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Citizens for a Better Spring Hill

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New EnSafe Data Reveals Health Hazard from Proposed Crematory

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The data from the new EnSafe report makes it clear: **During cremations of bodies with numerous fillings, mercury concentration will rise above safe levels** in areas surrounding the proposed crematory. (You can download the entire EnSafe November 2011 Report here.) Despite the report's stated conclusion that "the risk of adverse public health impacts" is low, examining the data from a new EnSafe report commissioned by the City clearly shows specific instances when mercury concentrations will be far higher than levels considered safe.

According to EnSafe's own report, **mercury concentrations could reach a staggering 283% and as much as 367% of safe levels** in some locations under the right circumstances. While cremations containing 3 or fewer mercury amalgam fillings will produce mercury concentrations generally considered low and relatively safe, that's not the case for cremations containing larger numbers of mercury fillings. The highest levels in the report would be reached in situations where the body contained the equivalent of 17 mercury amalgam fillings.

However, the data in the report reveals that in some areas **safe levels could be exceeded by cremations with as few as 4.7 mercury amalgam fillings.** We asked the question, "If it takes 17 mercury fillings to reach a whopping 367% of safe levels, how many fewer mercury fillings would it take to just exceed safe levels?" The data to produce such calculations is available in the EnSafe report, and reveals the following:

- **Every time a single body with 12.7 or more fillings is cremated, Mercury concentration in the Witt Hill neighborhood will rise above the 1-hour acute reference exposure level** — that's the level below which immediate adverse health effects are not expected to occur for adult humans. Just one cremation with 12.7 fillings exceeds that safe level.
- **Every time there are three cremations in any 8-hour period, and those bodies contain an average of 4.7 mercury fillings each, levels in EnSafe's "entire modeling domain" will rise above the 8-hour acute reference exposure level** and could produce immediate health effects for adult humans in the vicinity.
- **Every time three cremations occur in any 8-hour period that contain an average of 6.2 or more fillings per body, levels in the Witt Hill neighborhood will rise above 8-hour acute reference exposure** or "safe levels" and should be expected to produce immediate health impacts for people who live there.
- **Every time three cremations happen in any 8-hour period that contain an average of 8.1 fillings or more per body, levels at the First Baptist Church** will rise above the 8-hour acute reference exposure or "safe levels" and adverse health effects should be expected for people exposed.

We're the first to admit that these scenarios will probably not happen every day. **But they WILL happen, the question is merely HOW OFTEN?** At first, we should expect that such scenarios might only happen a few times a year — that's still enough to produce adverse health effects. But as the cremation rate rises and business grows, the frequency at which the crematory will produce dangerous levels of mercury will grow.

And here's the kicker: The safe level for children is likely far lower. The exposure levels above are for healthy adults, the actual levels of mercury concentration needed to affect children or other sensitive populations is conceivably far smaller (EnSafe documents this reality, see pg. 18 of the study).

Oh, and if that's not enough, EnSafe has this to say about the short-term reference levels used in their calculations, "Mercury accumulates in the body, so short-term repeated exposures could result in toxic effects that are unanticipated by the OEHHA short-term REL which could result in an understatement of risks" (pg. 18). **Let me translate: Continual low-dose exposure to mercury might produce health effects even if the short-term "safe level" is never exceeded.**

Is this crematory safe? Sure, some of the time. But as Citizens for a Better Spring Hill has stated since June, there are circumstances under which it's not safe, and sensitive populations for whom it's rarely safe. Our position has been the same, and the EnSafe report validates our concerns.

We hope you'll join us THIS MONDAY, 7:00 p.m. at City Hall for the Board of Mayor and Aldermen work session. We have the evidence. It's now confirmed that this proposed crematory is a danger to citizens of Spring Hill. Join us as we request that BOMA either requires mercury filtration or else rejects the proposal outright.

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Review article

Toxic emissions from crematories: A review

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ABSTRACT

In recent years, the cremation ratio of cadavers has increased dramatically in many countries. Crematories have been identified as sources of various environmental pollutants, being polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), and mercury those raising most concern. In contrast to other incineration processes for which the number of studies on their toxic emissions is considerable, references related to PCDD/F and mercury emissions from crematories and their health risks are very limited. In this paper, the scientific information concerning these issues, using the databases PubMed, Scopus and Scirus, is reviewed. Results show that in comparison with PCDD/F emissions from other sources, those corresponding to crematories are significantly lower, while those of mercury should not be underrated.

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1. Introduction: incinerators, crematories and toxic emissions

Nowadays, there are more than 1000 crematories in Europe (United Kingdom: 250, France: 125, Spain: 132, Sweden: 68, etc) being the percentage of cremations approximately 37% (ICS, 2006). In 2006, the total number of cremations in Europe was more than 1,500,000 (ECN, 2008). In turn, the countries with the highest number of crematories are China and Japan, with 1549 and 1500, respectively (data from 2006) (ICS, 2006). The pollutants emitted by the combustion of organic matter with presence of other trace elements are: combustion gases (NO_x, CO, SO_2, PM....), heavy metals, and polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), among other persistent organic pollutants. Heavy metals and PCDD/Fs, stand out because of their toxicity and capacity for bioaccumulation, which means potential risks for human health. Because of their toxicological properties, together with their persistence capacity, PCDD/Fs were listed by the Stockholm Convention on Persistent Organic Pollutants of 2001 as one of the "dirty dozen" pollutants whose levels should be significantly reduced. With regard to heavy metals, although most elements may be removed from crematory emissions through particulate control devices (EDL, 2006), as the concentrations of mercury may be considerable in human bodies due to the use of dental amalgam fillings, special attention should be paid to this toxic metal.

Environmental policies are becoming more and more stringent with respect to the emission limits of potentially toxic pollutants. However, monitoring surveys are important in order to ensure the proper working of cleaning systems, to control the environmental levels, to assess environmental exposure, to evaluate health risks associated with different pollutant sources, and to identify the relative importance emission sources into the atmosphere in order to adopt

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the necessary measures to protect the environment and the human health. In that context, ambient air monitoring is an essential issue to estimate pollutant emissions such as PCDD/Fs and mercury.

In humans, most PCDD/F and heavy metal body burden comes from the ingestion of contaminants (Parzefall, 2002; Llobet et al., 2008). Some physiologically based pharmacokinetic models have been applied to predict the PCDD/F levels in human tissues (including blood) on the basis of the ingestion of PCDD/Fs through food and human milk. These models are useful not only to investigate past, present, and future trends, but also to help in human health risk assessment due to PCDD/F intake. Using one of these models, Aylward and Hays (2002) reported that absorbed intake levels of 2,3,7,8-TCDD decreased from 1972 to 2002 by more than 95%. Notwithsatnding, and taking into account that food contamination is a direct consequence of the bioaccumulation of pollutants through the food chain, it is important to assess the contribution of the different activities to the environmental concentrations.

In contrast to incinerators, only a few studies have been published on PCDD/F emissions from crematories (Hutzinger and Fiedler, 1993; Takeda et al., 2000, 2001; Luthardt et al., 2002; Wang et al., 2003). Although human cremation is an increasing practice, the number of studies regarding the potential risks derived from crematory emissions is very scarce in relation to the most dangerous compounds (PCDD/Fs and mercury), being even non-existent for other compounds such as NO_x, CO, SO_2, PAHs, etc. In this context, further research on crematories is necessary. In the following sections the information currently available regarding this issue is presented and discussed.

1.1. Incinerators

In recent years, incineration has become one of the most widely used alternatives for waste management. This process is considered by regulators as a strategic option for waste reduction and disposal (Richter and Johnke, 2004; Kollikkathara et al., 2009). In comparison with other waste treatments, incineration presents advantages such as volume reduction, energy recovery, and elimination of pathogen agents (Kuo et al., 2008). However, the public opinion of most developed countries is frequently concerned about the installation of municipal, hazardous, and medical waste incinerators (Domingo, 2002; Singh and Prakash, 2007). Among the pollutants emitted by waste incinerators, PCDD/Fs have generated a lot of controversies (Schuhmacher and Domingo, 2006), mainly because they are among the most toxic environmental compounds (Kogevinas, 2001; Steenland et al., 2004; Mandal, 2005). Although PCDD/Fs, usually referred to as dioxins, are generally produced in many combustion processes (Kulkarni et al., 2008; Zheng et al., 2008; Shen et al., 2009), until a few years ago, incinerators were catalogued as one of the most important sources of toxic emissions, not only PCDD/Fs but also heavy metals (Shibamoto et al., 2007; Zheng et al., 2008). Therefore, incineration has received prolonged special attention, and the concern raised has had significant implications in current regulatory practices (Franchini et al., 2004; Lonati et al., 2007; Kim et al., 2008). Intensive studies have been conducted on various PCDD/F emission sources, including the waste combustion sources, chemical-industrial sources, and other thermal sources.

The installation of modern cleaning technologies to comply with the maximum emission level of PCDD/Fs, established by the European Directive in 0.1 ng I-TEQ/Nm^3 has substantially minimized the environmental impact of incinerators (Glorennec et al., 2005). Although incinerators have traditionally been pointed out as important air emitters of PCDD/Fs (Quass et al., 2004; Kim et al., 2008; Wang et al., 2009), there are many other industrial (cement kilns and power plants) and diffuse (vehicle emissions, domestic coal/wood combustion and natural fires) sources also emitting these pollutants (Fuster et al., 2001).

A number of recent studies have demonstrated that emissions of toxic pollutants from modern municipal solid waste incinerators (MSWIs) have a relatively low environmental impact in comparison with other alternatives of waste disposal or different industrial activities (Domingo, 2002; Schuhmacher and Domingo, 2006; Kao et al., 2007). Although human exposure to PCDD/Fs mainly occurs via food consumption, and more specifically through the ingestion of fatty foodstuffs (Domingo and Bocio, 2007; Llobet et al., 2008), environmental exposure to PCDD/Fs must not be neglected. Among the different pathways of direct exposure to these pollutants, inhalation seems to be the most important route (Nadal et al., 2004).

1.2. Crematories

Although crematories of human beings are also combustors, from a legal/regulatory point of view, these facilities are not considered as incinerators. A human crematory contains one or more combustion units known as cremators, used solely for the cremation of human bodies within appropriate containers. With respect to the potential PCDD/F emissions from crematories, it must be noted that these compounds are formed during combustion processes when chlorinated products such as plastic are burned. In crematories, these plastics may be present as prosthetics or as part of the container. The body also contains a percentage of chlorine, and thus cremation produces PCDD/Fs. Moreover, when waste wood is burnt, the level of PCDD/Fs in the flue gas emissions has been reported to be significantly lower than that derived from other sources (Lavric et al., 2004). Even non-treated wood contains small amounts of chlorine. It means that PCDD/F emissions might be only minimized, but not eliminated (Salthammer et al., 1995). PCDD/Fs are created on particles of soot that enable the hazardous chemical to travel from the incineration site. These particles will eventually settle out onto land (Suzuki, 2007). Contaminated grass enables PCDD/Fs to enter the food chain and it will ultimately be consumed by humans and stored in body fat.

Mercury is another environmental pollutant usually emitted during incineration (Llobet et al., 2002; Ferré-Huguet et al., 2007; Muenhor et al., 2009). In crematories, mercury enters the process because it is present in the body being cremated. Although mercury is only the thirty-sixth most abundant element in the body (at 6 mg for the average body), there is a source of mercury that means serious concern. Fillings made with dental amalgam contain more than 0.5 g of mercury. This metal will leak from these fillings because of mercury's low vapor pressure and add to the mercury levels already present in the body. The intense temperatures of cremation cause the mercury present in the fillings to volatilize, and added to the mercury present in the body may give place to a release of relatively large amount of this toxic metal. Studies have found as much as 200 µg/m^3 of mercury during the cremation process of a body with dental amalgam fillings (DEFRA, 2003).

Cremators are usually made of high-grade steel plate and lined inside with heavy refractory tile or brick. Most cremators have a variety of automatic controls and use gas for heating the cremator. As a result of the Clean Air Act of 1990, the US EPA first classified crematories as medical waste incinerators, and later as OSW ("Other Solid Waste") incinerators. After an intensive, costly and aggressive testing project in 1999 on working crematories that covered most types of emissions, including particulate matter, carbon monoxide, and mercury, done jointly with the Cremation Association of North America and reviewing information presented, the US EPA decided not to regulate human or animal crematories. As a result of the US Cremation Association's meeting with the US EPA in November 1991, it became known that the original regulations proposed for crematories were based on no actual test data. This inspired the US Cremation Association to have substantial testing performed to increase everyone's knowledge base. This testing was completed in 1999 and the data became US EPA's foundational information in their national emissions inventory (CANA, 2009).

Among the concerns raised by crematories, there does not appear to be any risk to the environment or the operator under normal conditions, when cremating someone who has been treated with radiation therapy. Generally, radioactive implants are removed prior to the cremation. Cremation of radio-nuclides, or radioactive "seeds," that might remain in a body does not pose a problem due to the rather small number of cremations that occur annually and their relatively short half-life. With respect to the possibility that any element in human remains that would be harmful to the environment as a result of cremation it seems the response is no. Human remains consist of 85% moisture, which vaporizes during the cremation process, 10% combustible solids which release approximately 1000 BTUs (British Termal Unit) per pound and transfer from a solid to vapor state, and 5% non-combustible solids which absorb heat and energy from the cremation process and remain as solids (bone fragments and ash materials) when cremation is completed. The 5% non-combustible solids are usually returned to the family (DEFRA, 2003; CANA, 2009).

In fact, a crematory furnace consists of a refractory chamber in which the mortal remains to be cremated are placed. The coffin is forwarded into the furnace by a conveyor fixture. In the so-called "cold type" furnaces, the coffin is placed inside at a temperature of about 300 °C. In the "warm types", the temperature is 800 °C or higher. The cremation is carried out in furnaces which are fired using oil or natural gas. There are also some which run on electricity. In more modern installations the remains are transported to a post burning chamber located beneath where they are post-fired (minimum temperature 850 °C). The cremation time is about 1.2–1.5 h in the warm types and lasts for 2–2.5 h in the cold types. The average volume of waste gases is approximately 1200 Nm^3/h for gas and oil fired furnaces and approximately 600 Nm^3/h for electrically heated furnaces. The waste gases from the muffle are transported via the post-firing chamber and the recuperator and are subsequently purified by cyclones and fabric or electro filters (EDI, 2006).

In Europe, crematoria are certainly not of high relevance for the total emission of PCDD/Fs. The European Dioxin Air Emission Inventory, whose results were published by Quass et al. (2004), reported a 1985 upper estimate of 28 g I-TEQ/year, and a 2005 estimation of 13 (minimum) and 22 (maximum) g I-TEQ/year from cremation (incineration of corpses). The emissions corresponding to the total of sources considered (g I-TEQ/year) were 13,690 for 1985, and 1963–3752 for 2005. Taking this into account, up to now, the data from crematoria suggest that in most cases these installations may be disregarded. However, from the local view crematoria without or low quality flue gas cleaning might have adverse environmental impact. Therefore some spot-check measurements might be necessary to assess the possible emissions and confirm the currently available data, especially in those countries which did not provide any data. In a PCDD/F emission inventory for the Tarragona Province (Catalonia, Spain) that we performed in 1999, a total of 2.24 g I-TEQ/year was found, with a contribution for crematoria of only 0.00029 g I-TEQ/year (Fuster et al., 2001).

On the other hand, for years, The Cremation Association of North America (CANA) has witnessed the concern surrounding cremating human remains, and the corresponding release of primarily two emissions: particulate matter (PM) and mercury. PM can be defined as solid particles suspended in a gas as a byproduct of all combustion processes, including cremations. PM emissions are released into the environment in many ways, including through residential and commercial fuel-based heating, cars, trucks, restaurant grills and fireplaces. None of these sources of PM have any emission controls to reduce, monitor or limit PM emissions, while crematories have emission controls as part of their design to limit the amount of PM entering the atmosphere (CANA, 2009). On the other hand, mercury is derived from the use of silver amalgam in dental fillings that is released into the environment during the cremation process.

2. PCDD/F emissions from crematories

In recent decades, PCDD/F emissions from refuse incinerators became a serious problem in a number of developed countries. Numerous studies focused on estimating the quantity of PCDD/Fs emitted from municipal and industrial waste incinerators have been published. In contrast, in those countries with a notable ratio of cremation of human bodies, until recently emissions of PCDD/Fs from crematories were, in fact, unknown. For example, in Japan, where a 98.8% of dead bodies were cremated in 1997 (the highest percentage in the world), and with 1607 crematories in operation at that time, only a few studies have been carried out on PCDD/F emissions from crematories.

The reports about PCDD/F emissions from crematories in the world are really limited (Hutzinger and Fiedler, 1993; Federal States Pollution Control Committee, 1994; Eguchi et al., 1996; Fiedler, 2006). In Japan, Eguchi et al. (1996) reported the concentration of PCDD/Fs from a crematory to be 0.14–2.56 ng TEQ/Nm^3. This was less than the concentration of PCDD/Fs from crematories in Germany, 8 ng TEQ/Nm^3 found by Hutzinger and Fiedler (1993). In 1994, a working group of a subcommittee of the German Federal State Pollution Control Committee reported the levels of PCDD/Fs for 13 crematories from Germany. It was found that the concentration of PCDD/Fs from those crematories was 0.1–14.4 ng TEQ/Nm^3, and almost all of them were more than 1 ng TEQ/Nm^3 (The Working Group of Subcommittee, 1993).

Since in Japan, about 99% of dead bodies were cremated in a considerable number of crematories, it seemed necessary to investigate crematories of various types to estimate the quantity of PCDD/Fs emitted from these facilities. Takeda et al. (2000) measured the concentrations of PCDD/Fs in emission gases from 10 Japanese crematories. The relationship between PCDD/Fs and several factors such as structure, equipment, and operational state of the crematory were assessed. Furthermore, emission of PCDD/Fs from all Japanese crematories was estimated. The most relevant results were the following: 1) total concentration of PCDD/Fs from a crematory was 2.2–290 ng/Nm^3, and TEQ concentration was 0.0099–6.5 ng TEQ/Nm^3, 2) the concentration of PCDFs was higher than that of PCDDs, especially tetrachlorodibenzo-*p*-furans (T4CDFs), being 2,3,7,8-T4CDF detected in almost all samples, 3) for a homologue pattern of PCDFs, the concentration of T4CDFs was high, while that of the higher chlorinated compounds was low. For that of PCDDs, two patterns were identified: (a) a mountain shape pattern with peaks of hexachlorodibenzo-*p*-dioxins (H6CDDs), which was similar to the typical pattern of waste incinerators, and (b) a pattern the same as the PCDFs pattern, with decreasing concentrations when increasing the degree of chlorination, 4) the total concentration of PCDD/Fs from crematories whose dust concentration was less than 50 mg/Nm^3 tended to be low, 5) the total concentration of PCDD/Fs was highest in the first 20 min from the start, 6) it was found that sex and age of dead body did not affect the concentration of PCDD/Fs, 7) the existence of a dust collector, temperature of the secondary combustion chamber, and the number of main combustion chambers connected to a secondary combustion chamber affected the concentration of PCDD/Fs, and 8) the total amount of PCDD/Fs emitted from crematories in Japan was estimated to be 8.9 g TEQ/yr. Takeda et al. (2000) concluded remarking that the number of data was not enough to grasp the state of PCDD/F emissions from crematories in Japan.

In a subsequent study of the same research group, PCDD/Fs and co-planar PCB concentrations in flue gases from 17 Japanese crematories were measured in fly ashes and bottom ashes (mainly bone) from several crematories to assess the state of PCDD/F emissions from those facilities (Takeda et al., 2001). The effects of several factors were discussed to prevent PCDD/F emissions from crematories. Total concentration (normalized by 12% O_2) of PCDD/Fs ranged from 4.9 to 1200 ng/Nm^3, and TEQ concentration ranged from 0.064 to 24 ng TEQ/Nm^3. According to the results of that study, these measures for existing crematories were recommended in order to reduce PCDD/F emissions: 1) keeping the temperature at 800 °C in main/secondary chambers during a whole cremation, and 2) lowering the temperature in the dust collector. For newly installed crematories, Takeda et al. (2001) suggested the following measures to prevent PCDD/F emissions, including the measures for existing ones: 1) connecting one secondary chamber to one main chamber, 2) installing the high efficiency dust collector and reducing dust concentration to less than 0.01 g/Nm^3, and 3) installing the sampling point for monitoring of PCDD/Fs.

In Germany, Luthardt et al. (2002) analyzed the concentrations of PCDD/Fs and PCBs, and estimated total TEQ, in flue gas samples from eight different sources (two municipal waste incinerators (MWI), one hazardous waste incinerator (HWI), two sintering plants, one cement kiln, and two crematories). The highest TEQ values were found at crematory No. 2, the sintering plants, and at the MWI with older technology. TEQ emissions below the 0.1 ng/Nm^3 limit were found at the modern MWI, the HWI, and at the cement kiln.

In a previous study also conducted in Germany by Hutzinger and Fiedler (1993), PCDD/F concentrations of about 8 ng TEQ/Nm^3 were detected in the stack flue gases of crematories, while in the UK, a study conducted by the Warren Spring Laboratory found a mean PCDD/F concentration of 46 ng TEQ/Nm^3 (11% oxygen) for the cremation process (Eduljee and Dyke, 1996). In the USA, PCDD/F emission rate (expressed as TEQ) for the crematory source was found about 9.1 g TEQ per year (US EPA, 2000), which was in the range of that found in the UK: 1–35 g TEQ per year (Eduljee and Dyke, 1996), but higher than that reported in Japan: 1.3–3.8 g TEQ per year by Takeda et al. (2001). The wide range of PCDD/F concentrations arising from various crematories was believed to be due to their intrinsic differences in operation conditions, air pollution control devices, and involved incinerating materials (Takeda et al., 2001).

In general, total PCDD/F emissions from crematories are relatively small compared with those from MWIs. For example, in the study conducted in Japan by Takeda et al. (2001) the crematory emission accounted for only 0.13–0.29% of that emitted from MWIs. However, it should be noted that most assessed crematories were equipped with a low stack, and were situated in the proximity of residential areas. In particular, most of them did not adopt any air pollution control device to eliminate PCDD/F emissions from stacks. Based on these, it could be expected that PCDD/F emissions from a crematory might significantly affect its surrounding environment.

Recently, the cremation ratio has increased dramatically in many countries (Santarsiero et al., 2005; ECN, 2008). In Taiwan, the cremation ratio was expected to increase from 66.9% in 2000 to 85.0% in 2005 (Wang et al., 2003). In the USA, the cremation ratio also increased significantly from 15.2% in 1987 to 25.0% in 2000, and was expected to reach 37.0% in 2010 (US EPA, 2007). Based on these data, it is expected that crematories will play an important role on PCDD/F emissions not only in countries such as Japan or Taiwan, but also in many other countries. In addition to PCDD/Fs, PCBs and PAHs, as well as total suspended particles (TSP) from crematories might also be a cause of problems to human health.

Wang et al. (2003) characterized PCDD/F emissions from Taiwanese crematories and assessed their impacts on the surrounding environment. Two crematories (C) located in southern Taiwan were investigated, including C1 with no air pollution control device installed, and C2 with a bag filter. The mean PCDD/F emissions (11% oxygen) from the stacks of C1 and C2 were 2.36 and 0.322 ng I-TEQ/Nm^3, respectively, while mean emission factors for C1 and C2 were 13.6 and 6.11 µg I-TEQ/body, respectively. The removal efficiency of the bag filter on PCDD/Fs was 55.1%. The estimated PCDD/F emission rate for all crematories in Taiwan was 0.838 g I-TEQ/year. In an emission inventory of PCDD/Fs in Taiwan, a total of 67.25 g I-TEQ of PCDD/Fs released annually was estimated (Chen, 2004). Secondary copper smelting accounted for more than 39% of the total PCDD/F emissions, being higher than those from all waste incinerators combined (23.7%). Based on that inventory, PCDD/F emissions from crematories would be relevant, as they were 227% and 22.4% of the annual emissions from all medical waste incinerators and MWIs, respectively. To assess the impact of PCDD/F emissions from a crematory to the surrounding environment, ambient air samples were collected from the downwind site of C1 with the maximum ground concentration (Wang et al., 2003). The estimated maximum ground concentration at the downwind site of C1 (0.521 pg I-TEQ/Nm^3) was much higher than that found at the background, rural area, residential area, urban area, and industrial area (0.006, 0.023, 0.052, 0.093, and 0.190 pg I-TEQ/Nm^3, respectively). The authors indicated that the high I-TEQ concentration found in the vicinity of C1 might be due to the fact that the involved crematory had a low stack, being installed with no air pollution control devices. It was concluded that PCDD/F emissions from a crematory did significantly affect its surrounding environment, and therefore, a proper control strategy was essential in order to eliminate PCDD/F emissions from crematories. A summary of the most relevant results corresponding to some of the above studies is shown in Table 1.

PCDD/F emissions from well-maintained cremators were measured (Edwards, 2001) and found to be much lower than previous measurements made in the early 1990s. The average emission was 61 ng I-TEQ per cremation, giving a UK total PCDD/F emission from crematoria of 0.027 g I-TEQ, which meant 0.008% of the UK total emission of 325 g I-TEQ. From measurements made in the early 1990s, about 5% of UK emissions to air of PCDD/Fs were attributed to crematoria. Recent emission levels were similar to PCDD/F emission limits in Waste Incineration Directive 2000/76/EC. Although that Directive does not apply to crematoria, its emission limits indicate what good exhaust gas treatment can achieve.

3. Mercury emissions from crematories

In addition to PCDD/F emissions from crematories, another environmental aspect that has received particular attention is the release of mercury. This element is liberated both because dental amalgams that are unstable at cremation temperatures (650–700 °C), and because of the free mercury metal is highly volatile (Nieschmidt and Kim, 1997). In Switzerland, Rivola et al. (1990) estimated that mercury contamination due to cremation varied in 1988 between 45.8

Table 1
A summary of data concerning air emissions of dioxins and furans (PCDD/Fs) from crematories in different countries.

Country	Emissions of PCDD/Fs	Remarks	Reference
Germany	8 ng TEQ/Nm^3	–	Hutzinger and Fiedler (1993)
Germany	0.1–14.4 ng TEQ/Nm^3	In almost all the 13 crematories assessed PCDD/F emissions were higher than 1 ng TEQ/Nm^3	Federal States Pollution Control Committee (1994)
United Kingdom	46 ng TEQ/Nm^3	1–35 g TEQ/year	Eduljee and Dyke (1996)
Japan	0.0099–6.5 ng TEQ/Nm^3	Total concentrations in 10 crematories: 2.2–290 ng/Nm^3	Takeda et al. (2000)
Japan	0.064–24 ng TEQ/Nm^3	Total concentrations in 17 crematories: 4.9–1200 ng/Nm^3	Takeda et al. (2001)
Germany	0.24 (Crem. 1) and 3.71 (Crem. 2) ng TEQ/Nm^3	Six industrial plants and two crematories were assessed. Among the 8 facilities, the highest TEQ values were found at Crem. 2	Luthardt et al. (2002)
Taiwan	2.36 (Crem. 1) and 0.322 (Crem. 2) ng TEQ/Nm^3	The mean emission factors for Crem. 1 and Crem. 2 were 13.6 and 6.1 µg I-TEQ/body, respectively	Wang et al. (2003)

and 79.0 kg, based on both data from the sample analyzed and the fact that 55.5% of Swiss funerals were cremations, the average age of death was 73, and that 70% of the people of that age retained some of their teeth. According to these authors, mercury contamination by cremation comprised 0.61–1.53% of the total mercury contamination produced by all waste incineration methods in that country. Also in Switzerland, Mattey-Grütter et al. (1995) determined the amount of mercury released at two crematoria. A total of 60 mercury "output" calculations were carried out by the Swiss Material Testing Institute. The amount of mercury initially present ("input") in the dentitions of 54 deceased persons was assessed from their post-mortem dental radiographs and by clinical examination. The correlation between the "input" and the "output" was 0.93, irrespectively of the age at death. However, the "input" was calculated to be 1.8 times higher than the "output" for the deceased people with amalgam restorations. In a blind study, the difference was 1.3 times. The main source of mercury was undoubtedly the amalgam restorations. The amount of mercury recorded during the cremation of 88% of the deceased people without amalgam restorations was under the accepted level of 200 µg/m^3. However, in three cases, the amount of mercury was slightly higher than 200 µg/m^3. In contrast, the amount of mercury recorded during the cremation of only 18% of the deceased people with amalgam restorations was less than the accepted level of 200 µg/m^3. The amount of mercury contamination during cremation as a result of amalgam fillings was so low that no additional preventive measures were required at those crematoria.

In Japan, Yoshida et al. (1994) measured the amount of mercury released at three crematories. The concentration of atmospheric mercury at those three facilities ranged from 4.3 to 19.7 ng/m^3. This rank was nearly identical to the levels found in the control (university campus) area, being also similar to the general levels of atmospheric mercury in the country. The amount of mercury released from one of the crematories was subsequently estimated using official published statistical data in Japan and calculated as follows: sigma[(age specific number of dead that were cremated) × (the number of restored teeth by age category) × (mercury content per amalgam filling (0.6 g))] × (prevalence rate of restoration with amalgam). The amount of mercury released from this crematory was estimated to be approximately 9.4 kg per year, or a daily release of 26 g into the ambient air, which indicated that mercury released by cremation was similar to that from other man-made sources.

A number of reports have been published giving estimates on the amount of mercury released into the atmosphere by crematoria and the concentration of soil mercury found around crematoria in the USA and England (Mills, 1990; Kunzler and Andree, 1991; Basu and Wilson, 1991; Burton, 1991; Hogland, 1994). As in other countries, in New Zealand, a high percentage of deaths are followed by cremation and this figure is expected to rise in the future. This increasing use of cremation as the method of corpse disposal, coupled with the fact that each amalgam restoration is approximately 50% mercury, implied that a significant amount of mercury was being emitted into the environment every year. In that country, Nieschmidt and Kim (1997) using cremation data available from the International Cremation Statistics (ICS, 1992) and the calculations of Burton (1991), estimated emissions about 22.8 kg of mercury per year, and that global annual mercury emissions would total 6962 kg. Globally, atmospheric mercury emissions from crematories of this magnitude would account for about 0.8% of total anthropogenic mercury emissions (based on the estimates of Nriagu and Pacyna, 1988). Recently, Santarsiero et al. (2006) reported some preliminary results concerning mercury and total particulate matter emissions during three cremation processes in Italy. A mercury concentration ranging from 0.005 to 0.300 mg/m^3 and a mercury emission factor ranging from 0.036 to 2.140 g/corpse cremated were obtained. The total particulate matter concentration range was from 1.0 to 2.4 mg/m^3.

It must be noted that mercury (as well as other pollutants) emissions from crematoria are not covered by the European Union regulations. Currently, matters of crematories are the responsibility of local Authorities. However, mercury emissions have been the subject of the OSPAR Recommendation. In fact, the OSPAR document, namely OSPAR Recommendation 2003/4 on Controlling the Dispersal of Mercury from Crematoria (OSPAR, 2003) in the OSPAR Convention Area identified crematoria as producing a significant source of mercury in the environment and listed various options, in terms of the best available technologies (BAT) to reduce and control mercury emissions. The reports on emissions made by parties involved with this recommendation, will provide an indication of the effectiveness and if further action is needed. Future trends in mercury emission are difficult to predict since they are strongly affected by the following variables: the number of cremations per year, the number of amalgam fillings and the related mercury, and the content present at cremation. Therefore, for the assessment of current and future mercury emission factors the following must be taken into account: the amalgam fillings and related dentistry practices used in the past, those currently used and those to be used in the near future, and the distribution of dental amalgams within the population (Santarsiero et al., 2006).

Recently, in the 9th International Conference on Mercury as a Global Pollutant (ICMGP) held in Guiyang, China, Reindl (2009) concluded that there were significant uncertainties in North American data, as few studies existed concerning mercury emissions from crematories. North American demographics may be different than European for restoration sizes, composition and number. An increase in emissions for the next several decades can be expected followed by a decrease. Reindl (2009) recommended collecting information on the amount of mercury released per cremation, mass balance, air, ash, deposited on crematorium surfaces and speciation of air emissions, which is essential for regulators.

The AEAT study for PCDD/Fs above cited (Edwards, 2001), included also measurements of mercury emissions 18 crematories in the UK. Most mercury in bodies is in dental amalgam fillings, and as the number of fillings varies from person to person, a wide variation of mercury emissions could be expected. The measurements showed 6 crematories with very little mercury and a considerable variation in emissions from the other crematories. The average emission across all the crematories was 0.9 g of mercury per crematory, an amount that was less than the calculated emission factor of 3 g per crematory that was used to estimate UK mercury emissions from crematoria, and reported in the National Atmospheric Emission Inventory (DEFRA, 2003). The calculations gave a range of mercury emissions from crematories as 5.3%–15.7% of UK mercury emissions to air in 2000. Crematoria emissions in the UK are expected to increase from 0.4–1.34 tonnes in 2000 to 0.68–2.2 tonnes in 2020 unless gas cleaning of exhausts is introduced (DEFRA, 2003).

4. Occupational and environmental health effects from crematories

Information on occupational exposure to individuals working in crematories is particularly scarce. To the best of our knowledge, only a study in the UK has examined this potential exposure (Maloney et al., 1998). By measuring the levels of mercury in hair, it was concluded that exposure to mercury vapor by workers in crematoria was rather low compared with others who were occupationally exposed to this element. Of the 97 crematoria workers assessed, 3% had concentrations higher than 6 µg/g, generally considered as a tolerable concentration for mercury in hair. According to their results, the authors considered that there was sufficient evidence to warrant emission monitoring and control in crematoria workers.

On the other hand, and related with environmental exposure to emissions around crematories, Dummer et al. (2003) investigated the risk of stillbirth, neonatal death, and lethal congenital anomaly among babies of mothers living close to both incinerators and crematories in Cumbria, north west England, 1956–1993. A significant increase was noted during this period on the risk of stillbirth closer to crematories. The risk of anencephalus was also significantly increased during the same period. Although most (92%) cases of anencephalus were stillborn, the significantly increased risk of stillbirth remained after exclusion of anencephalus cases from the analysis. From 1972 onwards there was an increased risk of all other congenital anomalies, excluding neural tube defects and heart defects, with increasing proximity to crematoriums, which was significant for the period 1983–1993. These findings remained significant after exclusion of the most influential births. It was concluded that threw was an increased risk of lethal congenital anomaly (specifically spina bifida and heart defects) in relation to proximity to incinerators, and an increased risk of stillbirth and anencephalus in relation to proximity to crematoriums (Dummer et al., 2003). However, a causal effect from the statistical associations could not be inferred, since as it was noted there are a number of factors (medial advances, clinical characteristics, etc.), that may also affect the results, which is one of the main drawbacks or limitations of all geographical epidemiological studies. On the other hand, since incinerators and crematories are sources of harmful substances, it is worth to keep investigating their potential effects on public health.

5. Conclusions

An exhaustive revision on the scientific literature by means of the databases PubMed (http://www.ncbi.nlm.nih.gov/pubmed/), Scopus (http://info.scopus.com/) and Scirus (http://www.scirus.com/) using crematories/crematoria, toxic emissions, dioxins and furans, mercury, and health risks as searching terms, has detected only a scarce number of published studies. With respect to organic emissions from crematories, PCDD/Fs have been the most investigated. In comparison with PCDD/F emissions from waste incinerators (municipal, hazardous and medical), those corresponding to crematories are significantly lower. However, if the facilities are installed near nuclei of population, any specific filter is used, and the high of the stack is relatively low, human health risks should not be discarded, and a monitoring program should be carried out. In relation to mercury, which is a highly volatile element, to date the most important source has been dental amalgams containing mercury, which are unstable at cremation temperatures. In recent decades, serious efforts have been made in most developed countries in order to reduce the levels of environmental mercury. In this sense, if mercury emissions from crematories are not properly controlled, these facilities could mean a relatively important source of atmospheric pollution. Another relevant aspect of toxic emissions of crematories is the noted lack of general regulations of these emissions. For example, neither the European Union nor the US EPA has established specific recommendations for crematories.

In summary, because of cultural and other reasons, in recent years the cremation ratio has considerably increased in many countries, a trend that is expected will continue in the near future. Therefore, we think that crematories must also be among the facilities whose emissions should be specifically regulated and monitored.

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Crematoria Health Risks

Incinerators may put babies at risk

Date released 29 May 2003

The risk of stillbirth and some abnormalities may be slightly increased among babies of mothers living near incinerators and crematoria, suggests research by the University of Newcastle upon Tyne.

The findings, published in the Journal of Epidemiology and Community Health, are based on an analysis of births in Cumbria, north west England, between 1956 and 1993. During this period, there were almost 245 000 births, of which 3234 were stillborn, and a further 2663 babies died shortly after birth. 1569 had congenital abnormalities.

There was no increased risk of stillbirth or death shortly after birth, overall among babies whose mothers lived near incinerators. But after taking account of influential factors, such as birth order and multiple births, the risk of neural tube defects, particularly spina bifida, was 17% higher and heart defects 12% higher.

When the analysis concentrated on birth defects and stillbirths in the period before the incinerators were operational, no increased risk was found.

The risk of stillbirth was 4% higher and the risk of the life threatening brain abnormality anencephalus was 5% higher among babies whose mothers lived near to crematoria.

The authors point out that the introduction of antenatal screening and termination of pregnancy would have reduced the number of potential stillbirths and babies born with lethal congenital abnormalities in recent years. Added to which, the lack of data on pregnancies of under 28 weeks could have underestimated the extent of serious and lethal birth defects

Incinerators and crematoria may emit harmful chemicals, including dioxins, although little is known about the long term effects of prolonged low dose exposure. But because of a lack of emissions data, no definitive conclusions can be drawn on the biological plausibility of the findings.

The study does not provide conclusive evidence of a causal effect, but nevertheless the statistical findings bear further investigation, say the authors, especially in view of the fact that so few comparable studies have been carried out, and that incineration is becoming more widely used as a method of waste disposal.

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Source:

Birth defect risks rise close to incinerators
By Julie Wheldon
29 May 2003

Women living near incinerators have a higher risk of having a baby with spina bifida or a heart defect, research released yesterday said. It also found an increased risk of stillbirths among women who lived close to a crematorium.

The researchers, who were led by Professor Louise Parker of Newcastle University and who published their findings in the Journal of Epidemiology and Community Health, stressed that they did not find conclusive evidence that living near an incinerator or crematorium caused birth defects or stillbirths.

But they said the issue should be investigated further, especially as incineration was becoming a widely used method of waste disposal. The research analysed births in Cumbria between 1956 and 1993. There were almost 245,000 births, of which 3,234 were stillborn and 1,569 had congenital abnormalities.

The risk of neural tube defects, particularly spina bifida, for babies of women who lived near incinerators was 17 per cent higher, and heart defects 12 per cent higher. **For women who lived near a crematorium, the risk of stillbirth was 4 per cent higher and the chance of the baby having a brain abnormality known as anencephalus was 5 per cent higher.**

Source: http://news.independent.co.uk/uk/health/story.jsp?story=410469

"Main results: ...there was an increased risk of lethal congenital anomaly, in particular spina bifida ...and heart defects ...around incinerators and an increased risk of stillbirth ...and anencephalus ...around crematoriums."

Journal of Epidemiology and Community Health 2003;57;456-461

RESEARCH REPORT

Adverse pregnancy outcomes around incinerators and crematoriums in Cumbria, north west England, 195693

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Study objective: To investigate the risk of stillbirth, neonatal death, and lethal congenital anomaly among babies of mothers living close to incinerators and crematoriums in Cumbria, north west England, 195693.

Design: Retrospective cohort study. Logistic regression was used to investigate the risk of each outcome in relation to proximity at birth to incinerators and crematoriums, adjusting for social class, year of birth, birth order, and multiple births. Continuous odds ratios for trend with proximity to sites were estimated.

Setting: All 3234 stillbirths, 2663 neonatal deaths, and 1569 lethal congenital anomalies among the 244 758 births to mothers living in Cumbria, 19561993.

Main results: After adjustment for social class, year of birth, birth order, and multiple births, there was an increased risk of lethal congenital anomaly, in particular spina bifida (odds ratio 1.17, 95% CI: 1.07 to 1.28) and heart defects (odds ratio 1.12, 95% CI: 1.03 to 1.22) around incinerators and an **increased risk of stillbirth** (odds ratio 1.04, 95% CI: 1.01 to 1.07) **and anencephalus** (odds ratio 1.05, 95% CI: 1.00 to 1.10) **around crematoriums.**

Conclusions: The authors cannot infer a causal effect from the statistical associations reported in this study. However, as there are few published studies with which to compare our results, the risk of spina bifida, heart defects, stillbirth, and anencephalus in relation to proximity to incinerators and crematoriums should be investigated further, in particular because of the increased use of incineration as a method of waste disposal.

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Last modified: 21 January 2007

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Crematory outcry has Minnesota cities weighing risks

Article by: HERÓN MÁRQUEZ ESTRADA , Star Tribune

As cremation rate rises, critics and backers debate potential for such toxic emissions as mercury.

Along with wastewater plants, halfway houses and homeless shelters, Minnesotans apparently have added crematories to the list of things that have neighbors howling "not in my back yard."

But public outcry over plans to build crematories in at least two metro-area cities has raised the question of whether they're the source of toxic emissions -- or whether opponents are exaggerating the risk.

Last week, a plan to build a crematory in North St. Paul was pulled off the table after drawing complaints. And last month, residents in Jordan filed the second of two lawsuits to stop a proposed crematory from starting operations across the street from a day-care center downtown.

"There were concerns about emissions expressed by many," North St. Paul City Council Member Jan Walczak said recently. "This issue is a little hotter than most."

It only figures to grow hotter as cremations increase in popularity. Their number has been rising in Minnesota for 25 years running -- to more than 17,000, according to the Minnesota Department of Health. Nearly half of the deaths in the state result in cremation.

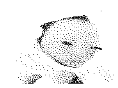
The concern among opponents is that mercury in dental fillings and other metals in bodies will lead to toxic emissions and contamination of air and water.

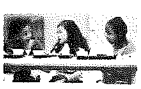
related content

This table shows cremations as a percentage of deaths in 2009. Statewide, the figure was 46.8 percent.

more from south metro

in case you missed it





"The things you cannot see are very toxic," said Tia Severino of the Community Awareness Network in Georgia, who has been working to block crematories nationwide, including Jordan's. "Jordan is one we are involved in because of the way the city is pushing people around."

The issue has divided the tiny community, mirroring the growing number of people around the country questioning the safety of such establishments, which burn bodies at 1,800 degrees and then use filters to trap the emissions.

Adding fuel to the debate: The state Department of Health reversed course on the Jordan crematory, deciding Jan. 6 that the operation would need an environmental assessment before starting up.

That was in sharp contrast to the department's decision last fall to allow the crematory to open without environmental assessment, which led to the filing of a suit in October.

The agency said it had received "new information recently" that made the department "reconsider its decision," according to a letter to the state Environmental Quality Board by a worker at the state Mortuary Science section.

"MDH has received and continues to receive additional information about the situation that we feel needs to be reviewed," said department spokesman Doug Schultz.

Schultz did not say what the additional information was or how it might affect the Jordan project or any of the state's 50 existing crematories.

Anti-crematory activist Severino, who helped block a crematory from going into her town near Atlanta, says her group has provided the state and others with new research indicating that emissions from crematories are unsafe, especially the mercury.

But, as of now, the country has more than 2,000 crematories and the federal Environmental Protection Agency (EPA) has not ruled that their emissions are above danger levels.

"I believe that will be changing soon," Severino said. "We do see it as a [local] problem and a national problem."

The industry disputes opponents' claims. John Ross, executive director of the Cremation Association of North America, said the country's roughly 2,000 crematories are "heavily regulated" and that the EPA has not found the emissions to be dangerous, especially given the modern equipment that new crematories would be using.

He said about 1 million cremations are done each year in the United States and that the number is growing.

"There is not an emissions issue at all," Ross said. "The measurements of mercury emissions by the EPA indicate that it is a very minimal amount."

Growing concerns?

The dental fillings of the deceased are the source of the majority of mercury emissions from crematories. In Minnesota, the first rejection of a crematory happened in Roseville in 2001, according to the Health Department.

The mortuary sued the city but in 2004, a Ramsey County judge ruled in the city's favor, without weighing in on the environmental issues raised.

From a regulatory standpoint, the issue is murky. There aren't any state or national requirements for environmental review for crematories. A 2005 EPA report found that there were no known standards on crematorium emissions in North America and noted the need for further study about emissions from such facilities.

In Jordan, Shari Schmit, a pregnant mother of three, is one of those concerned.

"It's basically in my back yard, across the street," Schmit said recently. "We want to know if it is safe or not."

A number of people plan to protest outside City Hall on Tuesday before the City Council meets. The meeting will be a showdown between the city's mayor, who opposes the project, and the City Council, which appears set to strip him of his powers to appoint members to the city's planning commission. It's part of the fallout from the debate over the Ballard-Sunder crematory, which already has been approved by the City Council but could yet be derailed by the lawsuits brought by citizens.

Calls for comment from Mark Ballard, one of the owners of the funeral home, were not returned.

Jordan Mayor Pete Ewals, who opposed the project, said he thought the council majority acted too quickly and without sufficient information about the safety of emissions.

"I was arguing that we should take some time," the mayor said. "They felt like they had all the facts."

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What are the dangers of having a crematory in a public area.(neighborhood)?

philbert...
7 years ago Report Abuse

Best Answer - Chosen by Asker

I don't know about "dangers", but I can tell you the stench will be unbelievable and the property in the area will go down in value.

7 years ago Report Abuse

Asker's Rating:
I thought so to, but do you know a crematory has no state or government air regulations .

missgodd...

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Other Answers (1)

- Incomplete combustion due to insufficient amounts of gas reaching the burners in the crematorium (due to a potential gas leak or malfunction), thereby potentially producing "thicker" byproducts.

  Let's put it this way - I wouldn't eat the snow that fell on the ground next door during the winter, no matter how safe it might be!

  7 years ago Report Abuse

  Dreamer

subtlety is needed, however, in dismissing the attempts by some other hospital staff to influence or control doctors' professional activities. Porters, for example, have no place in clinical medicine; nor can ambulancemen be allowed to usurp a doctor's judgment. It is time for doctors and administrators to say this loud and clear. And if general practitioners think that there are only hospital problems they may be disturbed to know that unions are now recruiting members from among the staff of privately owned practice premises.

Some of these unhappy problems have resulted from years of low pay, poor management, and understaffing of the NHS, with industrial action seen as the only way of achieving improvements. Doctors are no longer in such a strong position to criticise that. But having discovered the power they wield, the nursing, technicians, and other health workers' unions are using it to develop their influence on the management of the NHS, with administrators generally unwilling or even frightened to confront them when this influence is clearly detrimental to patient care. The patient is being used as a pawn, with militant unionists arguing that their actions are for his long-term benefit, a travesty of the ethic that the patient comes first. Thus decisions on closing hospitals, on improving departments' efficiency, or on allocating funds according to rational priorities are being stalled or even stopped by threat of militant action. While rational discussion in committee does not always achieve satisfactory results, surely it is preferable to the anarchy of arbitrary obstruction, when any decisions are taken along the line of least resistance.

This path will lead to demoralisation, chaos, and a breakdown of the Service. What is particularly depressing in this jungle of industrial relations in the NHS is the lack of any leadership from the DHSS. Health authority administrators may be criticised for their role in appeasement, but the silence of the DHSS in union-initiated disputes can give them no encouragement. The dangers of these internecine differences and battles for power and influence in the NHS are clear: the patient is at risk of being forgotten. So let us restate the obvious: the NHS exists to look after sick people. Its objective is not to guarantee employment for those who work in it—whether they stoke obsolescent boilers or do research into obscure diseases. Hospitals are there to serve the patient, who should not have to depend on a porter's whim for the time he arrives at the operating theatre.

What the patient needs is to be seen, diagnosed, treated, and cured by a competent doctor. All other activity and planning in the NHS are secondary to this end. Future generations will not forgive us for condoning appeasement in the 1970s, any more than we forgive those of our forebears who hailed the Munich agreement.

[1] *British Medical Journal*, 1977, **2**, 1610.
[2] Dyson, R, *The Management of Pathology Laboratories*. London, Association of Clinical Pathologists, 1977.

Hidden hazards of cremation

In recent years the number and variety of metal and plastic objects implanted in patients have increased steadily. These include joint prostheses, nails and splints for fractured bones, heart valves, and cardiac pacemakers. At one time pacemakers were occasionally removed post mortem for later reimplantation, mainly for reasons of cost. Nevertheless, nowadays in Britain it seems to be the rule that when a patient with a prosthesis dies no attempt is made to recover it, even though metallic prostheses generally show no evidence of structural defect.[1] In some less wealthy countries prostheses are still recovered and reimplanted with considerable saving in cost, and the time may come when we may have to adopt the same practice here. Meantime, however, non-combustible objects are being found more and more often among the remains after cremation: indeed, one survey[1] found that 5% of bodies undergoing cremation contained metallic objects—and, though most were orthopaedic implants, a Spencer-Wells forceps and a bowel clamp were also found.

Little notice was taken of the presence of surgical hardware post mortem until September 1976, when the mercury zinc batteries in a pacemaker left in a body exploded during cremation[2] with force sufficient to damage the brickwork lining of the cremation chamber. The strength of the explosion had possibly been increased by the presence of hydrogen produced in near-exhausted batteries. In the course of their duties those working at the crematorium periodically observe the process of cremation, and an explosion on this scale could cause injuries or even death. A further risk is that such an explosion could release toxic gases or even infectious material from the corpse.

Lithium batteries may well replace zinc mercury batteries in pacemakers, and when heated to a high temperature these are even more explosive. Moreover, since 1970 pacemakers powered by plutonium-238 have been tested clinically in several centres and have proved their worth. Since these contain up to 3 Ci of the isotope patients have been closely supervised and as a routine the pacemaker is removed after death. It takes about one hour at 800°C to cremate a body, and the latest models of plutonium pacemaker have now to pass a very stringent "cremation test" of withstanding 1300°C for 1½ hours. This should ensure that they could not leak during cremation, but it is also an admission that recovery post mortem may not be invariable. Possibly the same cremation test may eventually be demanded for all types of pacemakers. Even so, in the meantime, their federation has advised cremation authorities to ask area health authorities to add, as an interim measure, two questions to the statutory cremation form B, which is completed by the doctor who attended the deceased in his last illness. The questions ask the doctor signing form B whether a pacemaker (or any radioactive material) was present in the body and whether it had been removed. Coroners are expected to take similar action with form E. The federation has also advised medical referees to consider refusing to accept for cremation any body containing a pacemaker.

The 1972 code of practice[3] lays down that there is no contraindication to cremating corpses containing up to 30 mCi of yttrium-90, iodine-131, or gold-198 or 10 mCi of phosphorus-32 (on the assumption, presumably, that a radioactive isotope in the tissues would be expected normally to disperse harmlessly up the smoke stack). Nevertheless, the Federation of Cremation Authorities is also concerned about possible hazards from radioactive substances left in bodies brought for cremation. There is a possibility that an explosion (or some other event) during the cremation of a radioactive corpse could produce a blow-back releasing radioactive smoke or fumes into the crematorium. This risk seems to be largely theoretical, but a more serious cause for concern arises when the radioactive isotope is confined within a sealed container. Isotopes such as caesium-137 or iridium-192 are available for therapeutic use in amounts up to 75 mCi in the form of needles, tubes, grains, and pins. Moreover, radium itself, which has a very long half life, is also still used in needle form.

If such a source leaked during cremation the radioactivity would be dispersed harmlessly with the smoke, but nowadays therapeutic isotopes are normally contained in welded iridio-platinum or stainless steel capsules which should withstand the 800°C of the cremation furnaces. The implant would therefore survive as a radioactive object which would be hazardous to a cremator operator if he handled it directly.

A body intended for cremation which contains a pacemaker or a radioactive implant should not, therefore, be released to an undertaker. The pacemaker should be removed, but if it is not possible to remove a radioactive implant the undertaker should be given precise information regarding its nature, size, and location.

[1] Thomas, H O, *Journal of Bone and Joint Surgery*, 1976, **58B**, 135.
[2] Morrell, P J, *Practitioner*, 1977, **219**, 109.
[3] *Code of Practice for the Protection of Persons against Ionizing Radiations arising from Medical and Dental Use (Appendix J)*. London, HMSO, 1972.

Targets for prevention

The most charitable view of Mr David Ennals's White Paper[1] on prevention is that he really believes that people change their way of life when told to do so. For the last two years the DHSS has been singing the praises of a preventive approach to health, and the stream of exhortations, warnings, and advice seems never-ending: yet in terms of positive action the Government has done virtually nothing.

Last April the House of Commons Expenditure Committee (which had spent months taking evidence from medical experts) published a set of detailed proposals,[2] which we welcomed[3] as "concise and uncompromising." How has the DHSS, with its self-proclaimed commitment to prevention, responded?

On smoking the committee recommended a ban on tobacco advertising except at the point of sale; the abolition of cigarette coupons; the restriction of cigarette machines to premises to which children have no access; and a specific warning on cigarette packets that smoking causes cancer, bronchitis, and heart disease. Those proposals have all been flatly rejected. The Government is "considering" the recommendation that the price of cigarettes should be increased annually, but, says the White Paper, "tax increases raise the cost of smoking for those least able to afford it . . . other factors . . . include . . . the implications for wage negotiations." In other words, the Government is not prepared to take action that might be unacceptable to any substantial part of the population.

This chicken-hearted approach has been followed with many of the other proposals from the Expenditure Committee. The MPs had drawn attention to the close association between alcohol consumption and the price of drink; but the Government is not at present prepared to maintain liquor prices relative to average incomes, let alone increase them. On fluoride the Government simply continues to "promote the general introduction of fluoridation." Even on the simple issue of encouraging exercise the White Paper claims that "not enough is known about all the implications for health of exercise," using the old excuse of that "further research is required to avoid doing anything constructive. Nevertheless, some of the decisions are to be welcomed—in particular, the recognition by the DHSS that there is no case for a nationwide screening for breast cancer and the increased support for the Health Education Council; but most of the paragraphs are platitudinous or simply promise yet more publications from the DHSS, whose paper productivity is symptomatic of the troubles of the NHS.

The glaring omission from the document is that there is no hint of constructive Government action to tackle the current epidemics of deaths and injuries from road accidents. The Transport Secretary, Mr Rodgers, is said[4] to be waiting for public opinion to be convinced before contemplating legislation to make the use of car seat belts compulsory. Yet all the evidence from other parts of Europe and from Australia, where compulsion has proved its lasting benefits, shows that the force of law is the only way to persuade drivers to use belts.[5] Britain is equally out of date in its permissive attitudes to pedestrians: in what other countries with comparable traffic congestion may people dash across the road when and where they like? Stricter enforcement of speed limits and tighter controls over drinking and driving (as recommended last year by the Blennerhasset Committee) are straightforward measures which could reduce the load on the NHS, but they have been ducked, fudged, or postponed indefinitely by a Government which lacks the courage to take any action that might be unpopular with any section of the electorate.

[1] Department of Health and Social Security, Department of Education and Science, Scottish Office, Welsh Office, *Prevention and Health*. London, HMSO, 1977.
[2] *Preventive Medicine*. First Report from the Expenditure Committee. London, HMSO, 1977.
[3] *British Medical Journal*, 1977, **1**, 989.
[4] *The Times*, 15 December, 1977.
[5] *British Medical Journal*, 1977, **1**, 593.

Country health

Is town or country life preferable? The answer depends on the individual. But which is the more healthy? No dogmatic answer can be given—the disease pattern varies with the rural and urban areas compared. Is the familiar concept of the ruddy-faced, healthy countryman correct, or do rural communities, as a recent article from Australia suggested,[1] contain a higher incidence of chronic illness than is generally realised? To answer that question we need to examine the age structure of rural communities and the occupational hazards of farming.

In most remote parts of Britain the population has not increased over the past 100 years, owing mainly to an exodus of healthy young adults seeking jobs elsewhere. Often a small influx of retirement pensioners upsets the age balance further. In consequence many country areas have a high proportion of elderly people, and so we should expect a relatively high prevalence of chronic illness. Other population movements also occur. Rural areas abound with static caravan sites, which seem to attract people with special problems—often monetary, sometimes marital—which add to the morbidity within the rural area.

Agricultural workers are highly skilled, and low income is but one of their many occupational hazards. The hours of work are long; their working environment may be inclement and dangerous; sudden deaths from falls and accidents with animals and machinery occur with unpleasant frequency, but these are rarely noted outside the local community. Less severe accidents are numerous—injuries to feet from rusty