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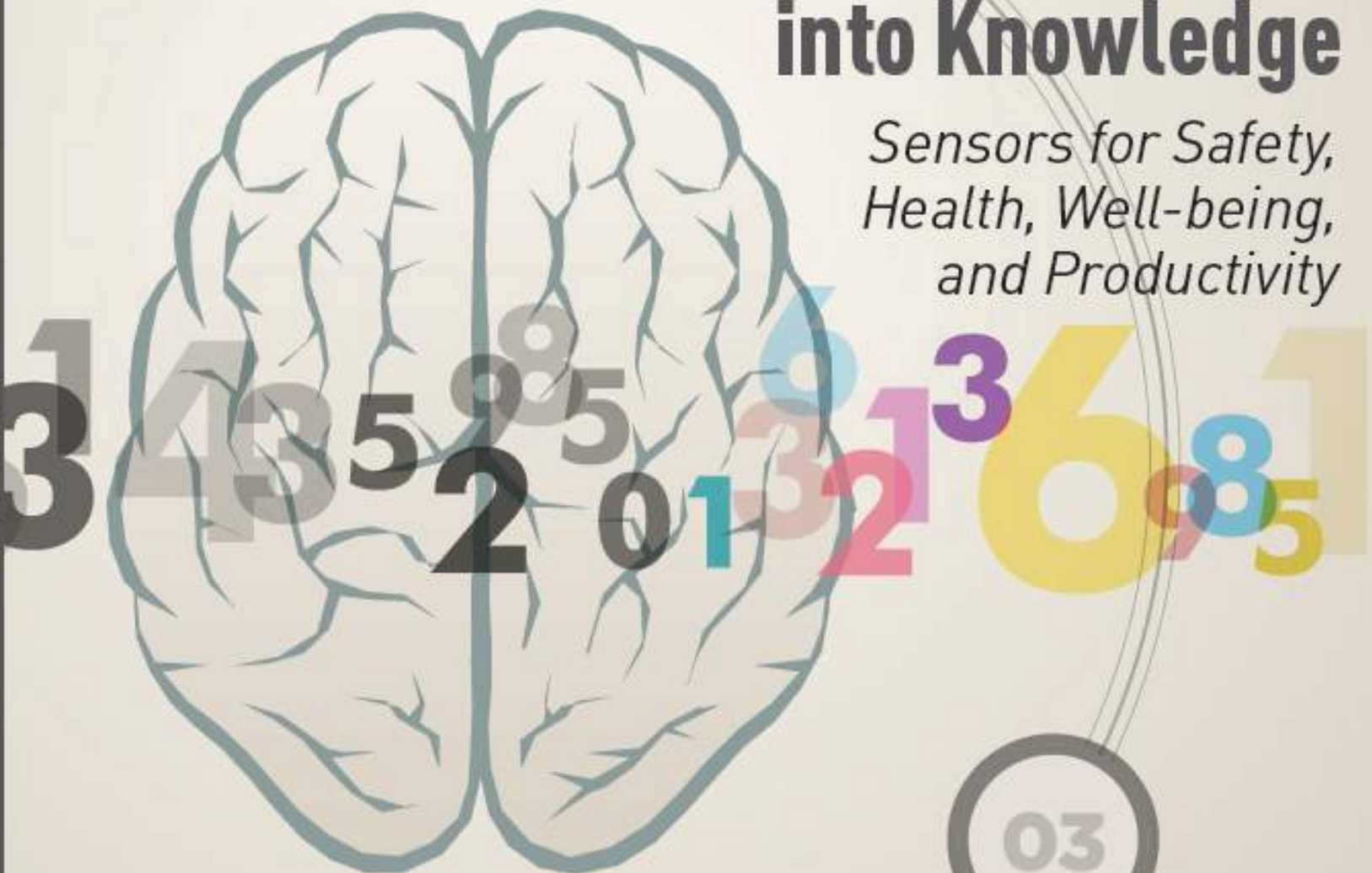

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04

Hidden Hazards

Protecting Wastewater Treatment Workers from Endotoxins and Hepatitis A

BY BRADLEY A. PRILL

Wastewater treatment plant workers face a multitude of obvious hazards, including drowning; slips, trips or falls; confined spaces; inadvertent exposure to energized equipment; and exposure to hazardous chemicals or gases. Still other hazards aren't visible to the naked eye. For occupations that have potential to come into contact with human feces, illnesses associated with bacteria, viruses, and parasites are a constant threat. As a precaution, wastewater treatment plant workers use personal protective equipment (PPE), wash their hands frequently, and get vaccinations for Hepatitis A and tetanus/diphtheria. This has been the routine practice.

The solid waste hazards are well known in the wastewater treatment industry. But it appears that few extensive studies have been conducted on potential airborne and surface hazards. This article describes work my company, Industrial Safety Solutions, completed at a California wastewater plant in response to the client's request to assess airborne and surface Hepatitis A (HAV) and bacteria (endotoxins) throughout the treatment facility. The project yielded several insights about best practices for protecting workers at wastewater plants.

WASTEWATER TREATMENT PROCESS

The plant processes approximately eight million gallons of wastewater a day from homes and businesses. It uses a tertiary treatment with a combination of physical, chemical and biological processes to remove contaminants. Sludge, or biosolids, is the unavoidable end-product of the wastewater process.

Primary treatment involves screening, clarification, and sedimentation. This is achieved through use of a series of screens and grit-removal clarifiers referred to as "headworks." Secondary treatment removes dissolved and suspended biological matter by using indigenous, waterborne microorganisms in a managed habitat, such as aeration tanks and settling ponds. Tertiary treatment offers enhanced clarity, filtration, and disinfection through the use of reverse osmosis or media and gravity filtration. Sludge is dewatered in the biosolids building in drying beds and large centrifuges. The end product can be recycled as fertilizer. The treated water leaves the wastewater plant in purple pipes as recycled water to irrigate parks, golf courses, school fields, and cemeteries.

At the time of our study, HAV air monitoring had not been conducted. In collaboration with the analytical laboratory, we developed a new technique for conducting these measurements. The monitoring was intended to determine whether a PPE hazard assessment and current administrative control procedures, including vaccinations, were adequate to protect employees from possible exposures. There were two key questions we sought to answer: had HAV and bacteria become airborne, and could HAV be found on surfaces throughout the facility?

SAMPLING FOR BACTERIA (ENDOTOXINS)

According to the *Textbook of Bacteriology*, the term "endotoxin" applies to any cell-associated bacterial toxin. It properly refers to the lipopolysaccharide complex and can be associated with the outer membrane of Gram-negative pathogens such as *Escherichia coli*, *Salmonella*, *Shigella*, *Pseudomonas*, *Neisseria*, *Haemophilus influenzae*, *Bordetella pertussis*, and *Vibrio cholera*. ("Gram-negative" bacteria are those that can be identified via the Gram staining method of bacteria differentiation. Gram stain tests target the cell walls of bacteria.) Many of these Gram-negative bacteria have been associated with foodborne illness and may cause diarrhea, fever, cramps, vomiting, headaches, weakness, or loss of appetite. In severe cases, hospitalization may be necessary.

Our approach collected bacteria (endotoxin) samples using sterile Endotoxin cassettes, which were analyzed in the laboratory by kinetic chromogenic method analysis. The results were provided in endotoxin units (EU). Personal and area samples were collected from the aeration base, clarifier, equalization channel (EQ), ultraviolet channel (UV), outside the biosolids building, and drying beds. Personal air samples were collected for the duration of the employees' shift. Area samples were collected on catwalks or platforms above the area of concern and simulated the amount of time workers typically spend in the location.

SAMPLING FOR HEPATITIS A

The Centers for Disease Control and Prevention (CDC) states that HAV is an acute, contagious liver disease that can range in severity from a mild illness lasting a few weeks to a severe illness lasting several months with an incubation period of approximately 28 days. HAV replicates in the liver and is shed in high concentrations in feces from two weeks before to one week after the onset of clinical illness. Hepatitis A is usually spread when a person ingests fecal matter from contact with objects, food, or

Table 1. Recommended Exposure Guidelines for Endotoxin

Disease	Concentration (ng/m^3)	Approximate conversion to endotoxin units (EU/m^3)
Airway inflammation	10	100
Systemic effects	100	1000
Toxic pneumonitis	200	2000

Source: EMLab P&K (http://bit.ly/labpk_endotoxins)

drinks contaminated by the feces, or stool, of an infected person. The infection is considered a self-limited disease and does not result in chronic infection or chronic liver disease.

HAV area air samples were collected on catwalks or platforms above working areas including the biosolids building, aeration tanks, clarifiers, inlet channels, and headworks. Wipe samples were collected in areas routinely used by employees including door and bin handles along with steering wheels. The laboratory analyzed the samples by molecular real-time polymerase chain reaction (RTPCR). Results were provided as negative or positive.

REGULATORY REQUIREMENTS AND BEST PRACTICES

Currently, no regulatory requirements or OSHA permissible exposure limits (PELs) exist for HAV or endotoxins. In addition, ACGIH has not set any threshold limit values (TLVs) for HAV or bacteria (endotoxin). As a reference for endotoxin, a paper that appeared in the *International Journal of Occupational and Environmental Health* recommended a "no-effect level" based on field studies. These levels are presented in Table 1.

The survey described in this article was in no way able to determine whether the HAV and bacteria (endotoxins) were viable or able to propagate within the human body. All wipe samples and more than half of the area air samples were positive for HAV, demonstrating that HAV is present throughout the plant and on commonly used surfaces. All endotoxin results were below the level referred to in Table 1 as potentially causing airway inflammation.

Because HAV and endotoxins were found at the wastewater plant, it is prudent to focus on the prevention of illness. Currently, CDC recommendations do not support the Hepatitis A vaccination for sewage workers. They recommend only the tetanus-diphtheria immunization. Hand washing and personal hygiene must be used in these facilities.

At a minimum, workers and visitors should use nitrile gloves. When assigned tasks have the potential for contact with human waste, employees should consider double gloving with nitrile on the interior and thicker rubber gloves on the exterior. It is important to consider dexterity when selecting gloves. Employees typically won't wear gloves that make work tasks difficult to perform. Handwashing stations with automatic sensors or foot pedals should be placed throughout the plant. Rigorous handwashing before eating, drinking, or smoking is recommended. A separate room away from the work area should be available for employee breaks. Handwashing and sanitizing stations should be made available for visitors.

Because some pathogens can be absorbed by mucous membranes, face shields worn with safety glasses or goggles can help prevent splashes to the eyes, mouth, and nose. At a minimum, respiratory protection such as N95 filtering facepieces should be used where biosolids are aerosolized, as in the aeration and digestion process. In these facilities, workers walk over open tanks on catwalks. Hardhats and hearing protection will most likely be needed throughout the plant.

Steel-toed boots that are slip- and puncture-resistant will help protect feet. Employees should be encouraged to change shoes before leaving work and not to wear soiled clothes home. This can be challenging if the facility does not have showers. Installation of showers should be considered in upgrades or new construction of wastewater plants. If soiled clothes do go home, they should be washed separately from family clothes, and each load should be washed twice. Cleaning the washer tub with bleach or commercial product between loads is also recommended.

Providing employees with first-aid kits containing bandages and finger cots may encourage them to cover cuts to help prevent illnesses. The first-aid kits will need to be restocked on a routine basis. Employees should be instructed on proper use of their PPE, including disinfection and storage, as well as the limitations of PPE. Lastly, employees need to know how to report safety concerns. Addressing concerns up front will help prevent injuries and provide a platform for educating front-line workers.

HIDDEN HAZARDS

This study demonstrated that HAV and endotoxins are present in the wastewater treatment facility environment. HAV was found on both surfaces and in the air, and endotoxins were found in the air. Further monitoring and research is needed to truly assess the potential for infection of HAV and illnesses related to endotoxins, but based on the results of this study, it appears prudent to offer HAV vaccinations to wastewater employees. S

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