ISSN: 2278-4632
Vol-10 Issue-1 January 2020

MANAGEMENT OF MEDICAL WASTE IN PRIVATE HOSPITALS

[1*] *Dr. Harish Chand Giri,* [2]*Pinaka Bal*
[1*] *Professor, Dept. of Civil Engineering, NIT BBSR,*
Asst. Professor Dept. of Civil Engineering, OEC, BBSR
[1*]*harishchand@thenalanda.com,balpinaka@gmail.com*

Abstract: Hospitals constantly produce and discard garbage, and inappropriate management of these wastes causes environmental degradation and risks to the public's health. The survey described in this article was conducted at Al-Hadi and Al-Salam Hospitals, two prominent private hospitals, to ascertain the amounts of various types of trash created, segregated, collected, stored, transported, and disposed of.

The findings show that the trash generation rate ranges from 1.77 kg per bed per day to 3.27 kg per bed per day, with 27% domestic garbage, 61% infectious waste, and 12% sharps. In almost all of the hospitals, trash is separated into its many forms. Finally, incineration is used to dispose of all infectious and medical wastes.

The hospitals that were studied do not offer any training programmes to their personnel on how to manage hospital waste and the risks that come with it. The report makes recommendations for how to address current deficiencies.

Keywords: hospital waste; generation rate; segregation; incineration; Kuwait.

1 Introduction

The safe disposal of hospital solid wastes, which contain a variety of infectious harmful pollutants as well as fast population increase and industrialization, has emerged as one of the primary environmental concerns. In contrast to other types of garbage, hospital waste is unique in that it has a higher risk of infection and injury. Clinical waste is produced when people or animals are diagnosed, treated, or immunised, as well as when biological samples are produced or tested. Wastes such sharps, dirty waste, disposables, anatomical waste, cultures, expired medications, and chemical wastes might be included. They take the form of bodily fluids, human excreta, bandages, disposable syringes, swabs, etc. Hazardous garbage is very contagious and poses a major risk to human health if it is not handled carefully and scientifically. The State of Kuwait is a small nation with a population of 2.851 million. It is situated on the western shore of the Arabian Gulf between the latitudes of 28°30° and 30°30°N and the longitudes of 46°30°E. From 2005 and 2010, the average lifespan rose by about ten years, reaching 76. The infant mortality rate is 8.1 per 1,000 live births, while within the same time span, the population's literacy rate rose from 20% to roughly 90%. With a gross domestic product (GDP) of roughly US$ 109,981 million and an average population growth rate of 3.5%, the estimated 2007 GNI per capita was about US$ 49,970. (MOP, 2008; World Bank, 2005). The Ministry of Public Health is in charge of managing healthcare waste, although the Environmental Public Authority (EPA) is in charge of such trash disposal thanks to the Environmental Protection Act (EPA, 2001). Nearly 33,000 metric tons of medical waste is generated by public and private hospitals in Kuwait every year with about 10%–15% of all the waste classified asinfectious waste. These quantities represent about 31% of the total hazardous solid waste generated in the country. The wet waste generated in hospital kitchens and restaurants, and the soiled cloths sent to laundry are not included in the study.There is no unique definition of ‘medical waste’. The terms medical waste, hospital waste and infectious waste have often been used interchangeably. The World Health

ISSN: 2278-4632
Vol-10 Issue-1 January 2020

Organization (WHO, 1997) has classified medical waste into different categories. These are:

1 *Infectious:* material-containing pathogens in sufficient concentrations or quantities that, if exposed, can cause diseases. This includes waste from surgery and autopsieson patients with infectious diseases.

2 *Sharps:* disposable needles, syringes, saws, blades, broken glasses, nails or any otheritem that could cause a cut.

3 *Pathological:* tissues, organs, body parts, human flesh, fetuses, blood and bodyfluids.

4 *Pharmaceuticals:* drugs and chemicals that are returned from wards, spilled, outdated, contaminated, or are no longer required.

5 *Radioactive:* solids, liquids and gaseous waste contaminated with radioactivesubstances used in diagnosis and treatment of diseases like toxic goiter.

6 *Others:* waste from the offices, kitchens, rooms, including bed linen, utensils, paper, etc. Infectious wastes have been described as 'biohazardous', 'health-services hazardous', 'pathological', 'biological' and 'hazardous infectious' (Meaney and Cheremisihoff, 1989).

Biomedical waste management is a critical issue where hazards and risks exist not just for the generators and operators but also for the general community (Sandhu and Singh, 2003). Hence, the collection and disposal of waste properly is of great importance as it can affect public health and also inflict damage on the environment directly and indirectly (Centers for Disease Control and Prevention, 2001). Healthcare workers are exposed to blood and other body fluids as part of their day-to-day activities at the healthcare facilities. As such, healthcare workers face the risk of infection due to the pathogens carried in the blood and other bodily liquids. There are several pathways for the transmission of diseases to healthcare workers. Some of the most important are: percutaneous injuries with contaminated sharps (e.g., through the skin), contamination through the fecal-oral route (e.g., salmonellosis, hepatitis A), and contamination through airborne transmission (e.g., tuberculosis, measles). Percutaneous exposures account for 66–95% of all occupational exposures to blood borne pathogens (CCOHS, 2000; Puro et al., 2001; Romea et al., 1995). Injuries due to accidental punctures and injuries accountfor 62–91% of percutaneous exposures (NaSH, 1999; Puro et al., 2001; Romea et al., 1995).

An effective and efficient program for the management of healthcare wastes is a critical component of a facility's infection control program. Consequently, it plays an important role in the quality of care as well as in the occupational health of the entire staff of the facility. This paper aims to characterise healthcare wastes in private hospitals in Kuwait, and considers designing proper treatment facilities and developing a framework for managing healthcare wastes.

2 Materials and methods

Kuwait has sixteen public hospitals with a total capacity of approximately 4,900 beds, and nine private hospitals with a total capacity of 772 beds. In this study, two private hospitals, Al-Hadi and Al-Salam Hospitals, were assessed during a period of one year (January–December 2005). The study considered only private hospitals since they areless affected by financial constraints than the public ones. Also, public hospitals have previously been assessed in two previous studies (Alhumoud and Alhumoud, 2007;Hamoda et al., 2005).

ISSN: 2278-4632
Vol-10 Issue-1 January 2020

All private hospitals listed in Table 1 charge fees considerably higher than what public hospitals. All medical care in the public hospitals in Kuwait is free for citizens of Kuwait. For expatriates, a nominal fee of about US $7 is charged per visit. Patients in poor health or critical conditions are not admitted in private hospitals because of the limited number of wards and services available. Thus, these hospitals have a special status, and they are more concerned with the quality of services that they provide relative to the public hospitals. They also allow the status of waste management in their facilities to be assessed by specialists.

Table 1 Private hospitals in Kuwait and their capacities

Hospital	*Number of beds*
Al-Ahmadi	191
Al-Hadi	100
Al-Mowasat	96
Al-Rashed	64
Al-Salam	75
Dar Al-Shefaa	90
London	80
Mina Abdulla	14
Taeba	60
Total	*772*

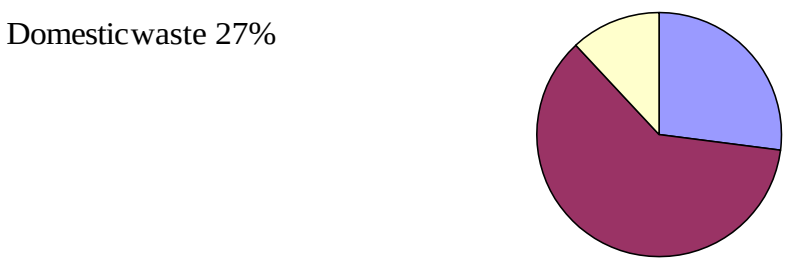
3 Results

General waste production

General waste produced at the hospital is related to food preparation, administrative departments and landscaping. This type of waste is similar to household waste and city waste. From the sampling technique, the amount of total wastes produced at the different hospitals in Kuwait was obtained. Various procedures carried out in the hospitals such as cobalt therapy, chemotherapy, dialysis, surgery, delivery, resection of gangrenous organs, autopsy, biopsy, para-clinical exams, injections, etc., result in the production of infectious wastes, sharp objects contaminated with patients' blood and secretions, radioactive wastes and chemical materials that are considered to be the hazardous wastes (Pruss et al., 1999). The amount of waste so generated depends upon several factors such as the number of beds, types of health services provided, economic, social and cultural status of the patients and the general condition of the area where the hospital is located.

The results of this study indicate that the total waste generation rates are 1.77 kg/bed/day and 3.27 kg/bed/day for Al-Salam and Al-Hadi hospitals, respectively. The total waste comprises about 27% domestic waste, 61% infectious waste and 12% sharps, as shown in Figure 1.

Figure 1 Typical type and percentage of wastes from Al-Salam and Al-Hadi hospitals (see online version for colours)



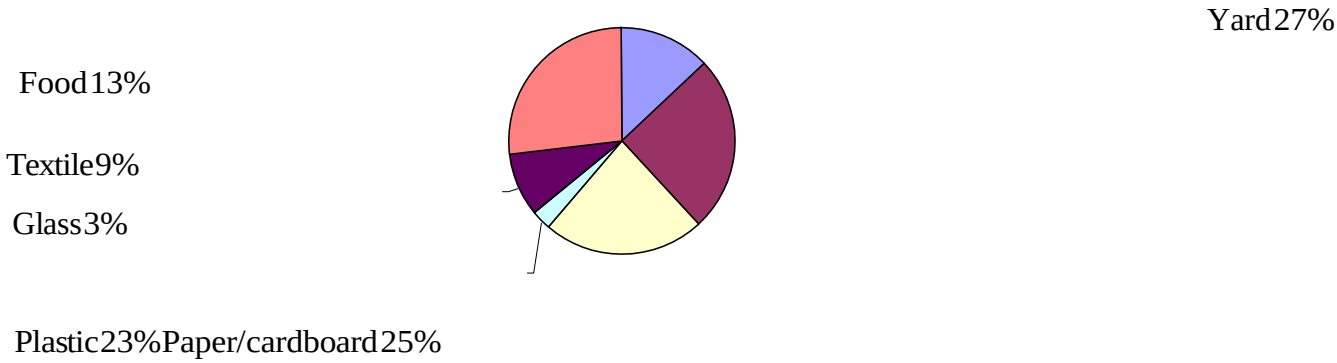
ISSN: 2278-4632
Vol-10 Issue-1 January 2020

Infectious waste 61%

Waste production at Al-Hadi and Al-Salam hospitals

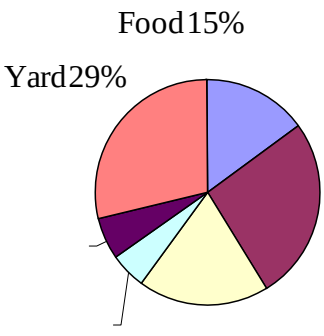
A maximum of 831 kg/day of total solid waste was generated at the Al-Hadi hospital. Figure 2 shows that the major component of this is yard wastes (29%), followed by paper and cardboard (26%). Also plastics constitute a good amount of the solid wastes generated at both hospitals (19%), while textiles make up the smallest amount (6%). The hazardous waste generation was 0.102 kg/bed/day.

Figure 2 Composition of non-hazardous wastes at Al-Salam hospital (see online version for colours)



A minimum of 26 kg/day of total solid waste was generated at the Al-Salam hospital. Figure 3 shows that the major component here is also yard wastes (27%), followed by paper and cardboard (25%). Plastics constitute 23% of the solid wastes, while textiles make up about 9%. The hazardous waste generation was 0.149 kg/bed/day.

Figure 3 Composition of non-hazardous wastes at Al-Hadi hospital (see online version for colours)



ISSN: 2278-4632
Vol-10 Issue-1 January 2020

Textile 6%

Glass 5%

Plastic 19%

Paper/cardboard 26%

The total organic wastes amounted to more than 65% at both hospitals showing that a biological treatment method such as composting would be a suitable treatment approach for such wastes.

Comparisons with other countries

The waste generation rates are compared to the general values obtained in other countries in Table 2. It is observed that in Japan, the hazardous waste generation rate is 0.471 kg/bed/day as an overall average value, while the net medical waste generation rate is between 1.5 and 3.0 kg/bed/day. The waste generation rate in Kuwait is much lower than that of 4.5 kg/bed/day in the USA, 4.0 kg/bed/day in Spain, 4.4–6.1 kg/bed/day in Jordan and 3 kg/bed/day in France. However, the average hospital waste generation rates in Mexico, Saudi Arabia, Bangladesh, Venezuela and Argentina vary between 1.05 kg/bed/day and 1.5 kg/bed/day. The patterns in hazardous waste generation are similar to the domestic wastes for which industrialised countries tend to have higher rates. The waste generation rate in Dar es Salaam (Tanzania) hospitals was reported to be between 0.84 and 5.8 kg/bed/day (Mato and Kassenga, 1997). The results of our study are consistent with the report by the WHO regarding the waste generation rate in general hospitals (Askarian et al., 2004; Pruss et al., 1999).

Table 2 Average rates of waste generation at hospitals in different countries

Country	*Rate (kg/bed/day)*	*Reference*
Kuwait	0.218–0.268	This study
Jordan	4.01–6.1	Bdour et al. (2006)
Saudi Arabia	1.1	Al-Zahrani et al. (2000)
UAE	3.9	Shuwaiter (1995)
Iran	4.2–21.1	Askarian et al. (2004) and Karamouz et al. (2006)
Turkey	1.92–2.01	Karaka (2002)
Japan	1.5–3.0	Tanaka et al. (2003)
India	0.5–2.0	Patil and Shedkar (2001) and Patil and Pokhrel (2005)
Thailand	0.11–0.65	Waste Not Asia (2001)

Table 2 Average rates of waste generation at hospitals in different countries (continued)

Country	*Rate (kg/bed/day)*	*Reference*
Bangladesh	1.2	Rahman et al. (1999)
France	3.3	USA, EPA (2002)
Argentina	1.5	Rahman et al. (1999)

ISSN: 2278-4632
Vol-10 Issue-1 January 2020

Tanzania	0.14	Askarian et al. (2004)
Norway	3.9	USA, EPA (2002)
Mauritius	0.398–0.478	Mohee (2005)
Spain	4.4	USA, EPA (2002)
Mexico	1.05	Rahman et al. (1999)
Brazil	3.245	Silva et al. (2005)
Venezuela	1.45	Rahman et al. (1999)
UK	3.3	USA, EPA (2002)
USA and Canada		
1.5–3.9	Mato and Kassenga (1997)	

4 Discussions

Operation assessment

The processes followed in handling wastes were explored. It appears that the hospital staff feel that if they handle bio-hazardous materials carelessly, it could be harmful to them and others, with the spreading of infectious diseases being as a potential possibility.

Segregation aspects

Wastes are typically segregated according to their characteristics at the source of generation, viz. mainly the patient care areas. Hospitals use colour-coded, high-density polyethylene bags for easy identification and segregation of bio-medical solid wastes. Non-infectious and domestic type of wastes are collected in black polyethylene bags and placed in bins while infectious wastes are collected in red, yellow and blue colour-coded polyethylene bags placed within blue high-density polyethylene bags labelled with a bio-hazardous infectious materials symbol in specific bins. The details relevant to the segregation of wastes in the containers are summarised in Table 3.

Table 3 Segregation of bio-medical solid wastes at hospitals of Kuwait

Colour coding of polyethylene bag	*Type of waste material collected*
Black	Non-infectious and non-hazardous waste.
Yellow (puncture prove)	Human anatomical waste, items contaminated with blood and body fluids, and waste generated from disposable items other than sharps, etc.
	Waste sharps, microbiological waste from pathological laboratory, items contaminated with blood and body fluids, and waste generated.
	Solid waste generated from disposable items other than the waste sharps such as tubing, catheter, i.v. sets, etc.

Collection, Storage and transportation

Wastes are collected twice a day, once in the morning before 8 A.M. and once in the evening before 6 P.M. Hazardous waste containers are labelled with biohazard symbols while other containers for non-hazardous wastes are not.

The collection of infectious and non-infectious wastes are undertaken by two teams, two members each, one for pulling the cart and distributing empty polyethylene bags and the other member for sealing the bags, putting the bags into the cart and replacing the bins with polyethylene bags. As protective measures against potential hazards, staff members wear impervious gloves and masks during collection of infectious waste, separating various colour-coded containers and transporting waste in an appropriately identified cart and taking adequate precautions to prevent any spillage from the plastic bags. Cleaners and nursing assistants are responsible for the collection, internal storage and transport of the medical wastes to external storage. The bio-medical solid wastes are not stored for more than 18 hours off-site. The bins in the wards are strictly placed away from patients and nursing stations. The place where the hospital waste is kept before transporting to the final disposal site is a temporary waste storage area. It is understood that this area must be well sanitised and secured in such a way that it should be accessible only to the authorised personnel (Pruss et al., 1999). Almost all hospitals have well sanitised and secured temporary storage areas. The infectious and non-infectious wastes are kept in separate containers and not mixed together in the hospital's own temporary storage area.

Final disposal

Non-infectious waste

A private company carries out the collection, treatment and final disposal of all wastes at each hospital. The non-infectious waste separately collected and transported is put in large municipal bins to be removed daily and dumped in the municipal waste landfills.

Treatment of infectious biomedical solid waste

It is generally accepted that the most appropriate means of disposing clinical waste is by way of high temperature incinerators (Karademir, 2004). There have been a number of proposals to establish alternative clinical waste treatment facilities in the Gulf region, but only a limited number of these facilities have been built. Consequently, the MOH of Kuwait has issued in 2006 a legislation that requires every private hospital and clinic install an autoclave on site for medical waste sterilisation.

Autoclave is an automated system to sterilise medical waste, reduce its volume (80% reduction), and render its components unrecognisable all in one fully enclosed and automated system. It combines direct heated steam, high pressure and shredding to treat infectious materials. Autoclaves offer many advantages such as ease of use, reliability, effectiveness, environmental safety and economy. Autoclaves work on cycles. Each cycle consists of the following phases:

- loading
- shredding
- heating
- sterilisation
- cooling
- draining
- vacuum

ISSN: 2278-4632
Vol-10 Issue-1 January 2020

- unloading.

Each cycle takes approximately 50 minutes for processing eight to ten bags of waste, weighing around 40 kilograms altogether. Twelve cycles can be completed in 16 hours from 6 A.M. to 10 P.M. Total processing weight in a single day will be in the range of 480 to 500 kilograms. The sterilised waste is removed and stored in sealed containers. Every private hospital and clinic in the country contracts a private company to transport its sterilised medical waste to the Shuaiba hazardous waste landfill. These companies pick the sterilised waste twice a day at 6 A.M. and 6 P.M.

Figure 4 General view of a hazardous industrial solid waste landfill (see online version for colours)

The Shuaiba hazardous waste landfill is a disposal facility engineered and constructed to prevent the potential migration of wastes or waste-derived effluents (leachate) either into the ground or into the atmosphere. The landfill consists of a lined excavation surrounded by a 30 centimetre-high berm to prevent rainwater from infiltrating into the cell. It has a plan area of 125 m □ 125 m at the ground surface and a nominal depth of 13 m. Its base slopes toward a sump that collects the leachate generated within the landfill. The capacity of the hazardous waste landfill, including the volume under the mounded cover, is approximately 135,000 m^3 (see Figure 4). The sloping sidewalls of the cell are made of a composite liner made of a 1-m thick compacted soil overlaid by a 2.5-mm thick high density polyethylene (HDPE) liner. The base of the landfill has a composite liner of a 1-m thick compacted soil layer overlaid by a bentonite membrane, a 2.5-mm thick HDPE liner, a 30-cm thick drainage layer sandwiched between two geo-textile membranes and, finally, a 30-cm thick protective soil cover. The HDPE liner over the entire cell is contiguous and acts as a barrier between the waste deposited in the cell and the ground below. The leachate generated within the waste volume is collected through a network of perforated PVC pipes buried in the drainage layer that runs into the sump. Leachate is pumped out, using an automatic pump placed inside the sump. A leachate extraction pipe attached to the pump carries the leachate to a leachate collection point at ground level outside the cell. The extraction pipe is secured to a concrete anchor placed just outside the cell at the ground level. Also, to ensure safety and security, fire protection and close circuit television monitor all activities in the hazardous cell vicinity 24 hours a day. Further, four borehole constructed around the landfill monitor groundwater quality.

5 Conclusions and recommendations

ISSN: 2278-4632
Vol-10 Issue-1 January 2020

Nearly all the hospital facilities studied promote segregation of medical/hazardous wastes. However, not much attention is given to other types of wastes. Non-hazardous wastes are usually managed without recycling and collected through the municipal collection system. Typically, these wastes are handled by workers who perform allactivities without proper training or guidance and with inadequate protection.

The total wastes vary between 0.218 kg/bed/day and 0.268 kg/bed/day. However, the amounts of non-hazardous waste vary between 0.121 kg/bed/day and 0.236 kg/bed/day. The hazardous waste generation rates vary between 0.102 kg/bed/day at Al-Hadi hospital and 0.149 kg/bed/day at Al-Salam hospital. A maximum amount of 831 kg/day of total solid waste was generated at the Al-Hadi hospital and a minimum amount of 26 kg/day at Al-Salam Hospital.

Based on the preceding findings, it is possible to improve the management of healthcare wastes in the local context. And, a rational framework for the management of wastes generated in various medical institutions in Kuwait can be developed, considering the following:

- Waste minimisation.
- A comprehensive study compiling necessary rules and establishing standards along with regular and effective training programs by way of lectures, posters and handoutsfor different personnel regarding hazardous wastes, their collection, segregation and storage, preventive measures, control of accidents and injuries, and emphasising the importance of protective measures should be considered as an urgent matter in all Health Service Departments.
- Periodic meetings should be conducted with the administrative and maintenance staffdirectly or indirectly involved with waste management in order to share and discuss the technical or practical difficulties and to provide suggestions that may be specific to a particular hospital and region.
- A compulsory introductory training program should be conducted for new staff to familiarise them with the operating procedures practiced in the hospital.

There is an urgent need for establishing and implementing a proper medical waste management program to control and improve the existing situation in Kuwait. This study aims at establishing a database, information on the healthcare waste sources, generation, collection, transportation, treatment and disposal. Also, it serves to provide policy makers with information on the need for further policy action and improvement of medical waste management.

References

Alhumoud, J.M. and Alhumoud, H.M. (2007) 'An analysis of trends related to hospital solid wastes management in Kuwait', *Management of Environmental Quality*, Vol. 18, No. 5, pp.502–513.

Al-Zahrani, M., Fakhri, Z., Al-Shanshouri, M. and Al-Ayed, M. (2000) 'Healthcare risk waste in Saudi Arabia', *Saudi Medical Journal*, Vol. 21, No. 3, pp.245–250.

Askarian, M., Vakili, M. and Kabir, G. (2004) 'Results of a hospital waste survey in private hospitals in Fars province, Iran', *Waste Management*, Vol. 24, No. 4, pp.347–352.

Bdour, A., Altrabsheh, B., Hadadin, N. and Al-Shareif, M. (2006) 'Assessment of medical wastes management practice: a case study of the northern part of Jordan', *Waste Management*, Vol. 27, No. 6, pp.746–759.

CCOHS, Canadian Center for Occupational Health and Safety, Needlestick injuries (2000) available at http:// www.ccohs.ca/oshanswers/diseases/needlestick_injuries.html/ (accessed on September 2003).

Centers for Disease Control and Prevention (2001) 'Healthcare Infection Control Practices Advisory Committee (HICPAC)', *Draft Guideline for Environmental Infection Control in Healthcare Facilities*, pp.96–101.

Environmental Protection Authority (EPA) (2001) 'Environmental protection act, Decision No. 210/2001', *Kuwait Al-Youm*, No. 533, Kuwait.

Hamoda, H.M., El-Tomi, H.N. and Bahman, Q.Y. (2005) 'Variations in hospital waste quantities and generation rates', *Journal of Environmental Science and Health*, Vol. A40, No. 2, pp.467–476.

Karademir, A. (2004) 'Health risk assessment of PCDD/F emissions from a hazardous and medical waste incinerator in Turkey', *Environment International Journal*, Vol. 30, No. 7, pp.1027–1038.

Karaka, Y. (2002) 'Management of clinical wastes. In appropriate environmental and solid waste management and technologies for developing countries', *ISWA*, Vol. 1, No. 4, pp.303–312.

Karamouz, M., Zahraie, B., Kerachian, R., Jaafarzaheh, N. and Mahjouri, N. (2006) 'Developing a master plan for hospital solid waste management: a case study', *Waste Management*, Vol. 27, No. 5, pp.626–638.

Mato, R.R.A.M. and Kassenga, G.K. (1997) 'A study on problems of management of medical solid wastes in Dar es Salaam and their remedial measures', *Resources, Conservation and Recycling*, Vol. 21, No. 2, pp.1–16.

Meaney, J.G. and Cheremisihoff, P.N. (1989) 'Medical waste strategy', *Pollution Engineering*, October, Vol. 23, No. 3, pp.92–106.

Mohee, R. (2005) 'Medical wastes characterization in healthcare institutions in Mauritius', *Waste Management*, Vol. 25, No. 4, pp.575–581.

MOP, Ministry of Planning (2008) *Annual Statistical Abstract*, Edition 39, Kuwait.

NaSH (1999) Summary Report for Data Collected from June 1995 to July 1999, The National Surveillance System for Hospital Care Workers, available at http://www.cdc.gov/ncidod/hip/nash/report99.PDF/ (accessed on 10 September 1999).

Patil, A.D. and Shedkar, A. (2001) 'Health care waste management in India', *Journal of Environmental Management*, Vol. 63, No. 2, pp.211–220.

Patil, G.V. and Pokhrel, K. (2005) 'Biomedical solid waste management in an Indian hospital: a case study', *Waste Management*, Vol. 25, No. 7, pp.592–599.

Pruss, A., Giroult, E. and Rushbrook, D. (1999) *Safe Management of Wastes from Health-care Activities*, World Health Organization, Geneva.

Puro, V., De Carli, G., Petrosillo, N. and Ippolito, G. (2001) 'Risk of exposure to bloodborne infection for Italian healthcare workers, by job category and work area, Studio Italiano Rischio Occupazionale da HIV Group, Infect. Control Hosp', *Epidemiology*, Vol. 22, No. 4, pp.206–210.

Rahman, M.H., Ahmed, S.N. and Ullah, M.S. (1999) 'A study on hospital waste management in Dhaka city, integrated development for water supply and sanitation', *25th WEDC Conference*, Addis Ababa, pp.342–355.

Romea, S., Alkiza, M.E., Ramon, J.M. and Oromi, J. (1995) 'Risk of occupational transmission of HIV infection among healthcare workers, study in a Spanish hospital', *Eur. J. Epidemiology*, Vol. 11, No. 4, pp.225–229.

Sandhu, T.S. and Singh, N. (2003) 'A hazard going unnoticed – biological waste is a threat to the community at large', *The Tribune*, Online edition, Chandigarh, India, Monday, 30 June 2003 [online] http://www.bvsde.paho.org/bvsacd/cd43/medical.pdf (accessed 29 July 2008).

Shuwaiter, H.A. (1995) *Management of Hospital Wastes in the United Arab Emirates*, Master's thesis, Environmental Science Program, UAE University, Al-Ain, UAE.

Silva, C.E.D., Hoppe, A.E., Ravanello, M.M. and Mello, N. (2005) 'Medical wastes management in the south of Brazil', *Waste Management*, Vol. 25, No. 3, pp.600–615.

Tanaka, M., Kaneko, K., Takahara, N. and Stella, A. (2003) 'Strategic management of healthcare wastes

ISSN: 2278-4632
Vol-10 Issue-1 January 2020

in Japan', *Sustainability in a New World, ISWA World Congress 2003*, Melbourne, Australia.

USA, EPA (2002) *Municipal Solid Waste in the United States: 2000 Facts and Figures (EPA-530-R-02-001)*, US Environmental Protection Agency, Washington, DC.

Waste Not Asia (2001) *Thailand Country Report*, Greenpeace South-East Asia, Taiwan [online] http://www.noburn.org/regional/pdf/country/thaialnd.pdf (accessed 20 March 2008).

WHO, World Health Organization (1997) 'Management of wastes from hospitals', Report on WHO meeting, Copenhagen (EURO Reports and Studies).

World Bank (2005) *A Water Sector Assessment Report on the Countries of the Cooperation Council of the Arab States of the Gulf*, Report No. 32539-MNA.