BERIBERI OUTBREAK AMONG COMMERCIAL FISHERMEN, THAILAND 2005

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Abstract. In April 2005, The Tahi Bureau of Epidemiology investigated a reported outbreak of beriberi among commercial fishermen in Maha Chai, a port city in the Gulf of Thailand. The objective of this study was to verify the diagnosis of beriberi in affected individuals, describe the possible outbreak, ascertain risk factors, and provide prevention and control measures. We interviewed ill persons and treating doctors, and reviewed medical records to conduct a descriptive study. A probable case was defined as a crewmember of Ship A with one of the following: leg edema scrotal edema or ascites, dyspnea, chest discomfort, chest pain, extremity numbness, or extremity weakness. Confirmed cases were those with clinical criteria and laboratory findings consistent with thiamine deficiency. The outbreak started in early March, 2005 and continued until March 31, 2005. Ship A had 28 crewmembers (four Thai, 24 Myanmar). Overall, there were 15 probable cases (attack rate 53.6%, with three confirmed and 12 probable cases). Only three were tested for Vitamin B1 deficiency. All cases were male, with a median age of 28 years (range 20-45). Fourteen of the 15 cases were Myanmar and one Thai. Due to limited resources, the crew ate only seafood and polished rice for almost two months prior to symptoms. Symptoms included edema (60%), chest discomfort (54%), and dyspnea (27%). Two persons died while on board the ship (case fatality 13%). The total time at sea for Ship A was 18 months, including a five-month delay in docking due to licensing problems.

INTRODUCTION

Beriberi is caused by thiamine (vitamin B1) deficiency. In the past it was commonly found in many parts of Southeast Asia. Thiamine deficiency occurs where diets consist mainly of milled white cereal grains, including polished rice and wheat flour, which are very poor sources of thiamine. Thiamine deficiency can develop within two to three months, and clinical beriberi is associated with significant morbidity and mortality (WHO, 1999). With improved nutrition beriberi is no longer a common disease, but it has been noted over the last 20 years in isolated outbreaks in Israel, ethnic Karen refugee camps in Thailand, Cuba, Taiwan, West Africa, and Gambia (Tang *et al,* 1989; Macias-Matos *et al,* 1996; De Montmollin *et al,* 2002; Chen *et al,* 2003; Luxemzerger *et al,* 2003; Fattal-Valevski *et al,* 2005. Beriberi has also been found in some specific risk groups, such as alcoholics, pregnant women, and people engaged in heavy physical exertion (Songchitsomboon *et al,* 1993; Wilson, 1998; Betrosian *et al,* 2004).

Beriberi was first described in 1593

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among sailors on a ship traveling from England to Patagonia. Kanehiro Takaki, a surgeon in the Japanese Navy, was one of the first to point out beriberi's association with food intake. In 1882, a vessel returned to Japan from New Zealand with 25 of the crew dead from beriberi. Takaki added meat, vegetables, and dairy products to the sailors' diets. After a repeat voyage to New Zealand, a second vessel returned without a single death (James, 1985; Lonsdale, 2006).

In Thailand, clinical beriberi is rarely reported. However, nutritional surveys conducted in the last 12 years have found that biochemical evidence of thiamine deficiency is fairly common, with 49% of males living in northern Thailand surveyed in 1999 having abnormal thaimine-status level (thiamine pyrophosphate levels of >15%) (Department of Health, 2003). One reported outbreak of infantile beriberi in Amnat Chareon Province, northeastern Thailand from June 2000-September 2001 found 22 beriberi cases, all associated with a history of exclusive breast feeding from mothers with low blood levels of thiamine (Cheungsamarn and Songchitsomboon, 2002). Studies conducted among Karen refugees in Thailand have documented both clinical and biochemical thiamine deficiency in pregnant and lactating women and clinical beriberi in infants (Dolan *et al,* 1993; Nosten *et al,* 1994 Luxemberger *et al,* 2001; McGready *et al,* 2001). Thiamine deficiency has been long recognized in these camps due to a combination of thiamine-poor foods, such as polished rice, and consumption of foods containing thiaminase, such as betel nut, fermented fish paste and tea leaves, and pregnant women now routinely receive thiamine supplementation (McGready *et al,* 2001) .

On April 6, 2005 the Bureau of Epidemiology, Thai Ministry of Public Health, was notified of a cluster of possible beriberi cases among the crew of an ocean going fishing vessel (Ship A) in Samut Sakhon Province. Twenty-four crew members presented to a private hospital on March 30 and 31, 2005, with generalized pitting edema and dyspnea. An investigation was done sent to confirm the diagnosis, verify the outbreak, and provide recommendations for prevention and control.

MATERIALS AND METHODS

Setting

The index cases were merchant seamen who had worked on a 200-ton oceangoing fishing vessel (Ship A) starting in October 2003. The vessel, which was registered in Thailand, had a crew of 28. It fished in Indopacific waters from the Gulf of Thailand to Australia. The Sriwichai 5 Hospital, which reported the cases, is located in Maha Chai, a major port city on the Gulf of Thailand.

Case definition

We defined a probable case of beriberi as illness occurring in a crew member of Ship A after October 2003, with had at least one of the following symptoms: leg edema scrotal edema or ascites, dyspnea, chest discomfort, chest pain, extremity numbness, or extremity weakness. Confirmed cases met the probable case definition and had at least one laboratory test indicative of thiamine deficiency [thiamine pyrophosphate effect (TPPE) >15% or erythrocyte transketolase activity (ETKA) <130 IU].

The captain of the ship brought all available crew members to the hospital for clinical examination on March 31, 2005.

Measurements

We interviewed cases regarding clinical signs and symptoms, job responsibilities, daily activities on the vessel and diet. We also reviewed available medical records. The largely Myanmar crew dispersed quickly after landing; we were only able to interview those cases who remained in Thailand.

Laboratory testing

Sera were collected from three subjects

and sent to the Research Center at Ramathibodi University Hospital to confirm thiamine deficiency. ETKA and TPPE were conducted using standard methods (Gradudel *et al,* 1985).

Data analysis

Data were entered on site into Excel, transferred to Microsoft Access and analyzed by frequency for time, place, and person using Epi Info Version 3.3 (CDC, Atlanta, Georgia).

RESULTS

Descriptive epidemiology

Ship A left Thailand in October 2003 and returned on March 30, 2005. There were 28 crew members (4 Thai, 24 Myanmar), all of whom were healthy men, with a median age of 27 years (range 19 to 45). The captain reported no illness among the crew before the current outbreak.

We interviewed three patients and examined medical records for 24. All crew members had difference work roles as seen in Table 1. Two patients died at sea from a condition consistent with beriberi before the ship arrived at port, and two did not report to the hospital for examination. Fifteen of the 28 men met our case definition of probable beriberi (attack rate 53.6%); the denominator includes two men who were not seen at the hospital but who were well according to the Captain. We classified 12 cases as probable and three as confirmed.

The median age of cases was 28 years (range 20 to 45). One of four (25%) Thai and 14 of 24 (53%) Myanmar sailors developed disease. Two cases died (case fatality rate, 13%). Case patients described a history of edema (60%), chest discomfort (54%), and dyspnea (27%). Of the 13 patients physically examined (excluding the two who had died at sea), all were hypertensive, nine had pitting edema, five had ascites, one had rales, and one had jugular venous distension. The three patients who were tested for thiamine deficiency had EKTA results ranging from 62.8 - 117.7 IU (normal range ≥130 IU) and TPPE results ranging from 28.1- 33.3% (normal range <15%). Electrolytes, blood urea nitrogen, creatinine, and serum albumin were all normal. Four of 12 patients whose urine was examined had hematuria, and five had proteinuria. Four patients had roentographic evidence of cardiomegaly and pulmonary congestion. The onset of the first case was in early March. This patient developed fulminant edema, chest pain, abdominal discomfort, dyspnea, and pink-tinged sputum; he died two days after the onset of symptoms. The second case developed the same symptoms six days after the first and died within two days. The other cases developed symptoms one

Table 1
Attack rate for beriberi, Ship A, by job description, Thailand, 2005.

Job position (N=28)	Job description	Sick/N	[a]AR (%)
Captain	Command	0/1	0
Helmsman	Steering the ship	0/1	0
Helmsman helper	Helping the steersman, and sometimes dragging the fishing net	2/3	67
Mechanic	Repairing the engines	1/1	100
Cook	Cooking 3-4 times a day, sometimes dragging the fishing net	1/1	100
Worker	Dragging the fishing net and sorting the fish.	11/21	52.4

[a]AR=attack rate

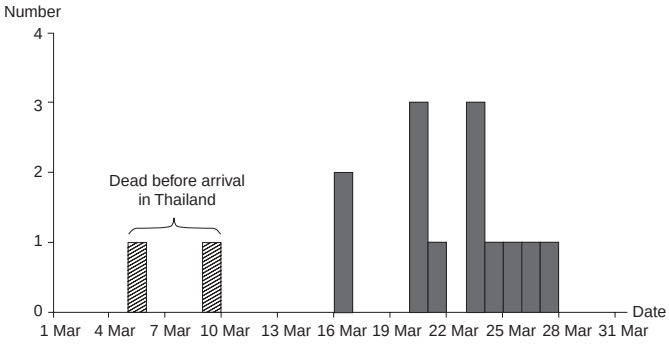

Fig 1–Beriberi cases (n=15) by date of onset, Ship A, Thailand, 2005.

week later (Fig 1). Three patients were hospitalized and dramatically improved within 24 hours after administration of intravenous thiamine. All others received vitamin B complex orally.

Dietary information

Some foods had been stocked before the ship departed from its last port of call, including white rice, mung bean, fermented fish, palm oil and pork. These stores were supplemented by purchase of pork and vegetables from passing ships about once every two months. All crew members ate the same food items three to four times daily, but the Thais cooked their food by themselves. All denied drinking alcohol on board the ship. First aid and some basic medicines, such as antipyretic drugs, were available, but there were no vitamin supplements.

About five months before returning to Thailand there was a problem with the ship's license and documentation, and it was not allowed to come into port. The seafarers had limited money to buy meat from the ship's stores, so they ate only fish that they were able to catch and white rice for the last two months of the voyage.

DISCUSSION

We were able to document a beriberi outbreak among fishermen who had a history of prolonged low thiamine intake. All of the cases were previously healthy young men. The clinical signs and symptoms suggested "wet" beriberi (Wilson, 1998), with substantial edema, chest discomfort, and dyspnea. We also found that the majority of the cases were Myanmar, possibly reflecting different work roles, levels of physical exertion, or prior dietary deficiency.

Thiamine is a heat labile, water-soluble vitamin, and body storage is minimal. In young and healthy non-alcoholic individuals, time to onset of deficiency symptoms varies from 18 days to three months after withdraw of thiamine from the diet (Ziporin *et al,* 1965; WHO, 1999). A 1996 Thai nutritional survey of construction and factory workers found that those workers had high rates of biochemical, but not clinical, thiamine deficiency (Department of Health, 2003). A food consumption and nutrition survey conducted in refugee camps along the Thai-Myanmar border during July to December 2003 found evidence of clinical and biochemical beriberi in all age groups (range 4.1 to 5.3/1,000 person) (ECHO, 2004). There are no available population-based data on the prevalence of either biochemical or clinical thiamine deficiency in Thailand. However, these two surveys in addition to this outbreak suggest that in some populations in Thailand and Myanmar diets may contain inadequate levels of thiamine possibly combined with increased levels of thiaminases in some foods.

Consistent with the outbreak reported among Chinese immigrants in Taiwan, Gambia and West Africa (Tang *et al,* 1989; De Montmollin *et al,* 2002; Chen *et al,* 2003), we found that this outbreak occurred in a confined environment with a history of prolonged dietary deficiency of thiamine. However, the case fatality rate in this episode was high compared with other outbreaks, possibly because the crew could not reach medical treatment in a timely fashion.

Our investigation was limited because after the ship landed the crew quickly dispersed. We were unable to interview and follow up all crew members and, given the modest crew size, we were unable to conduct a case-control study to identify specific risk factors for disease. Additionally, the crew members we interviewed could not give exact histories of food consumption so we were unable to estimate caloric and vitamin intake. However, given records of available food stores during the voyage, we were able to construct a general picture of the nutritional situation on Ship A and the likely cause of this outbreak.

After the investigation, we provided public information through newspapers as a general reminder about the persistence of this disease. We also recommended that persons who work for extended periods of time at sea take vitamin B complex or multivitamins. The unfortunate situation of Ship A encouraged collaboration among epidemiologists, nutrition experts, public health department staff, and health providers for commercial fishermen. Additional studies are planned, and based on these future studies a strategic plan will be developed to improve health among all commercial fishermen on Thai vessels.

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