Chapter 9

DISCUSSION SUMMARY: RECOMMENDATION FOR SURVEILLANCE SPIROMETRY IN MILITARY PERSONNEL

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INTRODUCTION

In the March 2012 issue of the *Journal of Occupational and Environmental Medicine* an article was published titled "Overview and Recommendations for Medical Screening and Diagnostic Evaluation for Post-Deployment Lung Disease in Returning US Warfighters."[1] This paper contained the proceedings of a one-day meeting held at National Jewish Health (Denver, CO) in February 2010 by a group of Department of Defense (DoD), Department of Veterans Administration (VA), and civilian physicians and environmental scientists.[1] At issue was the question of whether US military personnel deployed to Iraq and Afghanistan were at risk for respiratory symptoms and chronic lung disease resulting from exposure to airborne contaminants from open-air burn pits, geological dusts, industrial fires and emissions, and vehicular exhaust. The discussion at the meeting was based on environmental studies conducted in the theaters of operation and limited clinical data on lung disease compiled by civilian researchers. One general recommendation listed in the *Journal of Occupational and Environmental Medicine* article pertained to the role of pre- and postdeployment medical surveillance. According to Table 9-1 in that paper, the recommendation includes the following:

- a standardized questionnaire eliciting smoking history, pertinent medical history, and respiratory symptoms;
- spirometry (pre- and postbronchodilator); and
- an exercise-capacity evaluation (Physical Readiness Test), including 1- or 2-mile run times.

A work group at the National Jewish Health meeting addressed the need for medical surveillance using spirometry as part of a deployment evaluation and for the military population as a whole.

INDICATIONS FOR MEDICAL SURVEILLANCE FOR OCCUPATIONAL LUNG DISEASE

According to an American College of Occupational and Environmental Medicine position statement published in 2000, there are three main indications for the use of spirometry in the workplace.[2] The *first indication* is the primary prevention of respiratory disease in preemployment or fitness-for-duty examinations. Included are those individuals with a demanding physical job, such as firefighters, who require a high level of cardiopulmonary fitness and have a potential occupational respiratory exposure. An additional role of primary prevention is population screening for the potential effects of occupational respiratory exposures. In both these situations, identification of an abnormal spirometry may indicate the need to obviate their potential exposure or change occupations as a secondary prevention.

The *second indication* is that repeated spirometry is used in medical surveillance programs when workers are at risk of developing occupation-related respiratory disorders. Surveillance spirometry can detect the slowly developing or delayed losses of function that are characteristic of work-related respiratory disorders. Many healthy individuals may be tested to detect early excessive declines in the pulmonary function of a subgroup of sensitive workers, even though the spirometry test results of these workers may still remain in the normal range. Current regulations from the Occupational Safety and Health Administration recommend periodic spirometry for the following exposures:

- asbestos,
- cadmium,
- coke oven emissions,
- cotton dust,
- benzene,
- formaldehyde, and
- silica.[3]

An additional 25 respiratory exposures are recommended for screening spirometry by the National Institute for Occupational Safety and Health.[4] Screening needs to be done on a longitudinal basis to identify a 15% decline in forced expiratory volume at 1 second (FEV_1) based on initial recommendations by the American Thoracic Society and the American College of Occupational and Environmental Medicine.[5] A limit of approximately 10% decline in FEV_1 appears appropriate for quality workplace monitoring programs, whereas a limit of about 15% appears appropriate for clinical evaluation of individuals with an obstructive airway disease.[6]

The *third indication* is that spirometry is used in the clinical evaluation of symptomatic individuals because many pulmonary diseases manifest themselves as restrictive, obstructive, or combined ventilatory defects. Spirometry allows some quantification of the severity of lung function loss and is one of the pulmonary function tests used in assessing respiratory impairment to determine disability. This is the most common use of spirometry in physician clinics as part of an overall symptomatic evaluation.

SURVEILLANCE SPIROMETRY IN THE GENERAL POPULATION

The two most common chronic respiratory diseases in the United States are (1) asthma and (2) chronic obstructive pulmonary disease (COPD). Asthma is reported to affect as much as 10% of the population, whereas COPD has been diagnosed in approximately 12 million persons and is currently the fourth leading cause of death. These two affected populations with asthma and COPD are substantially much larger than the population with occupation-related exposures. Occupation-related asthma accounts for 10% to 15% of all asthma cases and overall may affect only 1% to 2% of the general population.[7] Contrasted with many other diseases where there is recommended surveillance, such as

- cancer (breast, colon, prostate, and cervical),
- diabetes mellitus,
- hypertension,
- hyperlipidemia,
- aortic aneurysms, and
- osteoporosis,

no current recommendations exist for routine screening of asymptomatic populations for either COPD or asthma. Two major scientific organizations do not recommend using routine screening for COPD in smokers: the American College of Physicians and the US Preventive Services Task Force. The American College of Physicians recommended in 2007 that "spirometry should not be used to screen for airflow obstruction in asymptomatic individuals," including those with known COPD risk factors.[8] The US Preventive Services Task Force also recommended against routine screening for COPD in smokers in the absence of clinical symptoms.[9]

The burden to the healthcare system of overdiagnosis in older patients, the accuracy of spirometry, and the lack of clinical benefit from earlier diagnosis were cited as reasons. Because spirometry is used as a confirmatory test, as well as a screening test for COPD, no gold standard exists for comparing precise estimates of sensitivity and specificity. Two cross-sectional studies that performed spirometry tests in adults with no history of tobacco use or respiratory disease suggest that spirometry yields some false-positive results and that the number of false-positive results increases in patients older than 70 years of age.[10,11] Further studies on asthma screening in children also found it to be not cost-effective compared with use of a questionnaire.[12]

INCIDENCE OF DEPLOYMENT-RELATED LUNG DISEASE

An excellent example of the use of surveillance spirometry is the World Trade Center (WTC) Worker and Volunteer Medical Screening Program. Of approximately 40,000 rescue and recovery workers exposed to the ambient particulate matter from the site, nearly 10,000 responders participated in the program. Notably, 59% of the workers in this cohort reported persistent respiratory symptoms. Evaluations using spirometry found a decrease in forced vital capacity in 21% of the workers and evidence of obstruction in 5% of the workers compared with preexposure values.[13] Among nonsmokers, 27% in the WTC population had abnormal spirometry compared with the reported 13% in the general US population (data taken from the Third National Health and Nutrition Examination Survey [NHANES III] data).[14] Additionally, the prevalence of low forced vital capacity among nonsmokers was five-fold greater than in the US population (20% vs 4%). Respiratory symptoms and spirometry abnormalities were significantly associated with early arrival at the site. A variety of reports identified pulmonary diseases as

- increased bronchial hyperreactivity,
- asthma,
- reactive airway dysfunction syndrome,
- chronic sinusitis,
- vocal cord dysfunction,
- eosinophilic pneumonia,
- granulomatous pneumonia, and
- bronchiolitis obliterans.[13]

A separate study involved 12,781 workers with the Fire Department, City of New York, who participated in a longitudinal study of spirometric measurements over 7 years. The average decline in FEV_1 was 439 mL during the first year with persistent declines and no recovery in the 6-year follow-up.[15]

How does exposure in the WTC workers, some with acute inhalational exposures and others with chronic exposure, relate to the issue at hand involving deployed military personnel? There is limited exposure data available in the military setting, but the symptomatic population is relatively small in comparison with the WTC cohort. In general, there are reported increases in respiratory symptoms, such as cough and dyspnea, during deployment. Reporting on the health effects of the Kuwaiti oil fires of 1991 among US troops, survey research by Army investigators found an increase in reported symptoms of upper respiratory tract irritation, shortness of breath, and cough associated with proximity

to the Kuwaiti oil fires. The effects, however, were generally short-lived and resolved after leaving Kuwait.[16]

Researchers from the Naval Medical Research Center (Silver Spring, MD) conducted a one-time survey of 15,000 redeploying military personnel from Iraq and Afghanistan, and estimated that 69.1% reported experiencing acute respiratory illnesses, of which 17% required medical care.[17] Long-term postdeployment survey data on respiratory symptoms from the Millennium Cohort Study conducted by the Naval Health Research Center (San Diego, CA) found that deployed personnel had a higher rate of newly reported respiratory symptoms than nondeployed personnel (14% vs 10%), with similar rates of chronic bronchitis/emphysema (1% vs 1%) and asthma (1% vs 1%) observed. The authors suggested that specific, but unidentified, exposures rather than deployment may be a determinant of postdeployment respiratory illness.[18]

In terms of common respiratory diseases, such as COPD and asthma, these rates also tend to be lower than the general population. Roop et al[19] surveyed deploying Army personnel and found that 5% of troops deployed to southwest Asia reported a previous diagnosis of asthma. In this study, there were no differences between asthmatics and nonasthmatics because both groups reported significantly increased respiratory symptoms during deployment compared with symptoms preceding deployment. A retrospective chart review of more than 6,000 VA medical records (based solely on the *International Classification of Diseases*, Ninth Revision [ICD-9] diagnostic codes) found higher rates of new-onset asthma in deployed US military personnel between 2004 and 2007 compared with nondeployed military personnel stationed in the US (6.6% vs 4.3%).[20] The lack of predeployment data and spirometry values in this cohort makes the determination of new-onset asthma suspect. Recent studies conducted at Brooke Army Medical Center (Fort Sam Houston, TX) evaluated the medical records of military personnel with diagnosed asthma undergoing a medical evaluation board, diagnosis of COPD or emphysema, and new-onset asthma. In each group, approximately 70% of the cohort had no history of deployment, and nearly 20% had an inadequate evaluation without documented spirometry to confirm evidence of obstructive airway disease.[21,22]

WORK GROUP DISCUSSION ON SURVEILLANCE SPIROMETRY

Numerous questions were presented to the work group to discuss general recommendations on the use of spirometry for military personnel. The following issues were discussed throughout the course of the workshop:

- Should surveillance spirometry be initiated in the DoD?
- Should a screening questionnaire be administered first?
- Would all military personnel or only specific individuals be tested?
- Should individuals be tested (at what point in a military career)?
- Should testing be completed once or repeated periodically?
- What are implementation issues across the DoD?
- What are the cost/benefit considerations?
- How will the evaluation of abnormal studies be handled?
- What information technology is required to store and retrieve results?
- What impact could an abnormal spirometry have on a military career?

CURRENT LIMITATIONS FOR IMPLEMENTATION

One major factor for consideration is the cost related to performance of surveillance spirometry across the DoD. The US Army Public Health Command provided an in-depth analysis for consideration of a single spirometry examination. Making an assumption that the cost of a single examination would be $15 per service member (if done in military facilities) and there are currently 2.2 million service members within the DoD, the start-up costs alone would be nearly $35 million. Additional costs would be incurred for repeat testing, further evaluation of abnormal testing, and other issues related to the conduct of quality spirometry. Given that the DoD system would not be able to undertake this added testing, costs would also increase if spirometry examinations were performed in the civilian healthcare system.

The primary issues in periodic spirometry evaluation are to establish good baseline measurement, maintain spirometry quality and low within-person variability, and identify individuals with excessive decline in lung function.[23] Longitudinal evaluation of spirometry data can be best tracked through the analysis software that can interpret periodic spirometry data, screen for individuals with abnormal spirometry results, and maintain spirometry precision and quality. An example of software that can be used is the Spirometry Longitudinal Data Analysis (SPIROLA) software that is freely available on the Internet. An essential component for obtaining spirometry in a large group, such

as a military population, would be a central database to collect, store, and track information aside from the current electronic medical record. Although many tracking systems exist for other military health issues, it would be burdensome to establish such a system for spirometry. Current electronic medical records in both DoD and VA do not allow the direct uploading of spirometry or other pulmonary test results into a predesignated section. Results are generally scanned in with PDF (Portable Document Format) files and located in different places in the medical record, severely limiting searching for results.

Because the main concern for respiratory disease is linked to deployment, should surveillance be limited to pre- and postdeployment spirometry? Additionally, there may be added value in use of a screening questionnaire for respiratory symptoms or preexisting respiratory disease (asthma,

EXHIBIT 9-1

SURVEILLANCE SPIROMETRY ALGORITHM

Indications for Testing Military Personnel

- Postdeployment (in the presence of respiratory symptoms only)
- Physical fitness test run failure (screening for subclinical lung disease)
- History of childhood asthma (rule out asthma recurrence)
- Military specialties with increased occupational exposures (annual testing)
- Evaluation of persistent respiratory symptoms as part of clinical evaluation

Requirements for Testing

- Trained technician—NIOSH spirometry course or higher
- Certified spirometer—meets American Thoracic Society standards
- Use of nose clips and patient in seated position
- Three reproducible efforts within 5% based on expiratory effort
- Minimum expiratory time of 6 seconds
- Reference values—NHANES III

Testing Documentation

- Demographics; age, gender, ethnicity, measured height, weight
- Smoking history
- Pulmonary history
- Active seasonal allergic rhinitis within 4 weeks
- Active upper respiratory infection within 4 weeks
- Current allergy and pulmonary medications (should perform spirometry off medications for 1 week if feasible)

Testing Outcomes

- Normal—no further evaluation
- Restrictive indices
  - Repeat study in 2–4 weeks
  - If study unchanged and FVC <70%, refer for full pulmonary function testing
  - Obtain chest radiograph to evaluate for interstitial lung disease
  - Refer for evaluation if full pulmonary function testing confirms restrictive defect (TLC <70%) or chest radiograph is abnormal
- Obstructive indices
  - Repeat study in 2–4 weeks
  - If study unchanged and FEV_1 <70%, refer for spirometry with postbronchodilator testing
  - If FEV_1 postbronchodilator response >8%, refer for further evaluation
- Abnormal flow volume loop
  - Interpretation of the FVL is required for an adequate spirometry
  - Truncation or flattening of the inspiratory flow volume curve (below the 0 axis) should prompt referral for formal spirometry
  - Repeatability of two-thirds abnormal FVLs confirms possible upper airway obstruction
- Technically inadequate study—repeat study in 2–4 weeks

FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; FVL: flow volume loop; NIOSH: National Institute for Occupational Safety and Health; NHANES III: Third National Health and Nutrition Examination Survey; TLC: total lung capacity

COPD) prior to deployment. Those with a positive response to exposure questions could then have baseline spirometry testing prior to deployment and repeat testing upon return. Although this approach may better identify those patients with demonstrable reduction in pulmonary function postdeployment due to underlying lung disease, many deployed personnel may not complete the questions honestly because of the perception that it may prevent deployment or compensation for deployment-related lung disease. Even pre- and postdeployment spirometry would have significant logistic implications given the numbers (>2.5 million) deployed and the numerous locations to which personnel are deployed.

Another significant question raised was the true incidence of new pulmonary disease in deployed or nondeployed service members. If the percentage is small, as currently suggested by epidemiological data, will there be any advantage in having baseline measurements for the vast majority of military personnel who will not develop symptoms or disease? Should we continue to evaluate current available data to better estimate more precise incidence of deployment pulmonary disease development? There are problems with analyzing current data, including use of ICD-9 codes to establish a true incidence of new and existing pulmonary disease.

SUMMARY

Is there a role for surveillance spirometry in the military population? Current evidence suggests that the military population reflects the general population as a whole, with respect to rates of pulmonary disease. Potentially, there is increased workplace exposure for certain military occupational specialties, and current deployment locations have documented increases in environmental ambient particulate matter from sand/dust, as well as burn pit smoke. However, no evidence suggests any significant increase in respiratory disease over the general population. The following recommendations are outlined in Exhibit 9-1:

- DoD policy at present should not require routine surveillance spirometry in all military personnel. The burden of evaluating asymptomatic personnel with pulmonary function testing abnormalities would outweigh any benefit from early disease detection. No such recommendations exist for asthma and COPD screening for the general population, and the incidence of other chronic lung diseases is extremely small.[24]
- Predeployment surveillance (baseline) spirometry should be evaluated in a feasibility pilot study. A research study is currently being conducted at Fort Hood, Texas, to obtain pre- and postdeployment spirometry (with chest radiographs) in deploying military personnel to Afghanistan. It is anticipated that the change in postdeployment spirometry will likely be minimal (<5% of FEV_1) and more prominent in smokers. Additionally, a feasibility study is being conducted in new soldiers at Fort Sam Houston to evaluate the number of abnormal baseline studies in an asymptomatic population.
- The use of bronchodilators (short-acting beta-agonists, such as albuterol or levalbuterol) is not warranted as part of routine surveillance spirometry. The use of bronchodilators outside of a clinical setting logistically complicates and prolongs the conduct of a spirometry examination. Information from recording postbronchodilator values is minimal unless the screening examination is strictly for asthma symptoms or detecting occupational asthma.
- Surveillance spirometry should be considered in those military occupational specialties with the potential for increased exposure to respiratory hazards, such as firefighters.[25] Additionally, some consideration should be given to spirometry for those persons who fail the aerobic event of a physical fitness test to rule out subclinical lung disease as part of an overall evaluation. However, use of physical fitness testing as the sole criterion fails to understand the complexities of dyspnea and cardiovascular fitness.

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