's sister, Yani (case A), a 15-year-old girl, also complained of similar symptoms the previous day. She was, however, given medication at home by her mother and was already feeling better. Yoti was given medication at the health centre and subsequently returned home.

Question1. Was the action taken by the community health nurse sufficient? What other actions do you think the community health nurse should have taken? What could be potential consequences of the situation depicted? (10 minutes) [1]

Answer:

Surulee County, Surulee Hospital, May 11, 2018; 4:00 am

A mother brought her two daughters (cases C&D) to the hospital with reported symptoms of vomiting, abdominal pain and general weakness. The mother stated that the symptoms had begun an hour before arrival at the hospital. Further investigation by the medical doctor in charge revealed that the food the two females had priorly eaten had been bought the previous day and not consumed at home.

Surulee Hospital, May 11, 2018; 5:00 am

Just one hour later, four other persons reported to the hospital with similar complaints. However, all of them were from different households. The medical doctor on duty was unsure of what was happening and therefore decided to place a telephone call to his superior while trying his best to manage the cases. Upon arrival of the senior medical officer, medical examination demonstrated that the respective patients might be suffering from suspected food poisoning. The senior medical officer knew exactly what to do – inform the Surulee District Health Directorate. On his way to making the call, more patients displaying similar symptoms were rushed in. After stabilising the new arrivals, the senior medical officer finally managed to place a call to his contact at Surulee District Health Directorate to inform his colleagues about the situation.

Question 2: Is this an epidemic? Explain your answer. (5 minutes) [2, 3]

Answer:

Surulee Hospital, May 11, 2018; 9:00 am

At around 9:00 am, the medical officer held a telephone conversation with the public health officer in charge of surveillance and disease control at the Surulee District Health Directorate.

Medical officer: Hello! Good morning. This is Dr. Issah from Surulee General Hospital. Please, am I speaking to the public health officer of the Surulee District Health Directorate?

Public Health Officer: Yes, yes...Please, I hope all is well.

Medical Officer: Uummmh...well not quite...About 13 patients reported to our hospital this dawn with complaints of abdominal pain, vomiting, headache and other symptoms...They are in critical condition, and I am afraid, I suspect food poisoning!

Public Health officer: Food poisoning?

Medical Officer: Yes...they all seem to have eaten food prepared outside of their homes and are currently hospitalised.

Public Health Officer: Ok...ok...Doc! Thank you for the information...I will get back to you as soon as possible.

Question 3. As the public health officer who received this call, what would you do? (5 minutes)

Answer:

Question 4. If the outlined scenario was to pass for an outbreak, what would be the key steps of investigation? (7 minutes) [2]

Answer:

Part two: Reporting and verifying the existence of an outbreak

Surulee District Health Authority; May 11, 2018; 11:00 am

Following the initiated emergency meeting and the formation of an outbreak response team, the local health authority deployed team members to start investigation at Surulee District Hospital. At the hospital, the team primarily went onto consulting the 15 case patients.

Question 5: What additional information would you intend to gather from the case patients? (5 minutes)

Answer:

Question 6: What categories of agents will you include in your investigation? (10 minutes) [4, 5]

Answer:

Surulee Hospital; May 11, 2018; 12:30 pm

The laboratory department of Surulee Hospital can perform basic haematological and biochemistry tests, but not microbiological tests. In light of these constraints, the Surulee District Health Directorate called his superior, the provincial epidemiologist, who resided in Bima, the provincial capital. He informed him about the limited capacities of Surulee Hospital laboratory. In turn, the provincial epidemiologist asked for some time to make some inquiries. He had remembered a friend, Bob, who worked at the Provincial Hospital laboratory in county Y.

Provincial epidemiologist: Hi Bob! It's been a while; I hope you're doing well.

Bob: Hey...you...how are you?

Provincial epidemiologist: I am good, but I have a problem on my hand, and really need your help.

Bob: Really, ok...what is it?

Provincial epidemiologist: There is an outbreak in one of the districts under my jurisdiction and I need to take samples for microbiological procedures and further analysis. But the district hospital laboratory has structural challenges. I was wondering whether you could help.

Bob: Oh...ok! Yeah, let them take the samples and bring them in. I will talk to my colleague in the microbiology department.

Provincial epidemiologist: Thank you Bob...thank you so much.

Following the phone call, the provincial epidemiologist informed the Surulee District public health officer to instruct hospital staff to take stool samples of the respective patients to the Provincial hospital laboratory for analysis. The distance between Surulee and the provincial capital was approximately 3 hours by vehicle.

Surulee Hospital Laboratory; May 11, 2018; 12:45 pm

Due to the distance between the site of stool sample collection (i.e., Surulee Hospital) and the microbiology laboratory in the province's capital, a laboratory staff on duty was tasked with transferring the samples into a special vial serving as transport medium. The staff had only recently been employed and therefore never packaged laboratory samples for shipping outside his county. After labelling the samples, he held the vials in his hand in order to place them into the secondary receptacle for transportation instead of using a safe tray. During this process, one of the vials containing a stool sample fell to the floor, broke and spilled over. In an attempt to cover up the accident, he quickly collected the pieces of the broken vial to dispose of them into a sharp box, cleaned the floor as well as the remaining vials with dry absorbent material, neglecting to apply any disinfectant. He then transferred the remainder of the sample in the broken vial into a new vial and placed all samples into a secondary receptacle (paper box) that he handed to the driver for delivery to the microbiology laboratory in the provincial capital.

Biological specimen spills must be cleaned with disinfectant (e.g., 0.5% chlorine solution) for decontamination purposes. Decision on the type and duration of treatment of spills with disinfectant depends on the specimen or pathogen at hand.

Question 7: Does the described accident give rise to any biosafety or biosecurity concerns? What would you as the laboratory personnel in charge have done differently? (10 minutes)
[6, 7]

Answer:

Samples such as the stool samples collected in the context of this case study constitute specimens obtained from humans (or in other cases animals) with the aim of identifying the pathogen responsible for the observed illness and subsequent diagnosis. They are referred to as infectious substances if they contain biological agents that can trigger infection in both humans and animals. Such infectious substances are classified as Category B if they contain biological agents with the ability to cause infection in humans and animals, but the outcome of this infection is not considered to result in disability or death. They are transported according to Packing Instruction P650, assigned to UN 3373, with their proper shipping name being *biological substance Category B*. Biological samples in this class must be shipped according to the triple packaging system comprising a primary receptacle, secondary packaging with additional absorbent material for liquids, and rigid outer packaging [8].

Provincial Hospital Laboratory; May 11, 2018; 5:30 pm

Given the three-hour travel time between Surulee and the provincial capital, where the Provincial Hospital Laboratory was located, the driver arrived when laboratory premises and surrounding departments had already closed. However, there is always a laboratory staff on call at this time.

The driver therefore exchanged a few phone calls with the provincial epidemiologist to obtain the contact of the staff on call. When he finally got a hold of him, the laboratory employee was yet to report on duty. The driver received instructions to hand the stool samples over to an intern, who had volunteered to support the lab staff on duty that day. Given that the driver had to return to Surulee the same day and could not wait much longer, he had no other option than to do as he had been told.

To unpack the vials he had just received, the intern put on a pair of gloves, not noticing that they had tiny tears in them. Subsequently, he removed the vials from the box used for transportation to place them in the incubator.

Question 8: What challenges do you foresee given the latest events and what might be the consequences? (10 minutes) [2]

Answer:

Part three: Identifying the source of the outbreak

Surulee Hospital; May 11, 2018; 12:00pm

On the same day, members of the outbreak investigation team at Surulee Hospital designed a structured questionnaire to consult/ the respective case patients. The subsequent interview with the case patients pointed to the local market square in Surulee being the probable source of the foodborne outbreak, as all of them had bought and consumed food there within the past days.

Surulee Market Square; May 11, 2018: 1:00 pm-6:00 pm

Mrs. Mooni, Yoti’s mother, is a food vendor who lives in Zola community, just a few miles away from the county capital Surulee, but frequently sells at the local market square in Surulee. She normally sells sliced yam with salad (lettuce and other vegetables) and stew and is usually supported by her daughter Yani in the process of food preparation.

The investigation team arrived at the local market square and based on the information provided by the affected patients regarding their food history, identified Mrs. Mooni as the vendor from whom they had all bought their food.

Question 9. How would you start your investigation in the field/field investigation? (5 minutes)

Answer:

The members of the investigation team swiftly introduced themselves to Mrs. Mooni and informed her of the purpose of their visit. Interviews with the case patients revealed that most people who ate the salad sold by Mrs. Mooni became ill – thus, the team attempted to find out where she usually obtains or purchases the salad used for further food preparation and sale.

The vendor mentioned that she buys all ingredients at the market, but that it is her daughter, Yani, who is usually responsible for salad preparation. She then added that for the past four days, Yani had not been feeling well and that she even gave her daughter medication. The members of the investigation team moreover found out that Yani had been experiencing symptoms including vomiting, abdominal pain, headache and general weakness.

Subsequently, food samples from Mrs. Mooni’s market stall were taken by the Food Safety Authority for analysis, while Mrs. Mooni’s food vending post was closed down for the time being.

Question 10. What immediate control measures would you implement in the current situation? Why? (5 minutes) [2]

Answer:

Surulee Hospital, May 11, 2018, 4:30 pm

Unfortunately, by 4:30 pm, two case patients had died at the hospital. A male and a female aged 5 years and 7 years, respectively.

Surulee Hospital, 13 May 2018, 10:00 am

At this point in time, neither the FSA nor the provincial hospital laboratory had communicated findings to the District Health Directorate or to Surulee Hospital.

Question 11. Calculate the case fatality rate (CFR) for the current state of the outbreak under investigation (3 minutes).

Answer:

Question 12. Is this CFR alarming? What would you opt to do at this stage of the outbreak? (10 minutes)

Answer:

Based on the information collected by the Surulee District Public Health Officer, there was no proper handwashing point installed (running water and soap) within the vicinity of Mrs. Mooni's vending post, neither for food sellers nor customers. Yani, during her time of sickness, still helped her mother at the market square; she was responsible for salad preparation, even though during that period she frequently visited the toilet. She did not adhere to proper handwashing practices before and during the preparation of the salads to be sold. This gives rise to the assumption that Yani may have contaminated the salad and is most likely the source of the observed outbreak. The District Public Health Officer generated a line list accordingly.

Question 13. What is a line list? Why is it an important document during an outbreak investigation? (10 minutes) [2]

Answer:

Table 1: Line list of suspected food borne outbreak, Surulee County, Country X, 2018

ID	Age	Sex	Abdominal pain	Vomiting	Weakness	Headache	E.coli isolated	Date food taken	Time of onset	Outcome
1	40	f	yes	yes	yes	no	Yes	9/5/18	10/5/18	alive
2	5	f	yes	yes	yes	no	Yes	9/5/18	10/5/18	dead
3	7	f	yes	yes	yes	no	Yes	9/5/18	10/5/18	alive
4	35	m	yes	yes	no	no	Yes	9/5/18	11/5/18	alive
5	5	m	yes	yes	yes	yes	Yes	9/5/18	11/5/18	alive
6	7	m	yes	yes	yes	yes	yes	9/5/18	11/5/18	dead
7	50	f	yes	yes	yes	no	Yes	9/5/18	11/5/18	alive
8	45	m	yes	yes	yes	no	Yes	9/5/18	11/5/18	alive
9	18	m	yes	yes	yes	no	Yes	9/5/18	11/5/18	alive
10	6	f	yes	yes	yes	no	Yes	9/5/18	11/5/18	alive
11	16	f	yes	no	no	no	Yes	9/5/18	11/5/18	alive
12	20	m	yes	no	no	no	Yes	9/5/18	11/5/18	alive
13	22	m	yes	yes	no	no	Yes	9/5/18	11/5/18	alive
14	44	f	yes	yes	no	no	Yes	9/5/18	11/5/18	alive
15	55	m	yes	yes	yes	no	Yes	9/5/18	10/5/18	alive
16	15	f	yes	yes	no	no	unknown	Unknown	5/5/18	alive
17	13	m	yes	yes	no	no	unknown	8/5/18	9/5/18	alive

Question 14. Provide a brief descriptive epidemiological summary based on the line list at hand (Table 1) (5 minutes) [2, 9]

Answer:

Question 15. Define and produce an epidemic curve for the outbreak under investigation. Describe this epi curve (25 minutes) [10].

Answer:

Provincial Hospital; May 13, 2018; 4:00 pm

By 4:00 pm on May 13, 2018, a laboratory staff from the provincial hospital laboratory called to inform the medical officer of Surulee General Hospital that the security personnel, who had received the stool samples of case patients, was showing symptoms of abdominal pain, vomiting and diarrhoea. The lab worker's intention was to find out whether the cases in Surulee General Hospital had demonstrated similar symptoms.

"Oh...yes...they showed the same symptoms," said the medical officer. The laboratory staff went ahead to confirm that *Escherichia coli* O157:H7 had been isolated from the stool sample of the

respective security personnel as was also the case with regards to the stool samples of the case patients from Surulee General Hospital.

An hour later, the Food Safety Authority sent a report of their findings to Surulee District Health Directorate. The report indicated that *Escherichia coli* O157:H7 had been isolated from the lettuce components of the salad from Mrs. Mooni's market stall as well.

Question 16. What in your opinion led to infection in the volunteer intern? (10 minutes)

Answer:

Question 17. How could this transmission of disease have been prevented? (5 minutes)

Answer:

Question 18. What measures need to be implemented to control the ongoing outbreak? Could it have been prevented? (10 minutes) [2]

Answer:

Summary

The underlying case study outlines the significance and implications of healthcare workers at the lower level of the healthcare system in the control and prevention of disease outbreaks. It also highlights the steps of outbreak investigation using the example of a foodborne outbreak, more specifically an outbreak of *Escherichia coli* O157:H7, and the importance of adhering to standard operating procedures (SOPs) and biosafety protocols in handling laboratory samples generally and with specific focus on outbreak situations. Furthermore, it emphasises the immediate and long-term measures that need to be implemented in order to control and/or even prevent future foodborne disease outbreaks.

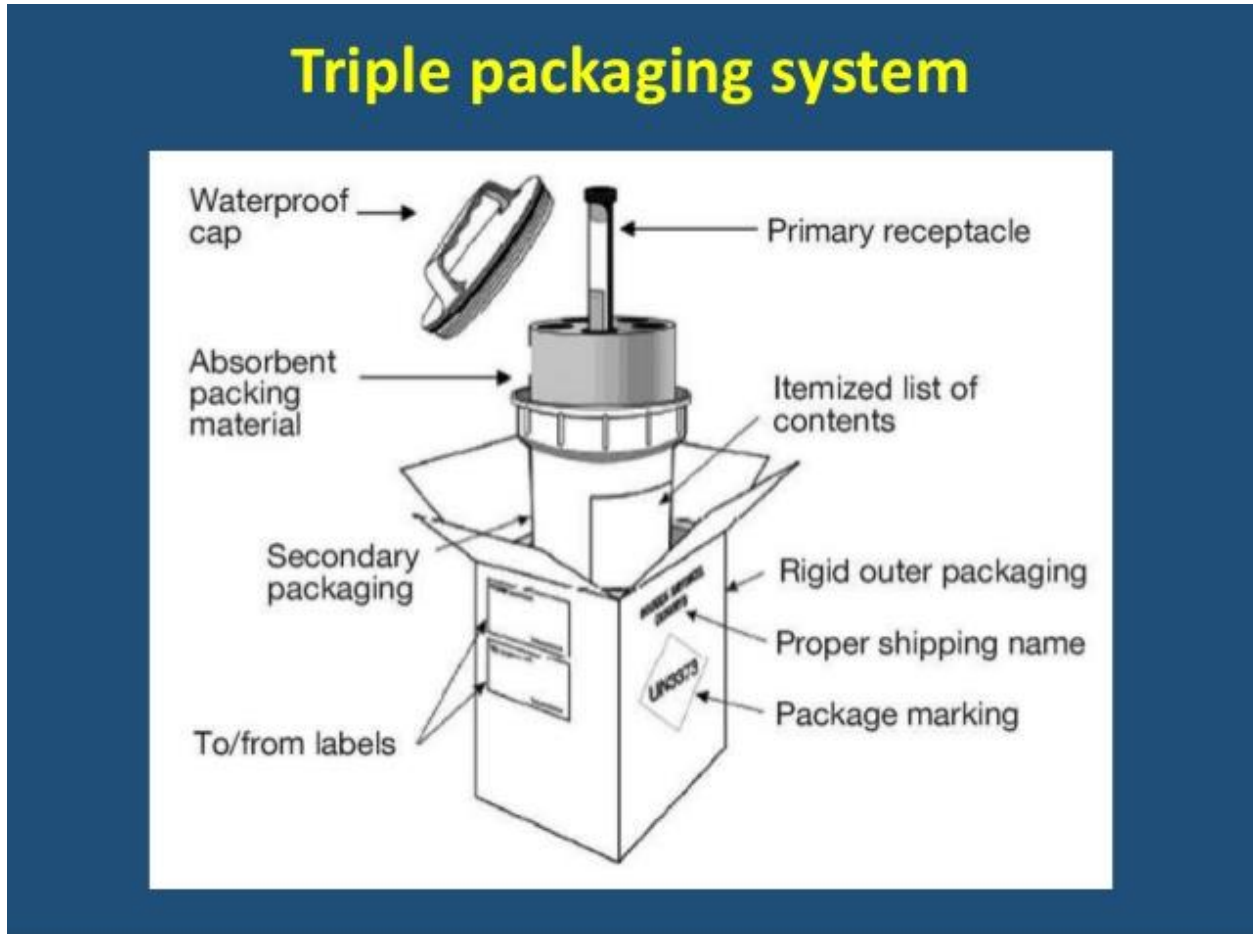
References

1. Ministry of Health Ghana. Technical guidelines Integrated disease Surveillance and Response Ghana. 2011;2nd edition.
2. Centre for Disease Control, Prevention. Principles of Epidemiology in Public Health Practice. 2012;(May). <https://www.cdc.gov/csels/dsepd/ss1978/index.html>
3. Alexander L, Mejia GC. Embarking on an Outbreak Investigation. 1(3):1–5.
4. Hashmey R, Genta RM, White AC. Parasites and diarrhea. I: Protozoans and diarrhea. J Travel Med. 1997;4(1):17–31.
5. Kirk MD, Fullerton KE, Hall GV, Gregory J, Stafford R, Veitch MG, et al. Surveillance for Outbreaks of Gastroenteritis in Long-Term Care Facilities, Australia, 2002–2008. Clin Infect Dis [Internet]. 2010;51(8):907–14. Available from: <https://academic.oup.com/cid/article-lookup/doi/10.1086/656406>
6. World Health Organisation. Biorisk management Laboratory biosecurity guidance Biorisk management Laboratory biosecurity guidance. 2006;(September). https://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006_6.pdf
7. Barbé B, Verdonck K, Mukendi D, Lejon V, Lilo Kalo JR, Alirol E, et al. The art of writing and implementing standard operating procedures (SOPs) for laboratories in low-resource settings: review of guidelines and best practices. *PLoS neglected tropical diseases*. 2016;10(11), e0005053.
8. World Health Organisation. Guidance on regulations for the Transport of Infectious Substances the Transport of Infectious Substances. 2008;(January 2007):13–6. https://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2007_2cc.pdf
9. Reintjes R, & Zanuzdana A.. Outbreak Investigations. *Modern Infectious Disease Epidemiology: Concepts, Methods, Mathematical Models, and Public Health*, 2009; 159–176. https://doi.org/10.1007/978-0-387-93835-6_9
10. Torok M. Epidemic Curves Ahead. Focus on Field Epidemiology. 1(5):1–6.

Appendix

Appendix 1:

Figure 1: Example of the triple packaging system for the packing and labelling of Category B infectious substances



Source: IATA, Montreal, Canada, adopted from WHO; Guidance on regulations for the Transport of infectious Substances 2007-200