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Scombrotoxic fish poisoning in Britain: features of over 250 suspected incidents from 1976 to 1986

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SUMMARY

Between 1976 and 1986, 258 incidents of suspected scombrotoxic fish poisoning were reported in Britain. Histamine analysis was carried out on 240 fish samples from these incidents, and 101 were found to contain > 5 mg histamine/100 g fish. The symptoms most consistently reported were rash, diarrhoea, flushing and headache. In recent years there has been a decrease in the number of confirmed scombrotoxic outbreaks and a trend towards more sporadic incidents. Of fish samples with > 20 mg histamine/100 g, 94% were from incidents in which scombrotoxic symptoms were characteristic, but where fish had 5–20 mg/100 g only 38% of incidents were clinically distinctive. Guidelines are presented based on the interpretation of quantitative histamine analysis of fish samples from scombrotoxic poisoning incidents.

INTRODUCTION

Scombrotoxic poisoning is a chemical intoxication which occurs as a result of eating food, almost always fish, that contains large amounts of histamine. The name is derived from the so-called scombroid fish of the families Scomberesocidae and Scombridae since these are the fish most commonly implicated. Various species of tuna, bonito and mackerel are included in this group. However, the name scombrotoxic fish poisoning may be misleading since certain types of non-scombroid fish can also be involved, for example sardines, pilchards and herrings.

Histamine is produced in fish by the action of bacterial decarboxylase enzymes on the amino acid histidine, which is present in abundance in dark-fleshed fish (Ferencik, 1970). Freshly-caught fish do not cause poisoning; the presence of histamine is indicative of prolonged storage at elevated temperatures (Behling & Taylor, 1982).

Despite compelling evidence supporting the causative role of histamine in scombrotoxic poisoning, orally administered histamine is surprisingly non-toxic to humans. The presence of potentiators of histamine toxicity in the implicated fish may explain this paradox (Taylor, Hui & Lyons, 1984).

The onset of symptoms is within 10 min to 2 h of consuming the toxic fish. A variety of symptoms can occur, but most patients experience only a few. In general a sharp peppery taste (in its extreme form a burning sensation) is present in the mouth, accompanied by flushing of the face and neck, and a feeling of feverishness. The flushing is often followed by a severe headache, and cardiac palpitations may occur (Arnold & Brown, 1978). Other manifestations include rash of the face and neck, itching, dizziness, diarrhoea, nausea and vomiting. In a study of 26 incidents in Britain the symptoms most frequently experienced were rash, flushing and a burning sensation in the mouth (Murray, Hobbs & Gilbert, 1982).

The earliest recorded incident occurred in 1828 following consumption of bonito by a group of British sailors (Henderson, 1830). The first detailed account in Britain was given by Cruickshank & Williams (1978). Since then the problem has become well recognized in this country and several reports have been published (Gilbert *et al* 1980; Murray, Hobbs & Gilbert, 1982; Turnbull & Gilbert, 1982). Even in countries with good records of foodborne disease, the condition is incompletely reported because it is usually a mild illness of short duration and also because the symptoms are often misdiagnosed as a food allergy. Japan, USA and Britain are the countries with the most reported incidents. Much of the early work on scombrotoxic poisoning was carried out in Japan in the 1950s, since it was a major cause of foodborne disease at that time (Kawabata, Ishizaka & Muira, 1955). Since 1980 there has been a significant decrease in Japanese incidents, which has been attributed to the institution of low-temperature storage of fish (Taylor, Hui & Lyons, 1984). The first incident in the USA was reported in 1968 (Anon, 1975) and since then there have been many reports. The American incidents have usually involved only a few cases in contrast to those in Japan, some of which have been very large. Other countries which have reported scombrotoxic incidents include Australia, Canada, Czechoslovakia, Denmark, the Federal Republic of Germany, Finland, France, Indonesia, Netherlands, Sweden, Turkey and Yugoslavia.

In spite of the controversy regarding the actual role of histamine in scombrotoxic poisoning, the demonstration of high levels of histamine in fish has proved to be a very good indicator of toxicity. Several methods are available for histamine detection in foods, but the most widely accepted are quantitative analytical methods involving extraction, separation and production of fluorometric derivatives (Lerke & Bell, 1976; Taylor, Lieber & Leatherwood, 1978; A.O.A.C, 1980).

MATERIALS AND METHODS

Samples

From October 1976 to December 1986, 258 incidents of suspected scombrotoxic fish poisoning involving 638 cases were reported to the Food Hygiene Laboratory, Colindale, Torry Research Station, Aberdeen or the Communicable Disease Surveillance Centre, Colindale. Samples of fish for histamine determination were obtained from 240 of these incidents and were analysed at the Food Hygiene Laboratory or at the Torry Research Station.

Table 1. *Types of fish involved in 258 suspected incidents of scombrotoxic fish poisoning*

	Number of incidents involving			
	Scombroid fish		Non-scombroid fish	
Year	Mackerel	Tuna	Sardines/ pilchards	Other*
1976	3	—	—	—
1977	1	—	—	—
1978	3	—	—	—
1979	40	1	2	1
1980	11	11	5	1
1981	11	9	3	1
1982	6	11	11	5
1983	8	7	4	10
1984	12	17	3	5
1985	10	6	4	9
1986	6	11	5	5
Total	111	73	37	37

* Other non-scombroid fish: salmon (12 incidents), herring/kipper/sprat/sild (10), crab (4), scampi (2), anchovies (1), gefilte fish (1), lobster (1), smoked cod (1), cod roe (taramasalata) (1), herring roe (1), huss (1), halibut (1), cockles (1).

Histamine analysis

The method of analysis used was based on that described by Taylor, Lieber & Leatherwood (1978). Methanol extracts of fish were subjected to a selective organic extraction procedure highly specific for histamine. The histamine was subsequently condensed with *o*-phthalaldehyde to produce a fluorometric derivative, which was assayed using a spectrofluorimeter (Shore, 1971). Histamine solutions of various concentration were included with each set of samples so that a standard curve could be plotted. Samples were tested in duplicate with their own blank to allow for any non-specific effects caused by the fish extracts. Results were obtained as μg/ml extract and converted to mg/100 g fish. In addition, two fish samples were included with each analysis, one of known histamine concentration and the other histamine-free, to serve as positive and negative controls.

RESULTS

The types of fish involved in the 258 reported incidents are shown in Table 1. Scombroid fish, in this case mackerel which was usually smoked and tuna which was usually canned, accounted for over 70% of all incidents, with half of the non-scombroid fish being of the sardine/pilchard type. Of the other non-scombroid fish involved, salmon and herring were the most frequently reported. It was not until 1982 that non-scombroid fish began to make a major contribution, but since then (with the exception of 1984) they have accounted for approximately 40–50% of suspected incidents each year.

The results of histamine analysis expressed as mg/100 g fish (mg%) are presented in Table 2, where they have been divided into the following categories:

Table 2. *Histamine analysis of fish*

Histamine concentration (mg/100 g fish)	No. of samples: Incriminated fish	Fish from same batch	All fish (%)
> 100	30	23	53 (22)
50–100	12	4	16 (7)
20–50	9	2	11 (4)
5–20	9	12	21 (9)
< 5	93	46	139 (58)
Total	153	87	240 (100)

Table 3. *Incidents of scombrotoxic fish poisoning*

Year	Number of suspected incidents	Number of cases	Number of incidents with > 5 mg % histamine in fish
1976	3	9	2
1977	1	1	—
1978	3	9	1
1979	44	178	29
1980	28	79	16
1981	24	41	14
1982	33	120	14
1983	29	31	10
1984	37	62	6
1985	29	58	5
1986	27	50	4
Total	258	638	101

<5, 5–20, 20–50, 50–100 and > 100 mg%. Histamine levels below 5 mg% are within normal limits for fish stored in ice or at less than 5 °C, but > 5 mg% histamine is indicative of storage at elevated temperatures (Murray, Hobbs & Gilbert, 1982). Of the 240 fish samples analysed for histamine, 101 (42%) contained > 5 mg% and were thus considered to have been mishandled and to be potentially harmful. Samples of incriminated fish were available from 153 of the incidents, of which 39% had > 5 mg% histamine. In 87 incidents where the incriminated fish was unavailable, samples from the same batch or cans with the same code number were analysed. Since 47% of fish from the same batch had > 5 mg% histamine, it would appear that this material was of value for testing.

The 101 incidents confirmed by > 5 mg% histamine are listed by year in Table 3, from which it is apparent that the number has decreased in recent years from 14 in 1982 to 4 in 1986.

The frequency of symptoms described in each of the confirmed outbreaks is given in Table 4. The symptoms most consistently reported were rash, diarrhoea, flushing and sweating, and headache. In any one incident the symptoms of all patients were similar, although each patient did not experience every symptom. Over 80% of incidents involved fewer than 5 persons, with 13 incidents involving 5–10 people and only 5 incidents involving more than 10 people. The largest

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Table 4. *Symptoms associated with scombrotoxic fish poisoning: data from 94* incidents confirmed by > 5 mg% histamine*

Symptoms	No. of incidents	Symptoms	No. of incidents
Rash – bright red	45	Stomach pain	17
Diarrhoea	45	Dizziness	7
Hot flush and sweating	38	Palpitations	3
Headache	37	Swelling of lip, tongue or face	3
Vomiting	30	Shaking and shivering	2
Nausea	27	Tingling	1
Burning in mouth	24	Chest pain	1

* Seven of 101 confirmed incidents had no information regarding symptoms.

outbreak reported affected 80 out of 155 persons following consumption of smoked mackerel containing > 200 mg% histamine.

DISCUSSION

The peak in smoked mackerel incidents in 1979 (Table 1) has been discussed in detail elsewhere (Gilbert *et al.* 1980; Turnbull & Gilbert, 1982), and was attributed in part to increased mackerel landings due to a depleted herring stock caused by overfishing. The following year, 1980, saw an increase in canned fish incidents involving tuna and sardines (Murray, Hobbs & Gilbert, 1982). Whereas the tuna originated from a number of countries, the canned sardines all came from Morocco, and further investigation led to the discovery of unsatisfactory practices in certain Moroccan sardine canneries which have subsequently been rectified (Ababouch, Alaoui & Busta, 1986). In 1982, eight incidents associated with canned pilchards from Peru were reported, also leading to further preventive action.

Although six incidents caused by canned salmon were reported in 1983, five involved fish with less than 1 mg% histamine, despite the presence of characteristic symptoms and incubation period. Salmon from the sixth episode had 17 mg% histamine. Salmon had not previously been associated with scombrotoxic poisoning, and it may be that another toxin causing similar symptoms was responsible. There was apparently no connection with the unexplained, gastrointestinal illnesses caused by canned salmon in 1978, 1979 and 1982, since the symptoms in these were very different (PHLS Communicable Disease Surveillance Centre, 1982).

The decrease over the years in the number of outbreaks with >5 mg% histamine (Table 3) is encouraging, as it implies that previous reports (Gilbert *et al* 1980; Murray, Hobbs & Gilbert, 1982) may have led to an improvement in fish handling and storage procedures. That the number of suspected incidents has not decreased suggests an increasing awareness of fish-associated food poisoning.

Recently there have been more sporadic incidents involving only one person. In such cases symptoms could arise from personal allergies to the fish in question. However, the fish involved are very popular and it seems unlikely that an individual would suddenly find himself allergic to a fish such as tuna. A more likely

Table 5. *Relationship of histamine level to symptoms: data from 55* incidents confirmed by > 5 mg% histamine in the incriminated fish*

Histamine concentration (mg/100 g fish)	Number of incidents involving: Scombroid fish	Non-scombroid fish	All fish
> 100	23 (23) †	5 (5)	28 (28)
50–100	8 (6)	4 (4)	12 (10)
20–50	5 (5)	2 (1)	7 ((6)
5–20	6 (3)	2 (0)	8 (3)
Total	42 (37)	13 (10)	55 (47)

* Five of the 60 confirmed incidents had insufficient information regarding symptoms.
† Numbers in parentheses are of incidents with characteristic symptoms and incubation period (i.e. rash, flushing or burning in the mouth within 2 h).

explanation of sporadic incidents may lie in the very localised distribution of histamine in fish muscle. It has been shown (Lerke *et al*, 1978) that the distribution of histamine in spoiling tuna is quite uneven, varying more than fourfold over a distance of 3 cm in length, and being considerably higher near the gut cavity than at other locations.

In contrast with previous reports (Arnold & Brown, 1978) gastrointestinal symptoms, especially diarrhoea, were frequently experienced (Table 4). However, it is the symptoms of rash, flushing and burning in the mouth that distinguish scombrotoxic poisoning from other foodborne intoxications. Since these symptoms do not occur in all cases, it can be difficult to confirm an incident on a clinical basis alone, though the characteristically short incubation period – 10 min to 2 h – is a significant pointer.

It was sometimes necessary to diagnose the condition on the basis of symptoms and incubation period, and not on histamine level. Of the 18 incidents where no fish was available, 13 were judged to be scombrotoxic on this basis. This also applied to 17 of the 46 incidents from which no incriminated fish was obtained and where samples from the same batch had < 5 mg% histamine (Table 2). However, in incidents where samples causing illness had < 5 mg% histamine, 36 out of 93 also gave a clinical picture indicative of scombrotoxic poisoning, and these represented an interesting group worthy of further study.

Fish were considered to be potentially harmful if more than 5 mg histamine was detected/100 g fish. This was based on previous findings (Murray, Hobbs & Gilbert, 1982) and also on a more recent study in which mackerel and herring stored in ice for 9 days were found to contain < 5 mg% histamine (Torry Research Station, unpublished results). In Table 5 an attempt has been made to clarify the relationship between histamine level and toxicity. Data regarding the presence of characteristic symptoms and histamine concentrations of incriminated fish from 55 incidents are presented. At high histamine levels the symptom match was obviously better than at lower ones. For samples with > 20 mg% histamine the symptom match was good (94%), whereas for samples with 5–20 mg% only 38% of incidents had characteristic symptoms. This direct relationship between amount of histamine and manifestations is further supported by the presence of

only small amounts of histamine in fish not associated with incidents. In a recent investigation of fish products of types associated with scombrotoxic poisoning purchased in the UK, 560 out of 592 (95%) had < 1.5 mg% histamine (Torry Research Station, unpublished results).

These various findings imply that the presence of > 20 mg% histamine in fish is a good indication of its potential to cause scombrotoxic fish poisoning. However, it is necessary to remember that the role of histamine is not fully understood, and that at present there is no explanation of why orally administered histamine fails to cause symptoms in humans, or of why in this present study 36/93 fish samples with < 5 mg% histamine still gave rise to characteristic scombrotoxic fish poisoning symptoms.

Uncertainty regarding the threshold toxic dose has meant an unwillingness to lay down firm regulations regarding permitted levels of histamine in fish. It has rather been the practice in this country, as in many others, simply to offer certain guidelines. The data presented in this paper would support the following recommendations:

< 5 mg% histamine – normal and safe for consumption
5–20 mg% histamine– mishandled and possibly toxic
20–100 mg% histamine – unsatisfactory and probably toxic
> 100 mg% histamine – toxic and unsafe for consumption.

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