Management of Infectious Waste by US Hospitals

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In July 1987 and January 1988, forty-six percent (441/955) of randomly selected US hospitals responded to a questionnaire intended to identify their waste disposal practices. Survey responses were received from hospitals in 48 states. United States hospitals generated a median of 6.93 kg of hospital waste per patient per day and infectious waste made up 15% of the total hospital waste. Most hospitals (>90%) considered blood, microbiology, "sharps," communicable disease isolation, pathology, autopsy, and contaminated animal carcass waste as infectious. Other sources of hospital waste that were commonly (>80%) designated infectious were surgical, dialysis, and miscellaneous laboratory waste. The infectious waste was normally (80%) treated via incineration or steam sterilization before disposal, whereas noninfectious waste was discarded directly in a sanitary landfill. Eighty-two percent of these US hospitals are discarding blood, microbiology, sharps, pathology, and contaminated animal carcass waste in accordance with the Centers for Disease Control's recommendations, while the compliance rate for the Environmental Protection Agency's recommendations (excluding optional waste) is 75%. No hospital could identify an infection problem (excluding needle-stick injuries) that was attributable to the disposal of infectious waste. While the management of infectious waste by US hospitals is generally consistent with the Centers for Disease Control's guidelines, many hospitals employ overly inclusive definitions of infectious waste.

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INAPPROPRIATE medical waste disposal incidents and the fear of acquired immunodeficiency syndrome have drawn national attention to medical waste management practices. Recent events such as the floating garbage barge, children playing with discarded tubes of blood found in an Indiana clinic's dumpster, youngsters jabbing each other in the arm with used needles found in a dumpster in Ohio, and the washing ashore of medical wastes on some eastern shores have focused public interest on problems of medical waste disposal (*Omni*. February 1988:40, 42, 44, 92-95, 96). While hospitals are considered the primary generator of medical waste by volume, all health care institutions generate medical waste, including health clinics, ambulatory surgery centers, and private physicians' and dentists' offices, as well as nursing homes and home care settings.

See also p 1669.

Recognizing the crucial environmental health problems posed by the improper disposal of hazardous wastes, Congress charged the Environmental Protection Agency (EPA) under Subtitle C of the Resource Conservation and Recovery Act of 1976 to regulate the management and disposal of infectious waste.[1] The EPA did not issue regulations to establish a management system for the small portion of medical waste that was considered infectious, because the EPA believed there was not sufficient evidence that those wastes harm human health or the environment. Instead, the EPA prepared a guidance manual for infectious waste management that was intended to provide technical assistance to health care institutions and states so they could establish appropriate programs and/or regulations on infectious waste management.[2] However, the Medical Waste Tracking Act of 1988 (HR 3515) required the EPA to regulate certain infectious waste and to develop a medical waste tracking program for New York, New Jersey, Connecticut, and possibly the states contiguous to the Great Lakes by July 1989.

Even without federal regulations, state governments have responded to this issue by developing infectious waste regulatory programs. Eighty-eight percent of the states in 1988, compared with 57% of the states in 1986, are or will soon be regulating infectious waste.[3] Unfortunately, inconsistencies exist both among states and between state regulations and local requirements, leaving hospitals and other medical waste generators with confusing and inconsistent regulations on how to manage infectious wastes.

In anticipation of the increasing public and regulatory interest in infectious waste management, we randomly selected 20% of US hospitals and surveyed them to identify their waste disposal practices and to determine if they were in compliance with the infectious waste disposal recommendations of the Cen-

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Table 1.—Total Hospital and Infectious Waste Generated per Patient by Bed Size*

Hospital Beds	Median Hospital Waste, kg/Bed/d		Median Hospital Waste, kg/Patient/d		Infectious Waste, % of Total†	
	N	Total Waste	N	Total Waste	N	Median Waste
<100	90	2.59	69	5.13	83	13.3
100-299	108	4.70	84	7.16	92	15.0
300-499	40	5.67	32	8.38	35	14.9
>500	27	5.83	23	7.69	22	14.9
Total	**265**	4.18	**208**	6.93	**232**	15.0

*The kilograms per patient per day data are derived from the kilograms per bed per day data by the following formula: kilograms per patient per day = (100/% occupancy) × (kilograms per bed per day). Since some hospitals did not supply occupancy rate data, the median kilograms per patient per day data were calculated using a smaller N.

†For each hospital, the kilograms of infectious waste was divided by total hospital waste, and this column represents the median of these ratios.

ters for Disease Control (CDC) and the EPA. Additionally, we assessed whether hospitals could identify an infection problem that was attributable to the disposal of infectious waste.

METHODS

A 12-page hospital waste questionnaire was sent to 10% of American Hospital Association hospitals (519) in July 1987. Seventy-four percent (5044) of the 6821 hospitals in the United States in 1987 were members of the American Hospital Association. A systematic random sampling method was used by selecting every tenth hospital from a list of American Hospital Association hospitals ordered by ZIP code. The questionnaire was sent to the infection control practitioner at each hospital. Hospitals were sent a follow-up letter and questionnaires within 60 days encouraging nonresponders to complete and return the questionnaire. A second 10% systematic random sample of American Hospital Association hospitals (443) was sent questionnaires in January 1988 and a follow-up letter and questionnaire within 60 days. To detect duplication, the ZIP code, bed size, and name of hospitals were compared and the seven duplicate respondents were eliminated from the second sample. To evaluate nonresponder bias, a 10% simple random sample of nonrespondents was drawn from the complete list of nonresponders from the second sample. The infection control practitioners at the nonresponding hospitals were contacted by telephone and their responses to specific questions (ie, designation and treatment of infectious waste and infection problems associated with waste) were recorded. We did not include the 10% subsample of nonrespondents in the results.

The questionnaire was designed to evaluate the institutions' waste management program with emphasis on infectious waste management practices. It included questions on the collection, storage, processing, transporting, and disposal of hospital waste. The questionnaire was pilot tested in 120 North Carolina hospitals[4] and the questions were principally multiple-choice. The results of the pilot survey were not included in this report. Hospitals were ensured that their responses would remain confidential. Unless otherwise indicated, all data presented reflected a 90% or better response rate to specific questions.

All data were keypunched, verified, and then analyzed using Statistical Analysis Systems software. For categorized variables (eg, designation of medical wastes as infectious), we reported frequencies, cross tabulations, and results of χ^2 tests and Fisher's Exact Tests. For continuous variables (eg, kilograms of hospital waste per bed), we reported means and medians. The 95% confidence intervals for proportions were computed using the normal approximation.

The terms *hospital waste*, *medical waste*, and *infectious waste* are often used inappropriately as synonymous. The term *hospital waste* refers to all solid waste (biologic or nonbiologic) that is discarded and not intended for further use (eg, administrative waste, dietary waste, and medical waste); *medical waste* refers to materials generated as a result of patient diagnosis, treatment, or immunization (eg, soiled dressing and intravenous tubing); and *infectious waste* refers to that portion of medical waste that could transmit an infectious disease (eg, microbiological waste and "sharps").

RESULTS

Characteristics of Respondents and Hospitals

The mean number of years that the primary respondent was employed in the hospital was 10.7, and while the infection control practitioner generally coordinated completion of the questionnaire, other persons (eg, in nursing, housekeeping, maintenance, and administration) often provided assistance answering certain questions. A response was received from 441 hospitals. Thirty-five percent of the hospitals (151) had fewer than 100 beds, 40.8% (176) had 100 to 299 beds, 14.6% (63) had 300 to 499 beds, 9.5% (41) had more than 500 beds, and 10 hospitals did not list their bed size. The response rates to the first and second 10% random samples were 39.1% (203/519) and 53.7% (238/443), respectively, for an overall response rate of 46.2%. Survey responses were received from the District of Columbia, Puerto Rico, and all states except Hawaii and New Hampshire. The responding hospitals were similar to US hospitals in terms of size and locale. The mean number of beds of the responding hospital was 220. Fifty percent (214) of the 432 hospitals responding to this question were community nonteaching; 23% (99), community teaching; 10% (44), government (city, state, or federal); 7% (29), proprietary (nongovernment and for profit); 4% (18), nonprofit and private; 3% (12), university; and 4% (16), other. (Percentages do not add up to 100% because of rounding.)

Quantity of Hospital Waste and Infectious Waste

Two hundred sixty-five US hospitals generated a median 4.18 kg of hospital waste per bed per day, which was equivalent to 6.93 kg of hospital waste per patient per day. Larger hospitals produced more waste per bed per day than smaller hospitals (Table 1).

According to 232 of the responding hospitals, infectious waste made up a median of 15.0% of the total hospital waste by weight (Table 1). The percent of medical waste treated as infectious increased with the number of types of medical waste the hospital classified as infectious. For example, if hospitals considered microbiological, blood, pathological, and sharps waste as infectious waste, 5.5% (n = 2) of the hospital waste stream was treated as infectious, while 12.8% (n = 32) was classified that way according to the EPA guidelines when including the optional waste. When hospitals considered the 18 types of medical wastes (excluding contaminated equipment) in Table 2 as infectious, 23.1% (n = 38) of the medical wastes were treated as infectious.

Designation and Disposal of Infectious Waste

Nearly all US hospitals (95.4%) segregated their infectious waste from

their noninfectious waste and 96.1% of these hospitals used labeled or color-coded bags or both. The designation of hospital waste as infectious by the CDC, the EPA, and 441 US hospitals is summarized in Table 2.

When the recommended methods for disposal of infectious waste from the CDC and EPA are compared, only three differences are noted (Table 3). First, although the CDC and EPA agree on five types of waste as infectious (ie, microbiological, pathological, blood, sharps, and contaminated animal carcass waste), they disagree on communicable disease isolation waste. Another difference between the CDC and EPA is that the EPA has identified an optional infectious waste category that consists of miscellaneous contaminated wastes (ie, surgery and autopsy, contaminated laboratory, and dialysis unit waste and contaminated equipment). The EPA suggests that a responsible, authorized person or committee at the health care facility evaluate these wastes and determine if they should be managed as infectious. Lastly, there are more treatment alternatives in the EPA guidelines.

The overall compliance rates with the CDC and EPA (excluding optional wastes) recommendations were 82.3% (95% confidence interval, 78.7% to 85.9%) and 75.1% (95% confidence interval, 71.0% to 79.2%), respectively (Table 4). Of the 76 (17.7%) hospitals in noncompliance with the CDC recommendations, 76% (58), 16% (12), 3% (2), 4% (3), and 1% (1) were noncompliant with 1, 2, 3, 4, and 5 types of infectious waste, respectively. The compliance rate for the EPA guidelines when including the optional wastes was 59.4% (95% confidence interval, 54.8% to 64.1%). There were no significant differences in the designation and treatment of listed infectious waste (Table 4) among the nonresponders who were contacted by telephone and the written responses. This demonstrates no serious nonresponse bias. For waste not listed as infectious by either the CDC or EPA, the nonrespondents designated certain waste (surgical, pediatric, obstetric, and all patient waste plus treatment and examination room waste) as infectious more commonly than the respondents (Table 2). Other wastes that US hospitals frequently (63.2%) treated as infectious (ie, by steam sterilization or incineration) were items containing secretions or excretions. In addition, from 24% to 41% of the hospitals either steam sterilized or incinerated wastes from intensive care units (37.4%), emergency departments (41.1%), surgical patients' rooms (33.2%), obstetric pa-

Table 2.—Types of Medical Waste Designated as Infectious by the CDC, the EPA, and 441 Randomly Selected US Hospitals*

Source/Type of Medical Waste	CDC	EPA	US Hospitals (%)†
Microbiological	Yes	Yes	Yes (99.0)
Blood and blood products	Yes	Yes	Yes (93.7)
Pathology	Yes	Yes	Yes (95.6)
"Sharps"	Yes	Yes	Yes (98.6)
Communicable disease isolation	No	Yes	Yes (94.4)
Contaminated animal carcasses, body parts, and bedding	Yes	Yes	Yes (90.1)
Contaminated laboratory	No	Optional	Yes (88.8)‡
Surgery	No	Optional	Yes (83.2)
Autopsy	No	Optional	Yes (91.9)
Dialysis	No	Optional	Yes (83.4)
Contaminated equipment	No	Optional	ND
Items contacting secretions or excretions	No	No	Yes (63.2)
Intensive care	No	No	Yes (37.4)
Emergency department	No	No	Yes (41.1)
Surgery patients	No	No	Yes (33.2)§
Obstetric patients	No	No	Yes (35.1)§
Pediatric patients	No	No	Yes (25.3)§
Treatment/examination room	No	No	Yes (30.3)§
All patient related	No	No	Yes (23.6)§

*CDC indicates Centers for Disease Control; EPA, Environmental Protection Agency; and ND, no data.
†Percent of responding hospitals that considered the waste infectious.
‡The survey specifically asked if hospitals considered "miscellaneous laboratory wastes (eg, specimen containers or slides)" as infectious.
§Nonrespondents designated these types of waste as infectious waste more frequently ($P<.01$ [Fisher's Exact Test]).

Table 3.—Types of Medical Waste Designated as Infectious and Recommended Disposal/Treatment Methods—CDC and EPA*

	CDC		EPA	
Source/Type of Medical Waste	Infectious Waste	Disposal/ Treatment Methods	Infectious Waste	Disposal/ Treatment Methods
Microbiological† (eg, stocks and cultures of infectious agents)	Yes	S and I	Yes	S, I, TI and C
Blood and blood products (ie, liquid blood and blood products)	Yes	S, I, and SEW	Yes	S, I, SEW, and C
Pathological (eg, tissue and organs)	Yes	I	Yes	I, SW, and CB
"Sharps" (eg, needles)	Yes	S and I	Yes	S and I
Communicable disease isolation	No	. . .	Yes	S and I
Contaminated animal carcasses, body parts, and bedding	Yes	S and I (carcasses)	Yes	I and SW (not bedding)
Contaminated laboratory wastes	No	. . .	Optional‡	If considered IW, use S or I
Surgery and autopsy wastes	No	. . .	Optional	If considered IW, use S or I
Dialysis unit	No	. . .	Optional	If considered IW, use S or I
Contaminated equipment	No	. . .	Optional	If considered IW, use S, I, or GS

*The Joint Commission on Accreditation of Healthcare Organizations[19] requires that there be a hazardous waste system designed and operated in accordance with applicable law and regulations. CDC indicates Centers for Disease Control[5,20,21]; EPA, Environmental Protection Agency[2]; S, steam sterilization; I, incineration; TI, thermal inactivation; C, chemical disinfection for liquids only; SEW, sanitary sewer (the EPA recommends secondary treatment); SW, steam sterilization with incineration or grinding; CB, cremation or burial by mortician; IW, infectious waste; and GS, gas sterilization.
†The CDC guidelines specify "microbiology laboratory waste" as an infectious waste. This term includes stocks and cultures of etiologic agents and microbiology laboratory waste contaminated with etiologic agents (eg, centrifuge tubes, pipettes, and tissue culture bottles).
‡Optional infectious waste: the EPA states that the decision to handle these types of waste as infectious should be made by a responsible, authorized person or committee at the individual facility.

Table 4.—Compliance With CDC and EPA Recommendations for Treatment of Infectious Waste*

Type of Medical Waste	CDC Recommendations	Compliance Rate of US Hospitals, %	EPA Recommendations	Compliance Rate of US Hospitals, %
Microbiological	S and I	98.1	S, I, TI, and C	98.1
Blood and blood products	S, I, and SEW	95.9	S, I, SEW, and C	95.9
Pathology	I	92.6	I, SW, and CB	92.6
"Sharps"	S and I	92.5	S and I	92.5
Communicable disease isolation	...	...	S and I	85.9
Contaminated animal carcasses, body parts, and bedding	I	89.1	I and SW (not bedding)	89.1
Contaminated laboratory	...	...	Optional†	87.0
Surgery	...	...	Optional	78.2
Autopsy	...	...	Optional	89.9
Dialysis	...	...	Optional	68.6
Contaminated equipment	...	...	Optional	ND

*CDC indicates Centers for Disease Control[5,20,21]; EPA, Environmental Protection Agency[2]; S, steam sterilization; I, incineration; TI, thermal inactivation; C, chemical disinfection for liquids only; SEW, sanitary sewer (the EPA recommends secondary treatment); SW, steam sterilization with incineration or grinding; CB, cremation or burial by mortician; and ND, no data. Overall compliance with CDC guidelines was 82.3%; overall compliance with EPA guidelines, 75.1%; and overall compliance with EPA guidelines including optional waste, 59.4%.

†Optional infectious waste: the EPA states that the decision to handle these types of waste as infectious should be made by a responsible, authorized person or committee at the individual facility. If waste is designated as infectious, steam sterilization or incineration is recommended.

Table 5.—Recommended Methods for Management and Disposal of 'Sharps'*

Source	Container	Needle Recapped Before Disposal	Disposal/ Treatment Method	Comment
EPA[2]—hospital and other generators	Rigid and puncture resistant	N	S and I	When required by state regulations, should grind or compact after S Contaminated needles should not be clipped unless the clipping device contains the aerosols
CDC[5,21]—health care settings	Puncture-resistant container	No	S and I	No bending, breaking, or manipulating by hand Do not remove needle from syringe Container as close to use area as practical
JCAH monograph[22]—health care organizations	Resistant to needle punctures	No	S, I, and SL	Containers should contain liquids Collect sharps at point of use Container securely closed when full No needle cutting and avoid overfilling
OSHA[23]—health care facilities	Puncture-resistant container	No	N	No bending, breaking, or manipulating by hand Do not remove needles from syringe Container located in patient areas where needles are commonly used

*EPA indicates Environmental Protection Agency; N, not indicated; S, steam sterilization; I, incineration; CDC, Centers for Disease Control; JCAH, Joint Commission on Accreditation of Hospitals; SL, sanitary landfill; and OSHA, Occupational Safety and Health Administration.

tients' rooms (35.1%), pediatric patients' rooms (25.3%), and treatment and examination rooms (30.3%) and all patient-related waste (23.6%). Only 9 hospitals (2%) reported disposal of infectious waste in a sanitary landfill without first treating the waste to render it noninfectious, even though 12 states currently allow the disposal of untreated infectious waste in landfills.[3]

Recommended methods for disposing of needles and other sharps capable of producing injury or illness are varied (Table 5). Of the 441 US hospitals, 92.1% (406) disposed of these items by using a rigid, puncture-proof container, while 2.5% (11) used a cardboard container, 0.5% (2) used a needle clipper, and 1.4% (6) used a cardboard box and needle clipper. The remaining 3.6% (16) of the hospitals used a combination of methods that included a puncture-proof container. The containers with the needles and syringes were then placed into an incinerator (79.8%), a sanitary landfill without sterilization (5.9%), a sanitary landfill after sterilization (10.9%), a combination of two of these methods (1.8%), or other methods (ie, grinding or melting). Nearly all hospitals (96.8%) had a written policy for managing needle-stick injuries. Most hospitals (93.6%) had a written infectious waste management policy, and nearly all hospital employees (96.6%) who handle infectious waste receive formal training in proper handling and disposal procedures, including potential health and safety hazards. No hospital could identify an infection problem (excluding needle-stick injuries) that had occurred in the past 5 years involving disposal of infectious waste.

COMMENT

Health care professionals in hospitals have been concerned about the proper management of infectious waste because of aesthetic concerns, state regulations, and the fact that certain wastes (ie, sharps) have been associated with transmission of infection or injury.[5] An important step in coordinating a waste management program is to determine the quantity of hospital waste generated. Overall, about 6.93 kg of hospital waste per patient per day was generated in the 208 acute-care hospitals responding to this question. This figure is about 15% higher than the 5.90 kg per patient per day that was reported in a North Carolina survey[4] conducted in October 1980. This probably reflects a continued increased use of disposable items in recent years. Thus, the actual amount of hospital waste generated in US hospitals is approximately 6063 tonnes per day. This figure is based on the 1.267 million hospital beds that existed in the United States in 1987, with an occupancy rate of 68.9% (American Hospital Association, unpublished data, 1987). Although the amount and composition of hospital waste from various hospital units (eg, the operating room and pediatric and medicine sections) were not evaluated, we did demonstrate a direct relationship between bed size and quantity of waste. This is thought to be related to the level of service provided, with larger hospitals providing heavy care units (eg, burn units, operating rooms, intensive care units, and trauma care) and maximum services generating more waste per patient. It should also be noted that the term *kilograms per patient per day* is a convenient but slightly inaccurate term, since it is computed by dividing the hospital waste (which includes

waste from outpatients, visitors, and paid and volunteer staff) by the inpatient population.

While hospitals are considered to be the primary generator of medical waste by volume, the aforementioned figures capture only a fraction of the health care facilities that generate medical waste. For example, there are approximately 180 000 private physicians' offices, 98 000 private dentists' offices, 2900 outpatient clinics, 16 400 nursing homes, 650 ambulatory surgery centers, 860 freestanding dialysis centers, and 225 blood banks.[6] If one considers these other generators of medical waste in aggregate, the volume could rival or exceed that produced by hospitals.

Infectious waste is defined as waste capable of producing an infectious disease. This definition requires a consideration of the factors in the chain of infection that are necessary for disease induction. These factors are dose, susceptible host, portal of entry, presence of pathogens, and virulence. Therefore, for waste to be infectious, it must contain pathogens with sufficient virulence and quantity so that exposure to the waste by a susceptible host could result in an infectious disease. Since there are no tests that allow infectious wastes to be objectively identified, responsible agencies such as the CDC, the EPA, or states define waste as infectious when it is suspected to contain potentially hazardous levels of microorganisms.[7,8] Not only has this subjective definition resulted in conflicting opinions from the EPA, the CDC, and state agencies on what constitutes infectious waste and how it should be treated, but it also gives undue emphasis to the mere presence of pathogens.

All environments except for those maintained under sterile conditions harbor some population of pathogenic microorganisms. In fact, Kalnowski and coworkers[9] compared the bacterial concentration of different hospital waste (ie, operating room, intensive care unit, and nursing station waste) with household waste and found the hospital waste was 10 to 100 000 times less microbially contaminated. Thus, organizations considering the issue of infectious waste must recognize that disease causation is multifactorial; that is, transmission will occur only when all factors (ie, virulent pathogens, dose, portal of entry, and susceptible host) are present simultaneously. This is why greater emphasis should be given to epidemiologic data rather than microbiological data when assessing medical waste. For hospitals, designating which portions of the medical waste stream are infectious and noninfectious is the essence of an infectious waste management program.

Table 6.—Infectious Waste Disposal Costs*

Assumptions IW disposal savings per patient per day from EPA compliance (including optional waste) to CDC; IW cost per patient per day to achieve EPA compliance	$1.29†
US hospital beds, 1987	1.267 million
US hospitals' occupancy rate, 1987	68.9%
Cost savings—EPA compliance to CDC 872 756 US patients/d × 59.4% EPA compliance = 518 417 US patients/d × $1.29 × 365 d	$244 million
Cost expenditure to achieve EPA compliance 872 756 US patients/d × 40.6% hospitals noncompliant with EPA = 354 339 US patients/d × $1.29 × 365 days	$167 million

*IW indicates infectious waste; EPA, Environmental Protection Agency; and CDC, Centers for Disease Control.
†Based on a study[10] showing that a 600-bed hospital with 75.9% occupancy saved $17 604 per month modifying from EPA compliance (including optional waste) to CDC.

We have observed that US hospitals discard infectious waste in a manner consistent with the CDC and EPA guidelines. The highest compliance rate (82%) was with the CDC guidelines, since they consider five types of medical wastes as infectious. The compliance rate with the EPA guidelines was 75% without the optional group and 59% when the optional waste was considered. According to 232 of the responding hospitals, infectious waste made up 15% of the total hospital waste. Not surprisingly, the percent of medical waste treated as infectious increased with the number of types of medical waste the hospital classified as infectious. Based on these data, US hospitals generate about 909 tonnes per day of infectious waste.

The majority of hospitals used overly inclusive definitions of what constitutes infectious waste. Greater than 80% of the responding hospitals identified isolation, surgical, dialysis, and contaminated laboratory waste as infectious, reflecting practice beyond the CDC guidelines. Since the new recommendations by the CDC in August 1987 on universal blood and body fluid precautions[5] were misinterpreted by some hospitals as classifying virtually all patient-contacted waste as infectious, this may account for the broad definition of infectious waste. However, when the survey results regarding the designation and treatment of infectious waste for the first 10% of US hospitals (July 1987) were compared with the survey results of the second 10% of US hospitals (January 1988), there were only minor differences. For example, blood (93.7% vs 97.8%; $P = .04$), sharps (89.9% vs 94.7%; $P = .06$), contaminated laboratory (82.2% vs 91.1%; $P = .01$), and contaminated animal carcass (85.1% vs 93.1%; $P = .09$) waste was more commonly treated as infectious waste in the second survey. Another explanation for the broad definition of infectious waste is that many hospitals designate certain waste (eg, isolation, surgery, dialysis, and laboratory waste) as infectious waste because materials from these areas show contamination by blood and landfills may reject blood-contaminated waste. However, these items are not considered infectious waste by the CDC, because this waste should not be involved in disease transmission if universal precautions and good personal hygiene are employed.[5]

The implications of this broad definition of infectious waste are significant. First, while the quantity of infectious waste is increasing, the options for on-site waste treatment are diminishing, owing in part to restrictions on incineration and some landfills banning treated infectious waste. Second, how infectious waste is defined can greatly affect the cost and type of waste management practices of hospitals. For example, one 600-bed hospital found that it saved $250 000 annually by changing its infectious waste designation from the 10 categories required by the EPA (including optional waste) to the 4 types designated by the CDC.[10] Based on these data and patient data from the American Hospital Association, if the EPA guidelines are issued as regulations, the 40% of US hospitals that are in noncompliance would pay at least an additional $167 million a year to comply. With competition for health care dollars becoming more intense, it would seem prudent to expect some health or environmental benefits for the additional expenditure, but this has not been demonstrated. Alternatively, if US hospitals that are now following the EPA guidelines issued policies consistent with the CDC guidelines, hospitals would save $244 million a year (Table 6).

Discarded needles are not only capable of inflicting injury but are also considered infectious. United States hospitals discard needles and syringes by using rigid, puncture-resistant containers, followed most commonly by delivery to an incinerator or a sanitary landfill after sterilization. Although needle

clippers were used for needle disposal by 80% of North Carolina hospitals in 1980,[4] less than 1% now use them. These devices are no longer used primarily because several professional organizations and agencies recommended that clipping or cutting not be practiced (Table 5). The reasons for this recommendation include (1) there is a potential for aerosolization of microorganisms during the clipping process[11]; (2) the surface may become contaminated with the hepatitis B surface antigen[12]; and (3) the clipping process is an unnecessary maneuver that could result in needle-stick injuries. Fortunately, new technologies for covering contaminated needles and facilitating their safe handling and disposal are emerging.

If most hospitals are appropriately managing their wastes, why have there been so many incidents of medical waste mismanagement? There are several explanations. First, regulations frequently do not apply to all generators of infectious waste, a few states do not have regulations, and many states do not enforce regulations. For example, one fourth of the states do not regulate clinics, while about half of the states do not list physicians' and dentists' offices.[3] A survey[13] of physicians' offices in Minnesota indicated that needle disposal is inconsistent (eg, 51% recapping and 27% landfill disposal without treatment) with recommendations followed in hospitals. Regulations based on the quantity of waste rather than health risk can result in some potentially harmful incongruities. Second, there are documented incidents of illegal dumping by unscrupulous private haulers paid by hospitals to treat their infectious waste by a commercial incinerator (*Omni.* February 1988:40, 42, 44, 92-95, 96). Third, there are incidents of careless mismanagement of hospital waste. For example, medical waste has fallen into the ocean when New York sanitation barges transport this waste to a Staten Island landfill (*Omni.* February 1988:40, 42, 44, 92-95, 96). Fourth, some hospital personnel may unintentionally place infectious waste (eg, sharps) into the general waste stream.

Do isolated incidents of medical waste mismanagement justify regulatory resources? Presently, there is a dichotomy between those who state that regulations are justified only when the health risks are known and significant and those who are primarily concerned with the potential harm and aesthetics posed by these wastes. Opponents of federal infectious waste regulations cite epidemiologic and microbiological studies that demonstrate that the microbial load associated with residential waste is 10 to 100 000 times more microbially contaminated than hospital waste,[9] and with the exception of needle-stick injuries and an antiquated waste treatment system,[14] there is no epidemiologic evidence that hospital waste disposal practices have caused disease in the hospital or the community.[15] Congress and the EPA have even used the term *medical waste* rather than *infectious waste* in the Medical Waste Tracking Act in deference to the remote possibility of disease transmission.[16] Proponents of federal regulatory involvement argue the public's concern about the health risks, aesthetics, and lost revenue in coastal towns via incidents such as beach washups. However, the EPA conceded in announcing the Medical Waste Tracking Act in March 1989 that the Medical Waste Tracking Act may have little effect on beach washups because only 1% to 10% of the recovered waste in 1988 was determined to be medical waste. The primary sources of these wastes (ie, primarily insulin-type syringes) included mismanaged sewage, the Fresh Kills landfill, and marine transfer stations.[16,17] Nonetheless, it is undisputed that incidents of careless behaviors by some health care workers or waste haulers or illegal dumping by unscrupulous waste processors has heightened public apprehension over current medical waste management practices. At a minimum, the EPA should spearhead a coordinated and consistent interstate approach to infectious waste management. Such a coordinated waste management program should be scientifically based. In addition, Congress should make funds available to the EPA to evaluate the health and environmental risks posed by these wastes and the alternative treatment technologies.[18] Lastly, the EPA should coordinate the development and distribution of education materials to medical waste handlers, medical waste disposal processors, and the general public about the real, not perceived, health risks associated with the management of infectious waste. Only then will the public's confidence in our medical waste management processes be restored.

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