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Contamination of Potable Water at Penang International Airport – a Disaster Averted

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Abstract

On 1 Oct 2010, the Penang International Airport started major renovation and construction. Water was distributed by a network of pipes for use on flights and at the airport. On 7 Oct 2010, coliforms were found in the water during routine sampling. Subsequent sampling showed further contamination at other areas in the water distribution system. An investigation was carried out to determine the scope and extent of the problem, identify the source of contamination and make sure that the water consumed at the airport was potable. Environmental inspection and observation were performed, workers were interviewed and surveillance data were reviewed. The water reticulation system was studied and water was sampled. Surveillance data showed that the contamination was localized within the airport only. Coliforms were detected at many water outlets along the various distribution lines. The pipes were flushed with disinfectant and water filters were provided to food outlets. This water contamination occurred after the onset of construction. The earthworks damaged the pipelines. After the remedial actions, the contamination was cleared and the water supply was kept safe until the completion of new pipes in July 2011.

Keywords: water contamination, airport, potable water

Introduction

The leading causes of waterborne outbreaks in Malaysia are cholera, typhoid fever, hepatitis A, dysentery and food poisoning. The contributing factors identified are related to unhygienic food handling practices followed by inadequate safe water supply and poor environmental sanitation.[1] In general, increased level of fecal coliform in water provides a warning of water treatment failure, a break in integrity of the distribution system or contamination with pathogens.

Penang International Airport serves as the main airport for the northern region of Malaysia. Over 3.4 million passengers passed through the terminal in 2008.[2] The airport is the hub for low cost carriers and serves a terminal for 14 other airlines. The airport water is used for drinking on all flights, food outlets at the terminal and food preparation for flights.

On 1 Oct 2010, the airport started major renovation and construction. On 7 Oct 2010 (epidemiology week 40), coliforms were found in the water samples during monthly microbial sampling at the airport. Subsequent samplings showed that there was more contamination at other areas in the distribution system.

Following discovery of contamination, an investigation was carried out to determine the scope and magnitude of the problem, identify the source of contamination and make sure that the water consumed at the airport was potable.

Methods

This is a descriptive study on water safety at the Penang International Airport. To determine the scope and magnitude of the problem, we examined surveillance data for acute gastroenteritis in the community and within the airport. Acute gastroentiritis is daily and weekly monitored at all health districts. The airport comes under the purview of the Barat Daya District Health Office where the data are captured and monitored. Data were analyzed for epidemiology weeks 30 to 42 (25 Jul to 23 Oct 2010) to compare if there was an increase in incidence of acute gastroenteritis in the community. Acute gastroenteritis was defined as diarrhea with abdominal cramps or pain, bloody stools, nausea and vomiting.

All workers and staff at the airport terminal were interviewed about presence of acute gastroenteritis over the epidemiology weeks 41 to 42 (10-23 Oct 2010) .

We also reviewed the data on routine drinking water quality, monitoring outside the airport perimeter. Water was sampled every month for chemical and microbiological contamination at the five fixed sampling points and was sent to the Chemistry Laboratory in Penang for analysis. This sampling was carried out by the water quality team from the Barat Daya District Health Office. The results were sent to the State Engineer at the State Health Department, who compiled and analyzed the data for the whole state. We reviewed the data from these five sampling points for presence of coliforms and *E. coli*.

In order to identify the source of contamination, we interviewed the supervisor of the construction site and manager of the Malaysian Airports to determine if any broken pipes or any other unusual events occurred during the construction.

Map of the water reticulation system in the airport was reviewed to determine the distribution lines that went through the airport. Outlets fed by the various lines were identified and water was sampled from the point of use for microbiological contaminants. Sampling was carried out according to the guidelines of the Engineering Department under the Ministry of Health, Malaysia. Disinfection of the pipe opening was carried out prior to sampling. At the water source pipe, because all were metal pipes, area around the pipe was first wiped clean with a wet cotton swab. The water was allowed to flow for about 2-5 minutes. The pipe was wiped with 70% methyl alcohol solution using a cotton swab and was then burned with a blow torch. Water was again allowed to flow freely for 2-5 minutes before it was collected in a thiobag containing sodium thiosulphate. Water was filled up to the 100ml line. The bag was then transported in a cool box to maintain the temperature at 4-10 degrees centigrade. The samples were sent on the same day to the Chemistry Laboratory in Penang for analysis by membrane filter for total coliforms and *E. coli*.

We evaluated the presence of contamination by regularly collecting water samples at the distribution lines and at the points of use. Since coliforms were still present at two out of seven lines, we carried out further investigations and observation to determine the cause of the problem.

Results

Surveillance of Community and Workers

There was no unusual increase in acute gastroenteritis cases at Barat Daya District (Figure 1).

Surveillance carried out amongst 681 out of 685 staff and airport workers for epidemiology weeks 41 and 42 showed that one case of acute gastroenteritis was reported in week 41 and two cases in week 42. There was no increase in incidence of acute gastroenteritis.

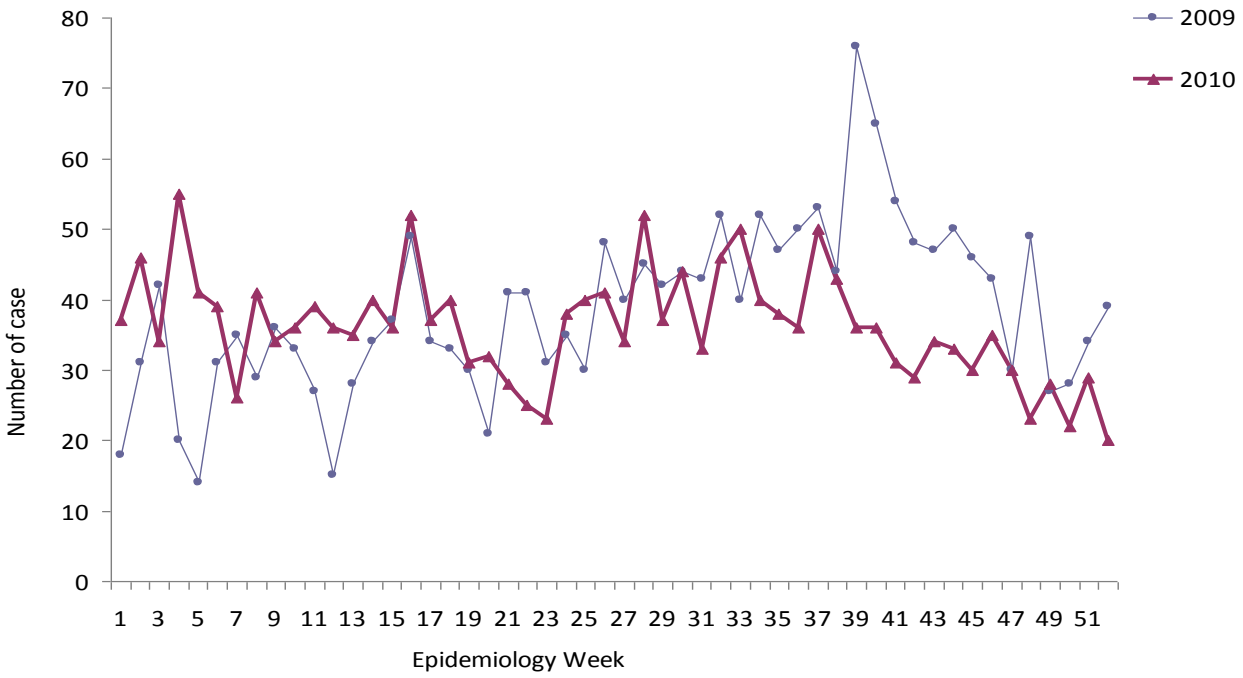

Figure 1. Acute gastroenteritis cases reported to Barat Daya District Health Office in 2009 and 2010

Water Monitoring Outside the Airport Perimeter

Routine monthly monitoring of drinking water outside the airport perimeter was carried out at five points closest to the airport by the Barat Daya District Health Office. Sampling was carried out on 11 Oct 2010 and there was no coliforms present in any of the samples. Up till November 2011, sampling was negative for coliforms.

Identification of Contaminated Source

During interview, we learned that the water hydrant located near the northern end of the terminal building had been relocated when the earthworks was started and the pipes in the area were submerged in a pool of stagnant water. On 24 Oct 2010, the hydrant was moved again and the submerged pipes were removed.

Provision of Potable Water

At 19:10 on 27 Oct 2010, bleach (sodium hypochlorite) at a concentration of five ounces per 1,000 gallons was put into the water tower and the water supply was shut off for 12 hours. It was then flushed out at 07:00 in the following morning. Water sample on 28 Oct 2010 showed presence of coliforms at the Outlet 12 (Table 1). On 30 Oct 2010, coliforms were present in two of the seven lines which included one line to the Outlet 5 and 6 at aircraft area, and one line to the food outlets 20 and 21 located at Level 2 (Figure 2).

From our investigation, the Outlet 20 never used water from the main water supply. They collected water from sinks in the restroom and the water was used at that food outlet for drinks and snacks preparation. After that, a pump channeled the water to a filter and then to the tap. The filter was observed to be in brown color.

The Outlet 21 at Level 2 used water from an extension pipe that was channeled from the lines above the ceiling. Even though they used a filter, it had not been cleaned.

After flushing with bleach, water filters were provided to all food and beverage outlets. A monthly schedule for changing the membrane was put up. These filters were used temporarily until the pipes for extensions to the airport were laid. The Outlet 20 was ordered to set up a water pipe in order to provide potable water. In the meantime, they were allowed to sell only ready to eat foods.

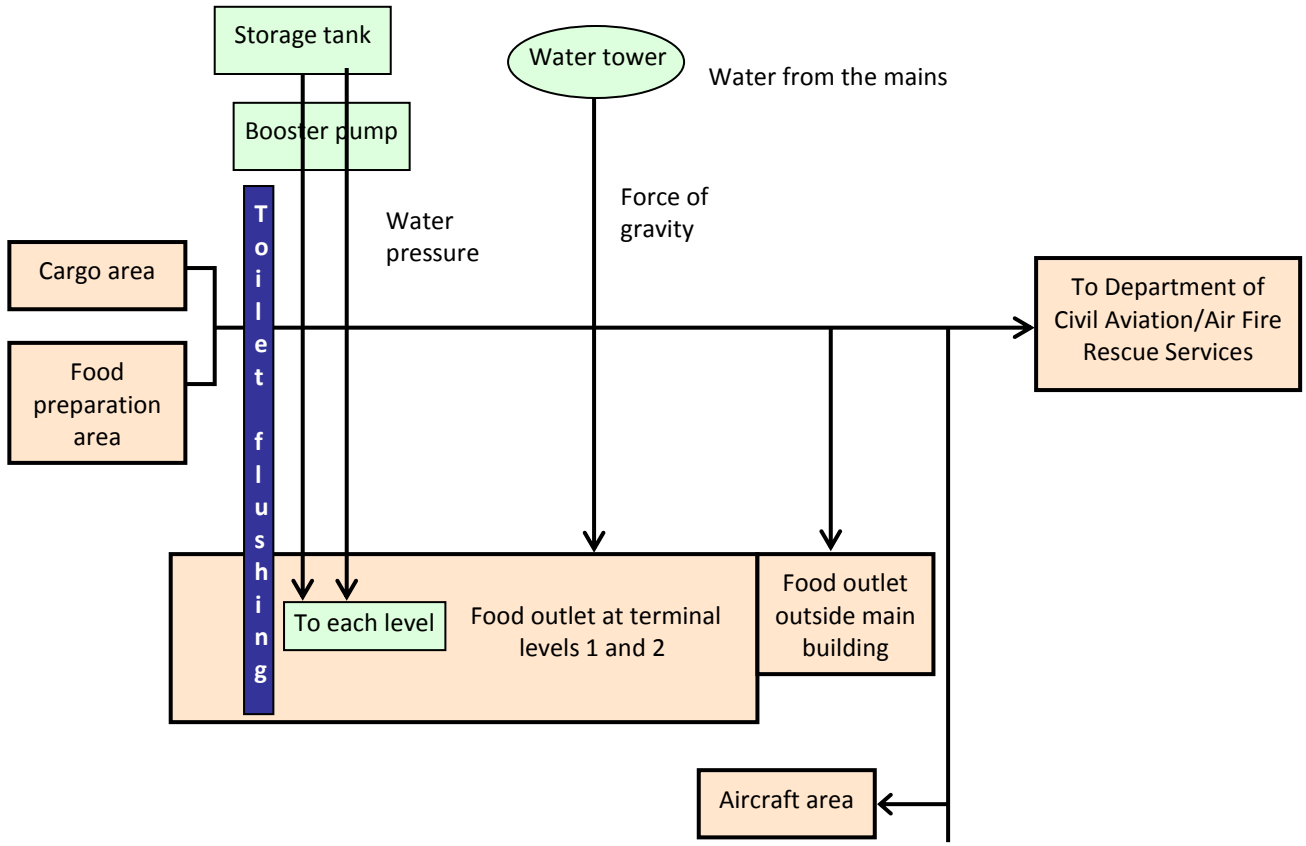

Figure 2. Schematic map of the water reticulation system at the Penang International Airport in October 2010, showing the areas covered by water sampling from 27 Oct to 2 Nov 2010

Table 1. Total coliforms level in drinking water supply collected from reticulation lines at Penang International Airport, 22 Oct to 4 Nov 2010

Location of line	Outlet	Date of water sampling													
		22 Oct	23 Oct	24 Oct	25 Oct	26 Oct	27 Oct	28 Oct	29 Oct	30 Oct	31 Oct	1 Nov	2 Nov	3 Nov	4 Nov
Aircraft area	1	-	-	-	●	●	●	-	●	●	-	●	●	-	-
	2	-	-	-	-	-	1	-	-	-	-	●	●	-	-
	3	-	-	-	●	●	●	-	-	-	-	-	●	-	-
	4	-	-	-	-	●	-	-	-	-	-	-	-	-	-
	5	-	-	-	●	1	●	-	●	1	-	-	●	-	-
	6	-	-	-	-	-	-	●	●	9	-	-	●	-	-
Food outlet outside main building	7	-	-	-	●	●	●	-	●	●	1	●	●	-	-
Booster pump	8	-	-	-	1	-	-	●	●	●	●	●	-	-	-
Food preparation area	9	●	-	-	2	-	-	●	●	●	●	-	●	-	-
Cargo area	10	-	-	-	37	-	-	●	-	●	-	-	●	-	-
Water tower	11	-	-	-	-	1	-	●	-	●	●	●	-	-	-
Food outlet at level 1	12	90	-	-	●	●	-	66	●	●	●	●	●	-	-
	13	-	-	-	●	-	●	-	●	●	●	●	-	-	-
	14	-	-	-	3	●	1	●	●	●	●	●	●	-	-
	15	-	-	-	9	-	-	●	●	-	●	●	-	-	-
Food outlet at level 2	16	-	-	-	>100cfu	●	●	●	-	●	●	●	-	-	-
	17	-	-	-	●	●	●	●	-	●	●	●	-	-	-
	18	-	-	-	13	-	-	●	-	●	●	-	-	-	-
	19	-	-	-	●	-	-	●	●	●	●	●	-	-	-
	20	-	-	-	-	-	-	25	10	2	1	-	●	-	-
	21	-	-	-	-	-	3	1	●	3	●	●	●	-	-
	22	-	-	-	19	-	●	●	-	●	●	-	-	-	-
	23	-	-	-	100	-	1	●	●	●	●	-	-	-	-

● – < 1cfu (acceptable)

> 100cfu – Too numerous to count

(-) – No water sample collected on that date

Note: All samples were tested for total coliforms and E. coli. All samples were less than 1cfu for E. coli.

Since 1 Nov 2010, there was no more contamination and subsequent samplings conducted later in this month showed that the water was free of coliforms. *E. coli* was less than 1cfu per 100ml in all the samples.

In summary, water contamination with coliforms was localized to the airport. It coincided with the earthworks in the area where the water pipes were broken. Initially, all the lines were contaminated. Flushing and disinfection with chlorine cleared the coliforms from all, except four out of 23 points. Two (Outlets 20 and 21) out of these four points had contaminated filters, which was rectified with changing of the filters, while the other two (Outlets 5 and 6) were the furthest from the flushing point and took longer to clear the contamination. With these actions, all lines were supplied with potable water.

Discussion

This incident in the international airport had the potential to cause severe morbidity. Airlines staff and airport workers depend on foods that were prepared using the tap water. Typhoid and hepatitis A are endemic waterborne pathogens in Malaysia.[3]

The contamination was detected through routine water sampling at fixed points which were situated along only one distribution line. Since the policy on monitoring of drinking water quality in Malaysia was to monitor water monthly at fixed points but not at the points of use, this may not detect any contamination. Thus, importance of testing water at the points of use was recommended after this incident. As a result, the number of formal sampling points was increased to cover all the lines, including the points of use at the food outlets. In addition, these sampling points were ordered to be well closed in order to prevent external contamination.

Although food and waterborne illnesses associated with air travel is not common today, it may have serious implications. Safety may be threatened if the

crew are affected. Quality of inflight catering depends on high standards of food preparation and safe water.[4] The water from the airport is transported for use on aircrafts. World Health Organization has set up guidelines on water safety for use on aircrafts which cover the water provided at source, transport and transfer to the aircraft as contamination can occur anywhere along the process.[5] There is no evidence of water being tested in this country after it has been transferred to the flights. In a study carried out by the Environmental Protection Agency (EPA) in the Unites States in 2004, approximately 15% of 327 water samples on flights tested positive for coliforms.[6] In another series of data on aircraft water tested in February 2008 released by the EPA, 10% out of 2,258 aircrafts had water positive for coliforms.[7] As budget airlines do not provide free water on flights and it has to be bought at a high cost, people may consume the tap water. Similarly, with the new regulations of not allowing bottled water taken into the departure area and the high price of bottled water, more people would resort to drinking from the water fountains, thereby being at risk.

Quick action helped to avert a potential disaster. As renovation was going on, there was a constant risk of pipes being broken. To overcome this, water at the points of use needs to be potable at all times. This was done by using the filters as specified standards of drinking water quality from Ministry of Health. The cost of fixing these filters was born by the airport management team.

The renovation to replace the old lines was previously planned by mid 2012. However, the process of laying new pipes was expedited after this incident and was completed in July 2011. During this period, there was no more contamination identified.

Limitations

We did not carry out surveillance of the passengers. As there was no sampling of water at food outlets prior to this incident, we could not know if the water was contaminated before that. However, disinfection and chlorination removed coliforms from all the lines.

Conclusion

Water contamination with coliforms occurred at the Penang International Airport after the onset of construction work. It might be due to the broken pipes. After repairing the pipes and flushing and disinfection with chlorine, the contamination was removed.

Public Health Actions and Recommendations

To ensure that water on flights is always potable, it is recommended that water onboard should be regularly tested for microbilogical contaminants.

On follow up in May 2012, massive renovations and construction in most of the outlets were moved out or relocated to elsewhere.

Suggested Citation

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