SHEA Position Paper

Medical Waste

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INTRODUCTION

In the past few years, public concern over the disposal of medical waste has markedly increased. The rising concerns over medical waste disposal were stimulated by reports of such waste washing up on the beaches along the east coast from Maine to Florida, the west coast, the Great Lakes, and the Gulf coast. This resulted in a number of beach closings and a loss in revenues to the tourist industries in these areas. While there also have been rare and isolated instances of public exposure, such as the report in 1987 of children in Indianapolis, Indiana, who were found playing with needles and vials discarded by a doctor's office, the literature shows no instances of public illness caused by such exposures.

While the problem of medical waste washing up on beaches is a serious one, the problem is less sensational than the media, general public, and legislative reaction would imply. For example, the quantity and volume of medical waste washing up on beaches is relatively small. This is one of the conclusions of four largely unnoticed reports of the beach washups that found that the vast majority of waste on beaches was debris (about 99%) such as plastic, glass, and paper, not medical waste.[1-4] Despite extensive investigations, the washed-up medical waste found could not be traced to illegal dumping or a specific source such as hospitals, but was more directly related to improper control of New York City's solid waste stream (e.g., malfunctioning sewage treatment systems) and changes in prevailing winds and currents.' Additionally, Environmental Protection Agency (EPA) documents acknowledge that much of the medical waste that washed ashore in the summer of 1988 was syringe-related (65%) and came from home healthcare and illegal intravenous drug use.[2,5] Chemical analysis of a few syringes collected during the EPA Harbor Studies Program have identified insulin and/or cocaine in 60% (3/5).[6] In spite of the failure of investigative efforts to uncover illegal dumping of medical waste and the absence of any evidence that medical waste has ever caused an infection in any person outside of a healthcare facility, the Medical Waste Tracking Act (MWTA) was signed into law on November 1, 1988.[5]

Fueling the fears of the public about medical waste are such concerns as the hypothetical risk of medical waste for transmitting the human immunodeficiency virus (HIV), hepatitis B virus (HBV), and other agents associated with bloodborne diseases. The public also is concerned about the emissions from incinerators that burn medical waste and whether these emissions may contain microorganisms or toxic substances.

Thus, a lack of understanding of the modes of transmission of agents associated with bloodborne diseases, the fear of a fatal disease such as the acquired immunodeficiency syndrome (AIDS), and a distrust of healthcare facilities accentuated by intense and often misleading media coverage has led to intense public pressure on federal, state, and local politicians to regulate medical waste.

Responses by state governments have ranged from no regulation of medical waste to imposition of extensive regulations[7] including refrigeration of medical waste while stored and awaiting transport to a waste disposal facility, inclusion of any article stained with blood or body fluids in the definitions of regulated medical waste, and elaborate procedures and

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precautions for cleaning up spills of medical waste similar to protocols for cleaning up spills of toxic chemicals. Most states have moved quickly to pass legislation or to formulate regulations governing the transport and disposal of medical waste, while a few states have chosen to study the problem and develop data on which to base rational laws and regulations. The EPA has declined to issue regulations governing the transport and disposal of medical waste, citing a lack of evidence that the current practices pose any risk to the public health.[8] Many of the rules developed by states for regulation of medical waste have no scientific basis, and in the absence of a scientific basis for the development of such, the rules promulgated vary widely in content. There are major conflicts between regulations published by various states.[7] In many states, unscientific regulation of the handling of medical waste has added or will add substantially to the cost of healthcare, at a time when heavy pressure is being applied to healthcare institutions to reduce the cost of healthcare.

In addition to promulgation of rules that are unscientific and costly, those responsible for writing such regulations have confused protection of the public health with providing an aesthetically pleasing environment and have confused biological agents with toxic chemicals. The latter issues should not be equated, and failure to understand the differences will lead to an extraordinary waste of the already limited dollars for delivery of healthcare to the citizens of this country while not adding to the protection of the public health or the environment. Some of these concerns have been addressed recently.[9] The purpose of this position paper will be to summarize the available scientific data with respect to the public health and environmental hazards associated with disposal of medical waste and to present conclusions as to its public health importance.

DEFINING AND CHARACTERIZING WASTE

Definition

Despite the attention given to medical waste by the public and all levels of government, the terms "hospital waste," "medical waste," "regulated medical waste," and "infectious waste" remain poorly defined. No standard universally accepted definition for these terms exists, and there appear to be as many definitions in use as there are government agencies (local, state, and federal) and other groups involved in this issue. Given the diversity of interest and scientific credentials of persons, groups, and agencies (e.g., physicians, health departments, hospitals, environmentalists, trade unions, state, and federal legislators) involved in the medical waste issue, these differences are not surprising. However, because the definition adopted by a regulatory agency dictates what waste will require special handling and treatment, it has serious ramifications.[10]

"Hospital waste" (or solid waste) refers to all waste, biological or nonbiological, that is discarded and not intended for further use. "Medical waste" refers to materials generated as a result of patient diagnosis, treatment, or immunization of human beings or animals. "Infectious waste" refers to that portion of medical waste that could transmit an infectious disease. Congress and the EPA have used the term "regulated medical waste" rather than "infectious waste" in the MWTA in deference to the remote possibility of disease transmission.[5,11] Thus, "medical waste" is a subset of "hospital waste," and "regulated medical waste," which is synonymous with "infectious waste" from a regulatory perspective, is a subset of "medical waste."

As stated, infectious waste is waste that is capable of producing an infectious disease. This definition requires a consideration of the factors necessary for induction of disease, which include dose, host susceptibility, presence of a pathogen, virulence of a pathogen, and the most commonly absent factor, a portal of entry 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. Because there are no tests that allow infectious waste to be objectively identified, responsible agencies such as the Centers for Disease Control (CDC), the EPA, or states define waste as infectious when it is suspected to contain pathogens in sufficient numbers to cause disease. 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.[11-13] When examining the designation of waste as infectious by the CDC and the EPA guidelines, one recognizes agreement on five types of waste (i.e., microbiological, pathological, animal, blood, and sharps) but disagreement on communicable disease isolation waste (Table 1).[8,14-16] In the MWTA, the EPA modified its position on "communicable disease isolation waste" by including only certain "highly" communicable disease waste such as Class 4 etiologic agents (e.g., Mar-burg, Lassa, Ebola) as regulated medical waste.[5]

Amounts and Composition

The amount of hospital waste generated in US hospitals is approximately 6,670 tons per day, or about 1% of the 158 million tons of municipal solid waste produced annually. The per-patient-perday genera-

TABLE 1

TYPES OF MEDICAL WASTE DESIGNATED AS INFECTIOUS AND RECOMMENDED DISPOSAL/TREATMENT METHODS, CDC AND EPA* t

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

* The Joint Commission for the Accreditation of Healthcare Organizations[16] requires that there be a hazardous waste system designed and operated in accordance with applicable law and regulations.

† See references 5, 8. 14. 15, and 21.

‡ I = incineration; S = steam sterilization: TI = thermal inactivation; C = chemical disinfection for liquids only; Sew= sanitary sewer (EPA requires secondary treatment): SW = steam sterilization with incineration or grinding; CB = cremation or burial by mortician; IW = infectious waste.

** The Act went into effect on June ‘X2.1989, and expired June 22, 1991. It affected only four states (New Jersey, New York. Connecticut, and Rhode Island). The Act required both treatment (any method. technique. or process designed to change the biological character or composition of medical waste so as to eliminate or reduce its potential for causing disease) and destruction (waste is ruined. tom apart, or mutilated so that it is no longer generally recognizable as medical waste).

†† The CDC guidelines specify "microbiology laboratory waste" as an infectious waste. This term includes stocks and cultures of etiological agents and microbiology laboratory waste contaminated with etiologic agents (e.g.. centrifuge tubes, pipettes, tissue culture bottles).

‡‡ MWTA specified used and unused sharps. The Act regulated wastes from persons with highly communicable diseases such as Class 4 etiologic agents (e.g., Marburg, Ebola, Lassa).

. ** Optional inkctious waste: **EPA** states **that** the decision to handle these wastes as infectious should be made by a responsible, authorized person or committee at the individual facility.

tion rate of 15 pounds reported in a US hospital survey conducted in 1987-1988[11] is about 15% higher than the amount reported in a North Carolina hospital survey (13 pounds per patient per day) conducted in October 1980.[17] This probably reflects the continued increased use of disposable medical items within the past decade.

Currently, US hospitals designate about 15% of their total hospital waste as infectious waste. Thus, they generate about 1,000 tons of infectious waste per day.[11] Not surprisingly, the percent of medical waste treated as infectious increases with the number of types of medical waste the hospital classified as infectious.

While hospitals are considered to be the primary generators of medical waste by volume, the aforementioned figures capture only a fraction of the healthcare facilities that generate medical waste. For example, there are approximately 180,000 private physicians' offices, 98,400 private dentists' offices, 38,000 veterinarians' offices, 15,500 medical clinics, 12,700 long-term care facilities, 4,300 laboratories, and 900 free-standing blood banks.[18] No reliable data are available on the quantity of waste produced from these nonhospita1 healthcare sites. Additionally, there are about 2 million diabetics who generate insulin-type syringes and about 1.2 million intravenous drug users nationwide who generate over 1 billion insulin-type syringes,[19] but they are not regulated.

Few data are available on the composition of hospital waste, although it is a heterogeneous mixture of many materials such as plastics (14% by weight), dry cellulosic solids (45% by weight), wet cellulosic solids (18% by weight), noncombustibles (20% by weight), and other.[20]

Plausible Bansmission Routes

Based on the principles of disease transmission, it is extremely unlikely that infectious agents from medical waste will be introduced into a host by the respiratory tract, urinary tract, gastrointestinal tract, or mucous membranes of the mouth, eyes, or nose so long as standard health measures and proper personal hygiene practices are adhered to (e.g., no ingestion, no injection). Similarly, the potential for infection resulting from contact with nonsharp medical waste is virtually nonexistent. For example, for infection to occur from contact with nonsharp medical waste, each of these events must take place in sequence. The waste must contain a viable human pathogen; an individual must come in direct contact with the medical waste; an injury must occur following this contact, thereby creating a portal of entry, or a portal of entry must already exist (e.g., open cut or scratches); a sufficient number of a viable infectious agent must enter a susceptible host via this portal of entry; then the agent causes infection that may or may not result in clinical disease.[19] Obviously, there are many effective means of interrupting this chain of transmission, and these include confining medical waste to bags or boxes or both and employing Universal Precautions.[21]

The only medical waste that has been associated with infectious disease transmission is contaminated sharps. This is not surprising, given the intrinsic capability of sharps to disrupt the skin's integrity and introduce infectious agents into the wound.[19]

PUBLIC HEALTH IMPLICATIONS OF WASTE

Real Versus Perceived Health Risks

Medical waste poses virtually no infectious hazard to the public. Washups of floatable medical and other waste on the beaches of New Jersey and the New York area during the summers of 1987 and 1988 brought with them intensified public concern for public health and safety. While washups of floatable waste are not new, what caught the public's attention was the seeming novelty of finding medical waste on the beaches. Because of the public's concern with AIDS, medical waste on beaches brought a perceived threat to health and safety.[22,23]

Although the issue of medical waste on beaches is a serious aesthetic and economic problem requiring immediate attention, the public's health risks are virtually nonexistent. For example, the theoretical estimate that the events necessary for infection will occur in sequence and a person will develop HIV infection from a needle on the beach is one in 15 billion to one in 390 trillion (Figure).[9,19,24-28] Equally important, there is far less medical waste on beaches than the media led the public to believe.[1-5] The amount of medical waste, in the form of plastic syringes, collected on the beaches of our 23 coastal states constituted less than 0.1% of the total debris found.[3,4] In another study, New York and New Jersey were found to have more medical waste reported on their beaches (1% to 10% of the total debris) than the national average.' Even though there is agreement

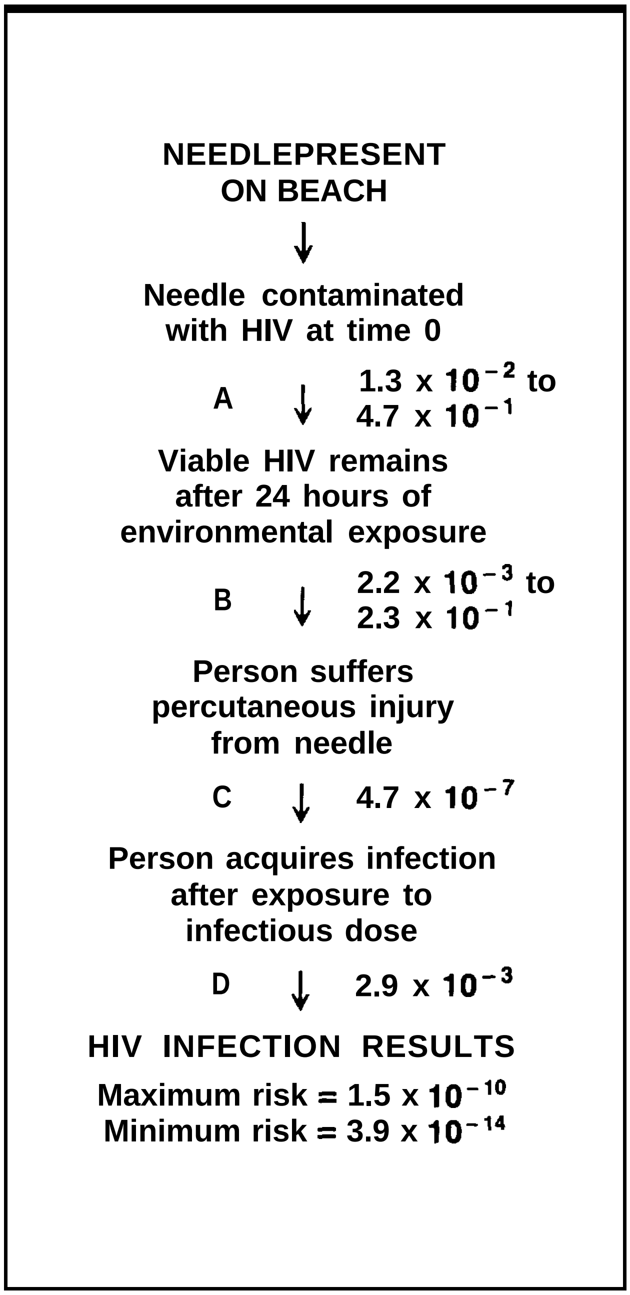

FIGURE. Theoretical estimate of HIV being transmitted via a needle on a New York beach. A: based on prevalence of HIV in sentinel hospital patients (1.3%)[24] or in New York drug abusers (47%).[25] B: based on HIV degradation rates following seawater exposure (HIV viability after 24 hours [23%])[26] or ambient air exposure (HIV viability after 24 hours [0.22%]).[27] C: based on number of visits to New York beaches and reported rates of needlestick injuries (5/10,597,000).[19] D: based on risk of HIV infection following HIV contaminated percutaneous needlestick injury in healthcare workers (0.29%).[28]

TABLE 2

BACTERIAL CONCENTRATIONS (ARITHMETIC **MEAN/G**) IN HOSPITAL WASTES AND HOUSEHOLD REFUSE

Authors	Group of Bacteria	Private Household	Operating Unit	Outpatient Surgery	Intensive Care Unit	SUrgiCal Ward	Internal Medicine	OB/GYN	Laboratory
Althaus et al, 1983	Aerobic bacteria	**7.2** × 10^6	I* 1.1 x 10^6 II 8.8 x 103	I 3.1 × 10^4 II 2.2 x 10^4	I 5.7 × 10^5	**I 3.3** x 10^7 II 2.8 x 105	II 2.6 x 10” III 2.0 x 10^6	I 4.3 x 10^4 II 1.0 × 10”	I 1.7 x 10” II 5.3 x 10^6
	Coliform bacteria	8.4 × 10^5	I 5.3 x 10^5 II 1.1 x 10^2	I 5.7 × 10^2 II 3.1 x 104	I 3.7 × 10^5	I 4.2 x 10^5 II 1.9 x 10^4	II 9.4 x 10^4 III 1.2 x 10”	I 6.6 x 10^3 II 1.8 x 10^6	I 8.2 x 10” II 1.2 x 10”
	E coli	1.3 x 10^5	I 3.3 x 10^5 II 1.2 x 10^1	I 1.6 × 10^0 II 1.8 x 105	I 3.5 × 10^4	I 8.0 x 10^4 II 2.4 x 10^4	II 5.6 x 10” III 6.9 x 10^4	13.7x 103 II 3.1 x 10^5	I 5.6 × 10” II 1.5 x 10^6
Kalnowski et al, 1983	Aerobic bacteria	6.1 x 10^9	**2.3** x 10^4	ND†	**2.2** x 10^6	**3.4** x 10^8	ND	ND	ND
	Gram-negative bacteria	6.0 x 10^7	5.8 × 10^3	ND	**7.2** x 10^4	**2.8** x 10^7	ND	ND	ND
	Streptococci Group D	1.0 × 10^7	0	ND	2.9 x 10^5	1.2 x 10”	ND	ND	ND
	Facultative anerobes	9.6 x 10^6	1.7 x 10”	ND	2.1 x 10^6	**2.6** x 10^7	ND	ND	ND
Jager et al, 1989	Total bacteria	2.5 x 10^8	IV‡2.0 x 10^6 **v 5.0** x 10^5	N D	IV 3.5 × 10^5(S)** IV 7.1 × 10^5(M) v 1.4 x 10^6(S)	IV 1.1 × 10^7 V 1.1 × 10^7	IV 2.8 × 10^6 v 7.9 x 10^6	ND	ND
	Streptococci group D	1.0 × 10^7	IV 4.0 × 10^3 v 4.0 x 10’	ND	IV 2.0 x 10^3(S) **I v 4.0 x** 10^4(M) V 1.6 x 10^4(S)	IV 6.3 x 10^5 v 1.0 x 10^6	**Iv 2.0** x 10^5 v 7.9 x 10^4	ND	ND
	Gram-negative rods	7.9 x 10^7	**IV 6.3** × 10^3 V 2.5 × 10^3	ND	IV 2.0 x 105(S) **IV** 5.0 × 10^4(M) V 2.5 x 10^4(S)	IV 2.0 × 10^6 V 1.3 x 10^6	**Iv 1.3** x 10” v 1.3 x 10”	ND	ND
	Obligate facultative anerobes	2.0 × 10^3	**Iv** 4.0 × 10’ v 1.0 × 10^1	ND	V 6.3 x 10^2(S) IV 5.0 × 10^2(M) V 1.6 × 10^3(S)	IV 1.6 × 10^2 V 4.0 × 10^2	**IV 2.5** x 10” v 4.0 × 10^2	ND	ND

* I, II, III = different hospitals.
† No data.
‡ IV= large hospital (1,300 beds); V= small hospital (250 beds).
.* S = surgical: M = medical.

among public health experts that the actual risks or “hazards” posed by medical waste at the beaches or in landfills are exceedingly low, the present climate in our society is that complete safety (i.e., zero risk) is a feasible goal regardless of cost. In such a climate, legislators or public health officials may respond with extreme measures. Because increased costs for the affected services are not obviously linked to the actions or laws, the system becomes tilted to overreaction.[29]

Renn and Covello hypothesize that the public perceives the risk of medical waste as a serious threat because the potential outcome is death (e.g., from AIDS), and the pathway to infection is intuitively plausible. They also point out that several factors amplify the public’s risk perception or “outrage” to include: dreaded consequence (e.g., AIDS) ; lack of personal control; familiarity with risk (e.g., people downplay the risk of commonplace hazards such as peanut butter or motor vehicles while exaggerating the risks of unfamiliar ones); the perception of equitable sharing of the benefits and risks (i.e., people living near a waste-disposal site rarely appreciate the benefit because they assume a larger burden of the costs);

TABLE 3
NUMBER OF SYRINGES COLLECTED ON BEACHES BEFORE (1988) AND DURING (1990) IMPLEMENTATION OF MWTA*

	No. of Syringes in State(s)/Total Syringes in 23 Coastal States		
States	**Before MWTA, 1988[3]**	**During MWTA, 1990[4]**	**p†**
Connecticut	0/1,718 (0%)	142/3,738 (3.80%)	<.001
New Jersey	11/1,718 (0.64%)	152/3,738 (4.07%)	<.001
New York	33/1,718 (1.92%)	291/3,738 (7.78%)	<.001
Rhode Island	11/1,718 (0.64%)	59/3,738 (1.58%)	.004
Total in MWTA states	**55/1,718 (3.2%)**	**644/3,738 (17.23%)**	**<.001**
Total syringes on beaches in 23 coastal states/total items on beaches in 23 coastal states	**1,718/1,973,995 (0.09%)**	**3,738/4,227,791 (0.09%)**	**.601**

* The Medical Waste Tracking Act went into effect on June 22, 1989, and affected only four states (New York, New Jersey, Connecticut, and Rhode Island). It expired on June 22. 1991. Sharps (syringes or needles) constituted about 65% of medical waste that washed ashore in the summer of 1988.'
† p values by Fisher's Exact test.

and the potential for blame (i.e., the possibility of assigning blame to a person, institution, or industry for creating a risky situation).[30] Efforts to explain a "hazard" are unlikely to succeed so long as the "outrage" is high. Risk perception researchers believe that to lessen public concern about exceedingly low "hazards," experts and public health officials must diminish the "outrage."[31,32]

Ironically, the combined forces of public opinion and federal legislation of medical waste will do little to correct the problem of beach washups or the broader issue of environmental degradation. The real source of the problem is not correctable by tracking medical waste, by broadening the definition of medical waste, nor by regulating medical waste from hospitals and clinics. The source of the washups is much more difficult to regulate: weather patterns (i.e., prevailing winds) and currents; mechanical failures in sewage systems of coastal cities; and a failure to deal adequately with garbage disposal in general and medical waste from nonhospital healthcare sites and the general public in particular.[22]

Microbiologic Quality of Hospital Waste Versus Household Waste

Household waste contains more microorganisms with pathogenic potential for humans on average than medical waste. Several studies have quantitatively and qualitatively evaluated the microbiological content of hospital waste and household waste (Table 2). In fact, several investigators have demonstrated that household waste contains, on the average, 100 times more microorganisms with pathogenic potential for humans than hospital waste.[33-35] Each of the eight studies conducted worldwide has found that household waste was on average more microbially contaminated than hospital waste.[33-38] Household waste that may contribute to large numbers of microorganisms include facial tissues, dog and cat feces, soiled disposable diapers, and putrescible foods.[39]

Kalnowski et al examined the microbial contamination and species pattern of hospital waste from a surgical department (operating unit, intensive care unit, nursing station) and household waste. Using a gentle homogenization technique, these investigators found household waste to be 10 to 100,000 times more microbially contaminated than hospital waste. In addition, common nosocomial pathogens (i.e., ***Pseudomonas aeruginosa, Klebsiella*** species, ***Enterobacter*** species, ***Proteus*** species, and group D streptococci) were detected more frequently from household waste than from hospital waste.[34] Kalnowski et al also summarized the results of a study by Schrammeck and Sauerwald and an EPA study by Burchinal, who also found the bacterial concentration of hospital waste (nursing unit, intensive care unit, operating room) similar to that reported by Kalnowski (Table 2).[34]

Althaus et al analyzed 264 hospital waste samples and 21 household samples for microbial contamination. The results again showed that the microbial contamination of hospital waste was less than or similar to household waste (Table 2), and that it was even free of microbial contamination in some cases, especially single samples of hospital waste (e.g., syringes, dressings, swabs). Qualitative methods allowed 21 pathogenic bacteria and fungi to be identified, and 12 of these were found in both household waste and hospital waste.[33] Mose and Reinthaler also found that household waste was more commonly contaminated, especially with fecal bacteria, and almost one-third of all hospital waste showed no bacterial contamination. Thirteen percent (19/149) of the eluates from blood-saturated refuse samples were hepatitis B surface antigen (HBsAg)-positive, as were 15% (155/1,041) of the serum samples.[36] While HBsAg is a marker for HBV, its presence does not demonstrate infectiousness, because HBsAg is present in greater numbers (1,000 x) and is more environmentally stable than HBV.

Jager et al also demonstrated that the bacterial concentration of hospital waste was less than or similar to that of household waste (Table 2). The concentration of gram-negative rods in household waste was on average 10,000 times higher than waste from the operating room.[35] Trost and Filip evaluated the concentration of pathogenic microorganisms in refuse from consulting rooms of general practitioners, ear-nose-throat specialists, dermatologists, dentists, and veterinarians, compared with municipal waste. They found that waste from medical consulting rooms generally had lower microbial counts as compared with the municipal waste.[38]

Lastly, another study compared the microbiologic contamination of trash originating from the rooms of patients on isolation precautions versus standard care. The mean log total colony forming units (CFU) per bag was 1.60 ± 1.55 CFU for isolation trash and 1.97 ± 1.83 CFU ($p = .44$) for nonisolation trash. Contamination by ***Staphylococcus aureus***, *Escherichia coli*, and ***P*** *aeruginosa* was comparable in both groups, but contamination with enteroviruses was significantly higher in nonisolation bags. These results suggest that the types and numbers of organisms in trash generated from isolation and nonisolation are comparable.[40]

We can deduce from our daily exposure to household waste and the decades of sanitary landfill burial that the public health risks for the less microbially contaminated hospital waste are nominal.

Public Health and Occupational Risks

There is no evidence that a member of the public or a waste industry worker has ever acquired infection from medical waste. The only medical waste that has been associated with infectious disease transmission is contaminated sharps.[19] All reports of transmission of infectious agents by contaminated sharps describe occurrences in the healthcare setting during patient care, laboratory procedures, or sharp disposal, and are not associated with environmental injuries that occurred after extramural disposal.[19] There is no epidemiological evidence that hospital waste disposal practices have caused disease in the community.[11,19,41] Further, occupational exposure of waste industry workers to medical and municipal waste has not been found to lead to an increased risk of acquiring bloodborne infections.[19,42,43] For example, Cimino reported on the disease and injury data over a two-year period (1968-1969) for the 14,000 persons employed by the New York Department of Sanitation. He found a higher overall injury rate than other industrial occupations, but no case of hepatitis developed in the group suffering needle punctures.[42]

Infection Risks Associated with Treatment Technologies

There are no infectious risks associated with any type of medical waste treatment method. Treatment of regulated medical waste by US hospitals is most commonly accomplished by incineration (range = 64%-93% by type of waste). About one-third of US hospitals steam sterilize their microbiological waste, and about one-fourth pour liquid blood down a drain connected to a sanitary sewer (Rutala WA. Unpublished data). Nonregulated medical waste is discarded via a sanitary landfill.[17]

None of these treatment or disposal procedures represent an infectious health hazard. For example, properly operated incinerators produce a sterile ash.[44,45] There is no difference between bacteria in stack emissions and ambient air,[46] and when ***Bacillus subtilis*** is mixed with waste, the bacteria are inactivated.[47]

While most **states** have prevented sanitary landfill disposal of regulated medical waste, data suggest that untreated medical waste can safely be disposed of in sanitary landfills, provided procedures to prevent worker contact with this waste during disposal are employed.[19] Presumably the reason for excluding medical waste from landfills has been concern that pathogenic microorganisms might persist in and move through landfilled solid waste, become part of the leachate produced, enter the surrounding environment (i.e., ground and nearby surface waters), and result in human exposure and disease through ingestion of leachate-contaminated waters. Several laboratory and field studies on the survival and transport of pathogenic microorganisms in solid waste and its leachate found that enteric viruses and bacteria are largely adsorbed and inactivated in landfilled solid waste, are present in leachates at relatively low concentrations, and are unlikely to migrate through soils into groundwater (Sobsey MD. Written communication.).[39,48-52] These studies were confirmed by the failure to detect enteric viruses in leachates from 21 landfills in the United States and Canada, which represented a wide range of conditions regarding solid waste landfill practice, geography, soil, and climate.[52] There also is no evidence that waterborne outbreaks of disease caused by enteric microbes are because of municipal solid waste landfills or their leachates.[39]

As previously noted, municipal solid waste contains on average more microorganisms with pathogenic potential for humans than medical waste, and yet there are no restrictions on placing municipal waste into landfills. However, use of sanitary landfills for medical waste is not a viable long-term alternative because one-third of the remaining landfills will reach their capacity within the next five years.[53] There also is some concern about blood being discarded via the drain connected to a sanitary sewer. This concern is unwarranted for several reasons. First, conventional treatment processes of sewage, such as primary sedimentation, secondary (biological) treatment, and effluent disinfection are designed to reduce the microbial content of raw sewage by 90% to 99%, depending on the type of microorganisms and specific treatment processes.[54] Second, the microbial load added to the sewer via the usually sterile body fluid-blood-is negligible compared with major sources of pathogenic microbes in sewage, which include the bacteria and viruses in human feces that exceed 10^{10}/g.[39] Third, blood discharged into the sanitary sewer system by hospitals is diluted to a very low concentration by the enormous amounts of effluent from hospitals and residences. Fourth, no bloodborne disease risks from occupational exposure to sewage have been described.[39,55]

Noninfectious Risks Associated with Treatment Technologies

There are no demonstrated noninfectious health risks associated with waste treatment technologies that are currently employed; however, public health concerns regarding treatment technologies require further investigation and subsequent development of scientifically based standards. The health risks associated with the incineration of medical waste continue to be debated because of the paucity of data. The pollutants of primary concern from both hospital and municipal waste incinerators include dioxins and furans (some of which are suspected carcinogens), acid gases (e.g., hydrogen chloride), metals (e.g., lead, mercury, cadmium), and particulate emissions (which may absorb heavy metals and organics and serve as irritants). Some of these substances (e.g., heavy metals, dioxins, and furans) also can be a constituent of incinerator ash.[20] Preliminary studies using the *Ames Salmonella typhimurium* assay indicate that stack fly ash and particulate emissions from medical waste incinerators are less mutagenic than emission estimates published for wood stoves, automobile gas engines, and residential furnaces.[56] However, the public health concerns of chemicals in the emissions or ash require further investigation that should lead to the development of scientifically based standards.

Currently, statewide moratoriums or stringent rules (particularly air emission) and permit requirements make it virtually impossible for hospitals to install incinerators and difficult for hospitals to use installed incinerators. Health facilities in New York are preparing for strict new incineration standards that took effect January 1, 1992, and may close about 75% (220/300) of the health facility incinerators. New Jersey's incineration standards have forced most health facilities to close their incinerators or pay fines of $5,000 per month.[57] This results in increased disposal costs for the shipment of regulated medical waste, sometimes long distances to regional incinerators.

Documented health risks from steam sterilization do not exist. Potentially, workers could be exposed to aerosolized organic solvents or other hazardous chemicals if these materials were autoclaved and the workers were exposed to the vented steam. This potential emission problem can be prevented by not autoclaving hazardous chemicals.[20]

The health risk associated with new alternative technologies (e.g., microwave, gamma radiation, infrared) requires further examination. When an alternative waste treatment technology is considered, any new (e.g., gamma radiation exposure) or additional employee exposures that could result from the new methods should be identified and evaluated.[20]

Infection Risks Associated with Recycling Hospital Waste

There are no infectious risks associated with recycling hospital waste. Effective management of hospital waste incorporates a waste reduction and recycling component where appropriate. Presently, recycling efforts by hospitals have generally focused on nonpatient contact sources of waste such as glass, scrap metal, aluminum cans, cardboard, and packaging material.[58] Although there are no infection risks posed by recycling these components of the hospital waste stream, reports of hospitals being unable to market certain items for recycling (e.g., glass intravenous bottles) because they are perceived to be "infectious/medical waste" have occurred. This highlights the need for better understanding of the actual public health risks posed by the medical waste stream. From an infectious disease perspective, only a few items (e.g., sharps, plastic associated with microbiological cultures) generated in the healthcare setting are not likely candidates for recycling.[20]

MWTA Costs and Benefits

The cost of complying with the **MWTA** is much higher than EPA estimates, and there is no demonstrable environmental benefit. A key component in evaluating the impact on cost of a medical waste management program is the quantity of infectious waste produced per patient. As stated, the percent of medical waste treated as infectious increases with the number of types of medical waste classified as infectious. For example, using the CDC guidelines, about 6% of hospital waste will be treated as infectious.l' In contrast, a New York university hospital and university reported it designated 45% of its waste as regulated medical waste (or infectious waste) to be in compliance with the MWTA.[59] This occurs because some of the waste listed in the MWTA is included because it is aesthetically displeasing to the public.

Additionally, the terminology associated with some waste categories is nebulous, such as "items saturated and/or dripping with human blood." This wording can lead state and federal inspectors to inappropriately consider any items tinged with blood as regulated medical waste. Because it might be difficult to maintain separate waste containers for regulated and nonregulated medical waste in a manner that ensures no confusion in certain patient care areas (e.g., operating room, emergency room), facilities would be forced to designate all waste generated in these areas as regulated medical waste.

Additionally, hospitals overdesignate waste as regulated medical waste because the penalties for violating the MWTA rules are so severe. With the exception of pathological waste, the use of aesthetics as a criterion to regulate medical waste establishes a controversial precedent and reinforces the public's perception that more of this waste has an infectious potential than is true.[20] It also increases hospitals' waste disposal costs significantly more than the EPA estimate of $3,757 per hospital per year.[5]

To illustrate, a New York university hospital and university reported that, in order to comply with the MWTA, the amount of regulated medical waste generated increased 315% from 1984 (443,000 pounds) to 1989 (1837,000 pounds), their total cost increased from $106,000 to $835,000 per year, or nearly 700%, and the cost per patient per day for regulated medical waste went from $1.04 to $5.19.[59] This is largely because of the need to consider a greater portion of medical waste as regulated medical waste, and because of the cost differential between disposing of nonregulated medical waste (i.e., $0.02$0.05 per pound) compared with regulated medical waste (i.e., $0.20-$0.60 per pound). Other hospitals such as Yale-New Haven Hospital in Connecticut also have documented soaring costs under the MWTA.[60] Based on the New York hospital data and patient census data from the American Hospital Association, it would cost US hospitals about $1.3 billion a year to comply with the MWTA. This is approximately seven times the amount allotted ($182 million) by the federal government in 1991 for all childhood immunizations. Ultimately, this additional cost likely will be passed on to the public in the form of higher medical fees, insurance rates, and/or taxes.

It should be noted that while the principal purpose of the MWTA was to reduce medical waste on beaches, it has not demonstrated its intended benefit. The number of syringes on the beaches in the MWTA states was significantly greater during implementation of the Act (644/3,738, 17.23%) than before the Act went into effect (55/1,718, 3.2%) (Table 3). There was no relative increase in the total number of syringes on the beaches in the 23 coastal states before and during implementation of the MWTA (Table 3).[2-4] This may substantiate some concerns that strict and expensive requirements for medical waste may promote mismanagement by unscrupulous generators, processors, and haulers. Although the MWTA expired on June 22, 1991, and affected only four states (New York, New Jersey, Connecticut, and Rhode Island), it is possible that it or similar legislation will be passed by Congress this year and extend to all states.

CONCLUSIONS

The hasty promulgation of unscientific regulations for transport and disposal of medical waste should be replaced with the development of uniform regulations based on scientific data for proper decontamination and disposal of the very small amount of medical waste that may pose an infectious hazard. Additionally, an intensive public education program regarding the actual risks posed by medical waste and methods for their proper management may reduce the public's outrage. This approach may prevent the wasteful expenditure of precious healthcare resources and would safeguard the environment and the public's health.

Based on the scientific literature reviewed in this position paper, we conclude the following.

- The vast majority of waste on beaches is general debris (>99%), not medical waste, and the risk of acquiring infection from medical waste on a beach is virtually nonexistent.
- There is no scientific evidence that medical waste has ever been the source of infection for any person outside the healthcare setting, and there is no evidence that a waste industry worker has ever contracted an infection from medical waste.
- Medical waste may be safely landfilled, provided procedures to prevent worker contact with this waste during disposal are employed. Bulk blood and

body fluids may be safely discarded by pouring them into a sanitary sewer system.

■ Based on epidemiological and microbiological data, only two types of medical waste would require special handling and treatment: sharps and microbiological waste.

a Implementation of the MWTA for all US hospitals would result in an extraordinary increase in medical waste disposal costs with no environmental or public health benefit.

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