CC/08/15

COMMITTEE ON CARCINOGENICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

UPDATE REVIEW OF CANCER INCIDENCE NEAR MUNICIPAL SOLID WASTE INCINERATORS

Introduction

1. COC is asked to advise whether revision of the 2000 COC statement on Municipal Solid Waste and cancer is required in the light of recent published studies.

Background

2. In March 2000, COC published a statement on municipal solid waste incinerators and cancer (Cancer incidence near municipal solid waste incinerators in Great Britain, COC statement COC/00/S1, Annex A). The statement concluded that

"*The Committee was reassured that any potential risk of cancer due to residency (for periods in excess of 10 years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern epidemiological techniques. The Committee agreed that, at the present time, there was no need for any further epidemiological investigations of cancer incidence near municipal solid waste incinerators.*"

3. The by-products of the incinerator process may contain hazardous or toxic pollutants and emissions will contribute to background pollution levels. Since 1996 there have been significant cuts in emissions from incinerators in order to meet strict limits set by European Union Legislation. The European Union Waste Incineration Directive (often termed "WID" 2000/76/EC) which applies to the incineration and co-incineration of both hazardous and non-hazardous waste will further reduce the potential to pollute. The WID requires the setting and maintaining of stringent operational conditions, technical specifications and emission limit values for plants incinerating and co-incinerating waste throughout the European Community. This transposed into UK law on the 28th Dec 2002 and the WID has applied to new incinerators since the end of 2002. Older incinerators had until 28th Dec 2005 to meet these standards. The new directive aims to reduce and/or prevent possible negative effects on the environment caused by emissions into air, soil, surface water and groundwater and thus lessen the risks which these pose to human health. The protocol on persistent organic pollutants signed by the Community within the framework of the United Nations Economic Commission for Europe (UN-ECE) Convention on long-range transboundary air pollution sets legally binding limit values for the emission of polychlorinated-*p*-dibenzodioxins and polychlorinated-*p*-dibenzofurans (PCDDs and PCDFs) of 0.1 ng/m^3 TEQ (Toxicity Equivalents) for installations burning more than 3 tonnes per hour of municipal solid waste, 0.5 ng/m^3 TEQ for installations burning

more than 1 tonne per hour of medical waste, and 0.2 ng/m^3 TEQ for installations burning more than 1 tonne per hour of hazardous waste. The WID 2000/76/EC also outlined emission limit values (ELV, the mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time) for a number of other pollutants including dust, TOC, HCl, HF, SO_2, NO_X, Hg, Cd and TI and heavy metals. These ELV are outlined in Table 1.

4. There have been a number of publications since the last review by the COC in 2000 of the data on cancer incidences in individuals living close to municipal solid waste incinerators. DEFRA published a report in May 2004 entitled "Review of Environmental and Health Effects of Waste management: Municipal Solid Waste and Similar Wastes". The report found no evidence of a link between the rates of cancer and the current generation of incinerators, nor any "convincing" evidence that emissions from modern landfill sites harm health. In 2005, a report entitled "The Health Effects of Waste Incinerators" was published by the British Society for Ecological Medicine (BSEM). This report indicated that large studies have shown higher rates of adult and childhood cancer around Municipal Solid Waste Incinerators (MSWI), supported by a number of smaller epidemiological studies. The report concluded that new facilities emitting substantial quantities of fine particulates, volatile heavy metals and hazardous organic pollutants should not be approved and that urgent measures should be taken to reduce the emissions from waste burning installations. The Health Protection Agency (HPA) responded to the BSEM report, outlining a number of deficiencies, including the failure to conduct a systematic review of the literature, to consider the Defra review on environmental and health effects of waste management, the COC statement on cancer incidence near municipal waste incinerators in Great Britain and the Royal Society critique of the Defra report.

Summary of recent epidemiology studies

5. Six further relevant epidemiological papers have been published since the 2000 COC statement. These were identified from a literature review of human studies published from 2000 to May 2008. They are reviewed here and summarised in the attached table (Table 2). These studies consider childhood cancers, soft-tissue sarcomas (STS) and non-Hodgkin's lymphoma, and breast cancer.

Childhood cancers

6. Several studies by Knox have examined a possible association between childhood cancers and industrial emissions including those from incinerators. In the most recent study, Knox (2000) carried out an analysis of the birth and death addresses of children diagnosed with cancer using a technique that compares distances from suspect sources to the birth addresses and to the death addresses of cancer-children who have moved house. The child-cancer/leukaemia data showed a significant migration asymmetry around municipal waste incinerator sites demonstrated by a highly significant excess of migration away from birthplaces close to the municipal incinerators (RR = 1.27 for distances $\leq$ 3 km; $p<0.005$). Relative risks within 5 km of these sites were about 2:1. The study showed a greater incidence in cancer in children born close to incinerators and moving away than in those who were born further away and who moved closer to

an incinerator. The Defra report notes that the work is liable to criticism on the grounds that there is no information provided on the net migration of total population inwards and outwards from the vicinity of the plants and therefore no control for temporal changes in population densities. The COC has reviewed a number of other papers by Knox and given little weight to the studies.

Soft-tissue sarcomas (STS) and non-Hodgkin's lymphoma

7. In 1994, the EU limited PCDD and PCDF emissions from MSWI to 0.1 ng I-TEQ (International Toxic Equivalents)/m^3. In a press release in 1998, the French ministry of Environment revealed that dioxin emissions from a MSWI in Besancon (France) were 16.3ng I-TEQ m^{-3}. This MSWI was located in an area covered by a population-based general cancer registry, prompting Viel et al. (2000) to examine the spatial distribution of soft-tissue sarcomas and non-Hodgkin's lymphoma around this MSWI. Between 1980 and 1995, 110 cases of soft-tissue sarcoma were diagnosed, corresponding to a crude incidence rate of 1.4 per 100,000. The study found a significant cluster ($p = 0.004$) around the MSW incinerator which was made up of two specific areas, one which contained the MSW incinerator and one west of the plant and contiguous to the former. An excess of 14 cases was observed with a standard incidence rate of 1.44 with a 95% confidence interval [CI] of 1.1–1.9 (observed 45: expected 31). When the data was analysed according to gender, the findings were only significant for males ($p= 0.004$). For NHL, between 1980 and 1995, 803 cases were diagnosed, yielding a crude incidence rate of 10.4 per 100,000. A significant cluster ($p= 0.0003$) was found in the same areas as STS. An excess of 61 cases was observed with a standard incidence rate of 1.27 with 95% CI of 1.1–1.4 (observed 286: expected 225). The findings were consistent across gender ($p=0.04$ and $p=0.0004$ for males and females, respectively). It should be noted that the study did not take into consideration socio-economic status as a contributing factor and there were other uncertainties, due to the low spatial resolution of clusters. Furthermore, these results are not consistent with the results of a more detailed epidemiological study by Elliott et al (1996), which did not find any association between soft-tissue sarcoma and non-Hodgkin's lymphoma and distance from municipal solid waste incinerators (cited in Defra, 2004).

8. One of the discussion points raised by Viel et al (2000) was the need to exercise caution with linking dioxin release by the MSWI and clusters of NHL and STS without further investigation into this issue. To explore the environmental route suggested by the findings, Floret et al. (2003) carried out a population-based case-control study on the population living around the MSWI in Besancon, focusing on NHL. To estimate dioxin exposure the study used data published in 1999, which used a second-generation Gaussian-type dispersion model that allowed the three-dimensional modelling of the transport and dispersion of dioxin emissions. The areas were classified as very low (modelled ground-level dioxin concentration <0.0001 pg/m^3 zone), low (modelled ground-level dioxin concentration 0.0001–0.0002 pg/m^3 zone), intermediate (modelled ground-level dioxin concentration 0.0002–0.0004 pg/m^3 zone) and high (modelled ground level dioxin concentration 0.0004–0.0016 pg/m^3 zone) exposure areas. During the 16-year study period, 225 NHL cases were diagnosed, corresponding to a mean age-standardized (world) incidence rate of 14.9 per 100,000 for the 1980–1995 time period. The age-standardized (world) incidence

rate for France as a whole was estimated at 7.8 per 100,000 in 1995. They compared 222 cases (225 cases identified, address matching was successful for 222 cases with 3 medical records having incomplete address information) of NHL diagnosed between 1980 and 1995 and controls randomly selected from the 1990 population census, using a 10 to 1 match. Eighty percent of non-Hodgkin's lymphoma cases occurred within the 1990 ± 5 year time period and the proportion of males was 51%. The conditional logistic regression analysis showed that individuals living in the highest exposed zone were 2.3 times more likely (CI = 1.4–3.8) to develop NHL than were individuals living in the very low emission area. Low and intermediate exposure categories did not exhibit an excess risk. Results were adjusted for a wide range of socio-economic characteristics. It should be noted that no measured exposure data were available and the levels of dioxins predicted from the emissions were far below the usual urban and rural background for dioxins.

9. A case control study by Comba et al (2003) evaluated the association between the occurrence of soft tissue sarcoma in Mantua, Northern Italy and residence near an incinerator of industrial waste. Cases were subjects with histologically confirmed primary malignant STS diagnosed between 1989 and 1998 in the population resident in Mantua and three neighbouring municipalities. The study includes 37 STS cases (17 men and 20 women) aged 26-85 years and 171 controls (82 men and 89 women) aged 24-90 years. The annual incidence of STS in the area of the study was estimated as 5.0 per 100,000 in men and 5.1 per 100,000 in women. The main finding of this study was a statistically significant increase in the occurrence of STS in the population living closest to the industrial incinerator. Evaluated by logistic regression, the odds ratio associated with residence within 2 km, standardised by age and sex, was 31.4 (95% CI 5.6 to 176.1), based on five exposed cases. At greater distances, risk rapidly decreased, showing a fluctuation around the null value of 1. When the distance of the main residence from the incinerator was considered as a continuous variable, a non-significant decrease in risk with increasing distance was observed (OR 0.90; 95% CI 0.73 to 1.1).

10. Zambon et al. (2007) evaluated sarcoma risk in relation to the environmental pollution caused by PCDD and PCDF emissions from waste incinerators and industrial sources of airborne PCDD and PCDF within the Province of Venice. The study population resides in a part of the Province of Venice (Italy) where a population based cancer registry (Veneto Tumour Registry) has been active since 1987. The study took into consideration all waste incinerators and industrial sources of airborne PCDD and PCDF in the Province of Venice and also a large municipal waste incinerator outside the area but close to the boundaries. The emission levels were calculated through a historical reconstruction of the technology used by each plant and the quantity and quality of the waste/refuse treated. The Industrial Source Complex Model in long term mode, developed by the US EPA, was used to assess the level of atmospheric dispersion of the polluting substances. A specific value for exposure was calculated for each point (geo : referenced address); the value of each address in a given year is the sum of the values calculated for the plants that were active during that year and were located within a 50 km radius. The exposure value for each subject is the average of the values of the single addresses, weighted by time (values are expressed in WHO TEQs. The study took into account 172 cases and 405 controls. Risk of sarcoma increases in relation to both the duration and the extent of

exposure and is statistically significant in the group with the longest period and highest level of exposure (OR 3.30, 95% CI: 1.24 - 8.76). In both sexes, risks increased in relation to the level of exposure but reached statistical significance only for women (OR 2.41, 95% CI 1.04 - 5.59, P< 0.04). In the most exposed cases, there was a significant risk excess for connective and other soft tissue cancers (International Classification of Disease ICD-IX 171) with an OR = 3.27, 95% CI, 1.35 - 7.93.

Breast cancer

11. A further study by Viel et al (2008) examined the association between PCDDs and PCDFs emitted from a MSWI in Besancon, France and invasive breast cancer risk among women living in the area 'under direct influence' of the facility. From 1996 to 2002, a total of 434 invasive breast carcinomas were diagnosed in the northeast side of the city of Besançon, and 2170 population controls were therefore randomly selected. A validated dispersion model was used as a proxy for dioxin exposure, yielding four exposure categories. These cases corresponded to an age-standardized (world) incidence rate of 81.4 per 100,000, to be compared to the age-standardized (world) incidence rate of 90.4 per 100,000 for France, as estimated in 2000 (comparative morbidity figure [CMF] = 0.90, 95% CI, 0.81–1.00), and the age-standardized (world) incidence rate of 76.9 per 100,000 for the Doubs region that comprises the city of Besançon (CMF = 1.06, 95% CI, 0.95–1.18). The age distribution at diagnosis for all breast cases combined showed a bimodal pattern with incidence peaks near ages 50 and 70 years. Among women aged less than 60 years old, no increased or decreased risk was found for any dioxin exposure category. Conversely, for ages 60 years and over, women living in the highest exposed zone were 0.31 times less likely (95% CI, 0.08–0.89) to develop invasive breast carcinoma than women living in the very low emission area, with no relative risk estimate different from one for the other dioxin risk categories.

Discussion

12. Positive associations were found for non-Hodgkins lymphoma, soft tissue sarcomas and childhood cancers and MSWI in a number of the papers presented here. No association or a decreased association was observed for invasive breast cancer and dioxin emissions from a MSWI in Viel et al. (2008). It is noted that whilst these studies can provide evidence of an association between a health outcome such as cancer and an environmental pollutant, they cannot, by themselves, demonstrate a cause and effect relationship. The interpretation of these types of studies is often dependent on well-known limitations, including the possible sources of bias and confounding, together with the difficulty in obtaining reliable and accurate population exposure data.

13. The International Agency for Research on Cancer classified TCDD, the most potent of the dioxins, as a known human carcinogen. Dioxins are 'non-genotoxic' carcinogens, for which it is possible to establish a threshold of toxicity, below which there will be no adverse effect upon health. The IARC evaluation was based primarily on four cohort studies of herbicide producers and one cohort of residents in a contaminated area from Seveso, Italy. The relative risk for all cancers combined in the most highly exposed and longer-latency sub-cohorts is 1.4 (IARC, 1997). Comparing

the results obtained from exposures other than from MSWI, researchers have estimated that some epidemiology studies have shown an increased risk of cancer, notably soft-tissue sarcoma and non-Hodgkin's lymphoma, in populations occupationally or accidentally exposed to chemicals contaminated with dioxins (Saracci et al., 1991; Mukerjee et al., 1998). An increased risk for non-Hodgkin lymphoma was found in most of the populations studied in the four industrial cohort studies and in the Seveso population in the IARC evaluation in 1997, although the relative risks were mostly non-significant and below 2. These findings are in line with those from a study of the largest overall cohort of TCDD-exposed workers, where it was found that mortality from STS and NHL among workers was higher than expected from national mortality rates, although non-significantly for the latter type of cancer (SMR = 2.03, 95% CI, 0.75 – 4.43 for STS; SMR = 1.39, 95% CI, 0.89 – 2.06 for NHL) (Kogevinas et al., 1997).

Advice requested from COC

14. The committee is asked to consider the attached paper and to address the following questions:

What are member's views on the recently published epidemiological studies reviewed here?

COC is asked to advise whether revision of the March 2000 COC statement on Municipal Solid Waste Incinerators and cancer is required in the light of these recent published epidemiological studies.

Secretariat
June 2008

References:

British Society of Ecological Medicine (2005). The Health Effects of Waste incinerators. http://www.ecomed.org.uk/content/IncineratorReport.pdf

COC statement COC/00/S1. Cancer incidence near municipal solid waste incinerators in Great Britain. March 2000.
http://www.advisorybodies.doh.gov.uk/coc/munipwst.htm

Comba P, Ascoli V, Belli S, Benedetti M, Gatti L, Ricci P, Tieghi A. (2003). Risk of soft tissue sarcomas and residence in the neighbourhood of an incinerator of industrial wastes. Occup Environ Med. 2003 Sep;60(9):680-3.

Defra, Review of environmental and health effects of waste management: municipal solid waste and similar wastes, May 2004.
http://www.defra.gov.uk/environment/waste/research/health/pdf/health-report.pdf

Floret N, Mauny F, Challier B, Arveux P, Cahn JY, Viel JF. (2003) Dioxin emissions from a solid waste incinerator and risk of non-Hodgkin lymphoma. Epidemiology. 2003 Jul;14(4):392-8.

HPA (2005) http://www.ecomed.org.uk/content/IncineratorHPA.pdf

Knox E.(2000) Childhood cancers, birthplaces, incinerators and landfill sites. Int J Epidemiol. 2000 Jun;29(3):391-7.

Kogevinas et al., 1997. M. Kogevinas, H. Becher, T. Benn, P.A. Bertazzi, P. Boffetta, H.B. Bueno-de-Mesquita, D. Coggon, D. Colin, D. Flesch-Janys, M. Fingerhut, L. Green, T. Kauppinen, M. Littorin, E. Lynge, J.D. Mathews, M. Neuberger, N. Pearce and R. Saracci, Cancer mortality in workers exposed to phenoxy herbicides, chlorophenols, and dioxins. An expanded and updated international cohort study. *Am. J. Epidemiol.* **145** 12 (1997), pp. 1061–1075.

Mukerjee D. (1998) Health Impact of Polychlorinated Debenzo-p-dioxins: A Critical Review. J Air Waste Manage Ass 48(2), pp.157-165.

Royal Society review of DEFRA's health and environmental effects of waste management options report, March 2004.
http://www.royalsoc.ac.uk/displaypagedoc.asp?id=11459

Saracci R, Kogevinas M, Bertazzi PA, Bueno de Mesquita BH, Coggon D, Green LM, Kauppinen T, L'Abbé KA, Littorin M, Lynge E, et al (1991). Cancer mortality in workers exposed to chlorophenoxy herbicides and chlorophenols. Lancet, 338(8774): 1027–1032.

Viel JF, Clément MC, Hägi M, Grandjean S, Challier B, Danzon A.(2008) Dioxin emissions from a municipal solid waste incinerator and risk of invasive breast cancer: a population-based case-control study with GIS-derived exposure. Int J Health Geogr. 2008 Jan 28;7:4

Viel JF, Arveux P, Baverel J, Cahn JY. (2000) Soft-tissue sarcoma and non-Hodgkin's lymphoma clusters around a municipal solid waste incinerator with high dioxin emission levels. Am J Epidemiol. 2000 Jul 1;152(1):13-9.

Zambon P, Ricci P, Bovo E, Casula A, Gattolin M, Fiore AR, Chiosi F, Guzzinati S.(2007)Sarcoma risk and dioxin emissions from incinerators and industrial plants: a population-based case-control study (Italy). Environ Health. 2007 Jul 16;6:19.