

MANAGING HAZARD SOLID WASTE IN A HEALTH FACILITIES REGIONAL NETWORK. EVALUATION OF A DISTRICT-SIZE SYSTEM.

Sonia Cedrés de Bello

Instituto de Desarrollo Experimental de la Construcción
Facultad de Arquitectura y Urbanismo
Universidad Central de Venezuela
Tele-fax: (58-2) 605.2046 / 605.2048
E-mail: sonia.bello@idec.arq.ucv.ve

ABSTRACT

The hospitals and related services solid waste represent a hazard for the environment and public health, for that reason they should not be disposed with common waste without previous treatment.

Medical waste decontamination is achieved either through destruction or inactivation. Destruction involves combustion processes such as incineration, while inactivation involves killing microorganisms without disintegrating them. Inactivation is accomplished using heat, chemicals, or radiation. The various medical waste treatment systems applying these processes are discussed.

In this paper a plan is presented on how to manage the medical waste of a regional network of health services. Particular attention is given to the managing of human placentas produced in delivery rooms at rural areas, radioactive waste of general hospitals, mercury residuals from dentistry practice, discarded radiographic films and corroded developer liquids from the imaging services.

It presents different planning options such as treatment by incineration in a centralized area, incinerators for each individual facility and burning of human placentas in rural facilities. This analysis is presented in relation to its costs and recommendation for the most feasible way.

INTRODUCTION

During the last decade the Venezuelan government is undergoing a process for modernization of the existing health facilities and improvement of the health services, in the frame of the Renovation of the Health System. This process, aimed to complete the health care network, is financially supported by International agencies such as the World Bank and the Interamerican Bank of Development.

There is also going on a process of decentralization of the government functions, giving responsibilities to regional and local authorities including the planning, construction, and management of the health care facilities, and the setting of its network. One of the aspects that have been emphasized in the process of Health Facility Projects is the management of solid waste, at the service level as well as the district level.

In this situation the regions are doing their own planning following directions from the Central level (MSAS, 1996). Each establishment is required to adopt national regulations (Venezuela, Gaceta Oficial, 1992) for internal collection of hazard waste and join the district plan for final treatment.

CLASIFICATION OF MEDICAL WASTE

The management of medical waste in Venezuela was regulated by Official Act n° 2218, published on April 1992 and updated by Act n° 2635 on August 1998. This legislation established the following classification:

Common waste (Type A): is like domiciliary waste, does not require any special treatment.

Potentially Infectious (Type B): includes soiled dressings, bandages, disposable underpads, disposable diapers, catheters, tissues, body secretion, sputum cups, masks, swabs, sanitary napkins, plastics casts.

Contaminated waste (Type C): includes material from infected patients (tuberculosis, hepatitis, HIV), needles and syringes, surgical waste, laboratory, blood bank.
 Organic or Biological (Type D): waste resulting directly from patient activities, this includes diagnostic, medical, surgical, autopsy, and wound dressings. Some items are placentas, organs and amputated limbs.
 Hazardous or Special (Type E): radioactive waste, mercury residuals, radiographic films, developer liquids, and residuals from nuclear medicine and radiology.

TABLE 1: Medical Waste production in different hospital departments

DEPARTMENT	POTENTIALLY INFECTIOUS (B)	CONTAMINATED WASTE (C)	BIOLOGICAL WASTE (D)	HAZARDOUS WASTE (E)
Emergency room, consultation, exam, treatment room	*			
Operating rooms, ICU, Delivery Hemodialysis, Blood Bank, Laboratory	*	*	*	
Inpatient wards	*			
Oncology, Chemotherapy, Nuclear Medicine, Radiology.				*
Pathology		*	*	*
Surgery		*	*	

MEDICAL WASTE TREATMENT REQUIREMENTS

The term *medical waste* is commonly defined as all solid waste generated from health care facilities. However the term is more synonymous with such terms as biohazardous, biological, biomedical, infectious, red bag and regulated medical waste. Most medical waste treatment technologies are primarily designed and intended for processing and treating wastes that are either defined or regulated as being "potentially infectious". It is also worth noting that the terms *waste treatment* and *waste disposal* are different. Treatment involves the application of physical, chemical or thermal processes to alter or change the characteristics or properties of the waste prior to disposal. Waste disposal involves the final disposition of treated or untreated waste, including residues from treatment processes such as ash from incinerators.

Urbanowicz (1992) shows two basic requirements to which medical waste treatment systems are design and operated, these include *disfigurement* and *decontamination*, which are achieved to varying degrees by different technologies.

Disfigurement: relates to the recognizability or appearance of disposed medical waste, in addition to this, sharps, such as needles, scalpels, glass slide plates, and broken test tubes, pose a puncture hazard and are the medical waste items that contribute most to potential spread of infection. Therefore, disfigurement requirements for these items must not only deal with recognition but also destruction to the degree that they no longer pose a hazard. Some medical waste treatment systems utilize shredding to achieve disfigurement.

Decontamination: relates to a requirement for rendering the medical waste biologically safe for disposal. Decontamination is defined as the waste being sterilized. Sterilization is defined as the destruction or inactivation of all life. It is often incorrectly interchanged with the term *disinfecting*, which by definition, is the destruction or inactivation of disease producing microorganism, or pathogens.

Medical waste decontamination is achieved either through destruction or inactivation. Destruction involves combustion processes such as incineration, while inactivation involves killing microorganisms without disintegrating them. Inactivation is accomplished using heat, chemicals, or radiation.

MEDICAL WASTE TREATMENT PROCESSES AND TECHNOLOGIES

There are four broad categories of medical waste treatment technologies:

1. Mechanical processes
2. Thermal processes
3. Chemical Processes
4. Irradiation Processes

The two primary mechanical processes are *compaction* and *shredding*. They are not considered viable, alternative treatment system for untreated medical waste. This is specifically applicable to medical waste that has been autoclaved in order to make it unrecognizable.

Thermal processes: use heat as the primary means to achieve decontamination, the main systems are *autoclaving* and *incineration*. *Autoclaving* systems are designed to bring steam into direct contact with waste. The standard

criterion for acceptable performance using this method is sterilization. Several autoclaving systems are designed for using shredders to disfigure sterilized medical waste prior to landfilling.

Incineration is the use of high temperature combustion to destroy medical waste. Even that this system has become difficult, costly and often problematic to install because of regulations, this system properly designed, operated, and well maintained is environmentally benign and cost-effective treatment method.

Pyrolysis is a process, which involves heating in the absence of oxygen. Petroleum, electrical resistance, or plasma burners can generate the heat.

Chemical treatment: is synonymous of disinfecting, with this method water is needed to bring the chemicals and microorganisms together as necessary to achieve inactivation. Potential concerns using these treatment systems include liquid effluent and ambient workplace conditions.

Evaluation of systems

The following list has some of the key items that are recommended for consideration when evaluating alternative treatment technologies for medical waste:

1. Technical viability
2. Vendor Qualifications and Capabilities
3. Environmental Impacts
4. Occupational and Ambient Impacts
5. Waste Acceptability
6. Residue Acceptability
7. Permissibility
8. Economics.

HEALTH FACILITIES REGIONAL NETWORK PLANNING

Planning for treatment and disposal of hazard solid waste in a case study: Falcon State.

Demographic data (OCEI, 1993)

Population: 600.000 inhabitants
 Surface: 24.800 km²
 Density: 24.2 inh./km²
 Birth rate: 30 /1.000 inhabitants

Existing Health Facilities

3 hospitals (Coro, Punto Fijo, Churuguara)
 298 ambulatory care services: 29 Urban (UI- II) , 269 Rural (RI- II)

Type of Waste Production:

3 Hospitals: wastes B- C- D- E
 10 Urban ambulatory facilities (AUI-II) with lab, radiology and dentistry services: wastes B, C.
 69 Rural ambulatory facilities (ARII) with delivery rooms: waste D (placentas)

Quantification of waste:

There was a data collection (Lozada, 1994) for the waste production in the facilities prior to prepare the plan. Because there was no waste segregation, it was assumed that 40% of total waste could be considered as potentially hazardous, including waste B, C and D, following recommendation by OPS (1991). With this data and the total number of beds in hospitals and number of consultation rooms in ambulatory care services, it was obtained the media rate of 5 kg /bed /day in hospitals and 2 kg. /consultation room/ day in ambulatory facilities.

TABLE 1: Falcon State. media daily waste production in hospitals.

HOSPITAL	Nº BEDS	TOTAL WASTE Kg/ day	WASTE B, C, D Kg. / day
Coro	416	2080	832
Punto Fijo	30	150	60
Churuguara	30	150	60
Total	476	1380	952

Source: Lozada Avendaño. 1994

TABLE 2: Falcon State. media daily waste production in ambulatory care facilities.

AMBULATORY FACILITIES	UNITS	CONSULTATION ROOMS. N°	TOTAL WASTE Kg. / day	WASTE B, C, D. Kg. / day
Urban I (AUI)	27	54	108	43.2
Urban II (AUII)	2	10	50	20.0
Rural II (ARI)	73	146	292	116.8
Rural I (ARI)	196	196	392	N/P *
Total	298	406	842	180.0

Source: Lozada Avendaño. 1994

* These facilities do not produce C, D wastes, and very few of waste B, that can be managed with no risks.

TABLE 3: Falcon State. media monthly human placentas production in Rural II Facilities.

SANITARY DISTRICT	RURAL II UNITS	DELIVERY ROOMS N°	DELIVERIES / MONTH	WASTE PRODUC Kg. / month
1. Coro	20	16	80	80
2. Punto Fijo	15	15	75	75
3. Dabajuro	09	09	45	45
4. Churuguara	05	05	25	25
5. Tucacas	15	15	75	75
6. San Luis	09	09	45	45
Total	73	69	345	345

Source: Lozada Avendaño. 1994. The weight for placenta was estimated as 1 kg.

Alternatives for management of medical waste:

1. Individual incinerator for each facility, including the 3 hospitals and the 69 rural facilities that produce human placentas,
2. Utilization of landfills for burial of medical waste.
3. Establishment of a regional center for incineration.

Operative Program:

After analyzing the cost and the feasibility of the alternatives, the plan was design as a centralized system, with the operations located at the Central Hospital (Coro), and the transportation of the medical waste from the other facilities. Special attention is given to the medical waste B, C, D, E, generated in hospitals, the placentas produced in the 69 ARI, and the waste B, C produced in labs, mercurial residuals from dentistry practices and radiographic films and development liquids from radiology practices, produced at the 10 AUI- II.

The plan considers provide a Regional Center for incineration, at the Central Hospital with the replacement of the old obsolete incinerator with low capacity, and the acquisition of a new incinerator with capacity for 200 kg. / hour, besides there will be the training of 2 operators and two ancillaries, and the guarantee of the equipment and facility maintenance.

Treatment and final disposal of medical waste

Waste B, C, D: will be storage separately in storage ad hoc, in each facility and then transported in special refrigerated vehicles to the Regional Center for incineration.

Waste E: radioactive contaminated waste, and radioactive sealed sources from radiotherapy and radiology activities will be kept properly identify and labeled, in storage ad hoc located at the Regional Center for the time required for inactivation, with the control of the proper authorities (Ministry of Energy).

Chemical, pharmaceutical waste and mercury residuals will be collected in situ and storage in a room, build ad hoc, for best control.

Investment

This plan has been established for implementation in 6 years with an investment of \$ 2.9 millions, including:

Construction works in the facilities of: 1 special storage room for wastes E, 3 storage rooms located in each hospital and 29 storage rooms at the ambulatory facilities.

Equipments: 1 incinerator, 6 cool storage, 6 vehicles for refrigerated transportation.

Others as: managerial system, personnel training, operative expenses (plastic bags, uniforms, and protective gowns for maintenance employees). Maintenance expenses for infrastructure and equipment.

Implementation of the program

In a short term: the managerial system, training process of personnel, building of construction works, and organization of the central treatment system.

In the medium term: the functioning of the whole system, and operating the full program.

Other State planning for treatment and disposal of hazard solid waste:

In Aragua State there is a plan (Corposalud, 1996) for a construction of a central pyrolytic incinerator with capacity of 5 ton/ day, or several incinerators at the facilities level forming a network of hazardous waste treatment. This solution involves a high initial investment but reduces operation and maintenance costs.

Other alternative for this state, called the "green solution" because has lower environmental impact. Consist in the treatment of wastes B, C, D, in each facility with an electric incinerator, with capacity of 2- 5 kg/h. This alternative has the advantages of lower investment, and low maintenance costs, as well as accelerated personnel training at the service level.

COMMENTS

The proper segregation, treatment and disposal of medical wastes following official regulations are not in practice in the public health facilities at all. Also the quantification of waste in order to make accurate planning is not known. However there are few local experiences in quantification of waste production in health facilities. (Lara, 1991; PETA, 1992; Infante, 1993), that can lead us towards having planning indexes reflecting our reality.

Infante, et al (1993) reported at the University Hospital in Caracas (1.200 beds)

Total waste:	3.143 kg./day	2.6 kg/ bed/ day
Common waste:	2.682 kg./day (including kitchen)	2.2 kg/ bed/ day
Potentially infectious	300 kg./day	0.25 kg/ bed/ day
Contaminated	98 kg./day	0.08 kg/ bed/ day
Hazardous	0.2 kg./day	
Carton	62 kg./day	

Other quantitative results of medical waste were reported by Lara, et al (1991) in another public hospital, the Hospital "Domingo Luciani", in Caracas (600 beds) as shown:

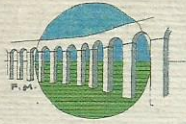
Total waste:	3.8 kg. / bed / day	2.500 kg/ day
Potentially infectious waste:	1.5 kg. / inpatient / day	
Special waste:	0.7 kg. / bed / day	

RECOMENDATIONS

Although there are planning and training programs for management of medical waste, they are still in implementation phase. They are part of the national health project (MSAS, 1996) and there are not yet results to be assessed so far. It is recommended to have more information about waste management systems and experiences in developing countries, as well as accurate data in order to do proper planning adjusted to our reality. That data should included aspects such as time of collection and volume of waste, in order to dimensionate the areas, amount of containers, equipment capacity, personnel and maintenance cost, at service level and district level as well.

REFERENCES

- Corposalud- Aragua. (1996) Plan Estatal. Manejo de desechos sólidos. AUI 23 de enero/ Version 18/01/96.
- Infante, O., Lizardo, A., Seijo, A. (1993) Caracterización, manejo, transporte y disposición de los desechos sólidos producidos en el Hospital Universitario de Caracas. Tesis de Grado. FI-UCV
- Lara, M., Olivares, B., Rodríguez, B. (1991). Caracterización, manejo, transporte y disposición de los-desechos sólidos producidos en el Hospital del Este. Tesis de Grado. FI-UCV.
- Lozada, C.A. (1994) Estado Flacón: Plan estatal de manejo de productos de desecho en establecimientos de salud públicos. Propuesta para la discusión. MSAS- Proyecto Salud. Caracas.
- MSAS-Proyecto Salud (1996) Términos de referencia para la elaboración de proyectos para Rehabilitación Física y Equipamiento de Establecimientos de Salud. Documento. Caracas.
- OPS (1991) Consideraciones en el manejo de los residuos hospitalarios en América Latina. Washington.
- PETA y DGFTZ (1992) Cuantificación y clasificación de los desechos sólidos producidos en Hospitales públicos y Clínicas privadas en el Área Metropolitana de Caracas. Seminario FI-UCV.
- Urbanowicz, G. (1992). Medical Waste Disposal, past, present and future. *Proceedings of the International Congress of Hospital Engineering*, 12, 376-383. Bologna, Italy.
- Venezuela. Gaceta Oficial (1992) Decreto 2218: Normas para la clasificación y manejo de los desechos en establecimientos de salud. 27/ 4/ 92.



UNIVERSITÀ DI ROMA "LA SAPIENZA"
UNIVERSIDAD CENTRAL DE VENEZUELA
UNIVERSITÀ DI ROMA TRE

ENERGY, ENVIRONMENT AND TECHNOLOGICAL INNOVATION

4th International Congress

September 19-24, 1999 Rome (Italy)

Proceedings Volume I

