CHLORACNE FOLLOWING THE INGESTION OF OLIVE OIL CONTAMINATED WITH POLYCHLORINATED DIBENZO-*P*-DIOXINS AND POLYCHLORINATED DIBENZOFURANS

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ABSTRACT

Analysis of the oil responsible for a familial episode of poisoning by PCDDs and PCDFs in Spain has provided data which can be used to estimate the validity of Toxic Equivalent Factors as they are applied to the development of chloracne in man.

INTRODUCTION

Despite the ubiquity of the polychlorinated dibenzo-*p*-dioxins (PCDDs) and their analogues there are few instances of the occurrence of the characteristic human skin lesion, chloracne[1]. Most episodes of exposure associated with skin toxicity have happened in an industrial environment. Exposure of, and toxicity in, the general populace has occurred following contamination of food oils with polychlorinated dibenzofurans (PCDFs)[2,3,4] or, as at Seveso[5] and Missouri[6], following environmental exposure to 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin (2378-TCDD).

In many instances exposure has been to a complex mixture of congeners of which the individual members vary widely in their toxicity. In order to be able to assess the toxicity of such complex mixtures, various tables of Toxic Equivalent Factors (TEFs) have been published which allow the toxicity of any PCDD or PCDF congener to be related to that of the most toxic isomer, 2378-TCDD itself[7,8,9].

Only in one or two episodes has it been possible to obtain reasonable estimates of the doses of PCDDs or PCDFs required to produce symptoms in humans. In most cases the exposure took place either before monitoring was feasible or as a consequence of a major accident. In this presentation we describe an incident in which a family was poisoned by consumption of an oil containing PCDDs and PCDFs. From analyses of the oil and of serum from the patients it has been possible to estimate the dose which members of the family received and to assess the validity of the TEFs used for various PCDD and PCDF isomers.

DESCRIPTION OF THE EPISODE

In September 1982 the members of a family presented at the Dermatology clinic in Seville. All, the father, the pregnant mother, three sons 4 – 12 years old and three daughters 3 – 11 years old, were affected to varying degrees with acneiform lesions which had appeared in July or August 1982.

The eldest boy was the most severely affected, with widespread papules, pustules, cysts and comedones. These were located on the face, covering the forehead, eye-lids, chin and the malar crescent, behind the ears, on the neck and thorax and in the axillae and groin. There was also hyperpigmentation of the face. During September 1982 he had been admitted to hospital with vomiting, oedema of the eye-lids and a transitory renal failure.

The father, aged 42, presented with lesions in the same areas as his eldest son and, in addition, with lesions of the flexural surface of the elbows, the shoulders, the back and of the genitals. He had both hyperpigmentation and hypertrichosis of the face. Coinciding with the chloracne this patient had suffered with severe respiratory symptoms.

The mother, aged 39 years, had only a slight acneiform lesion on the nape of the neck. She subsequently gave birth to a boy who was admitted to hospital a few days after birth with convulsions of unknown origin. The mother was advised to cease breast-feeding and there has been no recurrence of the convulsions. The boy now exhibits a retardation of growth.

The chloracne of all the patients, other than the father, had disappeared by November 1983. The father took a few more months to recover.

ORIGINS OF THE TOXICITY

Enquiries revealed that the family had stored their olive oil in a plastic container. The oil had been used for cooking and on salads between December 1981 and October 1982. The container had an estimated volume of 50 litres and had been used for the storage of materials other than the oil beforehand. Preliminary analysis of the oil in Spain indicated that it contained hexachlorobenzene. Further analysis at Carshalton confirmed the presence of hexachlorobenzene (538 ppb) and pentachlorophenol (2620 ppb) and detected the presence of polychlorinated dioxins. A full gc/ms analysis at Umeå indicated that the oil contained many toxic 2,3,7,8-substituted PCDDs and PCDFs (see Table).

A pooled sample of serum from the family was analysed for PCDDs and PCDFs approximately 5 years after the chloracne developed. PCDDs and PCDFs were detected in the sample (see Table).

Table: PCDD and PCDF content of the chloracneigenic Spanish oil and of the lipids from a pooled serum sample taken from the patients.

Isomer	Olive oil (ng/g)	Serum lipid (pg/g)
2378-TCDD	0.15	ND*
Other TCDDs	1.66	–
12378-PeCDD	1.38	109
Other PeCDDs	10.5	–
123478-HxCDD	1.10	306
123678-HxCDD	5.50	1262
123789-HxCDD	9.05	1293
Other HxCDDs	83.0	–
1234678-HpCDD	402	40330
Other HpCDDs	1037	–
OCDD	72747	936320
2378-TCDF	0.01	NQ†
Other TCDFs	0.10	–
12378-PeCDF	0.03	–
23478-PeCDF	0.03	48
Other PeCDFs	2.60	–
123478-HxCDF	0.05	58
123678-HxCDF	ND	ND
234678-HxCDF	0.76	56
Other HxCDFs	16.6	–
1234678-HpCDF	32.4	730
Other HpCDFs	11.2	–
OCDF	141	814

* Not detected

† Not quantified due to blank problems

DISCUSSION

The various members of the family displayed the skin lesions characteristic of chloracne. The severity of the lesions and their distribution are consistent with the consumption of toxic material over a considerable period of time. The rapid recovery of the younger members of the family, following removal of the source of exposure, is paralleled by the rapid recovery of children at Seveso. The association of renal toxicity with dioxin exposure is unusual.

From the analysis it is possible to calculate the toxic equivalents of 2378-TCDD (TEQs) present in the oil. This gives figures of 1.59, 79.7 and 79.7 ng TEQs of 2378-TCDD/g of oil using the TEFs of Barnes *et al.*[7], the Nordic nations[8] and NATO[9] respectively. The large difference between these figures can be attributed to the adoption, by the latter two schemes, of a TEF of 0.001 for octachlorodibenzo-*p*-dioxin (OCDD) based on the data of Birnbaum and her co-workers[10].

By making the assumption that the amount of oil consumed by each member of the family is proportional to the caloric requirement of a person of their age it is possible to make estimates of the mass of 2378-TCDD TEQs consumed. For the eldest boy, the most severely affected, this can be converted to a total dose, taken over a period of 10 months, equivalent to either 0.27, 13 or 13 μg 2378-TCDD/kg body weight. This would correspond to a dosage of *ca* 0.9, 43 or 43 ng/kg body weight/day.

On the basis of the levels of PCDD and PCDF analogues found in the serum, and using published values of the half lives, it was possible to back-calculate to the dose absorbed at zero time. The dose values derived by this method agreed very well with those calculated above.

The first of the dosage values, derived using the 1986 EPA TEFs[7], is very close to estimates of toxic doses of PCDDs and PCDFs based on the Yusho episode[11] and of 2378-TCDD itself from an unpublished EPA study. The estimates based on the later values of the TEF for OCDD are about 50-fold higher.

CONCLUSION

The observed discrepancy between, a) the toxicity of the Spanish olive oil sample, and b) the TEQs present in the sample as calculated by methods which apply a TEF for OCDD of 0.001, suggests that this TEF should be reconsidered.

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