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HOME
PAGE

JOIN
WEF

INFO
SEARCH

WEFTEC

LINKS

CATALOG

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Can Aids Be Transmitted By Biosolids?: Biosolids Fact Sheet

Executive Summary

Acquired Immunodeficiency Syndrome (AIDS) is the disease that results from Human Immunodeficiency Virus (HIV) infection. For AIDS to occur, HIV must be transmitted to and infect a person. The possibility of HIV entering municipal sewer systems has prompted inquiries as to whether HIV may be transmitted through contact with wastewater or with biosolids, the solid product created during wastewater treatment. The question is legitimate and deserves an informed response, but research has refuted links between contact with wastewater or biosolids and HIV transmission.

HIV invades and destroys human T4 cells, which detect foreign substances and instruct other cells to produce infection-fighting antibodies. HIV requires host blood- or T4-cells to survive and multiply. Outside of the host environment, HIV cannot survive or multiply. AIDS is the condition of depleted T4 cells leading to disruption of the body's entire immune response system and to susceptibility to myriad infections. The World Health Organization estimates that 3 million people worldwide died from AIDS through November 1995.

Routes of HIV transmission include sexual intercourse, intravenous drug use, blood transfusion, blood exchange as a result of percutaneous (through the skin) injury, and infection of infants either before, during, or after birth from infected mothers. Recent findings at the Dana-Farber Cancer Institute indicate that unprotected oral sex may also allow transmission of HIV through ingested body fluids. Also, some health care workers have acquired HIV from contact with infected blood. Patterns of reported AIDS cases lead researchers to conclude that the virus may not be transmitted in any other manner.

Public concern about HIV in biosolids relates to the disposal of blood and other contaminated fluids in municipal sewer systems. Hospitals and other medical facilities dispose of liquid medical waste by discharge to sewers. However, the necessary conditions for HIV transmission are absent in wastewater systems (i.e., separation from the host environment, dilution in vast amounts of water, chemicals from household and industrial sewer users already in the sewer system, and the length of time from discharge to treatment provide absolutely no favorable conditions for HIV survival).

Water itself destroys HIV and quickly diminishes the virus' infectiousness. Research by Moore shows that tap water can not support HIV and that chlorinated water should further deactivate the virus. Additional recent research demonstrates that HIV loses its infectiousness within hours of submersion in tap water. The osmotic pressure of water disrupts the

protein-lipid membrane HIV needs to infect target cells. Chlorine and ammonia, which are present in tap water and wastewater, may act as virucides to destroy HIV.

No research has produced a viable, commonplace scenario for HIV transmission by wastewater or from biosolids, the residuals from wastewater treatment.

SURVIVAL OF HIV IN VARIOUS MEDIA

In wastewater

Compared to other viruses, particularly poliovirus, HIV is unstable and loses its infectivity quickly. The characteristics of HIV render its transmission from wastewater to humans highly unlikely. No HIV have been recovered from samples of raw sewage.

Scientists have studied the survival of HIV in fecal matter, wastewater, and biosolids by seeding (placing) HIV virus samples directly into these media. For perspective, it is important to note that seeded wastewater samples contain far higher amounts of the virus than would exist in a municipal wastewater collection and treatment system.

Casson et. al. seeded HIV in samples of nonchlorinated secondary effluent from a conventional wastewater treatment plant. The seeded virus lost most of its infectivity within 48 hours. Results were similar in samples of primary effluent seeded with HIV. In one set of experiments, free and cell-associated HIV seeded in dechlorinated tap water lost 90 percent of infectivity within two hours and 99.9 percent of infectivity within eight hours. In another recent experiment, which introduced HIV-contaminated blood into tap water, no infectious HIV was found. Water itself, then, is a hostile environment for the infectivity of HIV.

HIV has not been detected in samples of actual raw wastewater collected from municipal sewage treatment plants. Palmer et al. found no detectable levels of HIV despite flows to a plant from at least one major medical research facility. Even large amounts of contaminated blood discharged to sanitary sewers are diluted by the much larger water flow to the system. While most hospitals are allowed to dispose of body fluids to sewers, many disinfect such material prior to disposal. In any case, HIV's fragility and dependence on a host preclude the virus' survival through a sewer system and wastewater treatment.

In Human Waste

The solid portions of fecal samples have been shown to inhibit HIV activity to levels that pose virtually no hazard to treatment plant employees or others in contact with such material. HIV has not been isolated from feces or urine.

Some wastewater treatment plant employees work near the solids removed from sewer systems. This material can include the excreta of HIV-infected persons, which is especially pertinent in light of research showing correlations between enterovirus levels in particular populations and enterovirus recovery in sewage effluents. Whereas some enteroviruses have been recovered in measurable quantities in sewage, HIV has never been detected.

In an experiment in which HIV was directly seeded into fecal material, Rangan, Akers, and Reimers find that the solid portions of fecal samples inhibited HIV because of factors hostile to the virus as well as to physical impedence. Indeed, the virus was rendered noninfectious within an hour when placed in a fecal sample from an HIV-negative individual, and HIV was

undetectable within three days in the liquid portion of the fecal suspensions. The researchers conclude that “The laboratory reconstruction studies and the studies of others suggest there is likely to be minimal or no HIV-related environmental hazard to waste treatment personnel or others once the solid components in the sewage effluents are completely removed.”

Some of the liquid portion of municipal wastewater is urine. Free HIV does not remain infectious in urine due to its acidity. Likewise, urine does not contain significant amounts of the receptor site necessary to carry the virus. No known cases exist of HIV transmission through urine, even in health care workers with direct exposure to urine from HIV-positive patients. Hence, intermingling of urine with waste solids does not threaten the safety of material which eventually becomes biosolids.

In Biosolids

The inability of HIV to survive outside the human body in either wastewater or waste solids eliminates biosolids from concern in the spreading of the HIV. No HIV has been recovered from samples of biosolids.

HIV loses its infectivity within hours of leaving the body. Research shows that the virus expires very quickly after introduction to water, and that it does not regain its potency after losing its ability to infect. Neither feces nor urine, the human wastes most common to sanitary sewer systems, appear to carry HIV. The human body fluids known to carry relatively high concentrations of the virus - blood, semen, and vaginal fluids - are released in small quantities to sewers and are diluted by much larger flows of water. Commercial and industrial materials in sewers, while presenting different challenges to wastewater managers, also are likely to destroy HIV. Therefore, HIV in material discharged to sewers holds little or no chance of surviving the journey to the treatment plant.

The average wastewater treatment facility provides an environment so hostile to even the most persistent virus that survival is virtually impossible. All land applied biosolids must meet one of a number of nine pathogen reduction requirements as outlined in Title 40 of the Code of Federal Regulations, Part 503. Regardless of the pathogen reduction option selected, the requirements provide for the reduction of pathogens so as not to pose a hazard to environmental or public health. Biosolids generators and landappliers meet such standards through thermal treatment, testing, and other procedures. Even if all wastewater and biosolids treatment procedures were to fail, HIV cannot survive outside the body of its host from more than 72 hours and is infectious for even shorter time periods.

PUBLIC SAFETY FROM HIV IN BIOSOLIDS

Impact of Current Regulations

The scientific basis for safety from HIV in wastewater is undergirded by the national regulatory framework. Federal worker-safety laws and U.S. Environmental Protection Agency standards for biosolids management and use protect the general public and treatment plant workers from HIV transmission.

Federal law protects workers who may come in direct contact with wastewater residuals. The U.S. Department of Labor Occupational Safety and Health Administration’s Bloodborne Pathogen Regulation, promulgated December 6, 1991, prevents potential infection of workers

by many pathogens, including HIV. The law requires all employers to minimize worker exposure to potentially infectious body fluids and to inform employees of their risks of coming in contact with such materials in the workplace. The Bloodborne Pathogen Regulation can reduce the HIV risk at wastewater treatment facilities to zero. Johnson et al. concluded that wastewater treatment plant workers can eliminate the opportunity for all types of pathogen infection by wearing protective clothing and practicing workplace hygiene. Likewise, the Centers for Disease Control recommends protective clothing as a barrier to various infections.

As stated previously, the chance of HIV survival and transmission of the virus through biosolids is virtually eliminated by processes mandated by the Part 503 federal regulations for the production, management, and land application of wastewater solids to agricultural and other types of land.

Health of Treatment Plant Workers

Epidemiological studies show no heightened risk of disease transmission from raw sewage to treatment plant workers. Several federal agencies have independently determined that workers at wastewater facilities face little or no risk of contracting HIV, but should follow basic hygiene procedures to ensure their safety.

In 1987, the National Institute for Occupational Safety and Health affirmed that no workers in contact with sewage contracted HIV transmission as a result of their jobs. The National Association of Plumbing-Heating-Cooling Contractors asked the national organization to study the issue. While the formal NIOSH report asserted a theoretical risk to workers in contact with sewage, officials stated publicly that virtually no risk exists. NIOSH stated that workers in contact with sewage should regard Hepatitis B as a much more serious threat than HIV infection.

More recently, a year-long review and analysis by the National Research Council concluded that HIV transmission to treatment plant operators “is no cause for alarm since the HIV virus does not survive in water.” Perhaps the only way for wastewater treatment plant workers to come in contact with viable HIV viruses is through direct contact with used condoms which have become twisted and sealed. The relatively low chance of such an occurrence may be further reduced by common hygiene habits. “In general terms, the risk of disease transmission appears to be quite low for those who frequently encounter sewage,” Johnson concluded.

Wastewater treatment workers are at no risk of acquiring HIV from insects sometimes associated with sewage and fertilizer. The physical processes which allow mosquitoes to carry malaria do not transport other diseases. The digestive processes of mosquitoes kills HIV, so the insects cannot acquire the virus from one host and transport it to another. Studies with other arthropods, including bedbugs carrying live infectious virus, yield similar results. The chance of an insect transmitting HIV from its own body parts which may have touched tainted blood to new hosts is virtually none.

Health of Citizens

Research on the health of families living on farms where indicator organisms were used and where biosolids were applied show no increases in possible disease transmission, including HIV.

The dangers of HIV make experiments using the virus outside laboratory settings impossible, but several studies which seeded innocuous viruses in land-applied biosolids have established the public safety of land use. Likewise, survival of HIV through the sewer system, wastewater treatment facility, biosolids production process, storage, and land application is highly unlikely, based on the conclusions of a great deal of scientific research. Moreover, the time between biosolids production and application allows for destruction of any remaining pathogens.

In conclusion, the risk of HIV surviving a wastewater treatment system probably is unquantifiably low. The general public is at no risk for contracting the virus through biosolids generation or beneficial use. The risk to workers in biosolids generation facilities face virtually the same low risk, but should follow sensible hygienic practices to ensure their safety from HIV or other constituents of wastewater solids.

QUESTIONS AND ANSWERS

What kind of workers are at risk from HIV?

As of December 1995, the Centers for Disease Control identified 49 documented cases of occupational transmission of HIV in the United States-- all among health care workers. The health care jobs which seem to hold the greatest risk are clinical laboratory technicians and nurses. HIV transmission is not a risk among wastewater treatment workers.

Can biosolids carry HIV to animals which might transmit the virus?

No. The chances are virtually none that HIV would survive the trip from the household or other sewer user to the wastewater treatment plant. If HIV did survive, the chances of survival for any of any remaining HIV end with treatment, storage, and transportation of biosolids and, hence, animals grazing on biosolids land application sites will not contract HIV. This issue was raised several years ago by a Maryland individual who asked his congressman if cattle eating grass from biosolids-treated land could produce milk tainted with HIV. Jack O'Brien, a reporter for *The Delmarva Farmer*, quashed the concern by contacting the U.S. Public Health Service. A representative of the federal agency stated unequivocally that HIV would not survive wastewater treatment and therefore could not infect livestock.

Where can I get more information on the public health risks of HIV and AIDS?

The Centers for Disease Control provides responses to all HIV- and AIDS-related questions through its national hotline. The hotline may be reached at (800) 342-AIDS, in Spanish at (800) 344-7432, and for the deaf at (800) 243-7889. Additionally, CDC maintains a national clearinghouse of information. The CDC National AIDS Clearinghouse may be contacted by mail at P.O. Box 6003, Rockville, Maryland 20849-6003.

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[Back to Fact Sheet Project Table of Contents](#)

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