# Medical Surveillance for Hazardous Waste Workers

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*The efforts to clean up hazardous waste disposal sites have led to an increasing number of workers involved in these activities. Industrial hygiene surveys have demonstrated that these workers are potentially exposed to low levels of multiple contaminants during the work day and to high levels of some contaminants for very short time periods. Personal protective equipment and work practices are important components in protecting workers from these exposures. Medical monitoring for these workers is problematic. While monitoring for the potential health effects of these multiple exposures may be useful, any attempt to monitor for possible health effects of all potential exposures could lead to a long array of medical tests. The utility and effectiveness of this approach is doubtful. Screening for a worker's physical ability to conduct hazardous waste cleanup jobs while he wearing protective equipment is also important and may cause difficulties due to our limited knowledge in this area. These issues will be discussed in the context of various programs designed to monitor these workers.*

Designing a medical surveillance program for hazardous waste workers is a difficult task.[1] At the present time, there are very few quantitative data about the occupational exposures and hazards for these workers. Available industrial hygiene data indicate that these workers have low-level exposures to multiple chemicals and the possibility of short-term higher exposures to many of these same chemicals. The latter exposure situations provide the rationale for much of the protective equipment and work practice programs usually provided for these workers.[2]

Most occupational medical screening is based on the known toxic effects of specific chemicals and is predicated on the occurrence of a significant degree of exposure to those toxic substances. Even for specific toxic substances, most medical screening recommendations have not been critically evaluated for efficacy. Combining the usual medical screening recommendations for each chemical to which a hazardous waste worker could be exposed would produce a costly, unwieldly list of screening recommendations that would be of doubtful effectiveness.

The following recommendations for a medical program for hazardous waste workers are based on the established health hazards for those workers, a review of the available data on their exposures, and a review of several established medical programs for those workers. These recommendations are based on the assumption that these workers will have adequate protection from exposures at hazardous waste sites. The recommendations are presented in four parts: preemployment screening, periodic screening, provisions for episodic and emergency medical care, and record keeping (Table).

## Preemployment Screening

The major focus of preemployment examinations should be to ascertain whether the worker is physically fit to perform the assigned work at hazardous waste sites. This work often involves physically strenuous activity (moving 55-gal drums, etc) and, in addition, requires the worker to wear personal protective equipment (respirators, protective suits, etc). Wearing this equipment poses an added physiological burden on the worker, particularly when working in high ambient temperatures. Unfortunately, this added physiological burden is not well quantitated at present.[3-6]

Therefore, the preemployment screening should include a medical history and physical examination focus-

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**TABLE**
Medical Program for Hazardous Waste Workers

I. Preemployment screening
  A. Recommended
    1. Medical history and physical examination with selective medical testing (eg, chest x-ray films, pulmonary function testing, ECG) to determine worker's fitness to work while wearing protective equipment.
    2. Preemployment or preexposure baseline biological monitoring for specific exposure at a hazardous waste site (eg, PCBs).
  B. Optional
    1. Freezing a preemployment serum specimen for later testing.
    2. Other routine baseline tests: blood count, liver enzyme tests, etc.

II. Periodic screening
  A. Recommended
    1. Yearly medical history and physical examination with appropriate medical testing selected on the basis of this examination and on the worker's exposure history.
    2. More frequent screening based on exposure to specific hazards (eg, organophosphate pesticides, PCBs) or individual health factors.
  B. Optional
    1. Yearly testing using routine medical tests: blood count, liver function tests, etc.

III. Acute medical care
  A. Recommended
    1. Provisions for emergency first aid at the site.
    2.. Provisions for hospital transportation, and for informing the hospital about exposures at the site, particularly if specific medical treatment is available for a toxic exposure (eg, cyanides).
    3. Mechanism for episodic health care with evaluation of possible site-related illness.

IV. Record keeping and program review
  A. Recommended
    1. Maintenance and access to medical records in accordance with Occupational Safety and Health Administration regulations.
    2. Recording and reporting of occupational injuries and illnesses.
    3. Periodic review of the medical surveillance program, including integration with available exposure information about the hazardous waste sites where the workers are employed.
    4. Review of specific site safety plans to determine if special testing is required for the workers at that site.

ing on the worker's ability to handle this burden. The Occupational Safety and Health Administration (OSHA) respirator standard (29 CFR 1910, Part 134), requires that no employee be assigned to a task that requires the use of a respirator unless it has been determined that the person is physically able to perform under such conditions. The medical history should ascertain information on past illnesses and chronic diseases (particularly asthma, pulmonary disease, and cardiovascular disease), and include a review of symptoms (especially dyspnea on exertion, other chronic respiratory symptoms, chest pain, and heat intolerance). Other characteristics that may make a worker more susceptible to heat stroke such as obesity and little physical exercise should also be ascertained. The physical examination should focus on the pulmonary and cardiovascular system. Depending on the results of the medical history and physical examination, and on the worker's age, further medical testing such as a chest x-ray film, pulmonary function testing, and/or an electrocardiogram may be useful in ascertaining the person's ability to perform strenuous work while wearing a respirator and other protective equipment. However, these additional tests need not be done for everyone. The medical history and exam by themselves may disqualify some workers. Little information would be gained from these additional tests for a young, healthy, non-smoking worker. On the other hand, pulmonary function testing and an ECG may prove quite useful in evaluating an older worker with a long hisory of cigarette smoking.

Based on the medical history, physical examination, and appropriate further tests, the examining physician must then make a decision on the worker's ability to perform the required work while wearing protective equipment. Unfortunately, there is very little guidance in the literature on which to base this decision.[3-12] Prospective employees with severe lung or heart disease should obviously be excluded. However, there are no clear-cut guidelines for an asymptomatic worker with modest reduction in pulmonary function. Usually, in these instances, the medical assessment must be based on an overall assessment of the person's medical examination. Current research on the physiological burden involved in wearing respirators and protective clothing, and on the effects of reduction in pulmonary function and respirator tolerance, should help provide better guidance for these assessments in the future.

Another major purpose of preemployment testing is to ascertain the worker's ability to work in hazardous environments (ie, is the worker unusually susceptible to specific chemical exposures?). Because exposures at hazardous waste sites are multiple and often unpredictable, other than serious medical conditions which would disqualify a worker by the above criteria or a history of severe asthmatic reaction to a specific chemical, further medical testing would not be effective for this purpose.

A final purpose for conducting preemployment medical screening is to establish baseline data to better evaluate the effects of subsequent toxic hazardous waste workers' exposures. This baseline testing may include both medical screening tests and biological monitoring tests. The latter (eg, blood lead level) may be useful for ascertaining preexposure body burdens of specific substances to which the worker may be exposed and for which reliable tests are available. Given the problem in predicting significant exposures for these workers, there are no clear guidelines for prescribing certain tests. Alternative approaches range from doing no testing to conducting an extensive battery of biochemical and biological monitoring. A more rational approach would include baseline testing selected according to the past history of the workers (previous medical and occupational history) and on some assessment of the predominant and significant exposures which the worker may experience.

The most common potential chemical exposures for hazardous waste workers are solvents. Although some solvents have specific toxicity (eg, leukemia can result from benzene exposure), the most common medical effects from solvent exposure are neurotoxic and hepato-

toxic. Other than history and physical examination, routine preemployment screening tests for neurotoxic effects are not available. Liver enzyme tests are commonly used in testing for hepatotoxic effects, but their sensitivity and specificity for detecting the effects from low-level exposures to multiple solvents are unknown and probabloy low.[13] Therefore, their use in preemployment or periodic screening is questionable. Likewise, the value of other commonly used preemployment biochemical tests (BUN, calcium, etc) or other baseline laboratory testing is also questionable.

An alternative approach to baseline testing would involve a situation where a specific significant exposure for the hazardous waste worker is known and biological or biochemical monitoring of that exposure is well established. For example, long-term cleanup of a polychlorinated biphenyls (PCB) waste facility could be monitored with preemployment and periodic serum PCB testing.[14] Lead, cadmium, arsenic, and organophosphate pesticides are additional examples of substances for which this approach could be appropriate. Given the common use of respirators and protective clothing for workers at hazardous waste sites, usual industrial hygiene monitoring will not provide an accurate indication of the worker's actual exposure (ie, through the respirator and protective clothing). Therefore, in situations where a hazardous waste worker may be exposed over a sufficient period of time to a substance that can be monitored by available biological monitoring techniques, preexposure and periodic biological monitoring for that substance may provide very useful information on actual exposure for that worker or group of workers.

A related approach would involve drawing preemployment blood specimens and freezing serum for later testing if environmental monitoring indicates significant exposures to an agent amenable to such monitoring (eg, PCB, some pesticides).

### Periodic Screening

The frequency and content of periodic screening of hazardous waste workers will depend on the nature of their work. In general, these examinations should take place at least yearly and include an interval history and physical examination. The medical history should focus on changes in health status, illnesses, and possible work-related symptoms occurring since the last screening examination. The examining physician should have some knowledge of the worker's exposure during that period of time. This information should include any exposure monitoring done at the worker's job site. This could be supplemented by self-reported exposure histories or more general information on the potential exposures at the hazardous waste sites where the employee has worked. Additional medical testing would depend on the available exposure information and on the medical history and examination results. This additional testing should be specific for the possible medical effects of the worker's exposure. The application of a large batch of medical tests in an attempt to cover all of the possible medical effects of the hazardous waste worker's multitude of potential exposures is not very useful. Such testing may only lead to problems due to the occurrence of elevated values due to other factors or to chance (ie, false positives).

More frequent monitoring may be appropriate for significant exposures at specific sites (eg, PCB, lead, etc) as described in the preceding section. The schedule for this monitoring would depend on the degree and type of exposure and the duration of work at the job site. Periodic review of the screening results can help determine the appropriate frequency. For example, workers involved in the cleanup of a PCB-contaminated building initially had monthly testing of their serum PCB levels.[14] Review of data from the first few months revealed no evidence of appreciable PCB exposure. Thus, the frequency of PCB testing was reduced accordingly.

### Acute or Episodic Medical Care

Provisions for acute medical care need to be developed for each hazardous waste site. This should include provisions for emergency first aid at the site. Key employees at the site should have some formal first aid training, particularly in dealing with explosion and burn injuries, with heat stress, and with acute chemical toxicity. Appropriate first aid equipment also needs to be available at the site.

Arrangements for evacuating injured or ill personnel also need to be available, including transportation to a nearby hospital. These arrangements should also include assisting the hospital in preparing for these occurrences. This preparation can avoid unnecessary delays in treating these workers due to inappropriate concerns about chemical contamination of the hospital. (This has actually occurred after a hazardous waste facility fire.)[15] The medical care facility should also be informed about the nature of potential exposures at the site, about the specific details on the incident involving the ill or injured workers, and about the worker's past medical history. These arrangements are particularly important when specific medical treatment is required for a toxic exposure (eg, cyanide, organophosphate pesticides).

A mechanism to provide episodic medical care for hazardous waste workers also needs to be arranged. This may be difficult, particularly if the worker is not close to the home office of the employer or is working in a rural area. Nevertheless, it is important to ensure that any possible occupationally related symptoms or illnesses are promptly evaluated in the context of the worker's exposures at the site and that other illnesses do not put the worker at greater risk due to the requirements of hazardous waste work. Arrangements also need to be made for the treating physician to have access to the worker's medical records. Depending on the situation, this can be done by keeping the medical records (or a copy) at the hazardous waste site (with appropriate provisions for security) or at a nearby hospital.

Another important group of workers who may be

exposed at hazardous waste sites is fire fighters and emergency response personnel. These workrs may encounter significant acute exposures in responding to fires or other emergencies at such sites. Proper preparation can help prevent serious exposures in these situations. Prior to the hazardous waste site cleanup, the fire department and other emergency response personnel need to be informed on potential hazards from incidents at the site. Procedures to limit these exposures and to assure the availability of appropriate protective equipment can be made. Arrangements also need to be made for decontamination or disposal and replacement of fire fighting equipment used at the site. In the event of significant exposure for any of these workers, arrangements need to be made for appropriate medical or emergency care, including informing the medical care provider of possible exposures at the site.

## Record Keeping and Program Review

Record keeping is an important part of any medical surveillance program. For hazardous waste workers, this may be difficult due to the multiple locations where they may work over a period of time. Current OSHA regulations require that medical records on exposed workers be maintained for 30 years after they leave employment (45 FR 35212). The results of medical testing and full medical records must also be available to the workers, their union representatives, and OSHA inspection staff. Informing workers about their exposures and medical testing is particularly important in helping them to take appropriate precautions and for informing their other or subsequent medical care providers of their exposures as a hazardous waste worker. Occupational accident and illness records must also be maintained and reported yearly to OSHA.

Maintenance and review of such records is also important for periodic assessment of the effectiveness of the health and safety program for the hazardous waste site, and for the overall program of the company or agency regularly conducting this type of activity. Each accident or illness should be promptly evaluated to determine the cause of the incident and to implement appropriate changes in the health and safety procedures for the site. This activity is particularly important in conducting a program for hazardous waste sites where the nature of the work and of the occupational exposures requires good compliance with work procedures (eg, respirator use) to maintain an effective health and safety program.

Periodic review of the results of medical surveillance testing is also important in maintaining the effectiveness of the medical surveillance program. This review should attempt to critically evaluate the efficiency of specific medical surveillance testing, particularly in the context of information on the exposures or potential exposures at hazardous waste sites. Industrial hygiene and environmental data may suggest the need for adding specific medical tests to the surveillance program. The director of the medical surveillance program should also review the potential exposures at new hazardous waste sites to determine if additional medical testing is required for the workers at that specific site.

## Discussion

The design and conduct of a medical program for hazardous waste workers is a difficult task. These workers are potentially exposed to thousands of toxic substances, often in situations where identification or quantification of these exposures is not possible. The medical program for these workers must provide a baseline of preemployment and periodic screening, yet remain adaptable to the exposures at specific sites. Most important, this program must be integrated with the industrial hygiene program, personal protective equipment program, and safety procedures for the site.

There are a number of similar occupations that have multiple exposures to toxic chemicals in situations where identification and quantification of these hazards is difficult. Sewer repair workers may be exposed to multiple organic chemicals when working in industrial areas.[16] Firefighters also may be exposed to toxic contaminants while fighting fires or responding to hazardous material incidents.[17] Medical surveillance for these groups would follow the same general patterns outlined above, but would take into account different aspects of these occupations. For example, fire fighting requires considerable physical effort leading to near-maximal individual heart rates. Medical surveillance for firefighters would place more emphasis on the cardiac and respiratory systems.

Medical surveillance for workers with multiple exposures will continue to be a challenge, particularly for those occupations whose exposures are continually changing. However, careful consideration of the potential exposures and job duties of the workers can provide a sound basis for this surveillance as part of an integrated occupational safety and health program.

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## The Sanctity of Space

Oh, I have slipped the surly bonds of earth,
And danced the skies on laughter-silvered wings;
Sunward I've climbed and joined the tumbling mirth
Of sun-split clouds—and done a hundred things
You have not dreamed of—wheeled and soared and swung
High in the sunlit silence. Hov'ring there,
I've chased the shouting wind along and flung
My eager craft through footless halls of air.
Up, up the long, delirious, burning blue
I've topped the wind-swept heights with easy grace,
Where never lark, or even eagle, flew;
And while with silent, lifting mind I've trod
The high, untrespassed sanctity of space,
Put out my hand, and touched the face of God.

—Sonnet "High Flight" by John G. Magee, Jr. 19-year-old American volunteer with the Royal Canadian Air Force, killed near Britain on Dec 11, 1941. From "Tribute: Airman's Sonnet" in *The New York Times*, Jan 30, 1986.