

Outbreak caused by food-borne *Salmonella enterica* serovar Enteritidis in a residential school in Perak state, Malaysia in April 2016

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Abstract

We performed epidemiologic investigations of a food poisoning (FP) outbreak that occurred in a residential school from Batang Padang district, Perak state, Malaysia in April 2016. The epidemiologic investigations showed significant association between consumption of 'net pancakes' (a.k.a Roti Jala, a popular Malaysian dish made with flour, coconut milk, water and eggs) and gastrointestinal symptoms experienced by the affected patients (RR: 10.5; 95% CI: 2.7-40.0; $p < 0.0001$). *Salmonella enteritidis* strain was isolated from the clinical samples of affected patients and the net pancake food sample. The isolated *Salmonella enteritidis* from the clinical and food samples showed >99% similarities through pulse field gel electrophoresis (PFGE) analysis. The epidemiologic, laboratory and PFGE results confirmed the source and the vehicle of contamination in the FP outbreak. The data obtained from this outbreak investigations is important for informed policy discussions to enhance the FP prevention strategy in the residential school kitchens and canteens in Malaysia.

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Introduction

Food poisoning (FP) is clinically defined as acute onset of vomiting and/or diarrhea and/or other symptoms associated with ingestion of food (MOH, 2006). It is a major public health issue in many regions of the world and is often caused by eating raw or undercooked meat, eggs, fresh produce and dairy products contaminated with norovirus, *Campylobacter*, non-typhoidal *Salmonella* and pathogenic *E. coli* (WHO, 2015).

In Malaysia, a suspected case that fulfills clinical definition without a laboratory confirmation is enough to be reported to the nearest District Health Department (DHD) and if there are two or more cases with epidemiological linkage is defined as an outbreak. For the year 2009-2014, there was an average annual incidence of 48.0 per 100,000 population of FP notified in Malaysia (MOH, 2015). Despite the mandatory requirement of disease notification, the reporting of FP cases depends largely on healthcare professionals and there are differences in reporting patterns between public and private health facilities.

Perak is one of the 13 states that form the federation of Malaysia. Perak is the second largest state in Peninsular Malaysia and has 12 administrative

districts. For the year 2009-2015 in Perak (MOH, 2015), there was an average annual incidence of 60.6 per 100,000 population of reported cases of FP which is higher than the national average incidence. There are three administrative levels of Ministry of Health (MOH) Malaysia namely the Federal Health Department, State Health Department and DHD. Each administrative level has a Food Safety and Quality (FSQ) division. This FSQ entity is established to protect the public from foodborne health hazards, unhygienic and unsafe food preparation and sales practices. One of the core activities of a district-level FSQ unit is to perform periodical risk assessment inspections of food premises (restaurants, café, and stalls), catering services, school canteens and residential school kitchens. This initiative was introduced by MOH in 2008 and the national results of inspections of school canteens and residential school kitchens for the same year revealed 23.5% obtained grade A, 45.5% grade B and the rest of the premises obtained grade C or D (MOH, 2010). All these food premises were then actively encouraged to be registered with the DHD and their staffs were required to undergo food handling and safety course at MOH certified training centers. MOH had implemented a self-inspection programme termed

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as 'KENDIRI' among operators in school canteens and residential school kitchens since 2008 and approximately 75% of school canteens and 54% of residential school kitchens in Malaysia were involved in the programme in the same year (MOH, 2010). In addition to all these activities, the FSQ unit also enforced the legal provisions stated in Food Act 1983, Food Regulations 1985 and Food Safety and Hygiene Regulations 2009.

Despite all these preventive mechanisms in place, food poisoning cases and outbreaks continue to occur in Malaysia (Bernama, 2016b; Malay Mail Online, 2016; The Sun Daily, 2016) and Perak (Bernama, 2016a; Free Malaysia Today, 2016) especially involving school canteens and residential school kitchens. In Perak state between January 2009 till June 2016, there was an annual average of 297 FP cases (11 FP outbreaks) involving school canteens and 446 FP cases (12 FP outbreaks) involving residential school kitchens. This paper presents the data from an epidemiologic investigation of a FP outbreak that occurred in a residential school from Batang Padang district, Perak state, Malaysia in April 2016.

Materials and Methods

There were 750 students and staff in the residential school. The FP outbreak occurred over the weekend and 111 individuals (students and staff) were in the school during this period. The rest of the students and staff had returned to their homes and were not exposed to the food served at the residential school kitchen. An interview was performed among the exposed students and staff (N=111) to elicit the symptoms and identify the foods consumed over the period of 72 hours from the first onset of symptoms. Descriptive analyses were performed to report the time, place and persons involved in this outbreak. Retrospective cohort analyses were performed to determine the correlation and relative risk of particular food consumption to the symptoms experienced by those affected by food poisoning. A risk assessment inspection of the residential school kitchen was done by public health inspectors from the district FSQ unit using the standard MOH issued questionnaire (Jeyaletchumi *et al.*, 2006). A food technologist from the district FSQ unit performed the Hazard Analysis and Critical Control Points (HACCP) (Worsfold and Worsfold, 2005) for the suspected food prepared from the residential school kitchen. The laboratory samples that were taken for analyses were the patients' clinical samples (rectal swabs), food cold holding samples, food handlers samples (hand swabs) and the kitchen utensils samples (utensil swabs). Verbal informed

consent was obtained before the collection of these samples. Microbiological cultures were done by the Perak State Public Health Laboratory followed by pulse field gel electrophoresis (PFGE) to determine serotype of the cultures obtained. The data was analyzed using Excel (Microsoft Corp., Redmond WA) and the statistical package IBM SPSS Statistics version 21 (IBM Corp., Armonk, NY).

Results

The clinical case definition for the FP outbreak was defined as patients with acute onset of vomiting, diarrhea and abdominal pain from the residential school between 2nd April 2016 and 5^h April 2016. From the active case detection performed at the residential school, a total of 64 students and staff fulfilled the clinical case definition. The attack rate was 57.7%. From those affected, 98.4% were students and 1.6% was staff. No case mortality was observed in this FP outbreak. The epidemiological analysis of the food poisoning outbreak is summarized in Table 1. The first onset of symptoms was on 3rd April 2016 and the last onset of symptoms was on 4th April 2016. Figure 1 shows the epidemic curve for the food poisoning outbreak. All cases appear to occur within one incubation period and the outbreak was for a short duration. The epidemic curve pattern suggested that it was a single exposure that did not persist over time (point source outbreak). The menu from 31/03/2016 till 02/04/2016 (72 hours) was identified and 57 different types of food consumed over that period were analyzed by using a 2x2 table. Four suspected types of food consumed were positively identified through Pearson's correlation (Table 2) and relative risk (Table 3) that had significant p-value.

Four routine risk assessment inspections had been performed at the residential school kitchen from April 2015 till March 2016. From those inspections, the average rating obtained by the school kitchen was 82.4%. However, the inspection rating performed during the outbreak incident on 03/04/2016 was only 66.0%. There were 17 local kitchen workers and cooks in the school kitchen. All the kitchen workers and cooks had documentation of typhoid vaccination. Fifteen of the 17 workers had proof of attendance to the food handling and safety course conducted by MOH certified training centers. The holding temperature for all the refrigerators and freezers (front door and top-loading) did not comply to the set standards. Inspection of the culinary equipment used at the school kitchen found them to be unclean and the defective cutleries were not replaced. During the inspections, information was obtained that the

Table 1. Epidemiological analysis of the food poisoning outbreak

Parameters	Frequency	Percentage (%)
Total exposed	111	14.8
Active case detection		
With symptoms	64	57.7
Without symptoms	47	42.3
Category affected		
Students	63	98.4
Staff	1	1.6
Age affected		
13 yrs –17 yrs	63	98.4
>20 yrs	1	1.6
Gender affected		
Males	33	51.6
Females	31	48.4
Symptoms		
Diarrhoea	61	95.3
Vomiting	23	35.9
Abdominal pain	64	100.0
Nausea	50	78.1
Fever	45	70.3
Headache	42	65.6
Treatment		
Hospital admission	38	59.4
Outpatient	26	40.6
Mortality	0	0.0

net pancakes served on 02/04/2016 at 22:00 pm were outsourced from an external supplier. The chicken curry that was served together with the net pancakes was prepared in the school kitchen. The external supplier was identified and risk assessment inspections were performed at the external supplier kitchen. The inspection ratings were 48.0%. The external supplier was not registered with the DHD and had not undergone routine inspections from the district FSQ unit previously. There were four foreign kitchen workers employed and only three of them had documentation of typhoid vaccination. All the kitchen workers did not have proof of attendance to a food handling and safety course. During the inspection, raw materials were found to be placed directly on the floor and the refrigerators contents were disorganized and unclean. The top loading refrigerator door was found to be defective and could not be closed properly.

HACCP analysis at the residential school kitchen found the temperature of the freezer which was used to store the raw chickens for 32 hours to be minus 6° degree Celsius. The recommended freezer temperature is minus 18° degree Celsius. In that period exponential growth of bacteria could occur and contribute to the cause of the food poisoning outbreak. Moreover, the cooking time (30 minutes) for the chicken curry was found to be not optimal to destroy the existing bacterial load during the cooking process. The HACCP analysis of external supplier of net pancakes found two factors that could contribute

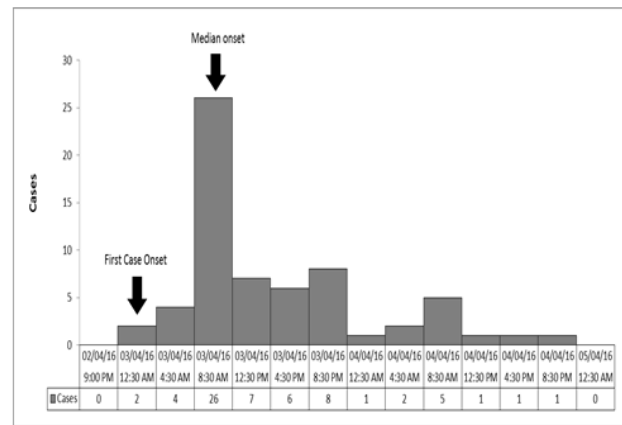


Figure 1. FP outbreak epidemic curve

to the cause of this food poisoning outbreak. First is the preparation table for the flour mixtures. The eggs trays were placed in proximity to the same table. It may have caused cross-contamination during the mixture preparation process. The second factor is the cooking time for the net pancakes. The cooking time was too short and low cooking temperature was used in the preparation process. HACCP analysis concluded that the most likely causative food responsible for the food poisoning outbreak could be the chicken curry or the net pancakes.

Clinical laboratory samples (rectal swabs) from 29 patients were taken for microbiological analysis of which 26 of the samples (89.6%) were found to be positive for *Salmonella enteritidis* bacteria. All of the isolates showed >95% similarities in their PFGE pattern indicating that they are most probably came from the same source. Eight food holding samples were sent for microbiological analysis. From those samples, the net pancake sample was found to be positive for *Salmonella* species, *Bacillus cereus* and coagulase positive *Staphylococci*. The *Salmonella enteritidis* isolates from the food sample (i.e. net pancake) showed >99% similarities to the isolates obtained from the clinical samples. No pathogenic bacteria presence was detected from the rest of the seven food samples including the chicken curry. All the food handlers' samples (hand swabs) and the kitchen utensils samples (utensil swabs) from the residential school kitchen and the external supplier were negative for bacterial presence.

The assistance of the Department of Veterinary Services was requested for the traceback investigations to identify the source of the eggs used in the meal preparation. The supply of poultry for the residential school kitchen (chicken curry) and the eggs supply chain for the external supplier (net pancakes) were positively identified. Poultry samples and eggs samples from the retailers were taken for microbiological analysis. Similarly, chicken samples

Table 2. Correlation analyses summary of the food poisoning outbreak

Date	Time	Food	Pearson's correlation	p-value
01/04/2016	22:00	Egg sandwich	5.25	0.0220
02/04/2016	22:00	Net pancakes*	39.14	0.0000
02/04/2016	22:00	Chicken curry	60.63	0.0001
02/04/2016	22:00	Chocolate milk	60.11	0.0000

*Net pancakes are a popular snack known as 'Roti Jala' in Malaysia served with curry dishes. It is made using flour, water, coconut milk and eggs

and eggs samples were taken from the identified production farms for laboratory analysis. All the samples tested by the department of veterinary services were found to be negative for *Salmonella* bacteria.

Discussion

The public health investigations have successfully identified the source of the FP outbreak as *Salmonella enteritidis*. The food or vehicle was the net pancakes prepared by the external supplier to the residential school. The median incubation period of the FP cases was short, hence suggesting a substantial inoculum of *Salmonella enteritidis* in the contaminated food. Cross-contamination (Humphrey et al., 1994) was suspected to have occurred during the preparation of eggs and the flour mixture for the net pancakes. The eggs or egg shells had been confirmed as the primary ingredient of food vehicle responsible for contamination in the majority of the *Salmonella enteritidis* outbreaks (Braden, 2006; Gantois et al., 2009; Howard et al., 2012; Andino and Hanning, 2015).

There are several lessons learned in this outbreak investigation. The risk assessment inspections performed at the residential school kitchen before the outbreak was found to be ineffective and could not identify the potential risk of foodborne infection. A persistent high rating marks and the inability of the inspections to detect practices which lead to FP outbreak may require MOH to reconsider the prevention strategy. The first step will require a series of audits to explore the effectiveness of the inspections. The allocation of valuable resources and time in the DHDs is a pertinent issue and should be based on a system that is proven to be accurate and effective (Mullen et al., 2002).

Table 3. Retrospective cohort analyses summary of the food poisoning

Date	Time	Food	RR*	95% CI†		p-value
				Lower	Upper	
01/04/2016	22:00	Egg sandwich	1.60	1.01	2.56	0.04
02/04/2016	22:00	Net pancakes*	10.46	2.73	39.99	<0.0001
02/04/2016	22:00	Chicken curry	27.07	3.92	187.08	<0.0001
02/04/2016	22:00	Chocolate milk	27.82	4.02	192.39	<0.0001

#RR denotes relative risk

†CI denotes confidence interval

*Net pancakes are a popular snack known as 'Roti Jala' in Malaysia served with curry dishes. It is made using flour, water, coconut milk and eggs

Some studies done locally has documented moderate to good knowledge and attitudes among the food handlers (Abdullah et al., 2015; Nee and Abdullah Sani, 2011). The food handling and safety course has been positively attributed as the contributing factor for these results. However, at the same time, this knowledge and attitudes were not turned into safe practices (Abdullah et al., 2015) and suggests a complex link between training, knowledge and food safety practices (Clayton et al., 2002; Tang and Fong, 2004; Malhotra et al., 2008). The self-inspection programme (KENDIRI) among operators in school canteens and residential school kitchens require the managers and supervisors to play an active role in monitoring and supervision of the workers. The effectiveness of the food handling and safety course to create safe food practices and the inspection programme (KENDIRI) currently employed as a self-monitoring tool require further research to assess their role in the prevention strategy.

Closure of the both the residential school kitchen and the external supplier was ordered by the DHD using the Control and Prevention of Infectious Diseases Act 1988 for a maximum of 14 days. However, the closure was only effectively enforced for five days because the business owners had carried out the cleaning and disinfection instructions issued by the DHD. The repeat inspection found both the premises to be satisfactory because the premises did not operate for some days and coupled with the recent cleaning work order. Enforcement strategies for food premises and food handlers who are found to be negligent need to be intensified. The legal provisions

stated in Food Safety and Hygiene Regulations 2009 must be allowed to be enforced without restrictions. The MOH must engage with the local authorities and Ministry of Education (MOE) for an effective enforcement strategy.

The prevention of FP cases and outbreaks in residential school kitchens and school canteens will require close cooperation between MOH and MOE. Recommendations by the MOH in safe food preparation practices and the legal provisions found in Food Safety and Hygiene Regulations 2009 must be incorporated into the residential school kitchen and canteen business contracts. The residential school kitchen and canteen business owners should not be allowed to outsource food from external suppliers. If they are to outsource from an external supplier, the residential school kitchen and canteen operators must ensure they are registered with the DHDs and have undergone the food handling and safety course.

Conclusion

This study highlighted the FP outbreak investigations and successful identification of the source as *Salmonella enteritidis* and the net pancakes as the contaminated food vehicle. The investigations and lessons learned in this FP outbreak are useful for informed policy discussions to enhance the FP prevention strategy in the residential school kitchens and canteens in Malaysia.

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