AIRBORNE HAZARDS RELATED TO DEPLOYMENT

Section III: Follow-up Medical Care of Service Members and Veterans

A patient receiving maximal oxygen uptake (VO_{2max}) testing.

Photograph: Courtesy of the US Army Public Health Command (Aberdeen Proving Ground, Maryland).

Chapter 11

DISCUSSION SUMMARY: BASIC DIAGNOSIS AND WORKUP OF SYMPTOMATIC INDIVIDUALS

MICHAEL J. MORRIS, MD*; CORINA NEGRESCU, MD, MPH†; DAVID G. BELL, MD‡; AND CAROLE N. TINKLEPAUGH, MD, MBA§

*Colonel (Retired), Medical Corps, US Army; Department of Defense Chair, Staff Physician, Pulmonary/Critical Care Medicine and Assistant Program Director, Internal Medicine Residency, San Antonio Military Medical Center, 3551 Roger Brooke Drive, Fort Sam Houston, Texas 78234

†Veterans Administration Chair and Medical Director, Veterans Benefits Administration, Contract Exams, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

‡Lieutenant Colonel, Medical Corps, US Army; Program Director, Pulmonary/Critical Care, San Antonio Military Medical Center, 3551 Roger Brooke Drive, Fort Sam Houston, Texas 78234

§Occupational Medicine Physician, Environmental Medicine Program, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

INTRODUCTION

Crucial to the understanding of the potential associations between airborne hazards and deployment is an appreciation of the extent and types of respiratory symptoms and diseases related to deployment of military personnel to southwest Asia (SWA) since 2003. Although it has been reported that deployment may be associated with new-onset respiratory disease, accurate analysis of trends and rates of postdeployment respiratory diseases are dependent on identification and characterization of respiratory disease in military personnel. A primary task for the group was to review and modify a proposed diagnostic algorithm in conjunction with the referral and diagnostic recommendations at both the primary care and specialty care levels. The following six discussion questions were developed and proposed to the convened working group on the basic evaluation of postdeployment military personnel with dyspnea or undiagnosed respiratory complaints:

1. What are the essential elements of a complementary standardized questionnaire for symptomatic individuals?
2. Which elements of the diagnostic workup should be done at the primary care level?
3. Is there a need to collect/archive information apart from individual medical records? Will there be any value for the epidemiological research community when collecting and interpreting data from the electronic medical record?
4. What are the possible programmatic, policy, logistical, and feasibility issues that might arise from a standardized evaluation?
5. What other needs (outreach, education, and risk communication) for symptomatic individuals might be important for implementation?
6. Is there additional benefit from use of standardized *International Classification of Diseases* (ICD)-9 or ICD-10 codes along with a diagnostic algorithm?

PRIMARY CARE EVALUATION

Service members may complain of respiratory symptoms that include cough, shortness of breath, wheezing, and chest tightness. There are numerous reported causes of exertional dyspnea in the active duty military patient to include anemia, metabolic disorders, anxiety, cardiovascular disorders, deconditioning, and multiple pulmonary disorders (eg, airway, parenchymal, pleural, vascular, and thoracic cage diseases).[1] Whereas obstructive lung disease—such as asthma and exercise-induced bronchospasm (EIB)—is most common, consideration needs to be given for other etiologies.[2] Basic indications for evaluation of active duty are listed in Exhibit 11-1. Initial evaluation at the primary care level should document the following six items:

1. Type and length of respiratory symptoms to include dyspnea, cough, sputum production, wheezing, chest tightness, and level of decreased exercise tolerance. Specific questions should address any decrement in regular exercise or changes in fitness testing run times. Symptoms should generally be at least 3 months in length to be considered chronic in nature.
2. Relationship of onset symptoms to deployment (before, during, and after) and history of preexisting lung disease.
3. Basic exposure history to include deployment exposure, such as burn pits, dust storms, vehicle exhaust, air pollution, or other atypical exposures. Cigarette smoking should likewise be documented in terms of pack-years (which is packs per day times the number of years smoking), as well as any change in smoking habits with deployment.

EXHIBIT 11-1

INDICATIONS FOR POSTDEPLOYMENT DYSPNEA EVALUATION

- Cough, shortness of breath, wheezing, or chest tightness for >3 months duration
- New-onset or worsened pulmonary symptoms during or postdeployment
- Excessive decline compared with earlier service-specific aerobic endurance event or failure to pass the running event
- Any abnormal spirometry pattern (below the lower limit of normal)
- >15% decline in FEV_1 or FVC between pre- and postdeployment testing or >10% if new-onset respiratory symptoms are also reported, even if spirometry is within the normal range

FEV_1: forced expiratory volume in 1 sec; FVC: forced vital capacity

4. Physical examination findings should include basic vital signs, including calculation of body mass index; pulse oximetry (if available); examination of the upper airway; cardiac examination; and auscultation of lung sounds for expiratory wheezing, crackles, or inspiratory stridor.
5. Posteroanterior and lateral chest X-ray (CXR) radiograph should be obtained in all patients with new symptoms to rule out pulmonary infiltrates, masses, or pleural effusions. It is expected that most patients have a normal CXR.
6. Baseline spirometry should be obtained at initial evaluation in all patients with new symptoms. If not available locally, the individual should be referred to obtain this test. Interpretation should be provided according to the current Third National Health and Nutrition Examination Survey (NHANES III) reference values.[3] Peak flow monitoring is not an acceptable substitute measurement in place of spirometry.

SPECIALTY EVALUATION

Indications for referral for specialty evaluation (cardiology, pulmonary, or allergy) are listed in Exhibit 11-2. The threshold for referral in those postdeployment patients with persistent symptoms, but normal CXR and spirometry, should be fairly low. A chronic dyspnea evaluation should be performed according to the specialty clinic and not strictly according to a specific algorithm. Recommended studies that may be performed are listed in Exhibit 11-3. The differential for chronic dyspnea changes considerably as patients age.[4] The provided commentary from the workshop is intended to describe the possible components of the evaluation and diagnosis of individuals who present with unexplained chronic dyspnea. It is a guideline and should not be substituted for the clinical judgment of a pulmonologist or any other medical practitioner based on the results of particular studies done during an evaluation. Potential causes of respiratory symptoms in military personnel are shown in Exhibit 11-4.

EXHIBIT 11-2

INDICATIONS FOR REFERRAL FOR SPECIALTY EVALUATION

- Abnormal chest radiograph (interstitial changes, lung mass, hilar adenopathy, lung infiltrate, and pleural effusion)
- Restrictive indices on spirometry (both FEV_1 and FVC < 70%)
- Resting pulse oximetry below 95% or a decrease of 4% with ambulation during a 6-min walk test
- Need for bronchoprovocation testing to confirm asthma or exercise-induced bronchospasm
- Symptoms >3 months with no response to treatment
- Prior treatment with oral steroids, hospitalization, or endotracheal intubation
- Unexplained dyspnea, cough, and/or sputum production
- Symptomatic individuals with normal basic evaluation (spirometry and chest radiograph)

FEV_1: forced expiratory volume in 1 sec; FVC: forced vital capacity

Medical and Exposure Histories

At the specialty level, more detailed pulmonary and exposure histories should be obtained along with the complete medical history. It is expected that the relationship of respiratory symptoms to deployment and prior history of pulmonary disease be extensively documented. There are questionnaires developed by the US Army Public Health Command, such as the Exposure and Respiratory Questionnaire, that may be used as part of the evaluation. An important consideration in this specialty evaluation should be a description of the dyspnea as outlined by the 2012 American Thoracic Society. Dyspnea can be linked to specific physiological processes based on sensations of work or effort (exercising muscle), tightness (bronchoconstriction), or air hunger/unsatisfied inspiration (imbalance in efferent activation and feedback from afferent receptors).[5]

Physical examination should focus on the upper airway, and pulmonary and cardiac examinations to document evidence of seasonal allergic rhinitis, gastroesophageal reflux disease, chest wall abnormalities, and auscultation of the heart and lungs. Pulse oximetry should be tested, and readings below 95% at rest or a decrease of 4% with ambulation should prompt further evaluation. In unexplained dyspnea, it may also be helpful to obtain both a complete blood count (particularly in females) to rule out anemia and thyroid stimulating hormone to eliminate subclinical thyroid disorders. Additional laboratory studies, such as immunoglobulins or radioallergosorbent testing, will not establish a specific diagnosis but may suggest underlying allergic disorders in atopic patients.

EXHIBIT 11-3

SPECIALTY EVALUATION STUDIES

- Pulse oximetry (rest and ambulation)
- Laboratory studies (complete blood count, thyroid stimulating hormone level, immunoglobulin E level)
- Spirometry with postbronchodilator testing
- Full pulmonary function testing with lung volumes and diffusing capacity
- Impulse oscillometry
- Maximal voluntary ventilation, inspiratory/expiratory pressures
- High-resolution computed tomography of the chest
- Bronchoprovocation testing (exercise spirometry, methacholine challenge testing, mannitol testing, or eucapneic voluntary hyperventilation)
- Exercise laryngoscopy
- Cardiopulmonary exercise testing with gas analysis
- Fiberoptic bronchoscopy
- Cardiac evaluation (electrocardiogram, echocardiogram)

Chest Imaging

Chest imaging needs to be obtained in all patients presenting for a postdeployment dyspnea evaluation. In most cases, the CXR will be normal, but may be insensitive for detecting some types of parenchymal lung disease. In the evaluation of major outbreaks of environmental or occupational pulmonary disease related to metal-working, swimming pools, or indoor environments, CXRs are typically insensitive.[6] It was shown to be uniformly normal in the results of a recent postdeployment study.[7] The exact role for high-resolution computed tomography (HRCT) of the chest has yet to be determined in the deployed population and may be considered for chronic symptoms or evidence of spirometric changes with a normal CXR.

Patterns of abnormality on HRCT in diffuse lung diseases consist of linear and reticular opacities; nodules and nodular opacities; or increased lung opacification, including consolidation of the airspaces and ground glass opacity. The use of HRCT may identify mosaic attenuation during the expiratory phase that may not be identified with a standard noncontrast chest computed tomography (CT) protocol. The diseases and patterns that can lead to a specific diagnosis by means of the HRCT include bronchiectasis, emphysema, usual interstitial pneumonitis, hypersensitivity pneumonitis, pneumoconiosis, sarcoidosis, and potentially constrictive bronchiolitis (CB). In these cases, the diagnosis may be sufficiently specific to obviate tissue confirmation.[8] Because there have been case series reporting findings suggestive of CB and hypersensitivity pneumonitis in patients with otherwise normal imaging, it is reasonable to perform HRCT in symptomatic patients given the low radiation risk with a single scan. A normal HRCT without interstitial changes, airway findings, or air trapping makes the diagnosis of an occult interstitial lung disease much less likely.

Pulmonary Function Testing

As part of any initial dyspnea evaluation, spirometry (off any long-acting inhaled medications) should be repeated by the specialty clinic to confirm findings done in primary care clinics. Given the frequency of airway hyperresponsiveness (AHR) in the military population, both pre- and postbronchodilator (PBD) spirometry should be done on a routine basis, especially when the forced expiratory volume in 1 second (FEV_1)/forced vital capacity (FVC) ratio is reduced. A PBD increase in FEV_1 may indicate AHR even when:

- the FEV_1/FVC ratio is normal or slightly reduced,
- there is reduction in the midexpiratory flow, or
- FEV_1 and FVC are elevated above 90% predicted and obstruction is present based on the FEV_1/FVC ratio.[9]

Identifying obstructive indices on spirometry does not establish the diagnosis of asthma unless there is a compatible clinical history with evidence of AHR on PBD testing or reac-

EXHIBIT 11-4

COMMON CAUSES OF DYSPNEA IN MILITARY PERSONNEL

- Obstructive lung disease (asthma, exercise-induced bronchospasm, chronic obstructive pulmonary disease, or bronchiectasis)
- Chest wall deformities (eg, pectus excavatum, scoliosis, trauma)
- Interstitial lung diseases (sarcoidosis, idiopathic pulmonary fibrosis)
- Hyperventilation/anxiety disorders
- Vocal cord dysfunction and other upper airway disorders
- Diaphragmatic weakness
- Gastroesophageal reflux disease or seasonal allergic rhinitis
- Deconditioning
- Metabolic disorders (anemia, thyroid disease)
- Other chronic lung diseases

tive bronchoprovocation testing (BPT). Consideration still needs to be given for chronic obstructive pulmonary disease, bronchiectasis, or other underlying obstructive lung diseases. An integral portion of a spirometry study is careful review of the flow volume loop (FVL) to identify evidence of fixed or variable airway obstruction. However, the airway needs to be significantly obstructed to cause FVL abnormalities. For example, in patients with vocal cord dysfunction, only 25% of patients will have baseline truncation of the inspiratory FVL because of the variability of symptoms.

Full pulmonary function testing (PFT) with lung volumes and diffusing capacity of the lung for carbon monoxide (DLCO) are generally less important in younger military populations. However, in the symptomatic, postdeployment military population, the threshold should be low and considered in the following situations:

- evidence of restriction or mixed restriction/obstruction on spirometry,
- obstruction with lack of significant bronchodilator response,
- evidence of hypoxia on pulse oximetry,
- radiographic changes suggesting interstitial lung disease, and
- truncal obesity or chest wall deformities to include kyphoscoliosis or pectus excavatum.

Patients with a body mass index above 30 kg/m^2 may have mild restriction solely because of their truncal obesity. It is thought to be from both deposition of adipose tissue around the chest and abdominal adipose tissue decreasing the excursion of the diaphragm.[10]

Bronchoprovocation Testing

Unless the patient clearly has asthma on the basis of obstructive spirometry with a bronchodilator response or a definite imaging abnormality suggestive of interstitial lung disease, BPT should be performed in all military patients as part of the diagnostic evaluation. A number of techniques are currently available to determine the presence of AHR. Methacholine challenge testing (MCT) is the most widely available and is the current test of choice at most military centers. The MCT lacks specificity, but is generally sensitive for AHR. Thus, a negative test essentially rules out AHR as the underlying cause for symptoms in this population. Alternative methods include mannitol and eucapneic voluntary hyperventilation that have a similar diagnostic yield as MCT.[11] Exercise spirometry may also be considered, but is surprisingly insensitive for detecting EIB.[12] A reactive BPT in a patient with exertional dyspnea and normal spirometry is highly suggestive of EIB, but should be confirmed with a clinical response to treatment during exercise.

Other Pulmonary Function Testing

There are other pulmonary function testing modalities available that may assist in establishing a diagnosis in selected individuals.

- The maximal voluntary ventilation may be an optional study and a significantly reduced value less than 70% predicted may be a marker of underlying airway obstruction, respiratory muscle weakness, or a reduced level of fitness.[2]
- Maximal inspiratory and expiratory pressures can be done rapidly in the pulmonary function laboratory. They are most helpful when ruling out diaphragmatic dysfunction based on findings of either restrictive PFTs or an elevated hemidiaphragm on CXR.
- Impulse oscillometry is a new technique that uses sound waves to measure central and peripheral airway resistance and reactance. In those patients with normal spirometry, evidence of increased airway resistance with a reduction PBD may indicate AHR not evident on spirometry.[13]

Exercise Laryngoscopy

In the presence of normal spirometry and negative BPT, another common diagnosis in the military population is vocal cord dysfunction. Although the inspiratory FVL may indicate the presence of a variable extrathoracic obstruction, because of the intermittent nature of the condition, the FVL may be normal in the absence of symptoms. Generally, exercise is the most common trigger for vocal cord dysfunction in this population, although consideration needs to be given to other triggers that include psychogenic or irritant-related causes (gastroesophageal reflux or postnasal drip). Additionally, the appearance of the glottis and associated structures may indicate the presence of a fixed anatomical lesion or findings of pachyderma and erythema consistent with gastroesophageal reflux disease. We generally perform laryngoscopy pre- and postexercise to document differences in vocal cord motion (paradoxical adduction) and glottis appearance postexercise.[14]

Cardiopulmonary Exercise Testing

Generally, cardiopulmonary exercise testing (CPET) is reserved for those patients in whom the diagnosis is not clear despite imaging and the other kinds of testing as described previously. This is a maximum exercise test that provides expired gas analysis and measurements of both cardiac and pulmonary limitation to exercise. In an older population,

CPET may be helpful in differentiating pulmonary or cardiac limitations to exercise or the presence of deconditioning. However, for the younger military population, there is generally little cardiac disease, and the presence of most pulmonary disease can be detected by other testing. Additionally, there are no established reference values for CPET parameters in this population.[15] Despite these limitations, CPET may further provide an estimate of the patient's ability to perform maximal exercise, which is important in determining further invasive testing. It may further clarify the differential diagnosis in the following situations: where the etiology of the dyspnea is unclear, where there is coexistent cardiac and pulmonary diseases, or where the severity of dyspnea is disproportionate to other objective findings.

Fiberoptic Bronchoscopy

Fiberoptic bronchoscopy (FOB) is generally not part of the evaluation for the military population, and the workshop did not deem it to be an essential component in all patient evaluations. It is currently being utilized as a research tool in the postdeployment dyspnea studies to establish the presence of an inflammatory milieu as part of the postdeployment dyspnea syndrome. In the general population, FOB is evaluated for suspected airway lesions or lung masses, infiltrates, or the presence of interstitial changes. For the evaluation of dyspnea in the postdeployment patient, normal chest imaging obviates the need for FOB unless there is a chronic productive cough or there is a need to identify respiratory cell populations in such conditions as eosinophilic bronchitis or neutrophilic asthma. In the presence of either focal findings or diffuse interstitial changes, FOB should be the first test of choice to further evaluate the patient. Both bronchoalveolar lavage and transbronchial biopsies may provide additional information on the etiology of the underlying lung disease. FOB has a limited yield for many interstitial diseases, but is less invasive than surgical lung biopsy.

Surgical Lung Biopsy

The report of CB in redeployed soldiers in the 2011 issue of *The New England Journal of Medicine* was described as the presence of extrinsic narrowing of the luminal wall caused by subepithelial fibrosis and smooth muscle hypertrophy in membranous bronchioles in patients with otherwise normal lung pathology.[16] Typical conditions associated with the histological finding of CB include

- inhalation of a variety of gases or toxins;
- drug reactions;
- viral or mycoplasma infections;
- connective tissue disease, especially rheumatoid arthritis;
- chronic rejection in heart-lung, lung, and bone marrow transplant recipients;
- hypersensitivity reactions;
- ulcerative colitis; and
- idiopathic causes.[17]

There may be identifiable CT findings in clinical cases of CB with the presence of interstitial changes, mosaicism, and air trapping.[18] Apart from the pathological findings, CB can be a progressive clinical disorder in which patients have a continued decline in pulmonary function with continued exposure. The patients described in the King series primarily had symptoms with high levels of exertion, and the majority had normal PFT and CT findings.

Surgical lung biopsy is generally indicated to establish a specific diagnosis in the presence of identifiable changes on CT imaging. In the absence of PFT or CT changes, there is no defined indication in the medical literature for a surgical lung biopsy. It was recommended at the workshop that a comprehensive evaluation, as outlined previously, be completed first to eliminate other causes of dyspnea. This should include full PFTs with DLCO, pulse oximetry, BPT, exercise laryngoscopy, and CPET. Additionally, prior to consideration of surgical lung biopsy, a less invasive procedure—such as FOB—should be performed first. FOB allows for transbronchial biopsy of the lung parenchyma in affected areas if present and obtaining BAL samples to demonstrate the presence of inflammatory cells.

The workshop further recommended the establishment of a central joint US Department of Veterans Affairs (VA)/US Department of Defense (DoD) board (pulmonologists, radiologists, pathologists, and cardiothoracic surgeons) to review the evaluation of any patients under consideration for surgical lung biopsy. It was further recommended that all biopsies be sent to the DoD's Joint Pathology Center for review.

Exposure Questionnaire

Every comprehensive clinical examination starts with medical history taking, to which components of occupational and environmental exposure histories should be added for evaluation of respiratory diseases related to airborne hazards exposure. For both military and civilian personnel returning from SWA, the definitions of occupational and environmental exposures have fine nuances. Exposure history, as well as personal medical history, should be accurately recorded by means of a questionnaire that is the most important research tool for collecting exposure information. Any questionnaire should be a standardized self-assessment tool by which individuals can identify, as well as characterize, their deployment environmental exposures. Individual exposures are highly variable and complex in terms of duration, location, intensity, and frequency. A questionnaire should be designed to

capture this variability, but every questionnaire has limitations because of the subjectivity of the recalled information provided. Because self-reporting of past exposures involves different degrees of accuracy, relevance, and potential bias, yes/no questions should be used instead of open-ended/free text questions.

Expanded exposure history questions should also be asked and may have an important role in assessing the risk for respiratory disease.[19] These questions would refer to deployment concurrent with and/or confounding respiratory injury, infections, and nondeployment inhalation exposures related to hobbies, geographical residence, and lifestyle exposure (eg, tobacco smoke). The occupational exposure component will be represented by questions regarding workplace exposure pre- and postdeployment, deployment service branch, and specific military service job description. As a public health tool, it would also collect demographic data, such as gender, age, height, weight, marital status, race/ethnicity, and education. From the disability perspective, the questionnaire does not constitute a legal document for individual claims or compensation, but can assist public health research on deployment exposures that potentially can translate in VA-rating schedule changes that will accurately address the degrees of disability because of airborne hazards exposure and its progression in time. Several airborne hazards evaluation questionnaires have been employed for specific research studies to include the Clinical Evaluation of Respiratory Conditions and Deployment Airborne Respiratory Exposures, but none reached the level of complexity needed to comprehensively collect required airborne hazards data.

Coding

The ICD-9 codes and Current Procedural Terminology (CPT) codes are important for a multitude of practical reasons. The codes constitute the main data source for incidence and prevalence reports for respiratory conditions in service members or veterans exposed to airborne hazards. Equally important, these codes serve as information for the financial and economic analyses and disability benefits recognition that results from the incidence and/or prevalence data of these diseases. The ICD-9 codes could be the most important source by which a respiratory condition can be studied as a disease and/or public health concern, guiding researchers to where and what to look for in individual medical charts. Considering only these two useful roles of information derived from coding, it is important to have the right codes for all respiratory diseases and symptoms, and to update the diagnostic code as the disease progresses or is better characterized. Previously deployed personnel with respiratory symptoms, such as exertional dyspnea, may have multiple reasons for these symptoms to include prior disease, deconditioning, occupational exposures, or cigarette smoking.

In the veteran's or service member's medical chart, the first ICD-9 code indicating a respiratory disease, independent of its cause, can appear as a code of only one symptom or a few symptoms together, not an ICD-9 code of a definite diagnosis or condition. At this stage in the diagnosis process, to choose the correct ICD-9 code can be challenging, and too often the conditions are miscoded. The most common cases of miscoding, especially from the electronic medical records where providers are required to select a diagnosis code, are the ones of very rare diagnosis or new conditions that are not well defined. A review of ICD-9 codes for CB in the DoD electronic medical record identified that the majority (>95%) of the patients did not have this condition. From the VA disability and compensation point of view, ICD-9 codes represent fundamental information. It is important that all symptoms and conditions be well coded and documented during the military service because they constitute evidence for the condition's service connection. It is also instrumental to keep ICD-9 codes updated when the diagnosis is definitely established or the disease progresses or a condition was discovered to be miscoded. To avoid medical errors, education in good coding practices becomes a priority, with Current Procedural Terminology codes being of no less importance than the primary care evaluation algorithm, referrals, and laboratory and imaging tests, at least from a disability point of view.

The most important goal for veterans and service members, besides treatment, is to be awarded the right disability for the diseases and conditions acquired as a result of their military service. Education in good coding is needed for all providers and should be mandatory in the context that most providers hired by the VA to perform disability examinations are from outside the VA and DoD health systems and practice medicine in private offices.

Education and Risk Communication

One of the benefits of integrating the results of clinical medical practice and research studies is better educational and risk communication expertise resulting in tools to distribute a clear message to military personnel and provide services with maximum positive impact. Respiratory diseases diagnosed in redeploying service members from SWA can be considered an occupational disease, that is that they are either caused or aggravated by exposure. The top environmental exposures noted by veterans in SWA are shown in Exhibit 11-5. Primary prevention would be the major priority for airborne hazards, such as the appropriate use of respiratory protection in high exposure areas. In addition to the programs and new initiatives to better control and/or eliminate the sources of exposure (eg, efforts to eliminate open-air burn pits), improved education, increased awareness, and avoidance of exposure risks play a pivotal role in preventing or exacerbating disease.

EXHIBIT 11-5

SOUTHWEST ASIA ENVIRONMENTAL HAZARDS

- Smoke from burning trash or feces
- Sand and dust storms
- Fuels (gasoline, jet fuel, diesel)
- Depleted uranium
- Paint, solvents, other petrochemicals
- Oil well fire smoke
- Contaminated food and water
- Anthrax vaccinations

For proper awareness of the airborne hazards risk, communication tools have to be used efficiently. The awareness campaign on airborne hazards has to be at the national level, using all combined tools, such as the Internet, publications, and other print materials; public service broadcasts and videos; media relations; spokespersons; and special events (exhibitions, seminars, and special days). The VA has robust experience with the previous hot topic awareness campaigns (eg, posttraumatic stress disorder and traumatic brain injury) that did not get the message through until a coordinated and sustained media informational assault was perfected.

The awareness campaign on airborne hazards should consist of two parts. First would be a public health effort with education on prevention of environmental exposures. Second would be recognition of disease symptoms and how to quickly seek medical evaluation and treatment early after exposure. Using the physician–patient relationship, DoD and VA providers have the best opportunity to disseminate the material and offer direct education with the greatest impact. A distinctive point that is uniquely important to all communication tools is the role of smoking and additive interactions with airborne hazards.

Programmatic Issues

Numerous programmatic issues obstruct the way forward in establishing a clear and concise understanding of the problem and the relationship to airborne hazards during deployment. Survey questionnaires are often retrospective; use self-reported data; and involve different degrees of accuracy, relevance, and potential bias. Numerous limitations are acknowledged in terms of subjectivity of the recalled information, characterization of exposures, and potential biases of the individual regarding the cause of symptoms. The information gathered through questionnaires will lack the precision to link respiratory conditions to specific exposures and (for military personnel with multiple deployments) to a specific location or country, although evidence of an increase in risk exposure among persons with land-based deployments will be statistically relevant. For the moment, data collected are insufficient to determine the long-term consequences of exposure to airborne hazards (eg, rate and severity of disease progression) or the impact of other co-morbidities.[20] Miscoding of respiratory symptoms and misdiagnosing early disease will make research very difficult and laborious. There is a tendency to label most respiratory symptoms in a young, healthy cohort as asthma. From the point of view of education and risk communication, it is clear that not all military personnel will benefit from all the tools of the awareness campaign. Depending on age, gender, and cultural background, some tools will be more efficient than others. Some time will pass until an implementation and monitoring study will show a way to tailor the programs to be efficient at all levels, especially considering all demographic, cultural, and geographical factors.

SUMMARY

All individuals with postdeployment respiratory symptoms require a basic evaluation to identify common lung diseases, such as asthma. This should primarily consist of describing symptoms, relating their onset to deployment, establishing specific exposures, performing an examination, and obtaining both CXR and spirometry. Common pulmonary diseases—such as asthma, EIB, and chronic cough—may be detected. A more in-depth evaluation may be necessary in some individuals and require the expertise of specialists to provide a diagnosis. Establishing a specific diagnosis may be difficult, but given the potential for occupational lung disease in deployed military personnel, determining current limitations and future risk are important.

REFERENCES

1. Parker JM, Mikita JA, Lettieri CJ. Appendix 2: causes of dyspnea in military recruits. In: DeKoning BL, ed. *Recruit Medicine*. Washington, DC: Department of the Army, Office of The Surgeon General, Borden Institute, 2006; 575–581.

2. Morris MJ, Grbach VX, Deal LE, Boyd SY, Morgan JA, Johnson JE. Evaluation of exertional dyspnea in the active duty patient: the diagnostic approach and the utility of clinical testing. *Mil Med.* 2002;167:281–288.

3. Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general U.S. population. *Am J Respir Crit Care Med*. 1999;159:179–187.

4. Pratter MR, Curley FJ, Dubois J, Irwin RS. Cause and evaluation of chronic dyspnea in a pulmonary disease clinic. *Arch Intern Med*. 1989;149:2277–2282.

5. Parshall MB, Schwarzstein RM, Adams L, et al. An official American Thoracic Society statement: update on the mechanisms, assessment, and management of dyspnea. *Am J Respir Crit Care Med*. 2012;185:435–452.

6. Hodgson MJ, Parkinson DK, Karpf M. Chest X-rays in hypersensitivity pneumonitis: a metaanalysis of secular trend. *Am J Ind Med*. 1989;16:45–53.

7. Dodson DW, Zacher L, Lucero P, Morris M. Study of active duty military for pulmonary disease related to environmental dust exposure (STAMPEDE) [abstract]. *Am J Respir Crit Care Med.* 2011;183:A4784.

8. Worthy SA, Müller NL. Small airway diseases. *Radiol Clin North Am*. 1998;36:163–173.

9. Kotti GH, Bell DG, Matthews T, Lucero PF, Morris MJ. Correlation of airway hyper-responsiveness with obstructive spirometric indices and FEV(1) > 90% of predicted. *Respir Care.* 2012;57:565–571.

10. Sutherland TJ, Goulding A, Grant AM, et al. The effect of adiposity measured by dual-energy X-ray absorptiometry on lung function. *Eur Respir J.* 2008;32:85–91.

11. Anderson SD, Charlton B, Weiler JM, Nichols S, Spector SL, Pearlman, DS. Comparison of mannitol and methacholine to predict exercise-induced bronchoconstriction and a clinical diagnosis of asthma. *Respir Res.* 2009;10:4.

12. Eliasson AH, Phillips YY, Rajagopal KR, Howard RS. Sensitivity and specificity of bronchial provocation testing. An evaluation of four techniques in exercise-induced bronchospasm. *Chest.* 1992;102:347–355.

13. Blonshine S, Goldman MD. Optimizing performance of respiratory airflow resistance measurements. *Chest*. 2008;134:1304–1309.

14. Morris MJ, Christopher KL. Diagnostic criteria for the classification of vocal cord dysfunction. *Chest*. 2010;138:1213–1223.

15. Morris MJ, Johnson JE, Allan PF, Grbach VX. Cardiopulmonary exercise test interpretation using age-matched controls to evaluate exertional dyspnea. *Mil Med*. 2009;174:1177–1182.

16. King MS, Eisenberg R, Newman JH, et al. Constrictive bronchiolitis in soldiers returning from Iraq and Afghanistan. *N Engl J Med.* 2011;365:222–230.

17. Myers JL, Colby TV. Pathologic manifestations of bronchiolitis, constrictive bronchiolitis, cryptogenic organizing pneumonia, and diffuse panbronchiolitis. *Clin Chest Med*. 1993;14:611–622.

18. Garg K, Lynch DA, Newell JD, King TE Jr. Proliferative and constrictive bronchiolitis: classification and radiologic features. *AJR Am J Roentgenol*. 1994;162:803–808.

19. Baird CP, DeBakey S, Reid L, Hauschild VD, Petruccelli B, Abraham JH. Respiratory health status of US Army personnel potentially exposed to smoke from 2003 Al-Mishraq Sulfur Plant fire. *J Occup Environ Med.* 2012;54:717–723.

20. Abraham JH, DeBakey SF, Reid L, Zhou J, Baird CP. Does deployment to Iraq and Afghanistan affect respiratory health of US military personnel? *J Occup Environ Med*. 2012;54:740–745.