"Issues and Concerns Towards Safe Management of Health Care / Hospital Waste - History and Future Horizon" - by Homi R. Mullan

Conference: National Conference on Hospital Waste Management-May 25th & 26th 2001, Bangalore
Sponsored by: Indian Society of Hospital Waste Management
Organised by: M. S. Ramaiah Medical College, HCWM Cell, Department of Community Medicine

Introduction;

This paper provides the reported Historical background of the Eighties in the USA, Scientific findings, Environmentalist views and Legislative developments related to the evolvement in the field of Medical Waste Management practices. Paper throws light on Outstanding & Current Issues and Concerns, as well as deals with the issues of the future, in relation with the Indian context. Historical incidences of the Eighties in USA and Europe compare very well with the evolving happenings on the subject today in India. This should be of help to the Administrators and the Society at large. The subject of the paper itself calls for a separate deliberation; however, the proceedings of this conference would contribute to very useful and apt information.

Ground Rules & Reality

Few aspects should be well understood to avoid unnecessary Issues and deliberation on it. The subject of Bio-medical (Hospital / Medical waste) is by and large a part of overall environmental concern, and should be looked at it in totality. The Environmental laws of the Country and the State should be followed. Each Health Care facility has its unique requirement of the Infectious and other waste management, and that they cannot be equated or generalised with that of the others. The prime emphasis should deal with 'Management' aspects and secondary emphasis should deal with 'Technological aspects, and not the other way around, as unanimously thought of and practiced today. The implementation of Waste Management is a gradually progressive phase and not an immediate one step act. The policy and steps taken for waste management should be Sustainable. The waste management at Health care facilities is not solely governed by Bio-medical (Management & Handling) Rules, 1998, and other Environmental Laws such as Hazardous Waste (Management & Handling) Rules, Amendment 2000 and other rules now in draft form such as for Household Waste will come in to force. Hospital Stays have become shorter and home care of patients have increased and most treatment of AIDS, Tuberculosis, and Hepatitis is apparently done on an outpatient basis. These smaller handlers of Potentially Infectious waste pose a potential great threat at their homes and within their localities

The 21st Century will not be of Rural areas and small towns, but of giant cities which will set the standards of how we live, how our environment is preserved or not preserved, how our economies work, and what kind of civil societies we develop. Our perceptions have to **change** (Janice Perlman, founder and president of the Mega-Cities Project, Inc.,). With ever increase in rapid rate of movement of goods and travel of people across the continent, there is a concern worldwide whenever an epidemic is reported at any place in the world.

Many environmental issues arise out of Sociology aspects from two social groups identified by S. Cotgrove (1982). The *Cornucopian*, who put their faith in technology and economic development and assert that increased quantities of resources can be easily available for all, provided the investment in technology is high and that the social structures encourage enterprise. The *Catastrophists* group think that there are physical limits to resources and

that planets life-support systems can be badly degraded by environmental contamination; reform needs attention to wastes and to a lower level of material consumption in the industrialized nations. Considering the majority distribution of these two social groups, the Environmentalist and the Nature conservationists have a large majority of *Catastrophists*; whilst the Industrialists, Trade Union officials and the Public have a large majority of *Cornucopian* (Humanity And Environment)

Historical Incidences of the 1980's in USA

1. March 24, 1986, GTX Waste Handling Company informed eight hospitals in Boston, Massachusetts, that it would no longer pick up their hospital wastes because the area landfills would no longer accept them.[1]
   (Massachusetts Dept. of Environment Quality Engineering, 'Infectious Hospital Wastes' internal memorandum, April16, 1986)
2. Approximately 1400 bags of Medical Waste were discovered at the warehouse by the New York City Fire Department. Energy Combustion Corporation illegally dumped the waste after submitting documents to New York State Department of Environmental Conservation, stating the waste had been incinerated.[1]
   (E. Holtzman, Press release, Brooklyn District Attorney's office, July 30, 1987)
3. Twelve Children in Indianapolis, Indiana, played with Vials of blood, two of which were infected with AIDS, that they found in trash bin outside an HMO medical office in June 1987. It was legal for the health clinic to dispose of the wastes in the open dumpster.[1]. (*'Infectious waste News'* pp. 2-3, July 2, 1987)
4. Eight children were hospitalised with high fever and skin eruptions after playing with smallpox vaccine they found at a garbage dump, in Valdivostok, Russia (AP) 19/06/2000. The ampoules were found near a public health station. The children aged six to twelve were diagnosed with a mild form of smallpox [vaccinia virus].[19. [TECHNET website]]
5. Five employees of the Los Angeles County - USC Medical Centre filed a US$50 million suit against the County after a pipe burst on July 9, 1987, and dumped possibly contaminated blood and fluids on workers. The California OSHA received complaints concerning the adequacy of protection provided for employees handling medical wastes at the Centre.[1]
   (Quinn vs. County of Los Angeles, case no. C669760, L.A., Superior Court of the State of California.)
6. Most of the non-infectious medical waste is landfilled, while most infectious waste from hospitals is incinerated. For infectious waste management, an American Hospital Association survey reported that approximately 67 percent of U.S. hospitals use on-site incinerators, 16 percent use only autoclave (i.e. steam sterilisation) systems and the landfill, and approximately another 15 percent use off-site treatment.[1]
   ([9] Doucet, L., "Infectious Waste Incineration Market Perspectives and Potentials", Waste-to-Energy '87 Conference, Washington, DC, September 1987. - [62] Rutala, W., and Sarubbi, F., "Management of Infectious Waste from Hospitals", *'Infectious Waste Management, 4(4): 198-203, 1983'*)
7. The degree of risks posed by medical waste is not known. Proper handling, treatment, and disposal of these wastes are believed to result in minimal health and environmental

[1] "Issues in Medical Waste Management", Background paper, OTA-BP-O-49, October 1988.

risks. Yet, incidents of careless or illegal disposal may pose health risks and aesthetic problems and certainly help create public apprehension over current medical waste management practices.[1].

8. The Washington State Department of Health in Olympia issued a news release dated March 04, 1998, regarding probable transmission of occupationally acquired Tuberculosis at Stericycle Inc, a medical waste processing facility in Morton, Washington. This is the first reported case of TB transmission from Medical waste. The transmission is believed to be related to aerosols being created during the processing of medical waste. Stericycle is the second-largest provider of regulated medical-waste management services in the United States. [20] [Medical News - 'Infection Control and Hospital Epidemiology ' Vol. 19 No. 5, Pages 370-371]

Historical Incidences Analogy applicable to India.

The above **INCIDENCE-1**, is relevant to worker attitude of not wanting to handle waste from hospitals, forcing a privatised waste handling company to stop collection of wastes from hospitals on contract with them. Such an attitude was also reported at National Workshop on Hospital Waste Management held on March 7th & 8th, 2000, in New Delhi. The waste transport contractors refused to carry untreated hospital waste from small hospitals to a centralised waste treatment plant at a large hospital within the area. Contractors expressed that the transport contract rates were not for hospital infectious waste. Stanley J. Pinto, Manglore, has reported similar worker attitude in News articles in TOI [22]. Considering that similar incidences have been experienced elsewhere, and that many Metro Cities are very rapidly falling short of adequate land waste disposal sites, this issue has to be addressed keeping in mind the fast awareness of Safety amongst the waste handling workers, as per factory Act. The issue is also of suspect that the waste being sent to landfill site could be infectious, which could result in spread of infection at the landfill site.

The above **INCIDENCE-2**, throws light on possible malpractice by privatised contractors licensed for Treatment and Disposal of medical waste from a Centralised Treatment Plant. There have been similar cases talked about. The wastes were collected from metro city hospitals for incineration at a centralised facility, on a chargeable basis. These wastes were later sorted at the centralised facility, where the medical disposable waste was sent for recycling and other waste was carried to city dump yard. The oil for incinerator was sold. Yet in another city, prior to Bio-medical waste Rules, the Bio-medical (potentially infectious) waste collected from city hospitals by the local Corporation, was sent for dumping at night hours along the highway, outside the city limits [22, similar incidences]. The Concern to address here is of 'Controls' and 'Medical Waste Tracking' laws to be in place, prior to privatising Central Treatment Plant facility.

The above **INCIDENCE-3** concerns small clinics, which were then exempted, and permitted to throw their waste in open dumpsters. Today in India there are several associations related with small clinics and nursing home, seeking relaxation in implementing the Bio-medical Waste Management and Handling Rules. You can imagine as to how dangerous this move could be. The incidence also deals with the Concerns of handling and treatment of vials of blood. It is a common observation at many sites that the rag pickers at hospital waste dumps are sorting the blood filled vials; and this is true even at hospitals practising Bio-medical waste Programme. Children play with vials of blood at some hospital sites.

The concern here is of the method to be adopted for vials of blood for its treatment, destruction and disposal. The **INCIDENCE-4** expresses similar concerns related to open disposal of vaccines, particularly when mass immunization programmes are in progress in India.

The above **INCIDENCE-5** deals with disposal of blood, a bucket full of blood at some hospitals, being thrown into drain. One Concern to address is of Safe disposal of bucketful blood, which should not be poured into drains. The second concern is to protect the workers for Occupational Health and Safety, and Legal issues related to for not complying with the Safety and Health requirements as per Factory Act. The second aspect is important as the Factory Laws for worker Safety now apply to hospitals in India.

The above **INCIDENCE-6** provides a picture of the medical waste treatment and disposal structure that was built over decades and existed in the 1980's in US, having 'On-site' waste incinerators and waste Autoclaves. The Issue to address here is that of the 'On-site' Vs the 'Off-site' Central waste treatment. In India the medical waste management is still in the infancy stage of evolving developments. There are no state of the art and comprehensive Central Treatment Plant System exists or likely to be set up in near future, across the country. Then, is the 'On-site' facility set-up, with incinerators and steam sterilises, the right and quick way to go in development of medical waste management system? Or, is it right to wait until the high environmentally complying 'Off-site' Central waste facility to be set up and be operating?

The above **INCIDENCE-7**, brings out the issue of educating the healthcare workers of minimal risks involved in handling of medical waste if the Universal Safety precautions are followed, and the understanding of how the diseases spread. Though until recently (until late 90's), there were no reported cases in the world of spread of infectious disease through medical waste other than injury by infected sharps, the first reported case of acquired TB to waste handling plant workers in 1998 as narrated in above Incidence-8 is of serous concern.

The above **INCIDENCE-8** of 1998 is of the first reported acquired TB infection from infectious medical waste by a waste-handling worker at the second largest waste service company in USA using state of the art alternate waste treatment facility. The concern in India is of setting up a central 'off-site' waste treatment and disposal plants without complete safety measures, procedures and laws in place.

Outstanding and Current Issues

1. AMOUNTS OF MEDICAL WASTE: The actual waste generated in the United States today (or in the past) is not known; even estimating this figure is problematic, as the number of different reported estimates indicate. The bed per day generation figure itself, however, is difficult to pinpoint[1]. It is therefore necessary for each healthcare facility to determine the actual quantum of harmful waste segregated from their daily waste stream, on regular basis, rather than relying on some random ratios.
2. COMPOSITION: The composition of medical waste stream is of concern given its effects on the incineration process [1]; as well as of its effects on alternate treatment technology processes such as Autoclave (Steam sterilisation) and Microwave, wherein the solvents

and hazardous chemicals are intimately mixed with the waste [2]. The issue here is that even where the waste is segregated and medical waste management practices are followed, the composition of waste is not analysed in terms of its types, quantity and density. Proper analysis of waste composition will enable to determine 'heat release' capacity of Incinerators[3],[4]; and, in the case of Steam Sterilisation and Microwave processes the hazardous emissions would be prevented or suitable treatment of emissions incorporated.

3. CLASSIFICATION: Bio-medical (Management & Handling) Rules, July 1998 of MoEF has defined and classified the wastes. However the issue is that a policy debate continues over how best to classify infectious wastes, and other medical wastes, as well. From a generator perspective, greater consistency on the classification of infectious and other medical wastes would help eliminate some of the current confusion over the proper treatment of this wastes[1].
4. SEGREGATION: Whilst the message is percolating that infectious waste is a fraction (5% to 40%) of total waste, and that when it mixes with general waste, the infectious waste to be handled treated and disposed is 100%. The issue to address is that there are some very toxic waste streams from Hospitals and Healthcare laboratories, and when this toxic waste finds it place with the rest of the waste, then you have100% hazardous toxic waste problem at hand. Whilst the cost for handling, treatment and disposal of general wastes is the least, the cost towards infectious waste is expensive and that for hazardous toxic waste costs are very much more expensive. Segregation at source should start at basic level of separating wet garbage from dry garbage. Putting the wet garbage for useful purpose such as vermin culture process, and profitably recycling the dry waste. Thereafter the issue of segregating of medical wastes will be bettering addressed and practised.
5. SOURCE REDUCTION: The message of source reduction has not reached every establishment and healthcare centres. Facilities having an established waste management system in place have not shown the way of the source reduction success stories of their establishment. The issue is that the trend is to towards finding of technological solutions of waste treatment and disposal without undertaking programmes of source reduction, waste segregation, waste quantification and waste composition exercise. Waste reduction begins by understanding what is purchased, how goods are used, and what it discards, and then is put to use[5]. The issue of source reduction is often talked about at National seminars and workshops, but practical success examples are yet to be seen and documented of the savings obtained by waste reduction programmes.
6. PACKING: Polyethylene bags are frequently used for containing bulk wastes (e.g., contaminated disposable and residual liquids)[1]. The question often asked at seminars and meetings are with regards to the thickness and specification for plastic bags, and no spot answers are available. The plastic bags should have minimum gauge of 225 μm

[2] 'Infectious Waste Incineration', Gordon F. Blizard, Jr., Standard Handbook of Hazardous Waste Treatment and Disposal, The McGraw-Hill Companies, Inc., 1998
[3] 'Medical Waste Disposal', by Calvin R. Brunner. ISBN 0-9621774-1-5. Copyright 1996 by Incinerator Consultants Incorporated.
[4] EPA Handbook 'Operation and Maintenance of Hospital Medical Waste Incinerators', January 1990, EPA/625/6-890/024
[5] "Waste Reduction Activities For Hospitals', California Integrated Waste Management Board, May 27, 1997

for high-risk waste and 100 μm for low risk waste [6]. An ASTM Standard (#D 1709-75) for tensile strength based on a dart drop test and mil gauge thickness of the plastic determine its resistance to tearing[1] ([ref. 62] Rutala, W., and Sarubbi F., "Management of Infectious waste from Hospitals", *Infectious Waste Management* 4(4): 198-203, 1983). The other issues about packaging, besides specification is its size and dimension. Very often the waste package size is larger than the waste feed opening into the incinerator, a common mode of waste disposal, and this mismatch results in operation drawback. The medical waste bags being transported to off-site Central Treatment Plant, are not suitably packed in solid cardboard containers, resulting in damages and leakage of blood and body fluids when stacked over each other. Similar situation applies to on-site treatment and disposable plants where the bags are stacked one upon another, and the staff at these plants are not equipped nor trained to handle blood spills and infectious waste spills. Plastic may be considered an unnecessary expense in some countries and it may be cheaper to use thick, leak-proof paper bags (these are often manufactured locally and therefore readily available). These bags can be labelled with colour-coded strips and should be placed in colour coded metal bins in the wards and departments and are equally effective means of separating waste at its source [6]. Command Hospitals have developed waste paper bags for medical waste (as discussed at 2nd National Seminar on 'Hospital Clinical Waste, Hazards management, and Infection Control', April 12th to 15th, 2000, at Indian Society of Health Administrators, (ISHA), Banglore. Paper presented by Group Capt. H S R Arora).

7. COMPACTION: In general, EPA does not recommend compaction of waste of infectious wastes before treatment. Even though it can reduce the volume of waste needing storage, compaction is not encouraged due to the possibility of packages being violated and the potential for aerosolization of microorganisms [1(Chapter-2, ref. [62])]. Compacted waste retards the processes of Incineration, Autoclave and Microwave. A case has been reported of injury due to a sharp piercing through a cardboard container, whilst compacting the container by hand.
8. GRINDING / SHREDDING- the issue often being discussed is whether to grind / shred the waste before disinfection treatment, or, after disinfection treatment. Commercially available grinding systems that first involve sterilisation before shredding or compaction may alleviate the concern of the potential for aerosolization of microorganism [1(Chapter-2, ref. [62])].
9. SYRINGE NEEDLES: Sharps are of concern; not only because of their infectious potential, but also because of the direct prick/stab type injury they can cause [1]. The MoEF Rules require Two conditions to be fulfilled. First, that the syringe needle should be disinfected. Second that the needle should be mutilated prior to its final disposal. Whilst using disposable syringe and needle, the issue is whether to first destroy the needle or to disinfect it. There are several different practices adopted at various healthcare facilities, and in many cases different practices are adopted at various different wards, laboratories, out patient departments within the same hospital. There are several alternate practices followed today, as observed from number of surveys conducted on waste management practices. One golden-rule to be followed whilst handling and management of sharps is to handle the sharps least number of times.

[6] "HOSPITAL INFECTION CONTROL, Setting up a cost-effective Programme", by Shaheen Mehtar, Consultant Microbiologist, North Middlesex Hospital and Senior Lecturer (Hon.), Royal Free Hospital, Oxford University Press, 1992

Some truly believe that the disposable items are meant to be disposed and therefore throw the disposable syringe and needle to waste immediate after its use. Some believe that first the destruction of syringe and needle is of prime importance and therefore resorts to needle clipper/cutter and /or thermal destroyer. Later it is thrown in waste collection for further sterilisation process. Each alternate procedure will achieve its objectives, but they will be involved with some risks, which should be known to the healthcare worker at risk. In the past, needles were re-capped, chopped, or disposed of by other practices that are no longer common due to their potential for worker injury and, in the case of chopping, for aerosolization of micro-organisms during the chopping procedures[1] (Chapter-2, ref. [62]). Localised Thermal destruction of needles in devices located at wards, clinics will form toxic metal oxides which may be released as aerosols, and the residual ash in insignificant quantity is of hazardous substance, requires safe disposal. Similar issue arises when sharp containers are sent for incineration, whereby toxic emissions will be released, and the ash content will contain hazardous metallic oxide residuals. Unburned needles and sharps contents in incineration ash may pose greater danger. Shirato has computed that the amount of each virus surviving in an infected syringe may remain above the infective doses for eight days after it was used on an infected patient[7]. One of the inconveniences of chemical disinfectant is that it may be ineffective against strains of pathogens that are resistant to the selected chemical[7]. Chances of disinfecting syringe chemically would be very low. It is likely that only the liquid at the tip of the needle would react with the disinfectant; diffusion of the disinfectant up the needle would take at a very low rate[7]. It is therefore recommended that medical wastes that have been chemically disinfected should continue to be treated as hazardous, unless careful bacteriological testing has shown the disinfection to be complete.

10. SEWAGE DISPOSAL: There is a strong suspicion that uncontrolled discharges of sewage from field hospitals in Chile and Peru have contributed to the spreading of cholera[7]. Cytotoxic drugs should never be diluted and discharged to sewer. Treatment of wastewater may not be effective in removing pathogens; too much confidence in wastewater treatment plants, especially during epidemics, may lead to public hazards. If there is an outbreak of acute diarrhoea infections, sewage from hospitals must be treated and disinfected. Even treated hospital sewage should never be reused for irrigation or discharged into water bodies used for drinking water. In case of the outbreak of acute diarrhoea infections, stools from patients must be disinfected, and not discharged in the sewers, whether or not a sewage treatment plant is in operation[7].
11. ISOLATION WARDS: All waste from isolation wards should be regarded as infected waste[7].
12. AUTOCLAVING: Several studies indicate that the type of container (e.g., plastic bags, stainless steel containers), the addition of water, and the volume and density of material have an important influence on the effectiveness of the autoclaving process[1] ([41] Lauber, J., Bat7tles, D, and Busley, D., "Decontaminating Infectious Laboratory wastes by Autoclaving," Applied Environmental Microbiology 44(3):690-694, September 1982; [54] Perkins, J., *Principles and Methods of Sterilization in Health Sciences*, 2d ed. (Springfield, IL Charles C Thomas Publishers, 1983; and [63] Rutala, W., Stiegel , M, and Sarubbi, F, "Decontamination of Laboratory Microbiological Waste by Steam

[7] "Managing Medical Wastes In Developing Countries", Report on Consultation on Medical Wastes Management in Developing Countries, WHO, Geneva, September 1992, edited by Dr. Adrian Coad.

Sterilization", *Applied and Environmental Microbiology* 43(60: 1311-1316, June 1982.). Each of these factors influences the penetration of steam to the entire load and, consequently, the extent of pathogen destruction. Since there is no such thing as a 'standard load' for an autoclave, adjustments need to be made by an operator based on variation of these factors. As with many technologies, proper operation of autoclave is key to effective functioning (i.e., in this case, sufficient pathogen destruction to render wastes non-hazardous)[1]. One method of assuring that pathogen destruction has taken place is the use of biological indicators, such as *Bacillus stearothermophilus*. Elimination of this organism (as measured by spore tests) from a stainless steel container requires a cycle time of at least 90 minutes exposure. This is considerably longer than is currently provided by standard operating procedures[1] ([63] and [61] Rutala, W., "Management of Infectious Waste by United States Hospitals," paper delivered to the 28th ICAAC, Los Angeles, CA, 1988). Several factors have led some hospitals to abandon autoclaving. For example, problematic operating conditions can lead to incomplete Sterilization. In addition, landfill and off-site incinerator operators are increasingly refusing to receive such wastes, questioning whether the waste has actually been treated[1] ([72] Spurgin, R., "Of-site-A Comparison With On-site Treatment Technologies", paper presented at Hospital Solid Waste Management Conference, San Francisco, CA, September 20, 1988).

13. INCINERATION: The incineration of medical waste has many of the same advantages and disadvantages associated with the incineration of any type of waste[1]. Some of the main drawbacks of medical waste incinerator operation include improper capacity selection, improper planning, improper operation (cold start, over charging, low temperature, high temperature), inadequate operator training, poor packaging and improper use by feeding of toxic and undesirable waste materials into the incinerator[8]. Amongst many issues related with the incinerator and its regulatory rules, the operation of small incinerators of low capacity (up to 90 kg/hour) with tall (30 m and above) chimney is questionable. 'It is not really practicable to fit such small incinerators with dust collectors of the standard installed in large plants, and in small unattended incinerators it is difficult to ensure that the furnace temperature is high enough at all times to prevent odour. Moreover the chimneys of such small plants cannot be made high enough or the velocity high enough to avoid downdraught and downwash of the gases if the chimneys are on the roof of the flats' [9]. Dioxin formation and emission from incinerator is a current issue, whilst it regulatory emission limits, its testing and monitoring procedures in India is of future concern. Understanding on issues related with Dioxin is dealt with under separate paragraph.
14. SMALL GENERATORS: Medical waste treatment and disposal for large hospitals are being addressed since 1989 in India[10]. The issue is with regards to large number of small problems, from small nursing homes, clinics and healthcare treatment at homes in urban as well as rural areas, where very little has been done. This is the most vulnerable area where unregulated waste discharges may be susceptible to direct public

[8] "Indian Perspective of Hospital / Medical / Infectious Waste INCINERATOR operation Drawbacks and Suggested Corrective Measures", by Homi R. Mullan; Paper presented at National Workshop on 'Hospital Waste Management', March 7-8, 2000, at International Development Centre, New Delhi.
[9] Industrial Air Pollution Handbook, Editor Albert Parker, Chapter:20 'Incineration of Refuse' by H. B. Johnson. J. M. Burnett.
[10] *Indian Standard* "Solid Wastes - Hospitals - Guidelines for Management- IS 12625 : 1989"

exposure to possible risk. Case #3 in the above Historical Incidences paragraph, occurred outside of doctor offices- not hospitals[1] (Infectious waste news, "Baltimore County Considers Moratorium on Infectious Wastes Incinerators," *Infectious Waste News*, pp. 1-2, June 18, 1988). A problem is how these smaller generators can efficiently and economically dispose of their infectious wastes. Commercial off-site facilities may not be readily available or may be highly costly.

15. ON-SITE TREATMENT AND DISPOSAL: The most established medical waste treatment and disposal facility, till today, has been the on-site facilities. In the early 1980s the State Health Services hospitals had their waste disposal incinerators in place, and the Defence Services hospitals had the system prior to 1980s. Earlier Infection Control aspects drove the medical waste management. Now, in today's context, medical waste management is driven by Environment and Economic concerns. The issue today is whether to do away with on-site treatment (incinerators and steam sterilisation) facility, when the off-site Central Treatment Plant along with its Transportation and Waste Tracking systems are not in place. The treatment and disposals systems implemented after the Supreme Court directives in New Delhi, and after MoEF Rules in 1998, have been on-site plants. The current schemes of Command Hospitals under implementation and on plan are working towards on-site facility.
16. OFF-SITE TREATMENT AND DISPOSAL: This is the obvious choice of management of healthcare facilities and large number of smaller users in Metro Cities. The Association of Hospitals along with Pune Municipal Corporation has set up a co-operative model Central Treatment Plant, which will shortly commence. City Corporations of Hyderabad, Banglore and Mumbai with the technical guidance from State Pollution Control Board are in the process of privatising Central Treatment Plants for medical waste. The transport, treatment and disposal costs indicated amongst these schemes vary from Rs. 3/kg in Hyderabad to Rs.20/kg in Pune[11]. The issue is that proper Transportation law and Medical Waste Tracing Act is not in place. How soon these schemes will be in operation and that how safely, efficiently and economically these plants will operate will be known in due course of time.

Future Issues

1. DIOXIN: Though this is the most currently talked about issue, the emission standard limits are yet to be included in the MoEF Bio-medical Rules. Let us briefly understand what are the issues known and talked about, and what are the issues we also need to know of. What is Known: i) Dioxin and Furan (PCDD/F) are one of the most toxic group of chemicals known to humans[12]. It is the most toxic synthetic chemical known, which is 10,000 times more potent than cyanide as determined in laboratory analysis[13]. ii) PCCD/F is synonymous with burning of chlorinated plastics such as PVC. iii) Hospital incinerators tend to produce more dioxins and furans per gram of waste burned than municipal incinerators. Given the smaller amount of medical waste incinerated, overall emissions from all medical waste incinerators are less than those

[11] Proceedings of 2nd National Seminar on "Hospital Clinical Waste, Hazardous Waste, and Infection Control", April 12-15, 2000, at Indian Society of Health Administrators (ISHA), Banglore.
[12] 'Industrial Air Pollution Monitoring', editor Andrew G, Clarke, 1998. Chapter 16 "Sampling and Analysis of PAH, Dioxin and Furan" by Paul T. Williams.
[13] 'Hazardous Air Emissions from Incineration', by Calvin R. Brunner, Chapman and Hall 1985, Chapter 6 'Dioxin'.

from existing incinerators[1]. What needs to be known: a) Microwave and autoclave can vaporise hazardous chemicals and solvents typically found in medical waste (acetone, ethyl alcohol, methyl alcohol, Pentane, xylene and many more)[2]. Solvent vapours act as precursor to formation of PCCD/F. b) Composting of organic waste containing chlorinated compounds form PCDD/F. c) PCCD/F species were detected in 60 per cent of the boiler stack samples[14]. d) Amongst natural sources of PCCD/F are Forest Fires, soils and sediments, rivers and lakes, 8000 years old deposits. e) PCCD/F is formed in combustion process from Smoking, automobile exhaust (Diesel & Gasoline) emission, and wood burning from residential furnaces. It is found in paper products of milk cartons and tampons[17]. f) Ambient measurements confirm that PCDD/F contamination is wide spread and that virtually everyone - regardless of age, gender or geographic location - is exposed to these compounds on a daily basis. Known sources of PCDD/F appear to account for only a fraction (10-30%) of the total annual atmospheric deposition of PCDD/F in the US[15] (chapter on 'Human Exposure to Dioxin, by Curtis C. Travis and April G. Nixon', pp 30). g) Higher chlorine content does not necessarily imply a higher level of PCDD/F emission. A study of chlorine in waste streams and dioxin emission from waste combustor stacks found no statistically significant relationship between chlorine input and PCDD/F stack gas concentrations, for the majority (80%) of the 90 facilities examined[15].- (American Society of Mechanical Engineers, *The Relationship between Chlorine in Waste Streams and Dioxin Emissions from Waste Combustor Stacks*, CRTD vol. 36, AMSE, New York, 1995). In fact, 9% of the facilities studied displayed decreasing PCDD/F concentration with increasing chlorine. h) 'The EPA has investigated the impacts on emissions of shifting the waste composition from chlorinated plastics to non-chlorinated polymers. However, the outcome of this investigation is inconclusive. A number of studies have concluded that the chlorine content of the waste is directly related to dioxin / furan emissions, while other studies suggest there is no relationship between the chlorine content of the waste and dioxin/ furan emissions. At this point, the effectiveness of a pollution prevention program directed at reducing dioxin / furan emissions through shifting the waste composition from chlorinated plastics to non-chlorinated polymers would be questionable[16]'. i) 'It is well established that the food chain, especially meat and dairy products, accounts for more than 90% of human exposure to PCDD/Fs and perhaps as much as 99% of human exposure to 2,3,7,8-TCDD[15] (C. C. Travis and H. Hattermer-Frey, Sci. Total Environ., 1991, 104, 97). Welge et al. Compared blood levels of PCDD/Fs in 24 vegetarians and 24 omnivores and found no significant difference (vegetarian mean = 32.6pg TEQ g^{-1} lipid; omnivore mean = 34.3pg TEQ g^{-1} lipid) between the two groups[15] - (P. Welge et al., *Organohalogen Compd.*, 1993, 13, 13). Estimates of total daily intake of dioxin via food in industrialised nations are fairly consistent, ranging from 1.3 to 2.3pg TEQ kg^{-1} day^{-1} [(15)]. j) 'The truth is that dioxin itself does serious human damage only at high doses. Yet dioxin and herbicides are regulated as if low doses pose a significant threat' [17]. k) 'The hundreds of millions of

[14] "Waste Incineration Handbook", by Paul Cheremisinoff, Butterworth Heinemann -1992.

[15] Issues in Environmental Science and Technology, edited by R. E. Hester and R. M. Harrison, Volume 6 "Chlorinated Organic Micropollutants"

[16] US EPA 40 CFR Part 60 'Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Hospital / Medical / Infectious Waste Incinerators - August 15, 1997

[17] 'Dioxin, Agent Orange, and Times Beach', with Brendon Swedlow

dollars spent on scrubbing air, soil, and water free of only recently perceptible particles of dioxin could be better utilised'[17].

2. HAZARDOUS TOXIC WASTE: Hospital hazardous waste is unique in several ways. There are a very large variety of wastes but the volumes are small relative to industrial facilities. Hospital employs toxic chemicals and hazardous materials for numerous diagnostic and treatment purposes. The hazardous materials include Chemotherapy and antineoplastic chemicals; Formaldehyde; Photographic chemicals; Radionuclides; Solvents; Mercury; Waste anaesthetic gases; and, other toxic, corrosive and miscellaneous chemicals[18]. This issue needs to be addressed particularly for wastes from Laboratories, Blood Banks, Radiology departments, as the hazards and toxicity of chemical is well proven and known. This will require lot of awareness training programmes to be conducted.
3. OCCUPATIONAL HEALTH: Healthcare workers need to be monitored for occupational health hazards. There have been known cases where the health of workers has been affected by hazardous solvent vapours inside laboratory, and in medical waste Shredding areas (Dr. T. K. Joshi, Centre for Occupational and Environmental Health, Lok Nayak Hospital, New Delhi). The other issue that will be involved is the Factory Act, wherein protective gear and training has to be given to the healthcare facility workers.
4. RADIOACTIVE WASTE MANAGEMENT: This is a very specialised subject and it goes beyond the use and disposal of isotopes. Handling and Management of waste from patient under treatment such as urine, stools, vomit and blood samples. The disposal of body when a patient dies during radioactive treatment / investigative procedure, has very special protocols to be executed.

Conclusion:

The field of medical waste management systems is still in its evolving infancy stage and a lot many issues have to be understood and concerns addressed, over a period of time. This will require a lot of continued research and trials, which are to be, monitored Nation-wide. 'Nonetheless, the need for research should not be taken as a suggestion for postponing consideration of adopting a comprehensive regulatory program to address medical waste management. In fact, research efforts could be a part of a regulatory program, if it is promulgated in phases' [(1)]. The approach to environmental control by developed Nations is 'zero-risk at any-cost', and the issue is as to what extent a developing country or underdeveloped areas can bear these costs. Nevertheless, we must look at the historical developments, research work and experiences of developed countries. We also need to carry our research, document and share our experiences at City, State and National level.

REFERENCES:

[1] "Issues in Medical Waste Management", U.S. Congress, Office of Technology Assessment, Background paper, OTA-BP-O-49, October 1988.

[2] 'Infectious Waste Incineration', Gordon F. Blizard, Jr., Standard Handbook of Hazardous Waste Treatment and Disposal, The McGraw-Hill Companies, Inc., 1998

[3] 'Medical Waste Disposal', by Calvin R. Brunner. ISBN 0-9621774-1-5. Copyright 1996 by Incinerator Consultants Incorporated.

---

[18] "Guides to Pollution Prevention: Selected Hospital Waste Streams", US EPA/625/7-90/009, June 1990.

[4] EPA Handbook 'Operation and Maintenance of Hospital Medical Waste Incinerators', January 1990, EPA/625/6-890/024
[5] "Waste Reduction Activities For Hospitals', California Integrated Waste Management Board, May 27, 1997
[6] "HOSPITAL INFECTION CONTROL, Setting up a cost-effective Programme", by Shaheen Mehtar, Consultant Microbiologist, North Middlesex Hospital and Senior Lecturer (Hon.), Royal Free Hospital, Oxford University Press, 1992
[7] "Managing Medical Wastes In Developing Countries", Report on Consultation on Medical Wastes Management in Developing Countries, WHO, Geneva, September 1992, edited by Dr. Adrian Coad.
[8] "Indian Perspective of Hospital / Medical / Infectious Waste INCINERATOR operation Drawbacks and Suggested Corrective Measures", by Homi R. Mullan; Paper presented at National Workshop on 'Hospital Waste Management', March 7-8, 2000, at International Development Centre, New Delhi
[9] Industrial Air Pollution Handbook, Editor Albert Parker, Chapter:20 'Incineration of Refuse' by H. B. Johnson. J. M. Burnett.
[10] *Indian Standard* "Solid Wastes - Hospitals - Guidelines for Management- IS:12625 : 1989."
[11] Proceedings of 2nd National Seminar on "Hospital Clinical Waste, Hazardous Waste, and Infection Control", April 12-15, 2000, at Indian Society of Health Administrators (ISHA), Banglore.
[12] 'Industrial Air Pollution Monitoring', editor Andrew G, Clarke, 1998. Chapter 16 "Sampling and Analysis of PAH, Dioxin and Furan, by Paul T. Williams.
[13] 'Hazardous Air Emissions from Incineration', by Calvin R. Brunner, Chapman and Hall 1985, Chapter 6 'Dioxin'.
[14] "Waste Incineration Handbook", by Paul Cheremisinoff, Butterworth Heinemann -1992.
[15] Issues in Environmental Science and Technology edited by R. E. Hester and R. M. Harrison, Volume 6 "Chlorinated Organic Micropollutants".
[16] US EPA 40 CFR Part 60 'Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Hospital / Medical / Infectious Waste Incinerators - August 15, 1997
[17] 'Dioxin, Agent Orange, and Times Beach', with Brendon Swedlow.
[18] "Guides to Pollution Prevention: Selected Hospital Waste Streams", US EPA/625/7-90/009, June 1990
[19] TECHNET website
[20] Medical News - 'Infection Control and Hospital Epidemiology ' Vol. 19 No. 5, Pages 370-371.
[21] Humanity and Environment
[22] 'Bio-medical Waste Disposal Causes Concern', Times of India Feb. 01, 2000, Stanley G. Pinto.

NOTE:
This paper is a revision update to the paper on "Issues in Medical Waste Management" presented at the Training Programme on 'Biomedical Waste Management' May 08 - 10, 2000, Sponsored by: Ministry of Environment and Forests, New Delhi and organised and conducted by Faculty of Centre for Environmental Science and Engineering, Indian Institute of Technology, Bombay, Mumbai.

CONTACT DETAILS:
HOMI R. MULLAN
23, Suraj Apartments, 274 Jaoji Dadaji Road, PO Grant Road, Mumbai- 400 007
Phone: (022)-3865290; Fax (~~022)-3875003~~ Cell: +91-9820811308
E-mail: ~~mullan@vsnl.com~~
homi-mullan@hotmail.com
mullan.hts@gmail.com