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CASE 3

Ciguatera Fish Poison: An Emerging Risk Associated with Climate Change?

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"I have never felt so sick in my life. It's like all my energy is gone and all I can do is lay in bed, sweating, nauseous ... We are all down. We are all poisoned."

– Crew from MV El Faro

BACKGROUND

Dr. Turner¹, the Chief Medical Officer of Health for the Bahamas, received a phone call from an unknown and long distance phone number. It was Ms. Gagnon from the Public Health Agency of Canada (PHAC). "We have 14 very sick seamen here. The whole crew of the MV El Faro has been admitted to hospital. Several are in dire states of dehydration. Their last port of call was Nassau. This is why I am calling you."

"You know, Ms. Gagnon, sailors are famous for misbehaving. Perhaps they are just exhausted from their shore leave – maybe too much sun?"

"Doctor, I assure you that we have one of the best outbreak forensic teams along the Atlantic coast. This is not a trivial matter. We've eliminated contaminated food in the galley and poor refrigeration that might lead to scombroid poisoning. It's also not gastrointestinal such as *Campylobacter jejuni* or *Vibrio parahaemolyticus* – no evidence in their stool samples. But they all ate fish that they claimed to have caught in Nassau. Within 24 hours they were all feeling bad – with sweating, chills, and a stiff neck – and several were confined to sick bay within 48 hours. The odd thing was that their hosts weren't sick – or at least not that we know."

Dr. Turner was now more interested and contributed, "I bet they were down at Haywire Cove – it's near the marine park. The coral fish are easy to catch and are big." Together, they agreed it was Ciguatera Fish Poisoning in one of Canada's provincial ports.

Ms. Gagnon was nervous. These occurrences were rare in Canada, but PHAC was concerned about having cases of imported Ciguatera Fish Poisoning (CFP) and also wanted to assess whether this was a concern for their citizens going to the Bahamas, as well as other Caribbean countries. "This isn't a Canadian issue, Dr. Turner. This is a Bahamian issue. We need to keep our citizens safe from this fish poison, whether that's through fish imports or as tourists to your country."

¹All names have been altered but represent real individuals in real situations.

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The conversation ended. The issue was now Dr. Turner's to handle. While this was a rare incident in Canada, CFP seemed to be on the rise in the Bahamas. While it was not a home-grown problem in Canada, that was not the case in the Bahamas. Still, it was PHAC's responsibility to report the occurrence to the country that was the source as per the 2005 International Health Regulations (IHRs). But now that it was brought to Dr. Turner's attention, what really could be done? While Dr. Turner knew of Ciguatera Fish Poisoning, he was unaware of the complex intricacies linked to the rising incidence of CFP. The name "Ciguatera" was popping up everywhere now. Was this a new environmental problem? Why have we not had this problem before? He knew little about how it would affect his country and his people. Was it a tourism issue? An exportation and trade issue? Was it a health problem or an environmental problem? Should he be coordinating with the Ministry of the Environment and Housing and Ministry of Tourism? Dr. Turner realized that an integrative, collaborative, and holistic approach was necessary in order to combat this issue and that working towards a solution was going to involve more than just him and his team.

CIGUATERA FISH POISON – THE PROBLEM AND SYMPTOMS

Ciguatera is a foodborne illness that is caused by eating reef fish contaminated with a toxin called "ciguatoxin" (Goater, Derne, & Weinstein, 2011; Llewellyn, Tester, & Hallegraef, 2013; Epelboin et al., 2014; Mattei et al., 2014; Muecke et al., 2015). Ciguatoxin is colourless, odourless, and tasteless. The toxin cannot be destroyed by cooking, smoking, freezing, canning, salting, or drying (Goater et al., 2011; Llewellyn et al., 2013). The poison is produced by small organisms (dinoflagellates) that attach to sea grasses and corals growing in warm ocean reef areas. Small plant-eating fish ingest these toxic algae and are then eaten by larger predatory fish, which are in turn consumed by humans. Symptoms of CFP can occur quickly, but the first symptoms are usually gastrointestinal. Within 24 hours patients develop nausea, vomiting, abdominal pain and diarrhoea, which is followed later by neurological symptoms such as dizziness, weakness, and numbness. Cardiovascular symptoms such as low blood pressure and heart rhythm abnormalities appear at a later stage. (Government of Canada, 2016; Donati, 2006). Although there is no specific treatment, hospitalization may be required for intravenous rehydration, cardiac monitoring, and the treatment of complications. Recent research has suggested that climate change could increase the burden of CFP by expanding the range of suitable warm water habitats (Tester et al., 2010b; Gingold, Strickland, & Hess, 2014).

Contaminated seafood is a concern among many nations in the world that depend on the sea for protein. In Canada, the Canadian Food Inspection Agency is mandated to assess the likelihood of the most common forms of contamination – usually bacterial contamination of poorly maintained or processed product. CFP differs from the usual food safety risk as the toxin/poison is integral to the fish tissue, does not affect the health of the fish, and becomes a foodborne illness on consumption of reef fish that are contaminated with a neurotoxin (Goater et al., 2011; Llewellyn et al., 2013; Epelboin et al., 2014; Mattei et al., 2014). While CFP has not historically been a Canadian issue, it is endemic to areas such as the Pacific and Indian Oceans as well as the Caribbean (Goater et al., 2011), areas that the global Canadian traveller commonly visit.

CFP has been estimated to affect between 250-500 thousand individuals globally every year – exclusively in tropical regions. Two global hot-spots are the central South Pacific Island nations (such as Kiribati, Samoa, and Cook Islands) and the islands of the Caribbean (Jamaica, Virgin Islands, etc.). However, global numbers are most likely grossly underestimated due to under-reporting and misdiagnosis (Goater et al., 2011; Llewellyn et al., 2013; Mattei et al., 2014). Presently, CFP cannot be confirmed through a laboratory diagnostic test in humans (Llewellyn

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et al., 2013). If food specimens are available, they can be collected and tested for presence of ciguatera toxin and, if positive, confirm the diagnosis.

Historical Changes in Ciguatera

The study of CFP is far more complex than most seafood safety problems. To comprehend the challenges posed by CFP, historical trends, changes in affluence (tourism and travel), social economics (attracting tourists into marine protected areas, the restriction of subsistence fishing), and environment (water quality, climate change, and over-fishing) must all be understood. Thus, an integrated public health approach is required to assess CFP occurrences.

CFP has been known to be part of Bahamian waters for centuries (Caribbean Epidemiology Centre [CAREC], 2010). Ship logs from the 1600's often reported symptoms when the sailors were fed barracuda – one of the top, older living predators of coral reefs. The first register of CFP was started in 1995 and indicated about 20-30 cases per year. Recent reports for 2010-2015 average approximately 170 cases per year. The incidence rate is about six cases per 10,000. It is generally understood that the reporting rate is very low (< 10%) indicating that there are likely over 1,000 cases per year in the Bahaman islands.

While it is largely unknown what causes an increase in CFP cases, researchers have suggested that the increase in global seafood trade, enhanced local fishing, and increased tourism place human consumers in the direct path of exposure, leading to a higher probability of an encounter with CFP-laden fish (Llewellyn et al., 2013). Additionally, there is ample evidence that the probability and intensity of CFP toxin production have also increased in many coastal reserves as ocean temperatures increase. Between 2002 and 2007, there was a notable increase in the Caribbean sea's temperature between 0.4°C-0.8°C, which coincided with a six-fold increase in reported CFP cases (Tester et al., 2010b). This seems like a small change in temperature, but it extends the range of coral fish in the Caribbean substantially north. The further north the range goes the closer to the Gulf Stream. The Gulf Stream could cause the cells that make the toxin to move into Florida and up the Atlantic seaboard to North Carolina. Here, the Cape Hatteras extension of the State of North Carolina will push the water away from North America – protecting the coastal communities of Washington, D.C., New York, and Boston.

For the Bahamian people, fish is a significant component of their diet. Local fishermen appear to be much more knowledgeable and tend to apply traditional knowledge and practice when fishing to provide for themselves and their families (Tester et al., 2010a). These traditional practices vary from merely catching and ingesting smaller fish, fish species that do not notably contain CFP, and in some areas, feeding the caught fish to their pets to see if they get sick post ingestion (Copeland, Palmer, & Bienfang, 2014; Friedman et al., 2008). Challenges arise when non-local fishermen such as refugees begin fishing in the area and contract CFP. Non-locals may be unaware of CFP and the species that can cause outbreaks, consequently catching and ingesting the larger and slower species such as grouper and snapper, with no knowledge of the symptoms of CFP.

THE BAHAMAS

Background

The Commonwealth of the Bahamas is an English-speaking cluster of islands in the Caribbean region, with a population of approximately 347,000 (WHO, 2013). After gaining its independence in 1973 from the British Government, the Bahamas became a sovereign state and a member of the United Nations (“The Bahamas”, 2015). It has become one of the wealthiest nations of the Caribbean, with tourism being their main industry and contributing approximately 50% to the

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total Gross Domestic Product (GDP). While incomes have increased steadily, wealth distribution remains widely disparate (Pan American Health Organization [PAHO], 2012).

Approximately 20% of the Bahamian population are documented and undocumented Haitian immigrants (PAHO, 2012), which contributes to wealth disparity. This Haitian population experiences an unemployment rate of 28.6% compared to the regular 14.2% nationally (PAHO, 2012).

Government and Political Context

Similar to Canada, the Bahamas is a commonwealth country and has adopted a parliamentary democracy, governed by a Prime Minister, Cabinet, Parliament, and a Governor General (The Government of the Bahamas, 2011). Individual islands are administered by elected district councils (PAHO, 2012). Due to their convenient location, close to Florida, the Bahamas is a staging ground for drug and illegal immigrant smuggling into the U.S. Consequently, this has resulted in a great deal of corruption within all levels of government (Economic Freedom – The Bahamas, 2015).

Employment Industries

Currently, the Tourism and Travel industry supports over 108 thousand jobs, both directly and indirectly (World Travel and Tourism Council [WTTC], 2014). There are approximately 1.5 million international tourists to the Bahamas every year.

Health and Health Services

Health services in the Bahamas are available through both private and public sectors, with health sector service areas provided by the Ministry of Health, Department of Public Health, Public Hospitals Authority, and the private sector. Public services are financed primarily through taxation while other services can be financed through both out-of-pocket payments and private insurance (PAHO, 2012).

Bahamas Island Health Indicators	
Total population (2011) ¹	347,000
% Population under 15 (2011) ¹	22
Population distribution % urban (2011) ¹	84
Life expectancy at birth (2011) ¹	
Total	75
Male	72
Female	78
Infant mortality rate per 1000 live births (2011) ¹	14
Maternal mortality ratio per 100 000 live births (2010) ¹	47
Total expenditure on health as % of GDP (2010) ¹	7.5
General government expenditure on health as % of total government expenditure (2011) ¹	15.2

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Bahamas Island Health Indicators	
Total poverty rate % (2012) ²	9.3
Total unemployment rate % (2012) ²	14.2

Sources: World Health Organization, 2013¹; PAHO, 2012²

Locals and non-locals can receive medical services from both public and private clinics and hospitals; however, the government-sponsored clinics provide the majority of the medical care (PAHO, 2012). Despite this, one-third of the population purchases private insurance. While the poorest citizens report insufficient time and cost as the main barriers to receiving health care services, they also report the highest rates of receiving social welfare assistance (PAHO, 2012). The Haitian refugee population has experienced a greater burden of disease and accounts for a longer average stay within the public hospitals (PAHO, 2012). The most common causes of mortality are chronic non-communicable diseases, such as hypertensive and ischemic heart diseases, closely followed by HIV/AIDs.

Public school health services ensure immunization coverage rates that are on average 97% for all vaccine-preventable diseases (PAHO, 2012).

INTERNATIONAL HEALTH REGULATIONS

With the increase of globalization, there is a much greater opportunity for illnesses to spread and emerge in areas where they were previously non-existent. A crucial role of the World Health Organization (WHO) is the management and control of the international spread of diseases (WHO, 2005). The World Health Assembly – which is comprised of WHO member states – adopted the International Health Regulations (IHRs) in 1969 to ensure the prevention and control of diseases (WHO, 2005).

The purpose of the IHRs is “to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade” (WHO, 2005, pg. 1). The IHRs – which are considered legally binding documents – have specific requirements and responsibilities for each Member State to uphold (WHO, 2005).

As an emerging issue, associated with climate change, the routes of impact are not fully realized. Tourists contracting CFP or industry bringing contaminated fish into Canada could cause a serious outbreak that might not be identified, reported, properly treated, or contained, especially since it is not a well-known illness in the region.

SURVEILLANCE AND REPORTING

Surveillance of emerging diseases is a crucial component of increasing capacity for prevention and control of communicable diseases – as is the surveillance of “upstream” disease reservoirs. Ecological surveillance also provides the opportunity for more accurate and realistic incidence levels and morbidity, estimation of health impacts, and earlier notification of illness (Todd, 2006). Surveillance would also aid in identifying regions of concern or heightened transmission, which would be useful for CFP monitoring.

In regards to CFP, there is no surveillance system in place nor is it a nationally notifiable disease in Canada, the United States of America, or The Caribbean Public Health Agency

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(CARPHA). While all regions are capable of conducting surveillance, monitoring, and ensuring reportability, currently nothing is being done or has ever been done. Surveillance for CFP not only could include increasing diagnosis and reporting of the illness, but also monitoring aspects known to contribute to the increase of CFP cases. This could include measuring the ocean temperature, monitoring known affected reefs, and testing different species of fish to identify those that are contaminated with CFP.

CFP affects a large number of tourists, which decreases the accuracy of reporting and surveillance systems. Tourists are more likely to return to their home country and see their primary physician, and CFP may go unreported as their doctors may be unfamiliar with CFP.

TOURISM AS A PUBLIC HEALTH ISSUE

With 1.5 million tourists every year, and that number estimated to double within the next ten years, the effects of tourism in the Bahamas can be both beneficial and detrimental.

Tourism contributes to the economy, development, and sustainability of the Bahamas. Without this incredibly large industry, the Bahamas would not be one of the richest and most developed countries in the Caribbean, as it is today. Tourism has provided a large number of jobs, consequently decreasing unemployment rates for the Bahamian population. It has also allowed for an increase in the minimum wage and annual salaries.

The tourism industry sells the idea of the “Four S’s” – sea, sun, sand, and sex (Rodriguez-Garcia, 2001). The Four S’s have been highlighted to encourage tourism in developing countries in order to create an opportunity for new industries and development. However, the Four S’s are accompanied by behaviours damaging to the health of both travellers and locals. Seas are being polluted through the abuse of boats, due to fishing and recreational sports, with sewage encouraging infectious diseases. Additionally, activities such as scuba diving and snorkelling disturb natural reefs and fish habitats. Over-exposure to sun leads to an increase in skin cancer, as well as sunburn and heat exhaustion. Behaviours such as over-use of alcohol and drugs can encourage unsafe sexual practices and domestic abuse, amongst tourists and locals. As it is, HIV rates are relatively high within the Bahamas, due to tourism and local practices.

LOCAL HEALTH IMPLICATIONS OF CFP

While local fishermen may be more aware of CFP and may use traditional knowledge to prevent contraction, a large number of the population is unaware of CFP prevention methods and treatment. They, like many tourists and members of other countries, assume it is merely food poisoning and will not seek medical care. The barriers preventing many citizens from receiving care also adds to the under-reporting of CFP.

To ensure that a large number of tourists do not contract CFP, hotels and restaurants are paying great attention to the size, species, and origin of the fish they purchase. This has led to fishermen providing the best fish to their purchasers, and whatever is left over goes to local markets and their own use.

WHO IS RESPONSIBLE FOR CFP?

CFP is a complex disease that depends on several different factors. There are international, federal, and municipal components that all contribute to both the control and spread of CFP. WHO has valuable rules and regulations dictating how to control the spread of CFP and has made recommendations on how to prevent the ecological incubators that harbour CFP.

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After much deliberation and research, Dr. Turner called together the Minister of the Environment and Housing, Minister of Finance, Minister of Tourism, and Minister of Health to discuss this current and pressing issue. Since CFP is affected by multiple factors, such as tourism and the environment, he decided it was crucial to have these parties involved in any decision making.

Each member stated their priorities and interests related to this problem, identifying common issues. Dr. Turner questioned what information was actually available for common use in regards to CFP. The group searched online to see what information existed, and noticed that everything available was merely for tourists coming from first world developed countries. While important, it left the members questioning how their own people were protecting themselves and what their government was doing to protect them. While obvious issues associated with CFP were identified, what were they missing, to what extent was this an emerging issue, and how could they work to control and prevent it?

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INSTRUCTOR GUIDANCE

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BACKGROUND

This case takes place in the Bahamas and surrounds a complex toxic illness, Ciguatera Fish Poisoning (CFP). It discusses how CFP is contracted and where it is most common, as well as prevention and diagnosis methods. It then goes into the context of the Bahamas, setting the stage in terms of health care, health of the population, government, and various employment industries. Due to its location in the Caribbean, the Bahamas has a large number of tourists each year contributing to the number of CFP cases, as well as affecting the local populations in a variety of ways. This case analyzes an environmental health issue, tourism, and social determinants of health.

OBJECTIVES

1. To consider the social, economic, and public health consequences of a complex toxic illness. CFP is a complex toxic illness with environmental, social, and community health implications. An objective of this case is to encourage students to identify solutions that are outside the normal public health sphere of influence.
2. To identify how climate change may contribute to emerging issues of public health concern. CFP represents a problem where systems thinking is required for both understanding the problem and finding a solution. Therefore, an objective of this case is to provide an opportunity for students to learn the intricacies of multiple systems working together to find a solution.
3. To introduce the concept of “decision making in a world of uncertainty”. Most of these terms would be new to Master of Public Health students (a great reminder that MPH is a path, not a destination).

DISCUSSION QUESTIONS

1. Who are the different stakeholders involved in this issue?
2. What could each department/stakeholder contribute or suggest to mitigate this issue?
3. Looking at the entire picture, what are the first steps to be taken to improve the situation?
4. How could tourism be involved to decrease the rates of CFP?
5. What could be done to improve surveillance and reporting, as well as proper diagnosis?
6. Create an influence diagram to show influencing factors and negative effects of CFP.

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KEYWORDS

Environmental health; food borne illness; social determinants of health; eco-health; climate change; stakeholders; developing country; surveillance; reporting.