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Clinical Waste Hazards:Has Science been Replaced by Perception

Imagine the public alarm and local authority response if you discovered a bag of clinical waste lying in the street where you live. Most people would be terrified to come within 10 metres of the bright yellow bag with its official-looking “UN3291” text and biohazard symbol that conjures up the same fear as the familiar radioactive symbol. These images and legal controls are in place to protect us, but really, how dangerous is clinical waste both absolutely and in comparison to household waste? Is the money spent on treating this waste justified? And how much fear is based upon perception rather than scientific research?

Instinctively and subconsciously, we assume that all clinical waste has originated from patients with pathogenic infectious diseases and that contact with any of it poses the high probability that we will fall victim to such. However, for waste to be infectious there must be pathogens of adequate virulence and number to infect a potential host. Since this cannot be readily measured in a given volume of waste, unlike say measuring pH in a liquid volume, the subjectivity of this assessment has led to conflicts between state agencies in the US and an over-emphasis on the mere potential presence of pathogens.

Real or Perceived Hazards?

It runs against common perception that the quantity and virulence of pathogens in ordinary municipal waste is up to several orders of magnitude greater than clinical waste. Collins and Kennedy (1992) cite studies carried out by Althus et al (1983), Kalnowski et al (1983) and Trost & Philip (1985a) that all demonstrated that human clinical waste contained considerably less pathogens than domestic waste; in one study the bacterial load of hospital waste was 10 to 100,000 times less than household waste. Studies have so far indicated that clinical waste is not a very good culture medium for pathogens and disease transmission, and that modern, properly managed landfills provide a great deal of protection. At this point we should take into account an interesting aspect that prior to entering hospital the patient with an infectious illness has been infectious in the community and generating waste for a relatively long period of time and also consider the various incubation periods of diseases. Their waste at home has mostly been handled by standard waste services personnel and entering conventional engineered landfill. Yet there is no public or official alarm to the relatively higher risk of infection.

In the “Letters to the Editor” section of the Journal of Hospital Infection, Borg M (2005) addresses several of the points mentioned above. He questions the apparent inconsistencies of European regulation. In St Luke’s Hospital Malta it was calculated that blood contaminated content of their clinical waste amounted to 20 litres per 1,000 national population whereas the blood content of the sanitary towels landfilled in Malta equated to 160 litres per 1,000 population. He questions why clinical waste cannot be landfilled once occupational safety precautions are used by the handling personnel, especially for sharps, given the lack of evidence that anyone has ever been infected by clinical waste. He strongly recommends that microbiologists need to be involved in microbiological and epidemiological investigations to clearly define for the authorities what waste needs special requirements to prevent infection. A clear example is waste or tissue contaminated by a patient suspected of having Creutzfeld Jacob Disease.

However Borg’s position is rebuked by Blenkharn J (2006) who calls Borg’s approach as a “hole-in-the-ground”. He ignores the advantages of modern engineered landfills with much improved leachate control over old style dumps, the volume reduction of mechanical shredding and the relatively more mobile and insidious environmental effects of incineration compared with landfill leachate. Furthermore he ignores the natural biocidal conditions within a modern landfill of high temperature (~60oC), low pH and metal content.

Treatment Technologies or Just Changing the Problem?

Incineration

There are many advocates of this technology but there is a growing shift away from this as a viable option essentially due to the toxic emissions produced. In 1994 medical waste incineration was identified as the single largest source of dioxin air pollution in the US including the most carcinogenic 2,3,7,8-Tetrachlorodibenzo- pdioxin. Medical waste incinerators also emit heavy metals, fine dust particles, sulphur dioxide, carbon monoxide, nitrous oxides and dioxins contained in the bottom ash residue. In 2001 the international Convention on the Elimination of Persistent Organic Pollutants (POP) was signed with most European countries committing to eliminate POP emissions.

Various attempts have been made at reducing these emissions but no abatement plant is totally efficient at capturing them. Even when the fly-ash is captured it still must be treated as hazardous waste due to its dioxin and other fractions. The segregation of medical waste and therefore the waste type feeding the incinerator influences the dioxin emissions. Therefore the segregation and removal of non-infectious items such as PVC IV drip lines would help lower dioxin levels since the major source of dioxins in the environment is the combustion of organic matter in the presence of chlorine and metals. The evidence is very much counter to Blenkharn (2005) when he states that a case can be made to co-dispose all healthcare wastes through incineration as an effective, non-polluting and all embracing technology. Despite the perceived gold standard status of incineration destroying microbial life, tests have shown that it offers only 10-6 reduction of B. Stearothermophilus as achieved by other alternative treatments.

Tests have been carried out to contain incinerator ash in cement based materials. Assessment of the effects of the ash's heavy metal content on the final material needed to be determined. The experiment assessed the physico-mechanical properties, leaching, chemical analysis and material behaviour on different atmospheres. The results showed leaching of metals, lower material density, chemical reaction between the ash and mortar, aesthetic changes in surface appearance but overall it concluded a material suitable for masonry block production. However how would the market place respond to a block with such a recipe remains to be seen.

Medical waste incinerators in China emit dioxin levels as high as 4000ngTEQ/Nm3. This has led to research into modifying and developing the incinerator process. The Chinese have produced a pilot plant that combines drying, pyrolysis, gasification, combustion and ash vitrification. Results have shown a significant reduction over conventional incinerators across the range of measurement including a dioxin level at least a factor of 5 below the USEPA legal limit due to more complete combustion. This does not seem from the literature to be at commercial stage yet.

Alternative Technologies

Alternative technologies exist but there is very little extensive scientific research into the environmental impact of these and their comparative performance of inactivating micro-organisms. Autoclaves and retorts are sealed vessels using steam for a predetermined time period to be effective, and typically place a spore culture in a container as a test during processing. Microwave technology renders the clinical waste biologically inactive by generating steam from the moisture in the waste. Chemical disinfection can have its effectiveness diminished by the pH, temperature and other compounds in the waste. In addition a different environmental hazard is created through the use of toxic chemicals such as formaldehyde and ethylene oxide. Tests carried out on a microwave unit showed that decontamination temperatures were sustained to achieve reliable microbiological decontamination.

Maceration and Direct Landfill as Another Alternative Treatment

As mentioned earlier in this review, the focus of management of clinical waste in Western countries has been on biological inactivation. This has almost placed as secondary the environmental impact of the process residue from each treatment technology which historically has been predominantly incineration and more recently steam sterilisation. However, by and large the waste mass inevitably ends in landfill as toxic dioxin rich bottom ash or a sterile shredded material. As already discussed earlier in this paper, research has shown that there is less pathogenic and virulent microbial content in clinical waste than in landfilled household waste raising the question whether the waste is a real or perceived hazard. With some humour Collins and Kennedy (1992) quote Taylor (1998) who considers “that even clinical waste was no more dangerous than the kitchen dishcloth”.

Conclusion

There is a clear need for up-to-date research to determine the true risks posed to the environment and human health by clinical waste. This needs to be assessed in absolute terms but also in relation to the risks associated with municipal waste and human burial so that more energy consuming and polluting treatment technologies can be determined as excessive or not. It would be the ultimate irony if our healthcare facilities were generating future “customers” by creating environmental health problems with inappropriate waste treatment, for example the dioxin release from incineration.

The engineered landfill where the waste ultimately is disposed of may well act as an adequate treatment plant for pathogenic microbes until a more sustainable and environmental treatment method is found. Current practice is not just a potential overkill use of technology. If scientific evidence can demonstrate that we are acting beyond safe requirements then the possible cost savings are enormous. Each year our health services spend millions of euros sterilising clinical waste which may be better spent on direct patient care, enhanced facilities or supply chain management systems which focus on improving the materials from which products and services are derived.

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