Outbreak of Ciguatera Fish Poisoning on a Cargo Ship in the Port of Hamburg

Clara Schlaich, MD, MPH,* Jan-Gerd Hagelstein, MD,† Gerd-Dieter Burchard, MD,‡ and Stefan Schmiedel, MD‡

*Hamburg Port Health Center, Institute for Occupational and Maritime Medicine, University Medical Center Hamburg-Eppendorf, Hamburg, Germany; †Port Medical Practice, Krankenhaus Wilhelmsburg, Hamburg, Germany; ‡Bernhard Nocht-Institut, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

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Background. Ciguatera fish poisoning is a travel-related illness characterized by a combination of gastrointestinal and neurological symptoms in persons who eat ciguatoxic seafood in endemic areas.

Methods. In 2009, an outbreak of the disease on a refrigerator vessel in the port of Hamburg was investigated. The ship’s crew fell ill after they ate fish from a catch in the Caribbean 2 weeks earlier. All 15 sailors on board were examined by port medical officers. Samples of blood and stool specimens were taken from symptomatic sailors. The frozen fish was secured for the prevention of further disease spreading and additional diagnostic tests.

Results. All but one sailor ate the fish. The intoxication resulted in gastrointestinal or neurological symptoms in all 14 sailors who consumed the fish and persisted in varying degrees in 93% of sailors over at least 14 days. No fatality occurred, but two seamen were “unfit for duty” on the ship due to severity of symptoms. The diagnosis was supported by the fact that all seafarers who consumed the same reef fish, experienced typical signs, symptoms, and time course consistent with ciguatera fish poisoning. The fish from the catch in the Caribbean was identified as *Caranx sexfasciatus* (Bigeye Trevally) and *Cephalopholis miniata* (Red Grouper). An experimental assay later confirmed presence of the ciguatoxin in the fish.

Conclusions. Sailors are an occupational group at risk for ciguatera fish poisoning due to potentially unsafe food sources during international travel. Even if no fatality occurred, the disease affected marine operations due to high attack rates and chronicity of symptoms. Medical doctors must be aware that ciguatera fish poisoning is a risk for seafarers traveling in tropical and subtropical areas. Stocking of food in affected ports from safe sources, adequate training of ship cooks, and informing sailors about the risk of fishing are needed to prevent disease occurrence in seafarers in international trade and traffic.

Ciguatera fish poisoning is an illness characterized by a combination of gastrointestinal, neurological, and neuropsychiatric symptoms in people who eat seafood that contains the naturally occurring ciguatoxins. Most of the reported cases are related to the consumption of large reef fish in travelers to tropical and subtropical areas and to inhabitants of endemic areas. The global incidence of the disease was estimated to affect annually between 10,000 and 50,000 individuals; however, the accurate epidemiology is difficult to assess since reporting is a requirement in only a few countries.¹,²

This article summarizes the investigation results in an outbreak on board a cargo ship under Bahamian flag that was docked in the Port of Hamburg in Germany for repair work.

Methods

All 15 sailors on board were examined by an outbreak evaluation team of three persons, including the medical officer on duty from the Hamburg Port Health Center on July 21, 2009. A ship inspection was performed to assess the sanitary condition of the ship. The standard clinical report form of the competent authority was utilized to document signs and symptoms of sick seafarers. Samples of blood and stool specimens were taken from symptomatic sailors that agreed to the laboratory testing. The frozen fish from the catch in the Caribbean was identified as *Caranx sexfasciatus* (Bigeye Trevally) and *Cephalopholis miniata* (Red Grouper). An experimental assay later confirmed presence of the ciguatoxin in the fish.
The reference laboratory for the Monitoring of Marine Biotoxins at the Federal Institute for Risk Assessment in Berlin was consulted and performed an experimental assay to detect traces of ciguatoxin in the fish. Identification of the suspicious fish was done by the specialists of the Tropen-Aquarium Hagenbeck in Hamburg.

**Results**

**Clinical Case Report**

The refrigerator vessel was returning from South America. Two weeks before arrival in Hamburg, the crew fished in the Caribbean near the Sombrero Island where the ship was laid up several weeks. All but one sailor participated in the fish barbecue that took place during lunch and dinner on the same day. When the vessel reached the port of Hamburg, three sailors sought medical care in a port clinic for neurological and gastrointestinal symptoms. The physician suspected ciguatera fish poisoning on grounds of the clinical picture (Table 1) and notified the port health authority for further measures.

Clinical interviews were conducted with the entire crew of 15 Philippine male sailors (mean age: 44 years; range 37–56). This included the ship’s cook, officers, and the shipmaster. Blood samples were taken from nine, and stool samples were received from six persons for further diagnostic tests.

Nine sailors had eaten two or more servings from the catch of fish, and five persons had one serving only. The one person who did not eat any fish remained free of symptoms. Most (86%, 12/14) sailors that consumed the fish experienced both gastrointestinal and neurological symptoms in varying severity. Two sailors developed neurological or gastrointestinal symptoms only. Gastrointestinal symptoms preceded neurological symptoms in most cases. In two sailors, only neurological symptoms were the first signs of the intoxication. Muscle and joint pain, weakness, and pruritis remained the only complaints in one person who only ate a small amount of fish. Within 6 hours to 3 days after the ingestion of fish, the seafarers experienced abdominal cramps (50%, 7/14), watery non-bloody diarrhea (71%, 10/14), nausea (29%, 4/14), or vomiting (29%, 4/14). Neurological symptoms started 6 hours to 3 days after the fish ingestion. Most common symptoms were muscle cramps, joint pains, aching of hand and feet, general weakness, fatigue, or mood changes (79%, 11/14). One person described troubles with falling asleep. Perioral and limb numbness was experienced in 50% (7/14) of sailors, pruritis in 43% (6/14), and temperature sensation reversal in 21% (3/14). In two persons (14%), problems with urinating occurred.

Fourteen days after the ingestion of the suspect fish, gastrointestinal symptoms still persisted in 71% (10/14) and neurological symptoms in 93% (13/14) of seafarers. All persons described a fluctuating course of their complaints with episodes of well being that were independent from their work load or the time of day. Intensity of symptoms correlated with the amount of fish consumed. Only in one sailor, symptoms had ceased by the time of the investigation.

Results of stool cultures were negative in all (6/6) samples from symptomatic sailors for relevant pathogens of infectious gastrointestinal disease. C-reactive protein, creatinine, and potassium levels were within normal range in all (9/9) blood samples. Creatine kinase as a marker of muscle damage was

<table>
<thead>
<tr>
<th>Number of fish servings on July 8, 2009</th>
<th>Number of sailors (age range in years)</th>
<th>Gastrointestinal symptoms</th>
<th>Neurological symptoms</th>
<th>Symptoms on July 21, 2009 (2 wk after fish meal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1 (39 y)</td>
<td>No symptoms</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>One meal</td>
<td>5 (40–56 y)</td>
<td>6 h to 1 d</td>
<td>6 h to 3 d</td>
<td>Any gastrointestinal symptom 2/5</td>
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<tr>
<td></td>
<td></td>
<td>Abdominal cramps 2/5</td>
<td>Myalgia/arthralgia/muscle cramps 4/5</td>
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<td></td>
<td></td>
<td>Watery diarrhea 2/5</td>
<td>Fatigue/weakness/mood changes 2/5</td>
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<tr>
<td></td>
<td></td>
<td>Nausea 2/5</td>
<td>Sleeping disorders 0/5</td>
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<td></td>
<td></td>
<td>Vomiting 0/5</td>
<td>Circumoral or extremity paraesthesia 1/5</td>
<td></td>
</tr>
<tr>
<td>Two or more meals</td>
<td>9 (32–49 y)</td>
<td>−6 h to 3 d</td>
<td>Pruritis 2/5</td>
<td>Any neurological symptom 4/5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abdominal cramps 5/9</td>
<td>Alteration of hot/cold perception 1/5</td>
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<tr>
<td></td>
<td></td>
<td>Watery diarrhea 8/9</td>
<td>12 h to 5 d</td>
<td>Any gastrointestinal symptom 8/9</td>
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<td></td>
<td></td>
<td>Nausea 2/9</td>
<td>Myalgia/arthralgia/muscle cramps 7/9</td>
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<td>Vomiting 4/9</td>
<td>Fatigue/weakness/mood changes 9/9</td>
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<td>Sleeping disorders 1/9</td>
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<td>Alteration of hot/cold perception 2/9</td>
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</tbody>
</table>
Identification of Suspect Fish
The suspect fish was identified as *Caranx sexfasciatus*, common name “Bigeye Trevally,” and *Cephalopholis miniata*, common name “Red Grouper” (Figure 1). The microbiological tests of the fish remained negative for relevant pathogens but tested positive for ciguatoxin.

Clinical Management
The medical officers from the Hamburg Port Health Center informed the crew on the presumptive cause and the natural course of the disease. Further dietary advice was given to prevent worsening of symptoms (such as avoidance of alcohol). Information leaflets were handed to the crew for written advice. The frozen fish from the catch in the Caribbean was removed to prevent further toxin consumption. Since vitamin B and calcium supplements were supplied to the ship for symptomatic treatment of muscle cramps and neurological symptoms, the request for a prescription of sedatives for the sleeping problems was denied because of ship's safety concerns. Two seamen were considered “unfit for duty” due to severity of symptoms and repatriated by the ship owners. All other sailors remained on the vessel. The further course of the disease in the crew is unknown since the ship left the port of Hamburg shortly after the investigation.

Discussion
Seafaring is an occupational activity for which outbreaks of ciguatera fish poisoning have repeatedly been described during the last decades. The disease is characterized by the combination of acute gastrointestinal symptoms, neurological, neuropsychiatric, and rarely cardiac symptoms developing 3 to 24 hours after ingestion of large reef fish. While gastrointestinal symptoms occur earlier in the course of the disease, it is often the peculiarity of the neurological symptoms, such as perioral numbness, itching, limb paresthesia, or warm cold reversal that catch the physician’s attention toward the diagnosis of ciguatera fish poisoning. In our case report, it was the local port physician who suspected the disease in two sailors that were sent to his office by the ship’s agent. He promptly alerted the port health officer for further evaluation and preventative measures being aware that the toxins do not produce immunity but do accumulate, thus remnants of the poisonous fish might produce further disease.

Confirmation of ciguatoxin in fish by appropriate laboratory diagnosis is not available as a routine test in most parts of the world. At present, therefore, ciguatera fish poisoning diagnosis is based on the presentation of typical symptoms and time course, the history of having eaten a reef fish in a “ciguatera belt” region like the Caribbean, and the exclusion of other diagnoses that could account for the symptoms. Ciguatera fish poisoning has symptoms in common with paralytic and neurotoxic shellfish poisonings, scombroid and pufferfish toxicity, botulism, bacteremia, and several neurologic conditions. In our case the diagnosis was strongly supported by the fact that multiple seafarers from a single ship that consumed the same fish, all experienced typical signs, symptoms, and time course consistent with ciguatera fish poisoning.

Ciguatoxins are known as highly potent natural substances that cause symptoms even in low doses. In our case study, we observed a relationship between severity of symptoms and amount of fish ingested. Owing to the preparation of food from a common source on ships, attack rates in crews are high. In a Norwegian cargo ship 85% of crew members got sick. In a port in the UK, half of the crew (14 people) on a Colombian ship ate white snapper in the Caribbean; as a result, all persons got sick with gastrointestinal symptoms and most with neurological symptoms.
In our case report from Hamburg, all 14 sailors that ate from the fish got sick. A varying degree of symptoms persisted for at least 2 weeks after the ciguatoxic fish meal in all but 1 affected sailors. While most authors describe the vanishing of symptoms after 1 to 4 days, others emphasize that neurological and neuropsychiatric symptoms may persist for years. On grounds of this uncertainty, the repatriation of the two most severely affected sailors was supported by the port medical officer (C. S.) for medical reasons.

Published data on the case fatality rate of the disease vary between <0.1 and 7%. Even if no fatality occurs, the disease may pose a threat to the ship’s operations and safety due to the neurological and neuropsychiatric symptoms that are associated with the intoxication. Hallucinations, giddiness, depression, or sleeping problems may potentially affect the function, vigilance, and judgment of the seafarers on duty. Costs to the ship operator may derive from diagnostic test and treatment. Even higher financial losses are to be expected with a deviation of the ship’s itinerary and repatriation of seafarers that are “unfit for duty.”

As seen in this case report, the well-being and workability of seafarers was affected not only by the somatic complaints but also by the anxieties and preconceptions that the symptoms caused throughout the crew. This is despite the fact that the disease is long known to seafaring and well described in the World Health Organization’s International Medical Guide for Ships, 3rd ed.

The appropriate treatment for ciguatera fish poisoning remains unclear. An antidote is not available. Several treatment efforts described in single patients or small numbers of patients seem to indicate some success in ameliorating the symptoms. Intravenous Mannitol is the most studied therapy for ciguatera fish poisoning (0.5 to 1.0 g/kg body weight over 30–45 min within 48–72 h after the ingestion of toxic fish). The effectiveness of Mannitol was not proven in randomized trials. Intravenous Mannitol treatment rarely is an option in seafaring: The drug is commonly not available on merchant ships to provide timely treatment. As in the Hamburg outbreak most sailors seek clinical care only after returning to their home country or when the next port of call is reached. Since timely diagnosis and treatment often is not available to sick seafarers, prevention of the disease is of outmost importance.

Control measures to prevent further disease on board were: securing the diagnosis, counseling of the seafarers on the natural cause of the disease, and the identification and destruction of the ciguatoxic fish that was stored in plenty in the freezer stores.

There is no legal obligation for the ship operator to employ trained cooks on ships. In the experience of the authors (C. S.), there often is a lack of proper training in hygiene and food safety in crew. In this particular case, the cook resisted the liquidation of the frozen fish that looked perfectly fresh to him, not being aware that the ciguatera toxin is tasteless, colorless, odorless, and not destroyed by either cooking, freezing, salting, pickling, or canning of any sort. The port health officer by his legal power needed to identify and destroy the toxic fish to control a potential threat to the crew and the public health. The series of published case reports on outbreaks of ciguatera fish poisoning in seafarers that caught and consumed fish in at-risk areas while en route points to the necessity to improve the training of ship cooks but also educate the sailors on the risks of fishing in endemic areas to avoid food-borne disease on ships. Beside this, it is the responsibility of the ship management to avoid stocking fish from unsafe sources in the ports of the “ciguatera belt” region.

Conclusion

Sailors are an occupational group at risk for ciguatera fish poisoning due to potentially unsafe food sources during international travel. The potency of the toxin and the preparation of food from a common source result in high attack rates that may affect the ship operation and safety. Port doctors and health officers must be aware that ciguatera fish poisoning is a risk for seafarers traveling in tropical and subtropical areas. Stocking food from safe sources only, adequate training of ship cooks, and informing sailors about the risk of fishing in endemic areas are needed to prevent disease occurrence in seafarers in international traffic.

Acknowledgments

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Declaration of Interests

The authors state they have no conflicts of interest to declare.

References

Ciguatera fish poisoning is an illness observed in people who eat seafood that contains a class of poisonous organic compounds known as ciguatoxins. The ciguatera toxin is tasteless, colorless, odorless, and not destroyed by either cooking, freezing, canning, salting, pickling, or canning of any sort. Most of the reported cases are related to the consumption of large reef fish in travelers to tropical and subtropical areas, and to inhabitants of endemic areas. In this outbreak the suspect fish were identified as the bigeye trevally and the red grouper. In this case, seafarers caught the culprit fishes in risk areas (in the Caribbean) and consumed them later (after freezing them) while en route to Hamburg, Germany. *Photo credit: Eric Caumes (Setting: Havana Harbour, Cuba)*