FOODBORNE DISEASE OUTBREAKS OF CHEMICAL ETIOLOGY IN THAILAND, 1981-1987

WITAYA SWADDIWUDHIPONG, PRAYURA KUNASOL, ORAPUN SANGWANLOY, DEJ SRISOMPORN

Division of Epidemiology, Ministry of Public Health, Bangkok 10200, Thailand.

INTRODUCTION

Foodborne disease continues to be a major public health problem in both developed and developing countries, where it causes significant human morbidity and mortality, and tremendous losses to the food industry and trade (Abdussalam, 1984). Toxic substances resulting in foodborne disease can occur in foods as a natural component of the plant or animal used as food, or as an accidental contaminant introducing during food-handling. Naturally occurring toxins include genetically inherent substances such as amatoxins in mushrooms, cyanogenic glycosides in cassava and tetradotoxin in puffer fish. While most cases of foodborne illness are due to contamination by disease-producing microorganisms, or by naturally occurring toxins, other toxic chemicals which are not naturally present in foods can also accidentally contaminate foods leading to foodborne illness. Chemicals such as pesticides are being used increasingly in agricultural, industrial, public health and related activities. Occasionally, because of food-handling errors or improper application of chemicals during storage or transport, food products may become contaminated with chemicals reaching levels that can constitute serious health hazards to consumers (Davies and Lewis, 1956; Kanagaratnum *et al.*, 1960; Coble *et al.*, 1967; Weeks, 1967; Davidson *et al.*, 1977; Diggory *et al.*, 1977; Goes *et al.*, 1980; Centers for Disease Control, 1986; Swaddiwuthipong *et al.*, 1988).

Reporting of foodborne disease in Thailand began in 1970 under the National Disease Surveillance Programme and are consistently among the most frequently reported diseases. Since 1981, investigations of foodborne outbreaks due to chemical contamination have been carried out to determine epidemiological features, including etiologic agent, food vehicle and means of contamination as the basis for public health action. We report here the epidemiological characteristics of foodborne outbreaks caused by chemicals as opposed to those of bacterial origin for the period 1981-1987 to assess the current situation with respect to the problem of chemical contamination so that it may lead to suitable measures for prevention and control.

MATERIALS AND METHODS

In Thailand, reports of foodborne disease outbreaks are submitted to the Division of Epidemiology through the National Disease

Surveillance Network by workers in public health centers and hospitals in the various provinces. Information recorded on the reports includes age, sex, clinical manifestations in the affected individuals, place of residence, date of onset, incriminated food, etiologic agent, and laboratory results if specimens are available and submitted for examination.

In the present study, a foodborne outbreak was defined as an incident in which individuals experienced illness, usually gastrointestinal manifestations, following ingestion of food or water that was reported to be the source of illness. An outbreak attributed to a chemical was confirmed if the chemical was identified in the incriminated food, water and/or clinical specimens taken from the victims. In many instances, however, the responsible etiologic agents may not be known due to incomplete laboratory testing or the unavailability of appropriate laboratory techniques. In this review we analysed the occurrences of foodborne outbreaks of chemical origin that were reported in the period 1981–1987.

RESULTS

From 1981 to 1987, there were between 20 and 35 foodborne disease outbreaks reported to the Division of Epidemiology annually with chemical etiologies reported to be responsible for approximately 30% of these outbreaks. During this period a total of 73 foodborne outbreaks attributed to chemical were reported throughout the country, in which 1236 persons were made ill and 54 died. The breakdown of chemical category in these outbreaks is shown in Table 1.

Insecticides: Insecticides were responsible for 27% of the 73 reported outbreaks and affected 722 persons, 9 of whom died. Some of these insecticide outbreaks tended to involve a large number of persons due to their occurrence in a school or a party in a village. Investigations of insecticide poisoning outbreaks which occurred in the period 1981–1986 (18 outbreaks) are reported elsewhere (Swaddiwuthipong *et al.*, 1988). The 2 outbreaks occurring in 1987 were associated with methomyl insecticide. One which took place in a small party in a rural village resulted in 14 cases with no deaths after drinking water that had been contaminated with methomyl. The water container had been used to store methomyl solution but was not thoroughly washed before being used for drinking water at the party. The other outbreak was reported to have caused acute poisoning in 23 children and 4 adults in one school. None died in the outbreak. The outbreak was associated with eating chicken curry that was later detected to contain methomyl. Unfortunately, we could not determine how the curry became contaminated with methomyl.

Other toxic chemicals: There was one outbreak of methanol poisoning causing severe illness in 10 adult males in one small household party. Five of the 10 cases died and 1 had permanent visual impairment. Alcoholic drink produced illegally was the source of the methanol which was identified by laboratory analysis. Subsequent investigation revealed that one of the victims intentionally used methanol to prepare the drink, but neither he nor the other victims knew the toxic nature of this substance. There was also a report of 4 cases of poisoning attributed to sodium nitrite. The victims accidentally drank water containing sodium nitrite which had been prepared for household use. All the cases were young children aged 1–3 years. They all had meth-

Table 1

Reported cases and deaths of foodborne disease outbreaks by type of chemical, Thailand, 1981-1987.

Etiologies	No. outbreaks (%)	No. cases (%)	No. deaths (%)	Case-fatality rate (%)
Insecticides				
Methomyl	17 (23.3)	436 (35.3)	5 (9.3)	1.1
Propoxur	1 (1.4)	223 (18.0)	0 (0.0)	0.0
Coumaphos	1 (1.4)	13 (1.1)	4 (7.4)	30.8
DDT	1 (1.4)	50 (4.0)	0 (0.0)	0.0
Subtotal	20 (27.4)	722 (58.4)	9 (16.7)	1.2
Other toxic chemicals				
Methanol	1 (1.4)	10 (0.8)	5 (9.3)	50.0
Sodium nitrite	1 (1.4)	4 (0.3)	0 (0.0)	0.0
Subtotal	2 (2.7)	14 (1.1)	5 (9.3)	35.7
Poisonous plants				
Mushrooms	21 (28.8)	211 (17.1)	28 (51.9)	13.3
Plant seeds	9 (12.3)	179 (14.5)	0 (0.0)	0.0
Cassava	8 (11.0)	18 (1.5)	3 (5.6)	16.7
Plant leaves	5 (6.8)	12 (1.0)	6 (11.1)	50.0
Subtotal	43 (58.9)	420 (34.0)	37 (68.5)	8.8
Poisonous animals				
Mussels (Paralytic shellfish poisoning)	1 (1.4)	63 (5.1)	1 (1.9)	1.6
Horseshoe crabs	4 (5.5)	11 (0.9)	1 (1.9)	9.1
Puffer fish	3 (4.1)	6 (0.5)	1 (1.9)	16.7
Subtotal	8 (11.0)	80 (6.5)	3 (5.6)	3.8
Total	73(100.0)	1236(100.0)	54(100.0)	4.4

emoglobinemia, were treated with intravenous methylene blue, and recovered uneventfully.

Poisonous plants: Forty-three outbreaks due to ingestion of poisonous plants were reported during the study period. Mushroom poisoning was the most common entity accounting for 21 outbreaks involving 211 cases of which 28 died. Of the 21 mushroom outbreaks, 20 occurred in the rainy season (May-September). The type of mushroom involved was identified in 9 outbreaks. Five outbreaks in which 105 persons were made ill with 24 deaths were due to Amanita species. Four outbreaks involving 17 cases and no deaths were caused by *Chlorophyllum molybdites* Mass. The implicated mushrooms in the remaining outbreaks were identified as poisonous but the species could not be detected due to incomplete laboratory investigations. Twenty outbreaks occurred in homes and one occurred in a party in a rural

village (86 cases, 16 deaths). Epidemiological investigations revealed that in all of these outbreaks, persons collected mushrooms of species not recognized as poisonous, which grew in their farms or nearby.

Plant seed poisoning was responsible for 9 outbreaks causing illness in 179 cases. Eight outbreaks occurred in schools and the cases were students aged 7–15 years. The other outbreak involved children of the same age in a home for the handicapped. A preponderance of boys (157 cases) over girls (22 cases) was observed, and there were no fatalities. The plants associated with the outbreaks were all in the family Euphorbiaceae. Four outbreaks resulted from *Jatropha curcas* L., 2 from *Jatropha multifida* L., 2 from *Hura crepitans* L., and 1 from *Jatropha podagrica* Hook. This family of plants is commonly cultivated in schools and temples in Thailand. People in the communities generally know the potential danger of the attractive seeds when eaten, but this may not be true in young children.

Cassava, a shrub cultivated in Thailand for its edible roots, accounted for 8 outbreaks affecting 18 cases of which 3 died. Fifteen of the 18 cases were children 2–6 years of age; while the other 3 cases were adults. All 3 reported deaths were children. They all had eaten the raw roots stored during the harvest period. The remaining 5 outbreaks due to poisonous plants occurred following ingestion of toxic plant leaves collected in the forest. The outbreaks caused acute poisoning in 5 children under 10 years of age, 3 of whom died, and in 7 adults aged 19–60 years, 3 of whom died. The toxic plants involved in the outbreaks could not be identified due to unavailability of specimens for laboratory analysis.

Poisonous animals: During the study period, one confirmed outbreak of paralytic shellfish poisoning (PSP) was reported to have affected 63 persons with 1 death following consumption of green mussels (*Perna viridis* (L.)). The mussels were found to contain paralytic shellfish poison of 465–714 MU/gm which is much higher than the standard for tolerable toxin titre (Halstead and Schantz, 1984). Environmental investigation discovered large quantities of the dinoflagellate Gonyaulax sp. present in the harvesting area in the gulf of Thailand. It was thought that the mussels had become poisonous while feeding on the toxic dinoflagellates. Four other outbreaks involving marine intoxications were sporadically reported in the coastal provinces. These outbreaks affected 11 cases with 1 fatality. Two cases were children and 9 were adults, 1 of whom died. Horseshoe crabs served as the vehicles for these 4 outbreaks. The crabs are believed to be vectors of PSP as well and can result in acute poisoning and fatalities (Trishnananda *et al.*, 1966; Halstead and Schantz, 1984). Unfortunately, in these outbreaks no laboratory investigations were carried out to determine the chemical nature of the poisons present in the incriminated crabs.

Puffer fish accounted for the remaining 3 outbreaks involving 6 cases of which 1 died. The outbreaks occurred in February, August and December. Five of the 6 cases were adults aged 24–64 years; the other case, a 3-year-old girl, was fatal. Epidemiological investigation revealed that the fatal case had eaten mainly the ovaries of the puffer fish.

DISCUSSION

This study shows that a variety of substances are responsible for outbreaks of foodborne poisoning in Thailand. Methomyl was

the most commonly recognized insecticide involved, accounting for almost 1/4 of all outbreaks. Because methomyl is a sugar-like white powder with little odour, and a small amount of contamination is very difficult to detect, the Thai Ministry of Public Health recommended that methomyl in the market have a coloured appearance (Swaddiwuthipong *et al.*, 1988). People in the communities should also be educated concerning insecticide toxicity, proper handling and storage of insecticides, and prevention of food contamination.

Among the outbreaks of chemical contaminants, the highest case-fatality rate was reported in methanol poisoning. The ingestion of methanol induces central nervous depression, occular damage, and sometimes coma and death if a large amount is ingested or treatment is delayed (Bennett *et al.*, 1953; Gosselin *et al.*, 1984a). Alcoholic drink produced illegally at home is common in the rural communities of Thailand. Since methanol is relatively cheap and easily available, it is occasionally substituted for ethanol by persons who do not know its hazards. The poisoning is best prevented by health education to the public emphasizing the serious toxicity of this substance. The outbreak of sodium nitrite poisoning was an example of inadvertent access on the part of children to the toxic chemical. Illness of this nature should be preventable by storing toxic chemicals in a proper place and keeping them out of the reach of children.

During the study period, Amanita species were responsible for most of the fatalities from mushroom poisoning outbreaks. However, we could not determine the specific type of mushroom in the Amanita group due to unavailability of laboratory studies. *C. molybdites*, which normally produced transient gastroenteritis and rarely results in death (Gosselin *et al.*, 1984b) served as the source in 4 outbreaks in which no deaths were reported. Most outbreaks of mushroom poisoning occurred in the rainy season when abundant rains and optimal humidity produce large quantities of mushrooms, including poisonous species. Simple tests to identify poisonous mushrooms i.e., by abnormal taste or smell, or discoloration of a silver spoon are of no value, and at present there is no safe way to detoxify the poisonous varieties. The only practical preventive measure is to avoid unfamiliar mushrooms unless they have been identified as edible by a knowledgeable and experienced person.

Most reported outbreaks following ingestion of plant seeds occurred in schools and school children, especially boys, were involved in the majority of cases. The outbreaks may be prevented by teaching students the health hazards of consuming plant seeds and the plants themselves should be clearly labelled as inedible. Although cassava is widely cultivated in Thailand as one of the main food crops, cases of cassava poisoning were infrequently reported due to the effective practice of cyanide detoxification by boiling prior to consumption. As seen in this study, most victims of cassava poisoning were children under 6 years of age, who had eaten the raw roots. Cassava roots should therefore be stored properly in places where young children cannot reach them.

Mussels were identified to be the vector in the one reported outbreak of PSP. They became poisonous by direct uptake of toxin from the toxic dinoflagellate Gonyaulax species in the affected area. The other outbreaks of illness from ingestion of poisonous marine animals were caused by horseshoe crabs which were also suspected to be associated with PSP, but no confirmatory laboratory studies were performed. Surveillance

of the coastal populations should be carried out to determine if there are unreported cases of PSP, and to identify the vectors and the toxic dinoflagellates involved in such poisoning. Effective surveillance can provide considerable information concerning seasonal incidence, the marine animals and the dinoflagellate species causing the poisoning, and the specific geographic areas of disease occurrence, all of which is information required for an effective preventive programme.

Although puffer fish are common in Thai waters, cases of tetradotoxin poisoning by the ingestion of puffer fish tissues are not commonly reported. This is probably becuase in Thailand puffer fish are generally regarded as inedible. In the outbreaks the reported fatality was seen in a young child who had eaten the ovaries of the puffer fish. The viscera of puffer fish, especially ovaries and liver, normally contain high amounts of the toxin (Kao, 1966; Russell, 1986). Since the toxin is heat stable, it is not inactivated by cooking, hence the poisoning is best prevented by advising people not to consume any part of the puffer fish.

The outbreaks reported in this study probably represent only a small fraction of the total number that occur. Large outbreaks and outbreaks involving serious illness or deaths are more likely to be recognized and reported than small outbreaks of mild illness (Sours and Smith, 1980). Another problem is related to the very few case and outbreak investigations being carried out. During the study period, 2207 cases with mild symptoms of food poisoning associated with mushrooms were reported sporadically, but no epidemiological investigations were conducted. While some of these might have been due to toxins of the mushrooms themselves, others might well have been caused by bacterial or chemical contaminants. This situation underscores the need for more effort in investigations of both cases and outbreaks. More complete reporting and investigation of outbreaks can contribute to a clearer understanding of the etiology and contributing factors involved in foodborne disease, including food-handling errors and means of contamination. Improvement in both the frequency and completeness of laboratory investigations should also occur. Only with this information can suitable measures for prevention and control be instituted.

SUMMARY

A study was conducted to determine the current situation of chemical foodborne outbreaks in Thailand for the period 1981-1987. Seventy-three outbreaks of chemical poisoning involving 1236 persons of whom 54 died were reported. Twenty outbreaks affecting 722 cases were caused by insecticide poisoning and methomyl was the most commonly recognized insecticide involved. Poisonous plants were responsible for 43 outbreaks with 420 cases. Mushroom poisoning was the most common entity (21 outbreaks, 211 cases), with plant seed poisoning next (9 outbreaks, 179 cases). There were 8 outbreaks following consumption of poisonous seafoods. Mussels were identified to be the vector in the outbreak of PSP. Horseshoe crabs which served as the vehicles for 4 outbreaks were also suspected to be associated with PSP. Puffer fish accounted for the remaining 3 outbreaks involving 6 cases of tetradotoxin poisoning. More complete reporting and more effort in outbreak investigations are needed for appropriate preventive and control measures.

ACKNOWLEDGEMENT

We thank Dr. Sidney Shindell, Consultant to the Field Epidemiology Training Programme, Division of Epidemiology, Ministry of Public Health, Thailand, for his assistance in editing the manuscript.

REFERENCES

ABDUSSALAM, M., (1984). The role of food safety in health and development. *WHO Chronicle, 38* : 99.

BENNETT, I.L., Jr., CARY, F.H., MITCHELL, G.L., Jr. and COOPER, M.N., (1953). Acute methyl alcohol poisoning: a review based on experiences in an outbreak of 323 cases. *Medicine, 32* : 431.

CENTERS for DISEASE CONTROL, (1986). Aldicarb food poisoning from contaminated melons-California. *J.A.M.A., 256* : 175.

COBLE, Y., HILDEBRANDT, P., DAVIS, J., RAASCH, F. and CURLEY, A., (1967). Acute endrin poisoning. *J.A.M.A., 202* : 489.

DAVIDSON, W., ELLINGTON, A.C. and MANLEY, D., (1977). Foodborne pesticides poisoning- Jamaica. *M.M.W.R., 26* : 317.

DAVIES, G.M. and LEWIS, I., (1956). Outbreak of food-poisoning from bread made of chemically contaminated flour. *Br. Med. J., 2* : 393.

DIGGORY, H.J.P., LANDRIGAN, P.J., LATIMER, K.P., ELLINGTON, A.C., KIMBROUGH, R.D., LIDDLE, J.A., CLINE, R.E. and SMREK, A.L. (1977). Fatal parathion poisoning caused by contamination of flour in international commerce. *Am. J. Epidemiol., 106* : 145.

GOES, E.A., SAVAGE, E.P., GIBBONS, G., AARONSON, M., FORD, S.A. and WHEELER, H.W., (1980). Suspected foodborne carbamate pesticide intoxications associated with ingestion of hydroponic cucumbers. *Am. J. Epidemiol., 111* : 254.

GOSSELIN, R.E., SMITH, R.P. and HODGE, H.C., (1984a). Methyl alcohol. In: Clinical of toxicology of commercial products, Gosselin, R.E., Smith, R.P. and Hodge, H.C., (eds.). William & Wilkins, Baltimore, pp. III-275-279.

GOSSELIN, R.E., SMITH, R.P. and HODGE, H.C., (1984b). Mushroom toxins. In: Clinical of toxicology of commercial products, Gosselin, R.E., Smith, R.P. and Hodge, H.C., (eds.) William & Wilkins, Baltimore, pp. III-289-307.

HALSTEAD, B.W. and SCHANTZ, E.J., (1984). Paralytic shellfish poisoning. World Health Organization, Geneva, pp. 6-33.

KANAGARATNAM, K., WONG, H.B. and TAN, K.H., (1960). Parathion poisoning from contaminated barley. *Lancet, 1* : 538.

KAO, C.Y., (1966). Tetradotoxin, saxitoxin and their significance in the study of excitation phenomena. Pharmacol. Rev., *18* : 997.

RUSSELL, F.E., (1986). Toxic effects of animal toxin. In: Casarett and Doull's toxicology the basic science of poisons, Klaassen, C.D., Amdur, M.O. and Doull, J. (eds.). MacMillan Publishing Company, New York. pp. 738-740.

SOURS, H.E. and SMITH, D.G., (1980). Outbreaks of foodborne disease in the United States, 1972-1978. *J. Infect. Dis., 142* : 122.

SWADDIWUTHIPONG, W., ITTIRAVIVONGS, A., KUNASOL, P. and RERK-NGAM, S., (1988). Surveillance of food poisoning outbreaks in Thailand 1981–1986. *Southeast Asian J. Trop. Med. Pub. Hlth., 19* : 327.

TRISHNANANDA, M., TUCHINDA, C., YIPINSOI, T. and OONSOMBAT, P., (1966). Poisoning following the ingestion of the horseshoe crab (*Carcinoscorpius rotundicauda)* : Report of four cases in Thailand. *J. Trop. Med. Hyg., 69* : 194.

WEEKS, D.E., (1967). Endrin food-poisoning: a report on four outbreaks caused by two separate shipments of endrin-contaminated flour. *Bull. WHO, 37* : 499.