Chapter 10

MEDICAL SURVEILLANCE

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INTRODUCTION

The two missions of occupational and environmental medicine in the Department of Defense (DoD) are (1) to prevent work-related injuries and illnesses from a population health perspective and (2) to address the clinical needs of individual employees. These two missions will be discussed separately. Medical surveillance consists of systematically and periodically collecting and analyzing health data on groups of employees to monitor changes in health status over time and to achieve primary, secondary, and tertiary prevention of workplace disease and injury.

Primary prevention refers to the prevention of illness or injury. The aim of primary prevention is to reduce or eliminate risk by preventing or mitigating exposures. Hepatitis B immunizations are a good example of a primary prevention initiative to prevent cases of this disease in the workplace.[1] Performing screening tests for glucose-6-phosphate dehydrogenase deficiency in explosive workers can help identify those workers at increased risk of hemolysis because they do not metabolize methemoglobin.

Secondary prevention refers to early detection and intervention to halt or reverse the progression of disease, before long-term health consequences occur.[1] Medical surveillance data helps occupational health and safety personnel focus on effective disease and injury countermeasures. Mallon et al conducted surveillance of TNT workers at an Army ammunition plant and noted an increased incidence of anemia in chronically exposed workers, which triggered several interventions to reduce workplace exposure to TNT.[2]

Tertiary prevention refers to medical interventions that alter the course of the disease and reduce the severity or recovery time, allowing employees to return to work earlier than otherwise would be possible. Medical surveillance may guide inquiries regarding which occupations involve risk and the degree of impairment resulting from each type of injury or illness.[1]

Medical surveillance is prospective and should be effective, efficient, and economical in terms of program design, medical screening performed, and use of the surveillance data. Medical surveillance is different from medical screening; medical screening is the search for a health characteristic in an individual or a group at risk that is cross-sectional in nature. It is rare that health screenings show abnormal health outcomes results due to job-related exposures.[3]

Lead screening is a population health measure performed to detect occupational exposure in the workplace above the action level for lead, which is 30 μg/m3 as a time-weighted average (TWA).[4] Airborne concentration levels above this level trigger periodic surveillance and workplace controls, including administrative and engineering controls to reduce ongoing exposures. If blood lead levels exceed 60 μg/dL employers must medically remove workers from continued lead exposure until the blood lead level drops below 40 μg/dL.[4]

It should be noted that chronic low-level exposure to lead may generate large bone stores of lead without blood lead screening levels exceeding the action level. As a result, the Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA) have initiated steps to lower the workplace and general population exposure limits to lead *before* workers are adversely affected. Chapter 21, Occupational and Environmental Lead, details policies related to workplace exposure limits in the occupational setting. Primary prevention, screening, and directed exposure countermeasures constitute effective medical surveillance.

ASSESSING THE NEED FOR SURVEILLANCE PROGRAMS

Before initiating a medical surveillance program, an occupational health program manager should identify the reasons for conducting medical surveillance and define which heath indices should be monitored. Most federal civilian workers today perform administrative tasks with minimal physical job demands or potential for exposure to job-related hazards. This group of workers is best targeted for health promotion and wellness initiatives and periodic health history screening to ensure that chronic disease risk is being managed appropriately.

The second group of employees have physical requirements specified in their job description that require sufficient health and fitness to perform their work safely and effectively. Medical screening in this group focuses on ensuring the employee can meet the physical requirements of the position while performing the essential job functions without undue risk to themselves or others. For example, US Department of Transportation (DoT) regulations require a commercial motor vehicle operator to be free of any medical condition that could incapacitate him or her while transporting hazardous cargo in interstate commerce. Thus, medical standards for this job might include the absence of insulin-dependent diabetes mellitus, and a medical surveillance program would screen drivers for diabetes. (Discrimination against

the medically handicapped is not at issue here if it has been documented that the medical condition will indeed compromise the job, ie, by causing sudden incapacitation.) The key to designing medical surveillance for these employees is to maintain clearly defined medical standards. The sole authority for writing medical standards belongs to the Office of Personnel Management.[5] A subset of workers who undergo medical surveillance will be required to wear personal protective equipment (PPE) to protect against workplace hazards, and this group must be medically screened to ensure the PPE can be worn safely while performing job tasks.

Medical standards that assess the worker's functional ability to perform job tasks are preferred to medical standards that require documentation of the absence of positive screening tests. For example, a medical surveillance for respirator wearers should be designed to ensure that employees are physically able to wear the respirator while performing job duties without a decrement in job performance. Previously, workers with beards were disqualified, but workers may now be able to wear a powered air purifying respirator that does not require a good face seal provided they can meet the other physical requirements to perform the job safely.

A performance-based medical standard could require employees to have intact pulmonary function. A physician or licensed healthcare provider may include normal pulmonary function testing (PFT) or negative responses on the OSHA respirator questionnaire as evidence of normal pulmonary function. Specification-type medical surveillance standards would require PFTs to be performed annually, set criteria all employees must meet, and recommend that someone with PFT results lower than 70% of expected based on employee demographics would be medically recommended for removal from the job. In contrast, a functional standard would offer someone not meeting the 70% of expected cutoff to demonstrate they can perform essential job duties while wearing the respirator. The DoD's occupational and environmental health (OEH) clinic staffs must work closely with safety and industrial hygiene professionals and installation management personnel to develop local guidance that meets DoD and Army regulations but allows for exemptions when it makes sense to meet mission and health requirements.[6]

Job-related medical surveillance must be tailored to employees based on job titles, worksites, or documented exposures and individual susceptibility to chemical, physical, or biological agents that may be hazardous. This is particularly true when exposures exceed standards in order to detect early health effects, monitor the effectiveness of the controls, and monitor the extent of the exposure.

MEDICAL SURVEILLANCE PROGRAM DESIGN

A medical surveillance program is based on industrial hygiene sampling data, which helps the occupational health provider decide who is exposed in the workplace and when the exposure exceeds thresholds that mandate medical surveillance. The determination of who to enroll in the medical surveillance program is often challenging because industrial hygiene sampling data is often not available, and instead healthcare providers must rely on the employee to provide a good occupational history (which may include self-reported exposures). When industrial hygiene sampling data is lacking, sampling done in similar exposure groups may provide clues as to whether exposure in the local workplace may be occurring. Other factors weigh into the determination as well, such as management-union agreements that call for medical surveillance.

Additionally, some assumptions regarding exposure should be evaluated before making decisions on enrollment in the medical surveillance program and the extent of the history and physical examination.[6,7] In order for a toxic substance to exert its effects, there must be a completed pathway of exposure from external exposure to internal exposure, and the presence of chemical and physical hazards in the workplace does not mean that a completed pathway of exposure exists. Further, if a completed pathway does exist, the worker exposure may not be biologically significant or it may not be sufficient to cause health effects. Finally, while health effects or end organ damage may be present, there may not be any screening test available to detect it.

Workplace exposures may trigger concern by employees, regardless of the level of exposure or potential for adverse health outcome. However, when employees face uncontrolled exposures in the workplace, steps must be taken to alleviate their concern and countermeasures implemented to eliminate the exposure. Except in cases of acute exposures to very high levels of toxic chemical or biological agents, there are few health effects that can be readily detected through medical surveillance. Thus, it is critical for OEH providers to communicate to employees and other stakeholders the low level of risk that most exposures pose. Further, not all subjects in a given population will be exposed identically, nor will they respond identically. For example, two Army ammunition plant workers standing side by side may be exposed to completely different levels of the same propellant because of different

air flows around their work stations. Even if the exposures are identical, the two might experience different toxicological responses. One worker might be very susceptible to TNT's negative effects, due to his or her cardiovascular status, while a coworker could be completely unaffected.

Once an exposure meets or exceeds the threshold for enrollment in medical surveillance, the employee should be examined for potential health effects. Knowledge of how toxic substances affect organ systems is critical to designing the medical surveillance program to look for internal dose, measures of early biologic effects, and end organ damage. When the pathway from external exposure to internal exposure is completed, the severity of the effect is determined by the route of entry, level and duration of exposure, and how the substance is metabolized in the body. OEH providers may be able to predict the likelihood of adverse health effects based on the substance's toxicodynamics. DoD-adopted criteria for predicting health outcomes or sentinel events that are based on exposures at the OSHA permissible exposure level (PEL) and at the American Conference of Governmental Industrial Hygienist (ACGIH) threshold limit value (TLV). Employees require job-related medical surveillance when their workplace exposures exceed the OSHA PEL or ACGIH TLV specified in DoD's *Occupational Medical Examinations and Surveillance Manual*.[7]

Determining Screening Examination Content

The content of the surveillance examination must be determined once the need for medical surveillance has been established. There are four parts of the medical surveillance examination:

1. medical and employment history;
2. physical examination;
3. diagnostic testing, including laboratory tests and radiological exams; and
4. special studies that include electrocardiograms (EKGs), PFTs, treadmill stress tests, and biological monitoring.

The utility of these tools is measured by their sensitivity, specificity, cost, acceptability, ease of use, accuracy, and reproducibility.[8] Few screening tools meet all criteria for widespread use.

Because the workforce is relatively healthy and job-related illnesses are rare, an interim medical and employment history is the preferred tool for tracking changes in employee health status and work ability. The interim work and medical history should identify changes in job duties or changes in health status. The interim history should address whether the employee (1) properly uses personal protective clothing and equipment, (2) has had exposures that exceeded the OSHA PEL or ACGIH TLV, (3) has experienced changes in health status, and (4) needs more in-depth health screening. The healthcare provider may use information obtained from the interim employment and health history to guide a directed physical examination for specific findings. By doing a focused physical examination, the specificity of the medical surveillance examination increases.[8]

Knowledge of the full range of possible health effects is important to identify adverse health effects in exposed workers. If the provider is unaware that isocyanates are pulmonary sensitizers, for example, he or she may not listen for wheezing in workers after isocyanate exposure and thus miss the fact that employees are developing job-related asthma.

For laboratory screenings (the third part of the medical surveillance examination) to be effective, the test's specificity must be high and costs must be low. A "shotgun approach" to laboratory testing performed on a group of employees based solely on their job description, or on the presumption that they were exposed to a hazard, is both costly and has low positive predictive value. Laboratory screening tests may be unable to detect end organ damage such as early cancers and may be considered useless. The Agency for Health Care Policy provides evidence-based guidelines for providers on which tests are effective and which are not recommended. One way to improve the sensitivity of the test is to screen a subgroup of workers for whom industrial hygiene sampling has detected exposures that exceeded the OSHA PEL or ACGIH TLV.

Medical surveillance guidance[6] based on specific workplace hazards (the fourth part of the medical surveillance examination) has been published. Healthcare providers are in a better position to direct the medical surveillance of workers when they talk to employees, visit the workplace, discuss issues with supervisors and safety and industrial hygiene personnel, and learn where breakdowns in engineering and administrative controls occur.

Biological monitoring involves testing blood and other body fluids to measure a toxic agent or its metabolites.[8] The biological monitoring test should have high specificity, but only a few tests are currently available. Approved biomarker tests include blood tests for metals, urine tests for metals and benzene metabolites, and red blood cell cholinesterase testing for organophosphate pesticide exposure.[8] (Chapter 29, Biological Monitoring, provides a more in-depth review of biomonitoring.) Special studies include audiograms to detect noise-induced hearing loss; chest x-rays and PFTs to test for changes in pulmonary function;

and EKGs, echocardiograms, and graded exercise testing to detect alterations in cardiac rate, rhythm, and cardiac function.

The timing of medical screening is essential.[8] Screening is done prior to employment to provide baseline data for comparison with future surveillance data. Periodic screening is done at routine intervals, and should include an interim history. The periodic screening examination should include tests based on the employee's exposure history, scheduled according to the time needed for physiological or physical changes to occur. Hearing tests, for example, are done after a 48-hour noise-free period. However, if acute effects are being sought, or if the extent of exposure is being documented, screening both later in the day and later in the week may be more appropriate. The toxicokinetics of the substance will affect the decision of when to screen. The half-life of one hazardous material in the body may be minutes to hours, while that for others may be days to weeks. Delayed screening for the agent or its metabolic breakdown product (biomarker) is useless if the hazardous substance is metabolized in minutes to hours.[8]

Use of Medical Surveillance Results

The medical surveillance program must be managed, and the data collected must be used appropriately. The healthcare provider must inform the employee of the screening results and recommend appropriate medical follow-up, including a determination of whether the exposure was work related. If the abnormal screening tests indicate an unacceptably high exposure has occurred, then the employee should be considered for temporary duty restrictions with a goal of reducing or eliminating workplace exposure through temporary job reassignment or time off.

Often the healthcare provider must use professional judgement when there are no published medical standards. OEH clinic personnel should act with the assumption that a sentinel event has occurred and ensure periodic surveillance of the remaining worker population that may be at risk. In these situations, the safety and occupational health team, including the OEH clinic staff, industrial hygienist, and safety officer must employ the hierarchy of controls to prevent future exposures in the workforce. These controls include substitution, engineering controls, administrative controls, use of personal protective clothing and equipment, and medical removal when necessary. Data collected on both normal and abnormal findings provides a basis for comparison for future testing with the aim of preventing adverse health effects. Abnormal screening tests can provide indications about where breakdowns in exposure controls are occurring.

Medical surveillance efforts should be evaluated for compliance with OSHA, DoD and service- specific metrics established in DoDI 6055.05, *Occupational and Environmental Health*,[9] and service regulations. Use of program metrics will ensure that cost effective surveillance is conducted and adverse health effects will be detected.

MEDICAL SURVEILLANCE AND CERTIFICATION EXAMINATIONS

Medical surveillance and certification exams looking for signs or symptoms of work-related disease or injury are the key tasks of an occupational health provider. The medical surveillance examinations are often mandated by OSHA regulations located in 29 CFR, Part 1910, Subpart Z.[10] Certification examinations are done to qualify a worker for a specific, potentially hazardous or safety-sensitive duty, such as wearing a respirator, driving a forklift, or operating a commercial motor vehicle. Both types of examinations involve a medical history, physical exam, and laboratory and special testing.

Medical Surveillance Exams

The examining provider who performs a medical surveillance examination must know the possible adverse health effects of the hazard in order to recognize whether they are present. The provider also needs to know whether the worker has been exposed to the hazard, and at what levels and for how long the exposure has been occurring. Someone who worked with asbestos-containing material since the 1970s is a likely candidate for developing asbestos-related disease. Conversely, someone who had a one-time, 5-minute exposure to asbestos at levels below the PEL last year would be highly unlikely to have asbestos-related disease a year later due to the latency period of developing disease after exposure. The last thing a provider must keep in mind is that non-work-related conditions may be aggravated by work. If there is a clear connection between a disorder and work, it should be documented in the employee's medical record. If not, the facts should also be documented in the record, including the provider's rationale for why the condition is not work related.

Certification Exams

Occupational health providers who perform certification exams must be familiar with the requirements of the certification process. They should obtain a copy of the

guidelines that list the requirements and any disqualifying conditions for the job. It should be noted that the DoT requires healthcare providers to pass a certification examination themselves before they can start performing medical certification examinations on commercial motor vehicle operators. In the case of other certification examinations, the healthcare provider must review the medical requirements of the position, the job description, the medical conditions and age of the employee being screened, and the results of prior certification examinations and any work limitations previously identified.

The healthcare provider should review the medical history form and address any positive responses in the comments section. The provider should update the master problem list (containing an individual's past medical and surgical history) if new conditions have developed since the last certification examination. He or she should also review all test findings, and date and initial all hard copies of each page of laboratory, audiogram, chest x-ray, EKG, and PFT results. The provider should reference prior chest x-ray, EKG, or PFTs when reporting the current results. For employees exposed to respiratory hazards, such as asbestos and isocyanate, the provider should review past PFTs to get an idea of trends.

Audiograms should be annotated with "no significant threshold shift (STS)" or "permanent threshold shift (PTS)" with "mild, moderate, or severe hearing loss" in the high, mid, or low frequency. For example, "the employee has a 15-dB shift at 4,000 Hz AD [in the right ear only] compared to 1997 reference; or high frequency loss AU [in both ears] consistent with noise-induced hearing loss." Visual acuity requirements for civilian positions are listed in the US Army Public Health Center Technical Guide 006, *Vision and Safety Eyewear Guide for US Army Civilian and Military Job Series*.[11] The corrected visual acuity must be sufficient to meet employment standards for the duties assigned. The vital signs should be reviewed, especially the employee's stage of blood pressure. If stage 2 or higher, consider referral to the employees treating healthcare provider for blood pressure control.

The provider must identify all abnormal results and the plan for follow-up. He or she should note the test results in the encounter note in the electronic health record and print it (the printed document is standard form [SF] 600, Chronological Record of Medical Care) for placement in the employee's hardcopy medical record.

DOCUMENTING THE PHYSICAL EXAM AND MANAGING RESULTS

The occupational history and physical examination should focus on identifying signs and symptoms of exposure and detecting adverse health outcomes associated with exposure to an individual's workplace hazards. As discussed above, the healthcare provider must document any findings associated with the employee's personal medical conditions in the employee's health record. If the exam is complete and no test results or other components are pending, the healthcare provider should make a determination on the worker's medical qualifications. If more tests are needed or the results are not back yet, the provider should check "pending" and advise the OEH clinic nurse and staff that some results are still pending.

Employees with non-work-related conditions should be referred to their personal physician for proper disease and injury management. The employee may be "qualified" for work or continued employment provided the condition does not interfere with the essential job duties. The referral to the treating provider must be documented in the employee's electronic health record. The original referral letter along with a copy of any abnormal laboratory or testing results should be given to the employee to give to the treating provider.

If the employee is not found to meet the medical requirements for the position, then the healthcare provider must explain why in writing to the employee and their supervisor. Healthcare providers may only disclose the employee's work ability to the employee and their supervisor. Further, employees must be advised of their privacy and Health Insurance Portability and Accountability Act (HIPAA) rights and notified that protected health information may only be disclosed to the supervisor or management with the express written permission of the employee, who must sign a consent form. The healthcare provider is encouraged to make the employee aware that failure to disclose health information to the supervisor may affect the manager's ability to make hiring and retention decisions. The provider must also advise the employee what actions are necessary to requalify for the position.

If the occupational health provider thinks an employee has developed an adverse health effect that may be related to a workplace exposure, the provider must advise the worker about ways they may be able to reduce or eliminate ongoing exposures. Supervisors may reduce or eliminate exposures by adopting administrative controls that involve reassigning employees to other duties and improving work practices. Implementing engineering controls can also reduce the employee's exposure. Less

hazardous agents may be employed, and proper use of PPE may reduce exposures. The industrial hygienist may assist the occupational health provider in implementing these controls. The bottom line is that the employee must follow safe work practices and appropriately use PPE. If not, adverse health effects may likely continue.

SPECIFIC OCCUPATIONS

Department of Transportation Commercial Driver Medical Examination

The following comments were taken from DoT regulations for commercial driver exams.[12] The medical examiner must be familiar with 49 CFR, Part 391, Physical Qualifications for Drivers, and should review these instructions before performing the physical examination. The DoT Federal Motor Carrier Safety Administration now requires the medical examiner to register with the agency and pass an examination demonstrating knowledge of the regulations and medical aspects of driving. (These regulations have changed sufficiently; the reader is encouraged to check the DoT website for the latest version of the regulations and advisories to medical providers who perform these examinations.) There is specific medical guidance on certifying commercial motor vehicle operators who have diabetes, hypertension, cardiovascular disease, congestive heart failure, heart murmurs and arrhythmias, syncope, stroke, seizure, vision and hearing problems including vertigo and Meniere disease, back problems, musculoskeletal problems, and impaired respiratory function including obstructive sleep apnea.

The medical examiner must be familiar with drivers' essential duties and the criteria for establishing work ability as a commercial motor vehicle operator. A commercial truck driver endures physical, mental, and emotional stresses each day and is subject to periodic unannounced drug testing. Commercial motor vehicle operators must operate a vehicle safely so that they do not pose a threat to themselves or others during the operation of the vehicle. The medical examiner must certify that the driver does not have a physical, mental, drug, or alcohol problem that might affect their ability to operate a commercial motor vehicle safely.

If a diagnosis suggests that a medical condition might interfere with the control and safe operation of a commercial motor vehicle, further testing and evaluation is required. The physician may order laboratory work to check the urine for protein, blood, or sugar. Deformities of the hand or fingers, or difficulty with grasp, may prevent the driver from maintaining steering wheel grip, resulting in losing control of the vehicle. If there is foot or leg deformity, the driver may not be able to operate pedals properly. A skill performance evaluation may be required when deformities interfere with vehicle operation. Drivers may apply to the state of their legal residence for a Skill Performance Evaluation Certificate under 49 CFR, Part 391.49.[12]

Commercial motor vehicle operators are usually issued a license by the state transportation department that is valid for 2 years unless any medical restrictions have been specified by the physician. Every commercial motor vehicle operator must undergo a medical certification examination every 2 years, unless specified sooner. The medical examiner may determine that more frequent monitoring of a condition is appropriate and can recommend that a certificate be issued for a shorter period than 2 years. The physician can also specify on the license that the driver must wear hearing aids or corrective lenses to drive safely, and disqualify drivers who do not have binocular vision.

Crane Operator

The crane operator medical examination guidance is found in the Navy and Marine Corps Public Health Center Technical Manual OM 6260, *Medical Surveillance Procedures Manual and Medical Matrix*,[6] and DoD 6055.05M.[7] Generally the employee must be 21 years old; have all extremities; have at least 20/30 vision in one eye and 20/50 in the other; be able to distinguish red, green, and yellow light perception; hear conversational speech at 15 feet; have sufficient strength, endurance, and agility; and have the needed reaction time to operate the equipment. Waivers may be granted to current operators who were previously qualified and have deviations from the current physical requirements.

Explosive Ordinance Handler and Explosives Vehicle Operator

The following guidance for explosive workers comes from Technical Manual OM 62606 and DoD 6055.05M.7 A candidate may be rejected as an explosive ordnance handler or explosives vehicle operator if they have a condition that interferes with safe performance of assigned duties. Employees may be rejected if they have uncorrected distant visual acuity worse than 20/40 in each eye; peripheral vision less than 70 degrees to each side; red, green, amber colorblindness; hearing loss in either ear averaging greater than 40 dB at 500, 1,000,

and 2,000 Hz with or without an aid; cardiovascular disease accompanied by syncope, dyspnea, or congestive heart failure; uncontrolled hypertension; or loss of a leg, foot, hand, or arm. Impairment of a hand or finger that interferes with grasping, or history of epilepsy, syncope, or other conditions that cause altered consciousness may be disqualifying. Employees using drugs or alcohol may not be certified to operate a motor vehicle unless authorized by the treating provider.

For all employees (active duty, reserve, or civilian), regardless of age, the maximum periodicity for the explosives handler certification examination is 5 years; the maximum periodicity for the explosives vehicle operator examination is 2 years.[6] Medical surveillance standards for active duty service members are evolving, so healthcare providers should periodically refer to the guidance for updates.[6,7]

Forklift Operator

The requirements for the forklift operator history and physical examination listed in the Navy and Marine Corps Public Health Center Technical Manual OM 62606 and DoD 6055.05M7 are similar to the explosive handler physical examination requirements. The provider should use clinical judgment in checking fasting glucose, hemoglobin A1C levels, fasting lipids, and EKGs based on the employee's occupational and medical history and physical examination. For all employees (active duty, reserves, or civilian), the maximum periodicity for the forklift operator certification examination is 5 years up to age 59; for age 60 and older the examination is required annually.

Firefighter

Firefighting is arduous work performed under dangerous conditions. Personnel who cannot safely perform firefighting duties should be restricted. The US Office of Personnel Management has established physical examination requirements for firefighters.[13] Firefighters must have corrected distant vision of at least 20/30 in the better eye, and 20/70 in the other eye. Their uncorrected distant vision must be at least 20/100 binocular, and they must have red, green, blue color vision. Firefighters must have hearing no worse than 30 dB at 500, 1,000, and 2,000 Hz.[6,7] Firefighters must be free of pulmonary conditions that interfere with speech, breathing, and use of respiratory protection equipment. They must be free of heart, valvular, and coronary heart disease; angina; recurrent syncope; and history of myocardial infarction.[6,7] They must be free of gastrointestinal conditions including inflammatory bowel disease, hernia, or enlargement of the liver or spleen that limits the performance of duties, as well as musculoskeletal conditions that limit movement of the spine, pelvis, or upper and lower extremities, including problems with the knees. Firefighters must also be free of neurological disease and disqualifying mental health conditions.[6,7]

The National Fire Protection Association (NFPA) has established guidelines for healthcare providers who perform history and physical examinations on firefighters and applicants for the position.[14] The NFPA coordinated with physician subject matter experts to develop lists of category A (disqualifying) conditions and category B (possibly disqualifying) conditions. Firefighters who have a category B condition must be evaluated on a case-by-case basis to determine if the condition prevents the individual from performing essential firefighting duties without causing undue harm to themselves or others. All OEH providers should reference the NFPA's list of category A and B medical conditions. In addition to the history and physical examination, the healthcare provider should order height, weight, blood pressure, heart rate, and heart rhythm measurements. The provider should review the OSHA respirator questionnaire completed by the firefighter every year. Hearing and vision tests, PFTs, laboratory tests, and EKGs should be ordered every 3 years for ages 18 to 29, every 2 years for ages 30 to 39, and every year after age 40.[6,9]

Police and Security Guards

Police and security guards must be able to meet the strenuous physical exertion requirements listed in the job description. Police officers and security guards must be able to engage in foot pursuit and participate in first responder duties in emergencies without risk to themselves or others. They must have near and distant vision, color vision, hearing with good speech discrimination, and emotional and mental stability. The Office of Personnel Management has established physical requirements for police and security guard positions, GS-0083[15] and GS-0085,[16] respectively.

The police and security guard occupational and medical history and physical examination is required annually; the requirements are listed in DoD 6055.05M.[7] The healthcare provider should obtain vital signs, check hearing and vision, and order a urinalysis and lipid profile. An EKG should be obtained at baseline and annually after age 45. A medical condition is considered disqualifying only if the condition limits the police officer or security guard from performing the essential duties of the position.

Army Regulation (AR) 190-56, *The Army Civilian Police and Security Guard Program*,[17] provides practical guidance for healthcare providers on the

medical screening of police and security guards who have cardiac risk factors; this document is also used by the Navy.[6] Under AR 190-56, all police and security guards must be screened for cardiovascular risk. If a policeman or security guard has known cardiac disease or significant cardiac risk factors (eg, a Framingham 5-year risk score > 15%), the individual is referred for level B screening, which assesses cardiac functioning with a stress echocardiogram or stress graded exercise test. Police and security guards with positive level B screening results should be restricted from work until they can be referred to their treating cardiologist for chronic disease risk management.

The American College of Occupational and Environmental Medicine has developed clinical practice guidelines for occupational health providers who perform law enforcement officer history and physical examinations.[18] The guidelines provide information on evaluating and managing officers with disqualifying or potentially disqualifying medical conditions; providers should consult the guidelines if questions arise regarding the medical qualifications of law enforcement officers.

ASBESTOS

Asbestos is a naturally occurring mineral that is both fibrous and noncombustible. It was used for many years in construction and engineering due to its thermal properties and ability to dissipate heat, especially for wrapping steam and hot water pipes to provide insulation. Asbestos was also used in brake linings and clutch facings because of its excellent friction properties. Asbestos has been used in textiles, paints, and coatings for over 100 years. In the 1970s regulations were passed that banned the use of asbestos in construction because health studies showed there was a causal association between exposure and lung cancer and mesothelioma. The fear of liability also limited its use. Nevertheless, heavy asbestos use and unprotected exposures continued in shipyards around the world between 1970 and 1980.

Workers exposed to asbestos during the years 1950 to 1970 were heavily exposed, and they were not afforded respiratory protection because asbestos health risks were poorly understood. Employees who removed or performed renovations on asbestos-containing material aboard ships or in buildings were at the greatest risk of exposure. Vehicle mechanics who performed brake and clutch work were also exposed, at levels high above the OSHA PEL. Employees who did insulation work, including pipe fitters and shipyard workers, were also heavily exposed. Once the health risks became known, occupational exposures in shipyards and construction were drastically reduced, and asbestos workers were mandated to wear PPE.[19]

Health Effects

Workers exposed to asbestos may experience parenchymal or pleural lung disease.[19] These disorders can occur independently, and workers who have similar exposures may develop different diseases. Asbestosis is lung parenchyma fibrosis associated with onset of cough and exertional dyspnea.[19] The cough is nonproductive at first, but may be productive in later stages, with the development of chronic bronchitis.[19] The course of asbestosis is slowly progressive and there is no known treatment. Occupational exposure to asbestos may also cause pleural disease. Workers who develop diffuse pleural thickening are usually asymptomatic, but they may complain of shortness of breath and pleuritic chest pain. Once workers develop pleural thickening, they are more likely to develop asbestosis and lung cancer.[19] As a result, occupational health providers and workers enrolled in the asbestos medical surveillance program must be vigilant for the development of other lung disease. There is no way to modify the course of either asbestosis or pleural fibrosis, but workers should be advised to continue participating in medical surveillance because of the latency period for developing cancer and asbestosis.

Also, workers must be advised to eliminate exposure to cigarette smoke and other pulmonary toxins because of the significantly increased risk of developing lung cancer in asbestos workers who smoke. The risk for lung cancer among workers with asbestos exposure is several times higher than the risk for non-exposed workers. There appears to be a multiplicative risk for lung cancer among smokers with asbestos exposure compared to the risk for nonsmokers with no asbestos exposure.[20–22] Additionally, several studies report a modest (10%–15%) increased risk of gastrointestinal cancers (esophagus, stomach, pancreas, colon, and rectum) in heavily exposed asbestos workers.[23]

Lung cancer caused by asbestos is indistinguishable from lung cancer due to other causes.[19] Mesothelioma is characterized by tumors on the pleura, peritoneum, or mediastinum that grow rapidly, are fatal, and are usually associated with asbestos exposure.[19] Benign pleural effusions can also be caused by asbestos exposure; these effusions are usually small and asymptomatic, may be unilateral or bilateral, and last

from weeks to months before resolving. Patients with pleural effusions must be tested to rule out lung cancer, mesothelioma, and pleural thickening.[19,24]

The latency period from onset of asbestos exposure to development of asbestosis is usually more than 15 years, except when the exposure exceeded the OSHA PEL by several orders of magnitude.[17] Pleural plaques and diffuse pleural thickening generally develop 20 years after exposure began,[19] but pleural thickening does occur sooner if the worker previously had benign pleural effusions. The average latency period for asbestos-related cancers is 25 years, and the latency period for mesothelioma is 30 to 35 years.[19]

Asbestos Medical Surveillance Program

Workers, both military and civilian, who are exposed to asbestos above the action level (half of the OSHA PEL) must be enrolled in the asbestos medical surveillance program (AMSP) specified in 29 CFR, Part 1910.1001.[19] Employees may voluntarily enroll in the "past worker" AMSP if they were previously enrolled in the AMSP, if they worked for the federal government and had asbestos exposure for 30 or more days, or if an occupational medicine physician and industrial hygienist determine that an employee met OSHA exposure criteria in the past.

A baseline exam includes a work history, standard respiratory questionnaire, physical examination focusing on the respiratory system, PFT, and a chest x-ray. The chest x-ray is read twice: the local "A" reading is done by a radiologist who looks for heart, lung, or other abnormalities that require urgent attention; the "B" reading is performed by a contracted, NIOSH-certified radiologist who is trained to read radiographs for signs of pneumoconiosis (Exhibit 10-1). Chest x-rays should be done in advance of the provider visit so the results can be discussed with the patient. An abnormal B reading must be discussed with the patient.[19]

Current asbestos workers and past asbestos workers age 45 and older who had more than 10 years of exposure should undergo an annual asbestos medical surveillance examination. Workers age 35 to 44 who were exposed for more than 10 years should get an exam every 2 years. Workers under age 35 with more than 10 years of asbestos exposure and all workers with less than 10 years of exposure should get the surveillance examination every 5 years. A termination examination is required at least 30 calendar days prior to last day of employment, if not performed within the last year. All asbestos medical surveillance documents must be kept for 30 years plus the duration of employment. The occupational health provider should refer to DoD 6055.05M,[7] Technical Manual OM 6260,[6] and the US Army Public Health Center Technical Guide 40-513, *Occupational and Environmental Health Guidelines for the Evaluation and Control of Asbestos Exposure*,[24] for required documentation of asbestos medical surveillance examinations.

DoD asbestos medical questionnaires (DD Form 2493-125 and DD Form 2493-226) are completed by the worker. The history and physical examination forms are completed by the occupational health provider. The Navy has additional forms used to document history, physical examination, and results of the chest x-ray B reading.[27,28] Chest x-ray B reading results and any changes should be noted in the worker's electronic health record.[29,30] Asbestosis produces a restrictive pattern on PFT, and smoking and asbestosis usually produces a mixed pattern on the PFT. Therefore, PFT results and trends over time must be noted. End-inspiratory rales suggest asbestosis. Physical exam findings may be absent even in the presence of significant x-ray or pulmonary function abnormalities. Providers must include their written medical opinion regarding the results of the asbestos medical surveillance examination and whether exposure resulted in development of asbestos-related health outcomes.

Considerations in making a diagnosis of asbestos-related disease include latency period, duration of exposure, intensity of exposure, and chest x-ray findings.[19] The latency period (described above) serves as a firm guideline for ruling in or out a diagnosis of asbestos-related disease. Duration of exposure can be determined by the employee's occupational history. The occupational health provider should coordinate with an industrial hygienist to obtain an estimate of the intensity of exposure for the worker by position held, industry, decades during which exposure occurred, and the employee's self-reported use of respiratory protective equipment. The higher the intensity of exposure, the more one should consider the possibility of asbestos-related disease when faced with a consistent clinical picture. Chest x-ray findings are the most important consideration. The lack of x-ray changes consistent with asbestos-related disease should raise concerns about the diagnosis, and consultation with a pulmonologist is recommended.

RADIATION

Radiation is classified as ionizing or nonionizing depending on whether it is capable of producing ions, directly or indirectly, in passing through matter. Ionizing radiation includes gamma rays, x-rays, alpha particles, beta particles, neutrons, protons, and other particles and electromagnetic waves capable of

EXHIBIT 10-1

INTERNATIONAL LABOR ORGANIZATION GUIDANCE FOR THE CLASSIFICATION AND INTERPRETATION OF CHEST X-RAYS

The plain chest x-ray is the standard imaging technique for detecting asbestos-related lung disease, although computed tomography is more sensitive. Usually there are no chest x-ray findings until 20 years after the onset of exposure unless the patient has had a benign pleural effusion. Asbestos-related pulmonary fibrosis is linear and most commonly involves the lower lobes of the lungs. It begins peripherally and moves centrally. With advanced disease, it can involve the middle and upper lobes. Irregular opacities, class s and t, in mid and lower lung fields and at low grades of perfusion are the common findings of asbestosis. Diffuse pleural thickening and extensive pulmonary fibrosis are classic features of advanced asbestosis. Discrete pleural plaques can be seen face-on, laterally, or on the diaphragm. They occur most commonly in the middle of the diaphragm and on the posterior and lateral chest wall between ribs 6 and 10. Pleural plaques can be bilateral or unilateral, round or irregular. Non-calcified plaques are more common than calcified ones; however, they tend to calcify with time. Apical pleural thickening up to 10 mm is a common variant of normal; most definitions only consider thickening that occurs below the fourth rib as abnormal. Diffuse pleural thickening or pleural fibrosis is often a sequelae of benign asbestos-related pleural effusions. Findings are classified according to the standards listed below.

Opacities

- Small opacities are 1 cm or less; large opacities are more than 1 cm.
- Small opacities are judged by their shape as either round (p, q, r) or irregular (s, t, u), increasing in size from "p" to "r" and from "s" to "u."
- The predominant type of opacity is called primary; the second most predominant type is secondary.
- Large opacities are judged in increasing size as A, B, C (seen in silicosis and black lung).
- A concentration of opacities (called a profusion) is described as one of 12 ordered subcategories, within four main categories (0, 1, 2, 3), indicating an increase in concentration as the number increases.

Pleural Changes

- Pleural thickening is classified as either discrete (called plaques) or diffuse.
- Calcifications if present and costophrenic angle blunting if present are noted.

Data sources: (1) US Navy. *Periodic Health Evaluation: Navy Asbestos Medical Surveillance Program History and Physical Examination*. NAVMED Form 6260/5; 1990. http://www.med.navy.mil/sites/nmcphc/Documents/oem/amsp_6260_5_front.pdf. Accessed August 1, 2016. (2) Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Chest radiography: ILO classification. http://www.cdc.gov/niosh/topics/chestradiography/ilo.html. Accessed August 1, 2016. (3) International Labour Organization. Guidelines for the use of the ILO international classification of radiographs of pneumoconioses, Revised edition. http://www.ilo.org/safework/info/publications/WCMS_168260/lang--en/index.htm. Published 2011. Accessed August 12, 2017.

producing ions. Occupational exposure in the services occurs in four distinct areas: medical or dental services, naval nuclear propulsion, nuclear weapons, and industrial applications. Chapters 22 and 23 in this textbook further explore ionizing and nonionizing radiation, respectively, along with the benefits and potential risks associated with its use in the DoD.

Regulations

Occupational exposure to ionizing radiation is covered in OSHA regulations 29 CFR, Part 1910.1096,[31] Toxic and Hazardous Substances, Ionizing Radiation. In addition, the Environmental Protection Agency has issued radiation protection guidance that applies to the DoD under Executive Order 12196.[32] DoDI 6055.08, *Occupational Ionizing Radiation Protection Program*,[33] directs the services to establish and maintain occupational ionizing radiation protection programs and ensure that unnecessary exposure is avoided. The DoDI takes efficiency, cost, and mission requirements into account and requires the services to maintain occupational and environmental exposures to ionizing radiation as low as reasonably achievable. The services have published guidelines for their programs.[34-42]

Ionizing Radiation Medical Examination

The ionizing radiation medical examination[42] is performed on radiation workers who are identified by their command as being occupationally exposed to ionizing radiation. Normally, these employees work directly with ionizing radiation and have a significant potential for exposure. They receive special training

before they are allowed to participate in the program. The radiation medical examination is documented on form NAVMED 6470/13.[43] There are preplacement, periodic, postexposure, and termination radiation physical examinations.

Occupational health providers may only perform radiation medical examinations after they have attended a radiation health training course.[42,44–47] The exam includes a focused medical history of cancer and significant exposures to ionizing radiation as well as a focused physical examination designed to locate cancers of the thyroid, breast, testes, prostate, and skin. Laboratory testing should include a white blood cell count, hematocrit, and urine dipstick. A positive history or abnormality on physical or laboratory evaluation should be annotated as disqualifying or not disqualifying. Ionizing radiation medical examinations that are considered disqualifying must be sent to the Navy Bureau of Medicine and Surgery's Radiation Effects Advisory Board for final determination.[48]

OEH clinic staff should develop and maintain a working relationship with the local radiation safety officers, who serve critical roles in the execution of the radiation protection program. The radiation safety officer can assist clinic staff in obtaining employee exposure data and help clarify administrative questions that arise from radiation medical examinations. The Uniformed Services University of the Health Sciences' Medical Effects of Ionizing Radiation Course[49] is available for providers to increase their knowledge of the biomedical consequences of radiation exposure and how to medically manage casualties.

Navy and Marine Corps[42] radiation workers get a preplacement radiation medical examination prior to beginning their duties and periodic surveillance every 5 years until age 50, every 2 years from age 50 to 60, and annually after age 60. Postexposure examinations must be completed on any individual who has exceeded the radiation exposure protections standards.[42] Termination medical examinations must be completed for all radiation workers 6 months prior to separation from active duty or termination from employment. Army ionizing radiation worker examinations are done at baseline but are not performed periodically. A reported overexposure must be evaluated on a case-by-case basis to assess the need for medical examination and further medical follow-up. The circumstances surrounding the exposure and estimated organ and whole-body dose help determine the extent of follow-up needed.[49]

Air Force ionizing radiation workers do not undergo routine examinations unless their dose exceeds the radiation protection dose limits. Medical surveillance of overexposures is conducted and the results are evaluated on a case-by-case basis by the major commands' command surgeon's office in coordination with the Air Force Medical Support Agency's Bioenvironmental Engineering Division.[38] Doses greater than 5 rem during military operations require long-term periodic health monitoring performed by the Air Force School of Aerospace Medicine. Submission of bioassay samples to determine the absorbed dose may be necessary and annual medical examinations may be needed based on the latency period of the cancers involved.

REPRODUCTIVE HAZARDS

Workplace exposures may pose reproductive and mutagenic hazards to pregnant workers and their fetuses. Raising awareness of workplace reproductive hazards through education and medical surveillance tends to minimize or reduce the risk to the pregnant employee, her fetus, and male employees. Both males and females are at risk from workplace reproductive hazards based on studies of the biology of reproduction.[50–52] The services' reproductive hazards programs have focused on nursing, dental, medical, and veterinary personnel. In addition to evaluating pregnant women for potential exposures to chemical, physical, and biological hazards, exposures to nosocomial hazards (such as cytomegalovirus, herpes virus, and rubella) in the medical treatment facility must also be evaluated. Pregnant women should avoid unnecessary or regular contact with patients who either have hepatitis or who could be carriers of the hepatitis virus. Maternal infection with hepatitis B virus in the latter stages of pregnancy may cause significant illness or death in the newborn.

A pregnancy surveillance program must be conducted in accordance with established DoD 6055.05M7 and service guidelines.[50,53,54] One of the first steps in implementing a pregnancy surveillance program is for the occupational health provider, in coordination with military and civilian personnel offices and supervisors, to implement policies and procedures ensuring that personnel who are pregnant or planning to become pregnant get screened in the OEH clinic as soon as possible. The program for military women must be coordinated with the obstetrical/gynecological clinic staff as well.

The industrial hygienist should identify work areas or occupations that contain potential reproductive hazards through the health-hazard inventory and alert the occupational health provider and supervisor

in each work location of hazards present in the worksite. All personnel including women of childbearing age and male employees assigned to the area must be informed of reproductive hazards and their potential health effects. The occupational health provider should obtain a reproductive history including problems of infertility for affected employees, and must also inform workers of their right to work in spaces free of reproductive hazards and job-reassignment in the event of pregnancy to protect the mother or her fetus. Counseling and education on reproductive hazards must be documented in the employee's medical record.

When a pregnant employee contacts OEH clinic staff to inform them of her pregnancy, a physician or licensed healthcare provider must interview the employee and have her supervisor fill out the service-specific forms.[55,56] The occupational health provider, in conjunction with the industrial hygienist, must then determine whether the employee may continue working safely in her current job. The providers should inquire about the employee's job duties, expected delivery date, prior pregnancies, home exposures, and work hours. If there is any question about workplace exposures, the industrial hygienist should do a worksite evaluation to assess the potential for exposures to reproductive or developmental hazards. The occupational health provider should ask the employee to contact the OEH clinic immediately if any changes occur in the work environment.

Coordination between OEH clinic staff and the pregnant employee's attending physician is essential. The occupational and environmental medicine physician is familiar with the demands and exposures of the job, and the attending physician, while unfamiliar with the work hazards, knows the employee's medical status and prior reproductive history. When questions arise about the need for job-reassignment, collaboration leads to better decision making about transfers or other job accommodations.

The need for collaboration between the employee's treating physician and the occupational healthcare provider continues after the pregnancy. The treating physician must clear the employee's return to work after maternity leave, and the occupational health provider must be aware of and ensure workplace hazards do not pose a risk to the mother who may be breast-feeding the newborn infant. The occupational health nurse should evaluate the pregnancy outcome and document the results in the individual's employee health record.

EMPLOYEES WITH CHRONIC DISEASES OR PHYSICAL DISABILITIES

Surveillance of personnel with chronic diseases or physical disabilities ensures that the employees' optimal health status is maintained and that no adverse effects result from interactions of the job with the chronic illness or disability. If this surveillance is effective, these employees are more likely to remain active and productive members of the workforce.

OEH clinic staff should identify employees who have chronic diseases or disabilities that may affect or be affected by their work assignments. For each employee, OEH staff should review any documents that may contain information regarding functional level, including (but not limited to) SF 177, Statement of Physical Ability for Light Duty Work[57]; SF 93 (or DD 2807-1), Report of Medical History[58,59]; and SF 88 (or DD 2808), Report of Physical Examination.[60,61] Providers also can identify affected employees by reviewing the master problem list, which may be documented on a DD 2766, Adult Prevention and Chronic Care Flowsheet,[62] performing preplacement, periodic, and return-to-work examinations. Once employees with chronic condition have been identified, they should be medically evaluated to determine if they can perform the essential duties of their job. If the employee is unable to perform all of their job duties, the occupational health provider should notify both the employee and the supervisor in writing, placing a copy of the notification letter in the individual's employee health record. This may be accomplished by use of DD Form 68963 or another locally acceptable form.

The frequency of follow-up evaluations varies depending on the employee's condition. A follow-up evaluation may consist of either a telephone call by the occupational health provider to the employee to inquire about their health status, or a follow-up visit to the OEH clinic for further medical evaluation, which is documented in the employee health record. Documentation should include clinical data regarding the disease or physical disability, its current treatment, and the name of the employee's personal physician. The condition should also be added to the master problem list.

HEARING CONSERVATION

Service members and civilian employees working in hazardous noise environments face the single most injurious hazard in terms of cost and frequency of occurrence for active duty and civilian workers. Occupational health providers should become familiar with the DoD Hearing Conservation Program,[64] the

Army Medical Department Hearing Program,[65] and the Navy Medical Department Hearing Program.[66] Chapter 12, Army Hearing Program, addresses hearing conservation in greater detail. Successful hearing programs have many unique features. First, it is critically important to convey to service members and civilian employees the importance of wearing hearing protection to prevent noise-induced hearing loss and maintain warfighting capability. Next, hearing tests must be done regularly, and personnel must be referred to audiologists and ear, nose, and throat specialists when appropriate. Lastly, people with significant hearing loss must be removed from ongoing noise exposure.

All persons who are routinely exposed to noise levels greater than 84 dB (8-h TWA) or 140-dB peak sound levels of impulse noise (from activities such as firing a weapon or striking a nail with a hammer) should be identified and enrolled in the hearing conservation program.[64–66] This is the definition of the noise action level. Persons who are exposed to noise below the action level should not be enrolled in the hearing program.

Noise-induced hearing loss is a type of sensorineural hearing loss; it occurs in both ears and is usually greatest at 4,000 Hz. Conductive hearing loss occurs across most, if not all, frequencies. Normal hearing thresholds go up to 25 dB. Mild hearing loss is 30 to 40 dB; moderate hearing loss is 45 to 65 dB, and severe hearing loss is 70 to 90 dB. Profound hearing loss is 95 dB or higher.[64–66] Any individual who has average hearing loss of 90 dB in both ears at 3,000, 4,000, and 6,000 Hz that add up to 270 dB or more should not be assigned or hired to work in a hazardous noise environment (this is the "270 rule").[64–66] Environments in which the noise exposure level is 104 dB TWA or greater require double hearing protection. These areas should be appropriately labeled, and individuals working in them should be informed they require double hearing protection. Occupational health providers should work with audiologists to assess which worksites are likely to have cases of noise-induced hearing loss so that prevention interventions such as ear plug fitting and patient education regarding hazardous noise can be targeted to these high-risk groups.

SUMMARY

This chapter has discussed the common medical surveillance programs conducted by occupational and environmental medicine providers across the DoD, which promote the health and wellbeing of service members and civilian employees from a population perspective. The concepts of primary, secondary, and tertiary prevention were reviewed. The chapter included both the need for and design of surveillance programs. Designing an effective surveillance program has to be tailored to the workers, their exposures, and the biological effects of exposures. Medical surveillance also establishes the work ability of service members and civilian employees to assure that personnel can perform their job safely. Those employees who work with potentially hazardous chemical, physical, or biological agents require medical surveillance only when workplace exposures exceed safe levels specified by OSHA, the ACGIH, and the DoD. The surveillance is designed to detect service member and civilian exposures that produce exposure-related health effects and to monitor the effectiveness of workplace controls.

Job-related medical surveillance in occupational and environmental medicine consists of systematically and periodically collecting and analyzing health data on groups of service members and civilian employees for the purpose of early detection of personnel who are at increased risk of developing disease or identifying those who have developed workplace-related diseases and injuries. The screening examination content and use of medical surveillance results were discussed. The differences between certification and surveillance examinations were examined and the approach to dealing with adverse health outcomes was discussed. The differences between screening and surveillance were reviewed: screening is performed when excessive exposure to lead, for example, occurs and elevated blood lead levels result; screening conducted over time is medical surveillance. Surveillance done when high airborne lead levels are encountered includes comparison of annual blood lead levels to monitor for trends. Lastly, several specific medical surveillance examination types were covered, including DoT commercial drivers, firefighter, police, forklift, ionizing radiation, reproductive hazards, hearing, and asbestos.

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