RESPIRATORY SYSTEM[1]

I. INTRODUCTION

The respiratory system can be divided into the following groups of disorders to facilitate consideration of pulmonary fitness and the ability to perform the job functions of a patrol officer.

A. Obstructive Respiratory Diseases
   1) Asthma
      - Exercise-Induced Bronchoconstriction (EIB)
   2) Chronic Obstructive Pulmonary Diseases (COPD)

B. Restrictive Respiratory Diseases

C. Obstructive Sleep Apnea (OSA)

D. Miscellaneous Conditions

II. IMPLICATIONS FOR JOB PERFORMANCE

Patrol officers must have the capacity to engage in vigorous activities requiring above-average degrees of fitness, which may involve intense aerobic metabolism (Adams, 2010, Bonneau, 1995). A pulmonary limitation restricts the capacity of the officer to sustain near-maximal exertion, resulting in a risk of serious injury to both the patrol officer and the public. The following are examples of such situations[2]:

- **Running in pursuit of suspects**: speed is important to successful completion of a pursuit in up to 90% of incidents; distances covered may range up to 500 yards or more.

- **Pursuit followed by physical altercation**: subduing combative subjects takes an average of three minutes, during which the officer may be working at maximum exertion.

- **Moving incapacitated persons**: the ability to lift and carry someone distances of 40+ feet when speed is critical.

The minimum exercise capacity required to perform these tasks can be estimated from published tables of oxygen consumption (Jetté, et al., 1990). Oxygen consumption at a level of approximately 42 ml O_2/kg/min^{-1} is necessary to perform essential activities such

---

[1] **Authors:** Leslie Israel, D.O., M.P.H. (Med-Tox) and R. Leonard Goldberg, M.D.
Specialist Review Panel: John R. Balmes, M.D.; Tee L. Guidotti, M.D.; Akshay Sood, M.D.

[2] See Patrol Officer Job Demands: Their Implication for Medical Screening in the Background Information section of this Manual.

as those listed above, and to engage in wrestling, running, and lifting at a level of moderate to heavy intensity (Adams, 2010). However, since oxygen consumption in a life-or-death struggle can be much greater than 42 ml O_2/kg/min^{-1}, this value represents a valid *minimal* level of fitness. Historically, this value has been noted to represent the average fitness level of the most common group of arrestees: males <30 years old (Pollack, et al., 1980).

Depending on the location of the hiring agency, patrol officers can work in a variety of adverse environmental conditions, including:

- Extreme heat
- High levels of dust, pollutants, or other allergens
- Cold air
- High altitude (low oxygen)
- Exposure to toxic substances (this may occur when officers investigate clandestine drug labs or become first responders at toxic spills or fires)
- Exposure to oleoresin capsicum (OC) spray / “Mace”, an upper airways irritant

Finally, sleep apnea can significantly degrade a patrol officer's cognitive function, showing up as lapses in judgment, short-term memory loss, inability to concentrate, irritability, impaired wakefulness and can affect tasks requiring vigilance and surveillance.

Respiratory symptoms such as cough (particularly if coughing spells are triggered), chest tightness and shortness of breath may limit capacity. Therefore, careful assessment is required to ensure that candidates are free of any respiratory condition that can severely limit exercise tolerance and the ability to respond to or exert maximal effort in a critical situation. A history of chronic respiratory conditions requires further evaluation.

III. MEDICAL EXAMINATION AND EVALUATION GUIDELINES

Evaluation of patrol officer candidates to identify respiratory diseases and to evaluate their functional significance requires a comprehensive history, physical examination and spirometry. A chest radiograph may be indicated with abnormal findings in the history, physical examination, or spirometry testing, but is not required for screening purposes alone.

For individuals who have chronic respiratory disease, the measurement of exercise capacity is an important part of the clinical assessment, since it cannot always be adequately predicted from resting physiological measurements (such as spirometry) alone.

A. History

Candidates' responses to the respiratory system items in the medical history questionnaire [POST Medical History Statement (POST 2-252) or equivalent] should be reviewed. Positive responses require further follow-up questioning and comparison with physical findings in order to assess their significance. Review of medical records is necessary to confirm the history and any prior evaluations of abnormal findings. For example, if a candidate responds positively to a history of asthma, follow-up questions should address the frequency of and activities preceding inhaler use, emergency room or urgent care visits due to breathing difficulty, the need for hospitalization, lost work days, recent lung infections and the candidates' rating of their breathing on the day of the screening examination (i.e., good or bad day).

B. Physical Examination

Inspection of the chest and spine should document abnormalities such as kyphosis, scoliosis, barrel chest, or pectus excavatum. A standard auscultation exam of the chest should be performed on all candidates.

C. Routine Testing

1) Spirometry

Spirometry should be conducted on all candidates. Valid pulmonary function testing requires that the tests be performed by trained technicians in strict accordance with the American College of Occupational and Environmental Association (ACOEM) and the American Thoracic Society (ATS) standardized techniques (ATS, 2005; ACOEM, 2011). This includes setting the spirometer to use the NHANES III reference range values (ATS, 2005). For spirometry interpretation criteria, refer to Figure X-1 (ACOEM 2011).

D. Supplemental Testing Procedures

1) Chest Radiography

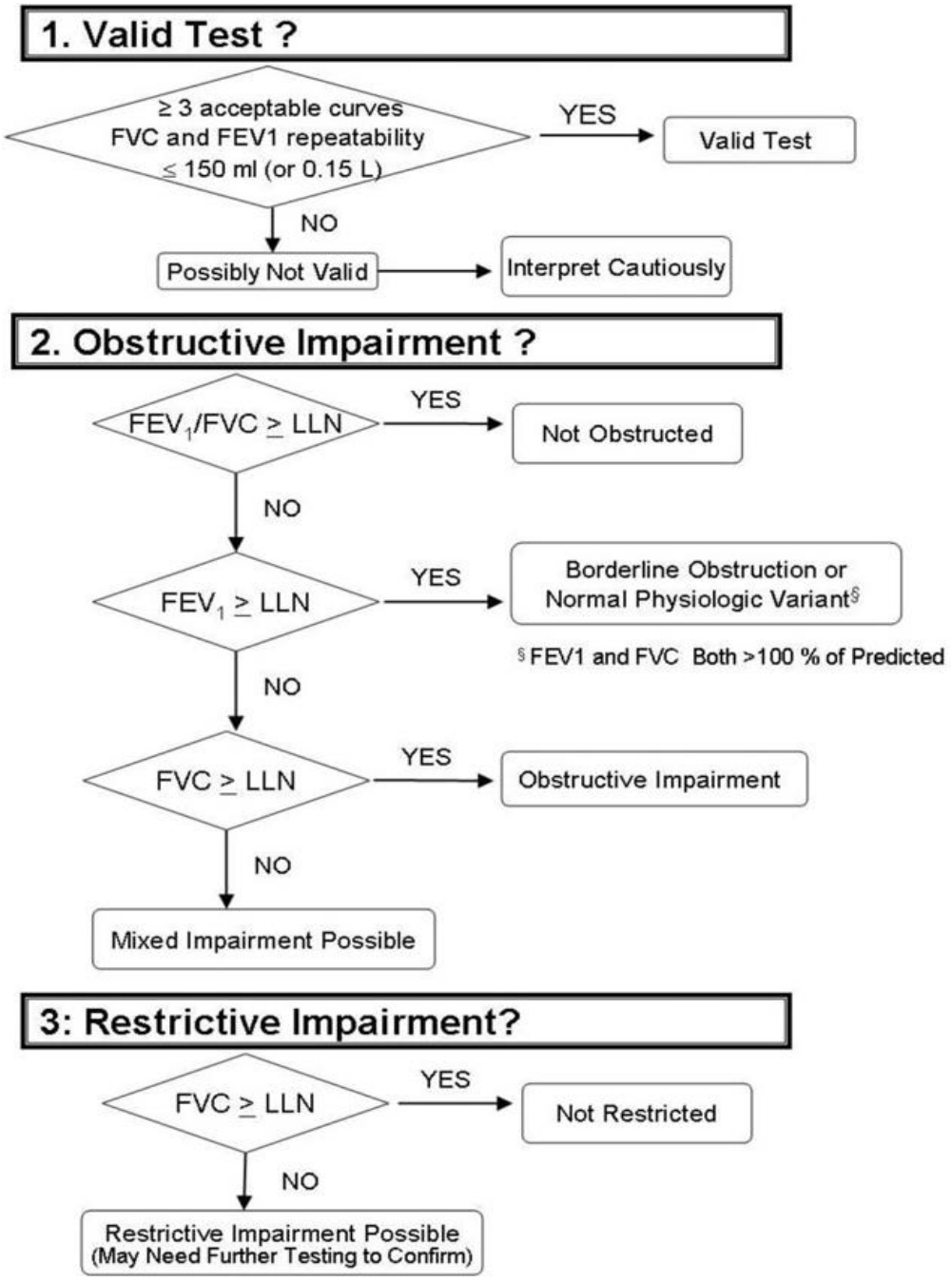
The use of a chest radiograph as a screening tool in healthy adults has an extremely low yield and therefore is not routinely recommended. However, the chest radiograph may provide important information in candidates who have respiratory symptoms without a specific diagnosis, or those with a restrictive pattern on spirometry testing.

2) Computed Tomography (CT) Scan

Imaging techniques such as CT scans have shown that plain radiographs are relatively insensitive in recognizing the early signs of many lung diseases. CT scans offer considerable insight into the precise anatomic changes that accompany a disease state. A high resolution CT scan, as compared to simple chest radiography,

allows for identification of more subtle interstitial change in the lung parenchyma, therefore CT scans may be performed as indicated by a pulmonologist.

FIGURE X-1: Interpretation of Spirometry



(Fig. 13, ACOEM, Spirometry in the Occupational Setting, 2011 Update)

3) Exercise Testing (ET)

Routine ET to assess a potential respiratory limitation to exercise is not necessary in candidates with no history of pulmonary disease or abnormal spirometry. However, when a respiratory limitation to exercise is suspected, an ET is an important ancillary tool to help assess the candidate's maximal aerobic capacity. Lack of respiratory limitations does not obviate the need for exercise testing due to cardiac reasons (refer to Cardiology chapter) or for assessment of aerobic capacity.

There are several exercise testing protocols that can be used, employing either a cycle ergometer or a treadmill (refer to Cardiology chapter for exercise testing recommendations). Post-exercise drop in FEV_1 from baseline can help diagnose exercise-induced asthma or vocal cord dysfunction.

4) Cardiopulmonary Exercise Testing (CPX)

The addition of Cardiopulmonary Exercise Testing (CPX) - direct measurements of ventilatory gas exchange during exercise testing - can assist in the evaluation and management of complex cardiovascular and pulmonary disease. However, CPX requires specialized equipment and personnel proficient in the administration and interpretation of these tests (Balady et al., 2010).

IV. EVALUATION OF COMMON CLINICAL SYNDROMES

Respiratory diseases can be broadly described as causing either airway obstruction (e.g., asthma, bronchitis and chronic obstructive lung disease) or restriction (interstitial lung diseases).

A. Obstructive Respiratory Disease

1) Asthma

The initial goal of evaluation is to document the presence of asthma. When the FEV_1/FVC ratio is below the lower limit of normal, a short-acting beta-adrenergic agonist should be acutely administered in an effort to identify reversible airflow obstruction. Presence of reversibility (defined as a ≥12% increase in FEV_1 from baseline and an increase of ≥200 ml in FVC in response to administration of inhaled bronchodilator) suggests the diagnosis of asthma.

Candidates with normal spirometry and a history suggestive of asthma may be directed to see their personal physician for further evaluation of their asthma by bronchoprovocation, using a nonspecific bronchodilator challenge (i.e., methacholine challenge testing).

As depicted in Table X-1, the severity of asthma is determined by frequency of attacks despite appropriate treatment, the need for rescue inhalers, interference with normal activity, and impairment of lung function.

Table X-1: Classification of Asthma Severity

Components of Severity	Intermittent	Persistent		
		Mild	Moderate	Severe
Symptoms	≤ 2 days/week	> 2 days/week, but not daily	Daily	Throughout the day
Nighttime Awakenings	≤ 2 times/month	3 – 4 times/month	>1 time/week but not nightly	Often 7 times/week
Rescue Inhaler Use	≤ 2 days/week	> 2 days/week, but not daily, and not more than 1 time/day	Daily	Several times/day
Interference with Normal Activity	None	Minor Limitation	Some Limitation	Extremely Limited
Lung Function	FEV_1 > 80% of predicted & normal between exacerbations	FEV_1 = 80% of predicted	FEV_1 = 60% - 80% of predicted	FEV_1 < 60% of predicted

(Adopted from Busse et al., 2007)

Candidates with a history of intermittent or persistent asthma (per Table X-1), or who use long-term asthma control medications or objective physiologic measures, would be restricted in one or more job functions that require increased physical activity and aerobic capacity or exposure to harsh environments.

Candidates with a history of childhood asthma/remote asthma, or stable intermittent asthma without use of bronchodilator or steroids during the past two years, should be referred for ET to evaluate exercise capacity.

No restrictions are necessary if the candidate is able to complete an acceptable level of exercise without clinically significant exercise-induced asthma and without use of as-needed bronchodilator medication, or use of medication on day of exam. However, the candidate's ability to maintain adequate functioning when exposed to severe environmental/toxic conditions must be considered.

Exercise-induced bronchoconstriction (EIB) commonly occurs in individuals with a known history of asthma and in others who may deny asthma but have a history of allergies such as hay fever (Pongdee & Li, 2013). The trigger for EIB is thought to be an increase in ventilation of cool and dry air, which occurs during strenuous exercise with mouth breathing. Symptoms of EIB can occur either during or immediately after a

period of aerobic exertion of 3-8 minutes and can last between 5 and 30 minutes. Symptoms usually subside on their own, after exercise stops.

The clinical significance of EIB can be assessed by history and/or testing with pre- and post-spirometry. A protocol for evaluating exercise-induced EIB is provided in Figure X-2 (Parsons, et al., 2013). Post-exercise spirograms should be conducted at 5, 10 and 20-minute intervals. A decrease in FEV_1 of more than 10% compared to the baseline is abnormal. However, the functional and clinical significance also depends on the absolute value of the FEV_1, auscultatory findings, and symptoms. The primary concern is whether the candidate could reinitiate and sustain an exercise level requiring 42 ml O_2/kg/min^{-1} at the time of peak bronchoconstriction and symptoms.

Peace officers must be capable of maximal exertion without warning. Consequently, individuals who require pre-exercise medication to prevent EIB are at risk of significant and unpredictable degradation when performing job functions that require increased physical activity and aerobic capacity.

Candidates with a history of EIB who do not require or use pre-exercise medications should be referred for ET to evaluate exercise capacity. No restrictions are necessary if the candidate is able to complete an acceptable level of exercise without clinically significant EIB or the use of as-needed bronchodilator medication.

FIGURE X-2: Evaluation of Exercise-Induced Bronchoconstriction (EIB)

The purpose of this test is to detect and evaluate the severity of exercise-induced bronchoconstriction (EIB).

Procedure:

1. Ask the candidate if he/she has used any "quick relief" inhalers or pills on the day of the test. Below are examples of such medications:

Accuneb	Atrovent	Ipratropium	ProAir
Adrenaline	Combivent	Maxair	Proventil
Albuterol	DuoNeb	Metaproterenol	Ventolin
Alupent	Epinephrine	Primatene	Xopenex

   The test should be canceled if any of these medications have been used within the past six (6) hours.

2. Ask the candidate if he/she is having any current symptoms related to asthma. The presence of any current symptoms should be documented and the test cancelled. The candidate may be referred to a pulmonologist for further assessment of their pulmonary condition before medical clearance is determined.

3. Perform pre-test spirometry. The screening spirogram cannot substitute for this unless it was done within three hours of exercise testing and using the same spirometer.

4. Provide the candidate with standard instructions for running on a treadmill, including reporting of symptoms that would warrant stopping the test. Encourage the candidate to run as long as possible (do not use heart rate criteria for stopping). Tell the candidate that less than maximal effort may result in an un-interpretable test which will need to be repeated on another day.

5. Run the candidate on a treadmill, preferably using the Bruce Protocol. Record the treadmill start time. Note: No EKG tracing is necessary unless a simultaneous Cardiac Stress Test is indicated by the pre-placement examining physician or physician determining medical clearance of the candidate.

6. At termination, record the reasons for termination and treadmill stop time.

7. Perform spirometry at 5, 10 and 20 minutes post-treadmill. At each interval, only one blow should be done (unless the FEV_1 is clearly not valid). However, both unique volume-time and flow-volume graphs must be printed for testing at each interval. Record any reports of symptoms on the spirograms. NOTE: Exercise-induced bronchoconstriction is usually a self-limited, temporary condition. However, if the candidate demonstrates respiratory difficulties (i.e., wheezing, persistent coughing, difficulty talking in full sentences), they have failed the test, and may be permitted to use any inhaler they have brought with them.

8. A decrease in FEV_1 of more than 10% compared to the baseline is abnormal. However, clinical significance also depends on the absolute value of the FEV_1, auscultatory findings, and symptoms. The primary concern is whether the candidate could re-initiate and sustain an exercise level requiring 42 ml O_2/kg/min^{-1} at the time of peak bronchoconstriction and symptoms. Candidates that require the use of pre-exercise medication should be disqualified from performing the job of a patrol officer.

(Parsons, et al., 2013)

2) Chronic Obstructive Pulmonary Disease (COPD)

Chronic obstructive pulmonary disease (COPD) is a group of diseases characterized by airflow obstruction that can be associated with breathing-related symptoms (e.g., chronic productive cough, exertional dyspnea, and wheeze) due to chronic bronchitis or emphysema. Chronic bronchitis is characterized by excessive secretion of bronchial mucus and is manifested by productive cough for at least three months over two consecutive years or more, while emphysema denotes abnormal, permanent enlargement of the distal air space with destruction of the walls of the alveoli.

COPD can be present with or without substantial physical impairment or symptoms, and is the fourth leading cause of death in the United States. However, COPD is often a silent and unrecognized disease, especially in its early phases.

Traditionally, COPD has been diagnosed on the basis of patient-reported symptoms. The recently published definition from the Global Initiative for Chronic Obstructive Lung Disease (GOLD, 2014) has classified COPD as a disease state characterized by airflow limitation that is not fully reversible and recommends measurement of lung function both to diagnose disease and categorize disease severity (Vestbo, 2013; Qaseem, et al., 2011).

Airflow limitation is the slowing of expiratory airflow as measured by spirometry, with a persistently low forced expiratory volume in one second (FEV_1) and a low FEV_1/forced vital capacity (FVC) ratio despite treatment.

As depicted in Table X-2, the GOLD criteria for mild COPD (Stage I) is an FEV_1/FVC ratio of <70% and FEV_1 of >80% predicted; the criteria for moderate, severe and very severe COPD (Stage II, III &IV) is an FEV_1/FVC ratio of <70% and FEV_1 of < 80% predicted. In addition to physiologic measures, the impact of chronic obstructive lung disease (COPD) is also determined by frequency of respiratory symptoms or acute attacks of airway obstruction despite appropriate treatment, the need for multiple inhalers on a daily basis, the need for frequent use of oral steroids, hospitalization, and respiratory failure.

Table X-2: GOLD COPD Classification

Stage I	Mild COPD	FEV_1/FVC < 0.70	FEV_1≥ 80% normal
Stage II	Moderate COPD	FEV_1/FVC < 0.70	FEV_1 50-79% normal
Stage III	Severe COPD	FEV_1/FVC < 0.70	FEV_1 30-49% normal
Stage IV	Very Severe COPD	FEV_1/FVC < 0.70	FEV_1 < 30% normal or FEV_1 < 50% with chronic respiratory failure*

* Usually requiring long-term oxygen therapy

Individuals with moderate to severe COPD based on subjective measures, such as frequency of symptoms/exacerbation and treatment, or objective physiologic measures should not be cleared to perform job functions that require increased physical activity and aerobic capacity or exposure to harsh environments.

Some individuals who have abnormal lung function are still capable of performing most physical activities without restrictions. Therefore, it is appropriate to assess the exercise capacity of candidates who have mild obstructive physiology or who are

asymptomatic despite abnormal spirometry prior to making a final determination. Candidates with limited exercise capacity should not be cleared to perform job functions that require increased physical activity and aerobic capacity or exposure to harsh environments.

OBSTRUCTIVE RESPIRATORY DETERMINATIONS:

GROUP I: Obstructive Pattern on Spirogram (FEV1/FVC Ratio is < LLN) or Positive Findings on Lung Ascultation (Wheezing) but Negative History of Obstructive Disease, EIB, or Medication Use in the Last 10 Years

Level 1: FEV1 and FVC are both ≥100% of predicted

These candidates have spirogram results that are interpreted as consistent with a normal physiologic variant (refer to Figure X-1).

Level 2: FEV1 <100% of predicted

These candidates should undergo an ET with pre/post spirograms including an estimation of $V0_2$ max (Figure X-2). A recommendation for unrestricted duty should be based on a reliable history and the ability to reach 42 ml O_2/kg/min^{-1} without clinically significant EIA.

If there is an objective reason to question the reliability of the history (for example, due to findings on exam or difficulty with spirometry testing), then medical records should be reviewed, if available, prior to determining medical clearance.

NOTE: Candidates who are restricted should be advised that they can be re-evaluated at a future time if their condition improves (Fiorenzano, et al., 2010).

GROUP II: Admits to a Positive History of Obstructive Disease, EIB, or Medication Use in Last 10 Years

The variability in the candidate's disease and the need for pre/post exercise medication during the past two years should be carefully assessed.

Level 1: Stable disease with no use of "pre-exercise" or "rescue" medications during the past two years

Pre-exercise medication is defined as medication prescribed for use prior to exercise to prevent an asthma attack. Rescue medications are defined as quick-relief medications used for rapid, short-term symptom relief during an asthma attack.

An ET with pre/post spirograms should be obtained. In general, no restrictions are necessary if the candidate is able to reach 42 ml O_2/kg/min^{-1} without significant EIB

and without the need for pre-exercise or rescue inhaler medication. In addition, medical records and work history should demonstrate no disability or significant sick leave (i.e., more than 10 days/year) related to obstructive disease.

Level 2: Unstable or variable disease or use of medication during the past two years

The medical records and work history must be reviewed to assess for pulmonary impairment, use of pre-exercise or rescue medications and/or significant sick leave (more than 10 days/year) related to obstructive disease. A history of chronically frequent, recent, severe and unpredictable breathing problems should be considered as disqualifying unless there is clear evidence of capacity to exercise at 42 ml O_2/kg/min^{-1} without EIB during symptomatic episodes. Candidates with infrequent breathing problems may be assessed as Level 1.

Note: Candidates who are restricted should be advised that they can be re-evaluated at a future time if their condition improves (Fiorenzano, et al., 2010).

B. Restrictive Respiratory Disease

Restrictive or interstitial lung diseases (ILDs) are a diverse group of lung diseases that are generally characterized by chronic inflammation and progressive fibrosis of the lung interstitium (Ryu, et al., 2007; Green, 2002). ILDs are not an expected pulmonary condition in the asymptomatic healthy candidate. Given the anticipated good health and relative youth of the majority of candidates, musculoskeletal deformities are generally the predominant reason for a reduction in lung capacity (restrictive respiratory disease).

A restrictive lung defect may be suspected with a decreased FVC. A decreased FVC does not by itself prove that there is a restrictive defect.

RESTRICTIVE RESPIRATORY DISEASE DETERMINATIONS:

GROUP I: FVC < LLN with Chest Wall Abnormality

Individuals with obvious chest wall abnormality or less than 1.5” of chest wall expansion on maximum inhalation should undergo ET to assess exercise capacity. If the candidate attains an exercise level of 42 ml O_2/kg/min^{-1}, then no restrictions are indicated.

GROUP II: FVC < LLN or with Positive History of Restrictive Respiratory Disease

Candidates with FVC < LLN, positive history, or a positive physical examination that is not due to obvious chest wall abnormality, should undergo further evaluation. Candidates may be referred to their personal physicians for further evaluation that should include a chest radiograph and ET. If the chest radiograph is normal, VO2 max is ≥42 ml O_2/kg/min^{-1} and no desaturation of pulse oximetry below 90% is documented

during ET, then the medical records and work history must be reviewed to assess for pulmonary impairment or significant sick leave (i.e., more than 10 days/year) related to restrictive disease.

If the chest radiograph is abnormal or desaturation on ET occurs, further evaluation under the supervision of a pulmonologist is indicated. Tests may include but are not limited to CPX, lung volumes, and diffusing capacity.

Asymptomatic individuals with normal vital capacity, diffusing capacity, and chest radiograph do not require further evaluation. A candidate who attains an oxygen consumption level of at least 42 ml O_2/kg/min^{-1} without oxygen saturation falling below 90% should be found suitable. Oxygen saturation below that level indicates inadequate oxygenation of the tissues, which impacts the ability to perform job functions requiring sustained effort.

C. Obstructive Sleep Apnea (OSA)

OSA is a frequent problem affecting about 2-4% of the adult US population (Epstein 2009). The consequences of OSA are excessive daytime sleepiness and decreased cognitive performance.

Risk factors for OSA include facial abnormalities, posteriorly positioned jaw, alcohol and sedative use and most importantly, central obesity (Dempsey, 2010).

Features to be evaluated that may suggest the presence of OSA include: increased neck circumference (> 17 inches in men, >16 inches in women), body mass index (BMI) ≥ 30 kg/m^2, lateral peritonsillar narrowing, macroglossia, tonsillar hypertrophy, elongated/enlarged uvula, high arched/narrow hard palate, and nasal abnormalities.

Sleep studies, preferably with polysomnogram, are used in diagnosing sleep apnea. The results of sleep studies are expressed as the respiratory disturbance index (RDI) or the apnea/hypopnea index (AHI). The AHI is the number of apneas and hypopneas per hour of recorded sleep. An AHI of 5 or less is considered normal. An AHI > 30 is graded as severe OSA.

Nasal continuous positive airway pressure (nCPAP) is the predominant treatment for OSA and is highly effective at eliminating periods of airway obstruction during sleep. Custom made oral appliances (OAs) may be effective treatment options in cases with mild to moderate OSA who prefer them to nCPAP, who do not respond to nCPAP, or who are not appropriate candidates for nCPAP.

Candidates with a clinical presentation suggestive of OSA or a history of untreated OSA should be referred to their personal physician or sleep specialist for further evaluation and management prior to making a medical clearance determination.

GROUP I: Normal Sleep Study

Candidates with an apnea + hypopnea index (AHI) of < 5 (events/hr.) are considered normal and no restrictions are needed.

GROUP II: Mild - Moderate OSA

Candidates with well-treated mild-moderate OSA (AHI 5 – 30) should submit their medical records for review along with a statement from their sleep specialist confirming that the candidate demonstrates effective device utilization patterns with objective monitoring and symptom evaluation. The records should specify the type of device used and confirm that the candidate is managed with routine follow-up evaluations, and as needed, for issues with the device, or persistent symptoms.

GROUP III: Severe OSA

Candidates with severe OSA (AHI > 30) despite medical treatment have a medical condition that negatively impacts wakefulness and cognitive performance and therefore should not be cleared to perform job functions requiring these capacities.

D. Miscellaneous Conditions

Many other less common respiratory conditions require special evaluation (American Thoracic Society/European Respiratory Society, 2003; Glazer, 2004). These conditions require careful consideration of the nature, severity, duration, and likelihood of impairment associated with the condition and the demands and conditions of the job.

The presence of a nodule or "spot" on the lung as detected on a chest radiograph should be evaluated. Although the principal concern in such cases is whether the nodule represents cancer, nonmalignant (noncancerous) nodules are common and often represent the healed result of old lung disease. They are more common in the Midwest United States and California because of the frequency of benign fungal diseases among residents. Most nodules have no implications for exercise capacity or overall work capacity and do not suggest that the candidate presents a risk to self and/or others. The exception are nodules that suggest a possible diagnosis of tuberculosis (see Infectious Disease section).

Upper airway (nose, mouth, sinuses, and trachea) disorders are usually less severe in their functional implications and of shorter duration than lung disorders. However, when severe, or when they lead to complications or medication side effects, they may degrade job performance. Severe allergies, especially sinusitis (which may be accompanied by severe headaches), may result in deterioration of cognitive function due to distraction, inflammation, medication side effects, and interference with sleep.

REFERENCES

Adams, J., et al., (2010). Measurement of functional capacity requirements of police officers to aid in development of an occupation-specific cardiac rehabilitation training program. *BUMC Proceedings*, 23(1), 7–10.

American College of Occupational and Environmental Medicine. (2011). Spirometry in the Occupational Setting 2011 Update. *JOEM*, 53(5), 569-584. Retrieved from: <http://www.acoem.org/uploadedFiles/Public_Affairs/Policies_And_Position_Statements/ACOEM%20Spirometry%20Statement.pdf>.

American Thoracic Society/European Respiratory Society. (2003). Standards for the diagnosis and management of individuals with alpha-1 antitrypsin deficiency. *Am J Respir Crit Care Med,* 168(7), 818-900.

American Thoracic Society/European Respiratory Society. (2005). Standardization of lung function testing: Interpretative strategies for lung function tests. *Eur Respir J*, 26, 948-968. Retrieved from: <http://www.thoracic.org/statements/resources/pft/PFT2.pdf.>.

Balady, G.J., Arena, R., Sietsema, K., et al. (2010). Clinician's guide to cardiopulmonary exercise testing in adults. A scientific statement from the American Heart Association. *Circulation*, 122(2), 191-225. Retrieved from: <http://circ.ahajournals.org/content/early/2010/06/28/CIR.0b013e3181e52e69>.

Bonneau, J. & Brown, J. (1995). Physical ability, fitness and police work. *J Clin Forensic Med*, 2(3), 57–164.

Busse, W.W., Boushey, H.A., Camargo, C.A., et al. (2007). *Guidelines for the Diagnosis and Management of Asthma*. National Asthma Education and Prevention Program, Expert Panel Report 3. NIH Pub No 08-5846.

Dempsey, J.A., Veasey, S.C., Morgan, B.J., & O'Donnell, C.P. (2010). Pathophysiology of sleep apnea. *Physiol Rev,* 90(1), 47-112.

Epstein, L.J., Kristo, D., Strollo, P.J., Jr. et al. (2009). Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *J Clin Sleep Med*, 5(3), 263-76.

Fiorenzano, G., Santoriello, C., Musella, V., & Polverino, M. (2010). Exercise capacity in chronic respiratory diseases. *Eur Respir J*, 35(5), 1193-4.

Glazer, C.S. & Newman, L.S. (2004). Occupational interstitial lung disease. *Clin Chest Med,* 25(3), 467-78, vi.

Global Initiative for Chronic Obstructive Lung Disease (GOLD), *Global Strategy for the Diagnosis, Management, and Prevention of COPD*, Updated 2014. Retrieved from: http://www.goldcopd.org/uploads/users/files/GOLD_Report2014_Feb07.pdf

Green, F.H. (2002). Overview of pulmonary fibrosis. *Chest*, 122(6), Suppl, 334S-339S.

Jetté, M., Sidney, K., & Blümchen, G. (1990). Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. Clin Cardiol, 13(8), 555-65.

Parsons, J.P., Hallstrand, T.S., Mastronarde, J.G., et al. (2013). An Official American Thoracic Society Clinical Practice Guideline: Exercise-induced Bronchoconstriction, *Am J Respir Crit Care Med,* 187(9), 1016-27.

Pollack, M.L., Schmidt, D.H., Jackson, A.S. (1980). Measurement of cardio-respiratory fitness & body composition in the clinical setting. *Compr Ther*, 6(9), 12-27.

Pongdee, T. & Li, J.T. (2013). Exercise-induced bronchoconstriction, *Ann Allergy Asthma Immunol*, 110(5), 311-5 http://www.sciencedirect.com/science/article/pii/S1081120613000884

Qaseem, A., Wilt, T.J., Weinberger, S.E. et al. (2011). Diagnosis and management of stable chronic obstructive pulmonary disease: a clinical practice guideline update from the American College of Physicians, American College of Chest Physicians, American Thoracic Society, and European Respiratory Society. *Ann Intern Med*, 155(3), 179-91.

Ryu, J.H., Daniels, C.E., Hartman, T.E. & Yi, E.S. (2007). Diagnosis of interstitial lung diseases. *Mayo Clin Proc*, 82(8), 976-86.

Vestbo, J., Hurd, S.S., Agustí, A.G., et al. (2013). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. *Am J Respir Crit Care Med*, 187(4), 347-65.