Effective medical waste management: It can be done

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Background: It was noticed that a large volume of medical waste was being generated for incineration at our hospital. The 2 incinerators at our facility were unable to effectively deal with the load of waste and, therefore, were operating for extended periods of time. This caused a significant amount of soot and other emissions to be produced as pollutants into the surrounding environment, which is considered to be a real health hazard.

Methods: A waste-management plan was introduced that included education, mandatory inservice training, auditing of the type and volume of waste generated by each department, and introduction of a written policy on waste management.

Results: Within a few months of implementation of the waste-management plan, the amount of medical waste was reduced by more than 58%, from 609 skips/mo (2000 kg/day) in the year 1999, to 256 skips/mo (850 kg/day) in the year 2000; skips are steel containers filled with infectious waste. This reduction was maintained throughout the year 2001 and lead to a 50% reduction in total financial costs (US $17,936) with savings in fuel of US $5262, labor-cost savings of US $8990, and maintenance and spare parts savings of US $3680.

Conclusions: This article discusses problems encountered in waste management in our health care facility, solutions and control measures introduced, and achievements. It also demonstrates that effective waste management can reduce health risk, save money, and protect the environment. (Am J Infect Control 2003;31:188-92.)

The infectious waste problem in developing countries like Saudi Arabia is usually caused by lack of a universally accepted definition of "infectious waste," rather than by financial and technical difficulties.[1] This usually leads to the overdisposing of waste that requires incineration, even though many hospitals in Saudi Arabia, including ours, have given full consideration to replacing single-use, waste-generating disposable items with those that are reusable and can be reprocessed.

At our institution it was noticed that the hospital incinerator was operating for an extended period of time, from 6 AM until 10 PM during 2 shifts. This caused a significant amount of soot and other emission to be produced and discharged into the surrounding environment. In addition to soot and volatile organic compound, incinerators handling medical waste produce significant discharges of mercury and dioxins in to the surrounding environment.[2-4] This was considered to be a real health hazard as the hospital incinerator did not meet the Environmental Protection Agency (EPA) requirements for air pollutant emissions under the Clean Air Act.[5] Furthermore, there are no local emission standards for incineration that are specific for Saudi Arabia.

The incinerator was operating for longer periods in an effort to accommodate the increased amount of medical waste that was identified at point of use as infectious and requiring incineration as the method of disposal. This prompted the Department of Infection Prevention and Control to further investigate this health hazard bearing in mind that in addition to health issues, the financial cost of incineration as a disposal method is higher than using a sanitary landfill.[4,6]

METHODS

The investigation was held at King Abdulaziz Medical City (King Fahad National Guard Hospital)

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Table 1. Summary of infectious waste-management plan

Waste category	Examples	Orange bag (incineration)	Black bag (sanitary landfill)	Steam sterilization
Microbiology	Stocks and cultures of infectious agents	X		X*
Pathologic waste	Placentas, organs, other body parts and their containers (collected in laboratory for burial)			
Blood/blood products (fluids):	Blood containers, intravenous tubing,† suction canisters, pleurovacs, evacuated containers, hemovacs			
Nursing units/outpatient clinics:				
<20 mL vol contained			X	
>20 mL vol contained		X		
Laboratory:				
<20 or >20 mL vol		X		
Blood-contaminated items:	Paper towel, gauze, disposable objects, gloves			
If saturated and/or dripping		X		
Not saturated and/or dripping			X	
Isolation/operating rooms	Ordinary		X	
	Infectious	X		
Sharps	Contaminated needles, syringes, scalpel blades, razors, Pasteur pipettes, and broken glass	X (Sharp boxes)		
Contaminated animal carcasses, body parts, and bedding	Contaminated animal carcasses, body parts, and bedding of animals that were intentionally exposed to pathogens	X (Carcasses)		X*
Other hospital waste			X	

*If steam sterilization is not used, place in orange bag disposal for incineration.
†First remove needle from intravenous tubing using mechanic device and discard in sharps container.

in Riyadh, Saudi Arabia, a 600-bed tertiary care center with an average of 3000 employees engaged in patient-related activities. The wide variety of services offered includes pediatrics, internal medicine, obstetrics and gynecology, neurosurgery, 6 critical care units, liver and renal transplantation, and a major cardiac science program. The average bed occupancy per year is approximately 400.

We began by conducting background research to obtain the most recent guidelines and recommendations for medical waste disposal from the EPA and the Centers for Disease Control and Prevention (CDC).[5,7] We also studied local guidelines to ensure that local and cultural regulations are met. The population of Saudi Araia is 100% Muslim, except for the minorities of Western and other expatriates. Under Islamic law, stillbirth, human organs and body parts, and human placentas are buried. However, human tissues and specimens generated from autopsy or during operation are incinerated (Table 1). At the time of this study there was an internal waste policy and procedure in the hospital, but it poorly defined "infectious waste," and there was no categorization of infectious waste according to type and volume. However, color-coded bags (orange for medical waste and black for general waste) were available and distributed randomly in all hospital areas. We checked the baseline disposal practices at the generation point and followed the route of the waste from its source (at point of use) to final disposal. In addition, staff, including physicians, nurses, housekeepers, and allied-health personnel involved in waste disposal, were interviewed to assess their knowledge about waste identification and the perceived disposal method. Finally, we audited the type and amount of waste generated from all hospital areas and determined if all waste designated as infectious waste truly was infectious waste as classified by CDC guidelines.[7]

Baseline data were taken on the number of skips (steel containers filled with infectious waste) being incinerated per month for 4 months before the intervention (August to November 1999). A waste-management plan was developed that included input from all user groups. The nursing managers and employees in different departments were interviewed, and their view of the problems and their input on the quantity and placement of orange bags was taken into consideration when developing the plan. The aim was to reduce the amount of waste being incinerated by source reduction. Color-coded waste disposal bags were distributed for ease of iden-

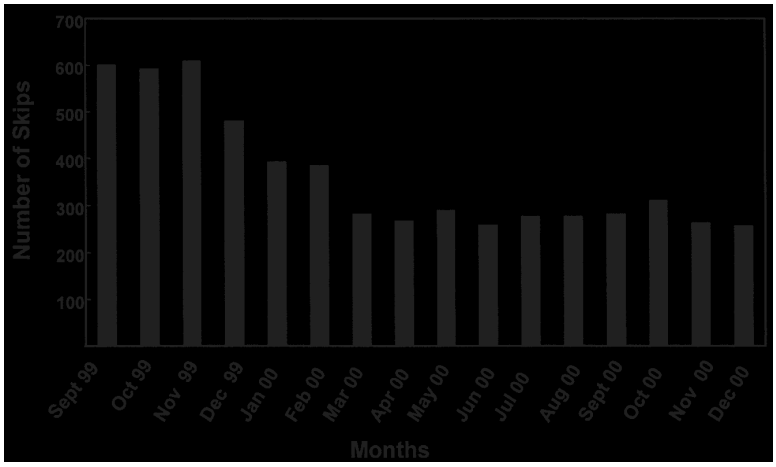

Fig 1. Number of skips incinerated per month from 1999-2000 (each skip weighs 100 kg on average).

tification and separation of waste. Orange was designated for medical waste, and black was designated for general waste. The requirements for placement of the color-coded bags were determined by the investigating team (infection control practitioner, environmental health specialist, and technician) with the aim of reducing the number of orange bags in each department. The investigating team completed a hospital-wide mandatory inservice training for all staff on waste management. We introduced a written policy on waste management in December 1999, and it was fully implemented in January 2000. The policy included the definitions of "infectious waste" and the disposal method for each waste category. Infectious waste was defined as "specific kinds of waste generated by patient diagnostic and therapeutic procedures that are capable of producing an infectious disease and must be disposed of in such a manner so as to minimize the risk of infection to health care workers, sanitation workers, and the general public." The categories of infectious waste requiring incineration are listed in Table 1. Finally, we evaluated the associated costs of the number of skips being incinerated in 1999 and compared it with that of 2000.

RESULTS

Before the introduction of the waste-management plan, the number of waste skips being incinerated per month (August to November 1999) was ranging from 579 to 609, with an average of 20 skips/day (Fig 1). The usual weight of a skip is about 100 kg, with an average of 2000 kg/day of infectious waste being incinerated. Two incinerator units operated simultaneously in 2 shifts, from 6 AM to 2 PM and 2 to 10 PM, to cope with the amount of incoming waste. The waste audit revealed that more than 50% of the content of the orange bags were noninfectious waste on the basis of our adopted definition. This was demonstrated in many random audits in various departments. The knowledge of our multinational staff demonstrated different levels of awareness and understanding of the problem. There was no uniform definition of "infectious waste," and many nurse managers exercised their own rules, regulations, and ideas regarding waste management from their home-country institution. The informal inservice education and the initiation of the investigation in December of 1999 resulted in a 21% reduction in the number of skips as 479 skips were incinerated that month. In January 2000, the full waste-management plan was initiated. The inservice education program was accomplished through lectures and handouts. Frequent auditing on the requirement of orange bags in all applicable areas was performed, and the written policy was implemented. By December 2000, an overall reduction of 58% was achieved in the number of skips (Fig 1) down to 256 skips/mo with an average of 8.5 skips/day (850 kg/day). This reduction was maintained for the subsequent year of 2001, with an average of 252 skips/mo.

Fuel cost

The fuel required to power the incinerator costs 0.33 Saudi riyals (SR) or US $0.09/L. The amount of fuel required in 1999 before the implementation of the waste-management plan was 119,600 L/y, with an annual cost of 39,468 SR (US $10,525). There was a 50% reduction in the amount of fuel required for incineration in the year 2000 (59,800 L/y) with an approximate fuel savings of 1150 L/wk at a savings of

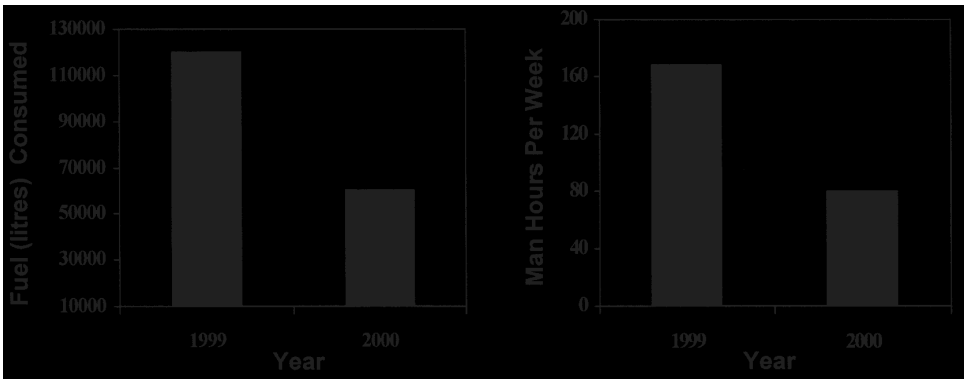

Fig 2. Fuel savings and labor operating hours in 2000 in comparison with 1999.

19,734 SR (US $5262) (Fig 2, *A*). At that time only 1 incinerator was required for incineration of medical waste, allowing us to use the second unit as a standby unit.

Labor cost

Labor cost was also reduced by more than 50%. With the huge amount of waste deliveries to the plant, it required a 2-shift schedule to be maintained during weekdays to incinerate the waste on the same day of delivery. The incineration operation time was reduced from 168 h/wk in the year 1999 to 80 h/wk in the year 2000 (Fig 2, *B*). The average hourly pay rate for an incinerator operator is 7.37 SR (US $2) and the resultant saving in labor operating cost was 33,725 SR (US $8990) per year.

Maintenance cost

The cost of maintenance, and wear and tear on trucks, incinerators, and bins was difficult to calculate; however, the savings in the reduction of spare parts used in the year 2000 compared with 1999 was estimated at 13,800 SR (US $3680) per year. The reduction of spare parts was a result of the reduced volume of waste and subsequent ability to control the operating temperature. By controlling the temperature, the tube and nozzle for postcombustion and diffuse disk lasts longer. In addition, the use of 1 incinerator reduced overall parts expenses. There was a minimal cost incurred by the initiation and the maintenance of the waste-management plan. The educational lectures, and handouts were produced by the employees of the infection control department during their daily work. There was no overtime required by infection control practitioners, engineers, or housekeepers. However, 1 full-time infection control practitioner was assigned for a period of 3 months, at a cost of 24,000 SR (US $6400), solely to investigate the problem and implement the waste-management plan.

Table 2. Overall operating cost savings per year

Fuel	SR 19,734 (US $5262)
Labor	SR 33,725 (US $8990)
Spare parts	SR 13,800 (US $3680)
Total	SR 67,259 (or US $17,936)

DISCUSSION

The objective of the waste-management plan was to reduce the amount of infectious waste by segregating it at its point of generation from general waste. The introduction of a well-formulated plan, written policy, and mandatory inservice education, continuous waste audit, and the cooperation of all staff was capable of causing a 58% reduction in the amount of infectious waste incinerated. This lead to more than 50% cost savings in fuel, labor, and spare parts (Table 2). We believe that the savings is more than what we calculated because maintenance of all equipments and the labor cost associated with personnel involved in collecting the waste was not included. The savings we accomplished through the introduction of the waste-management plan was comparable with other reports.[8-11] Zafar et al[8] showed that the introduction of such a plan in a US hospital caused an 80% decline in infectious waste, which was maintained during 4 years. Another report from a larger institution in Canada showed a 50% reduction of infectious waste on the introduction of such a plan.[9] Data from Saudi Arabia on waste management is very scarce. In fact, a literature search showed that there are only 2

reports addressing this issue.[12,13] One report from the eastern region shows a 65% reduction in infectious waste generation through education and a waste-segregation program; however, in that report no cost analysis was done before or during the implementation of the program.[12] Overdisposing of medical waste seems to be a problem in many hospitals in Saudi Arabia. A survey of 27 hospitals in different regions revealed that the health care-risk waste rate of generation was 1.13 ± 0.96 kg/bed/day. This is a higher rate compared with the international figures listed by the World Health Organization for low- and middle-income areas[4,13]

The waste-management plan that we initiated had many challenging aspects. First, the educational program was not an easy task but, by itself, was able to cause a 21% reduction in the first month. The most difficult aspect of the endeavor was changing or modifying the behavioral attitude of the hospital personnel. This was challenging in our hospital because our staff are multinational and are recruited from more than 50 countries where they demonstrate and verbalize different levels of awareness and understanding of the problem. Inservice and group-specific education on proper infectious waste procedures were provided to all staff. Hands-on infectious waste management was performed in busy units like the operating room, emergency department, and microbiology laboratory. This was accompanied by continuously reminding the staff of the environmental hazards of incinerating a large amount of waste.

The second aspect of our plan, which was the key to our success, was the auditing of infectious waste in each department. Before the implementation of the plan, the infectious waste (orange) bags were distributed randomly and were used frequently for regular waste. After implementation of the plan, the infection control department conducted the distribution and placement of the orange bags in predetermined areas. Direct feedback on the basis of the audit was regularly given to the supervisors and the staff in areas noted to generate a high volume of infectious waste, and they were encouraged to be active participants in the plan. The audit was initially intensive and then done randomly. The reduction in infectious waste is still being maintained and has been recorded for the past 2 years.

The introduction of a written policy on waste management was crucial in accomplishing waste reduction and cost savings. A clear and precise definition of "infectious waste" on the basis of CDC and EPA guidelines was included in the policy. In addition, infectious-waste categories were identified in an appendix that explained the disposal method of specific items (Table 1).

Finally, we believe that many hospitals in Saudi Arabia have a problem with overdisposing infectious waste, and initiation of a well-formulated waste-management plan can be cost-effective, protect the environment, and is feasible; it can be done.

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