



The Pulmonary Impact of Recent Military Operations Iraqi Freedom and Enduring Freedom

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Case Study

29 year old US Navy Sailor stationed in Bahrain transferred from outside hospital for increased hypoxic respiratory failure.

Past Medical History

- Stationed in Bahrain in August 2013
 - Started experiencing chest tightness
- September had bilateral swelling in his legs up to his waist
 - Went to the ED 9/11 and was sent home.
- The next day returned to the ED
 - Dx of pneumonia
 - Sent home with Azithromycin

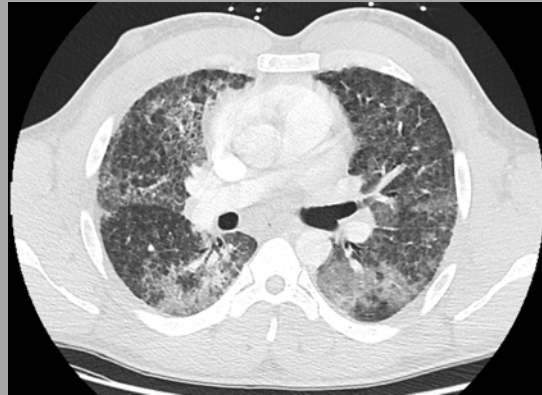


Past Medical History

- Continued to experience shortness of breath
 - Admitted to the local hospital with pneumonia sepsis on 9/15
- Chest CT
 - ? Interstitial lung disease vs. infection
- Due to his service history he was tested for MERS and TB
 - Both were negative
- The patient was discharged on 9/19/13

Past Medical History

- 10/2 presented to the ED again
 - Increased shortness of breath
- Treated for HCAP
- Another CT performed
 - concern for rapid progression of interstitial lung disease.

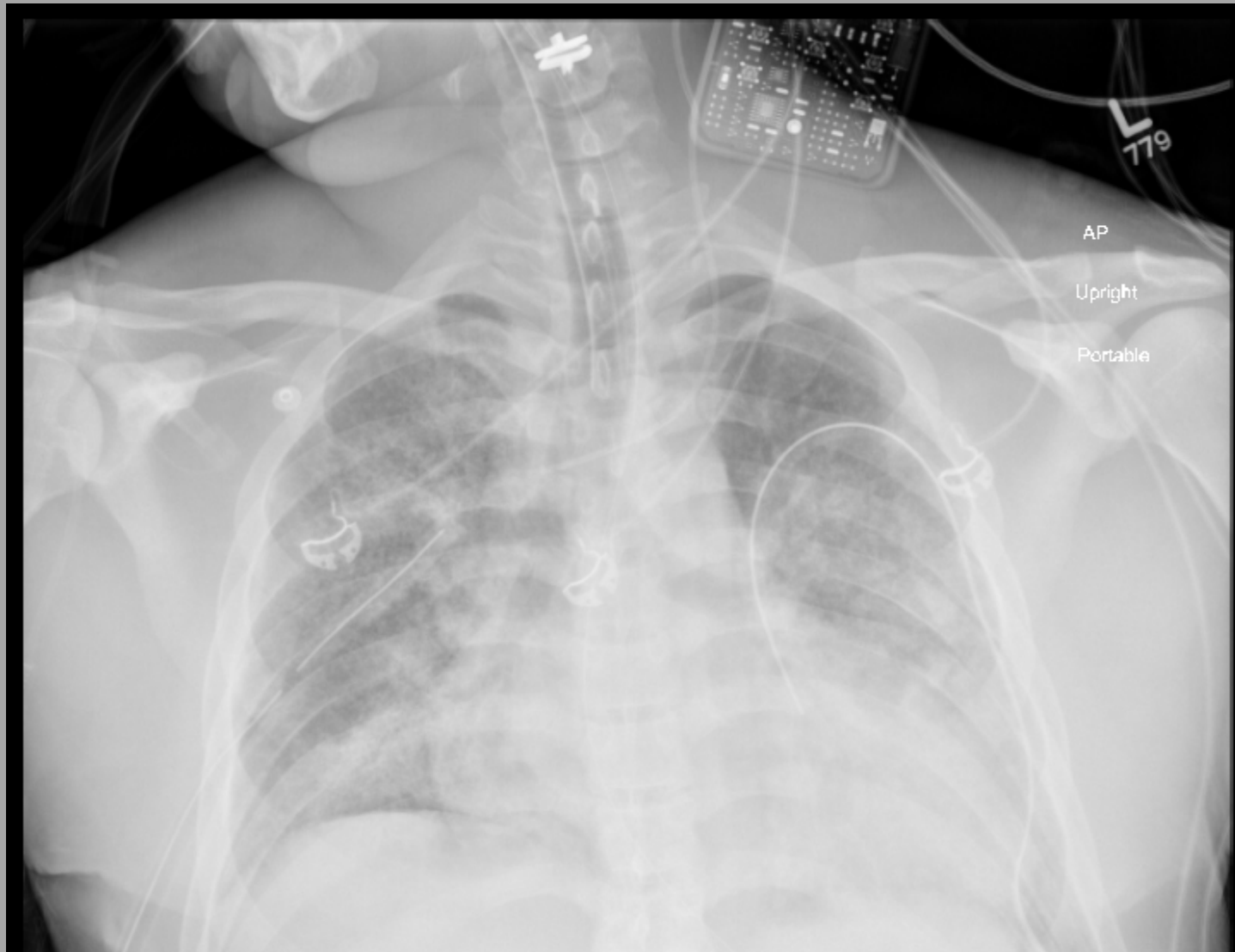


Past Medical History

- 10/5 open biopsy of the left lower lobe
 - patient returned to ICU on mechanical ventilation with bilateral chest tubes
- 10/6 patient was extubated
 - Immediately put on non-invasive ventilation
- 10/7 patient reintubated due to progressive hypoxemia

Past Medical History

- Started on high dose steroids and transferred to tertiary care center for progressive care of Acute Interstitial Pneumonitis



Hospital Course

- 10/14 FiO₂ .50 and peep 12
- Tracheostomy performed on 10/14
- GJ tube placed for nutritional support 10/23
- In the meantime patient received an expedited transplant evaluation for AIP

Hospital Course

- While on mechanical ventilation patient began working with physical therapy on 10/15 and was able to cycle in bed with resistance for 10 minutes
- By 11/5 patient was cycling for 30 minutes and 8 miles



Hospital Course

- 11/6 patient had a Bilateral Lung Transplant
- 11/8 patient walked 26 laps around the ICU
- 11/12 tracheostomy was de-cannulated
- On 11/15 the patient was discharged home



History of Deployment Related Pulmonary Disease

- World War I
 - Mustard Gas



History of Deployment Related Pulmonary Disease

- Vietnam
 - Agent Orange Act of 1991
 - Chronic nonmalignant respiratory conditions
 - Children of Vietnam Veterans

History of Deployment Related Pulmonary Disease

- Gulf War
 - Amyotrophic Lateral Sclerosis
 - Desert Storm Pneumonitis
 - Iraqi oil well fires



Present day deployment related exposures and diseases

Operation Iraqi Freedom

March 2003-December 2011

Operation Enduring Freedom

October 2001-present

Deployment Related Exposures

Exposure Insult

- Burn Pits
- Industrial Fires
- Particulate Matter from Desert Dust Storms and Other Sources

Exposure to Burn Pits



- Each American soldier generates 9 to 12 lbs. of waste a day.
- As of January 2011, 197 burn pits were still operating in Afghanistan

Exposure from Industrial Fires

Mishraq Sulphur State
Company -
Sulfur Mine Fire



Exposure from Industrial Fires

- Burning sulfur emits sulfur dioxide and hydrogen sulfide.
 - Sulfur dioxide is a respiratory irritant that causes rhinorrhea, cough, sputum production and dyspnea
 - May lead to irritant induced asthma, chronic bronchitis and constrictive bronchiolitis

Exposure to Desert Dust Storms



Exposure to Desert Dust Storms

- Sampling from Middle East deployment sites have found bacterial, fungal and other pathogens in soils and dusts
- Trace metal concentrations of lead, arsenic, cadmium, antimony and zinc were found in soil samples from 15 deployment sites in Iraq and Afghanistan

Embedded Metal Fragments

- 2008- Special registry for medical surveillance and management of veterans with retained metal fragments
- Aluminum, arsenic, cobalt, chromium, nickel-may have immunogenic respiratory health effects

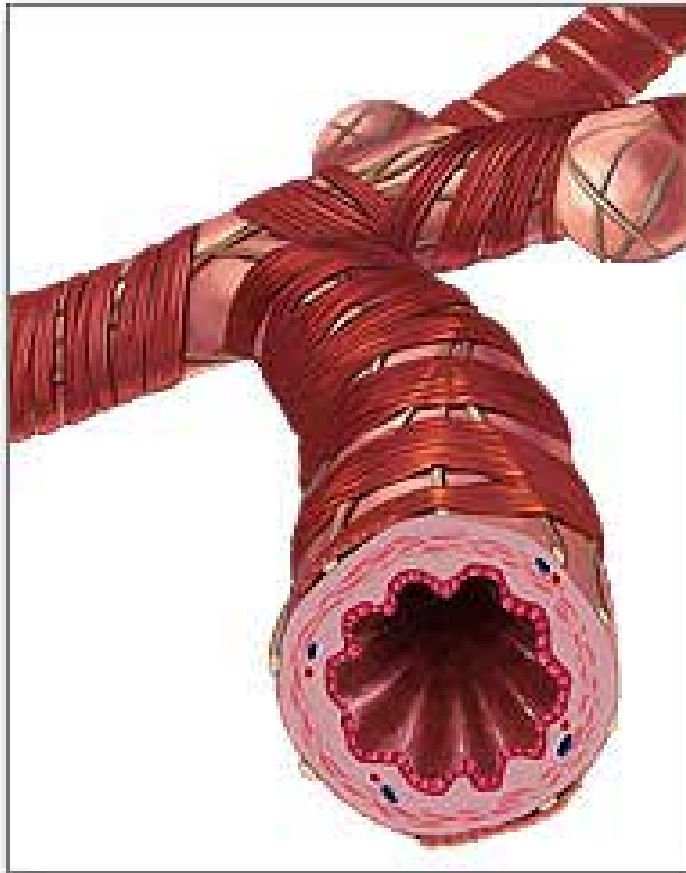


Respiratory Diseases of Concern

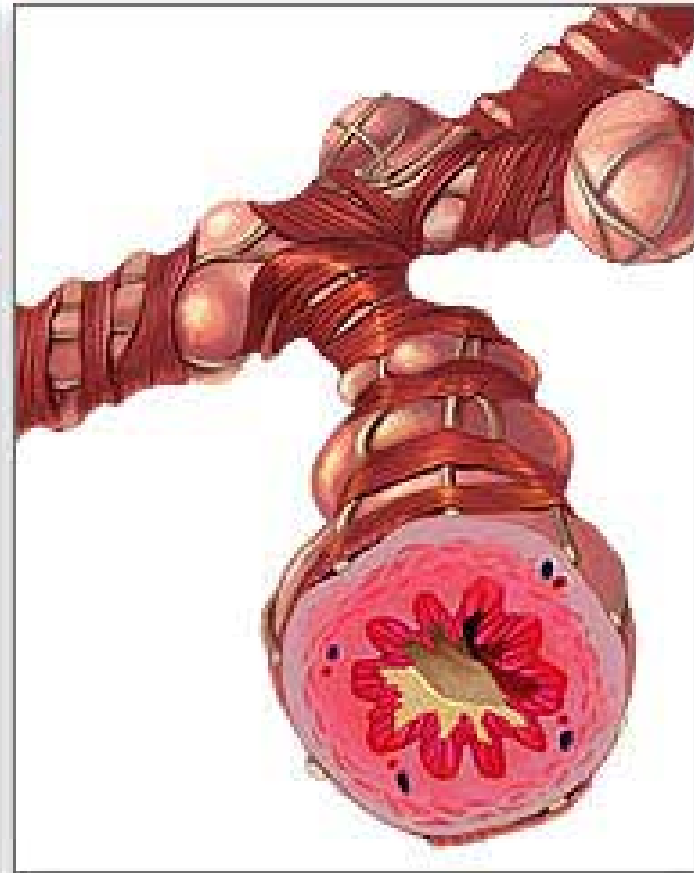
- Asthma
- Constrictive Bronchiolitis
- Acute Eosinophilic Pneumonia

Asthma

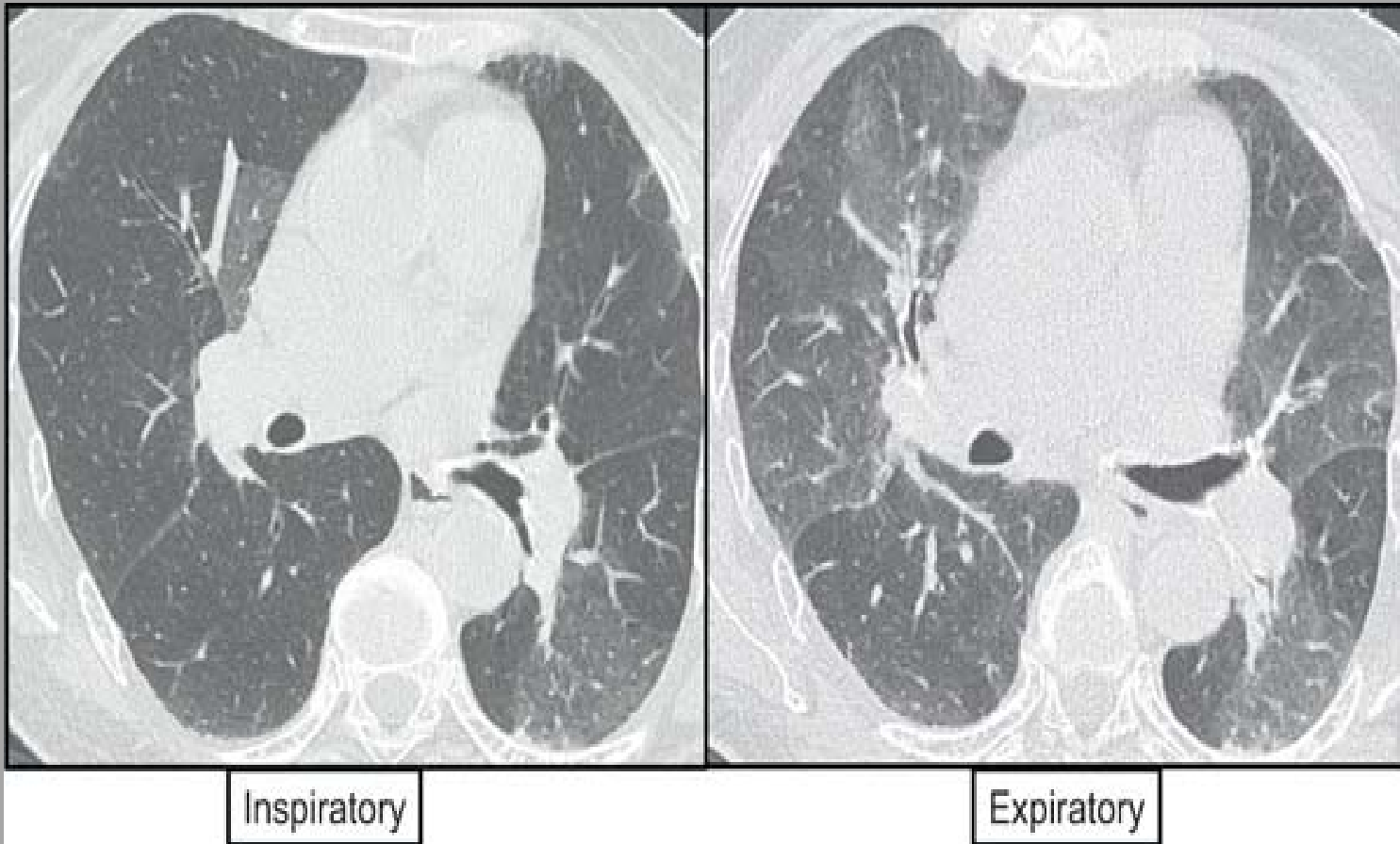
Normal bronchiole



Asthmatic bronchiole



Constrictive Bronchiolitis



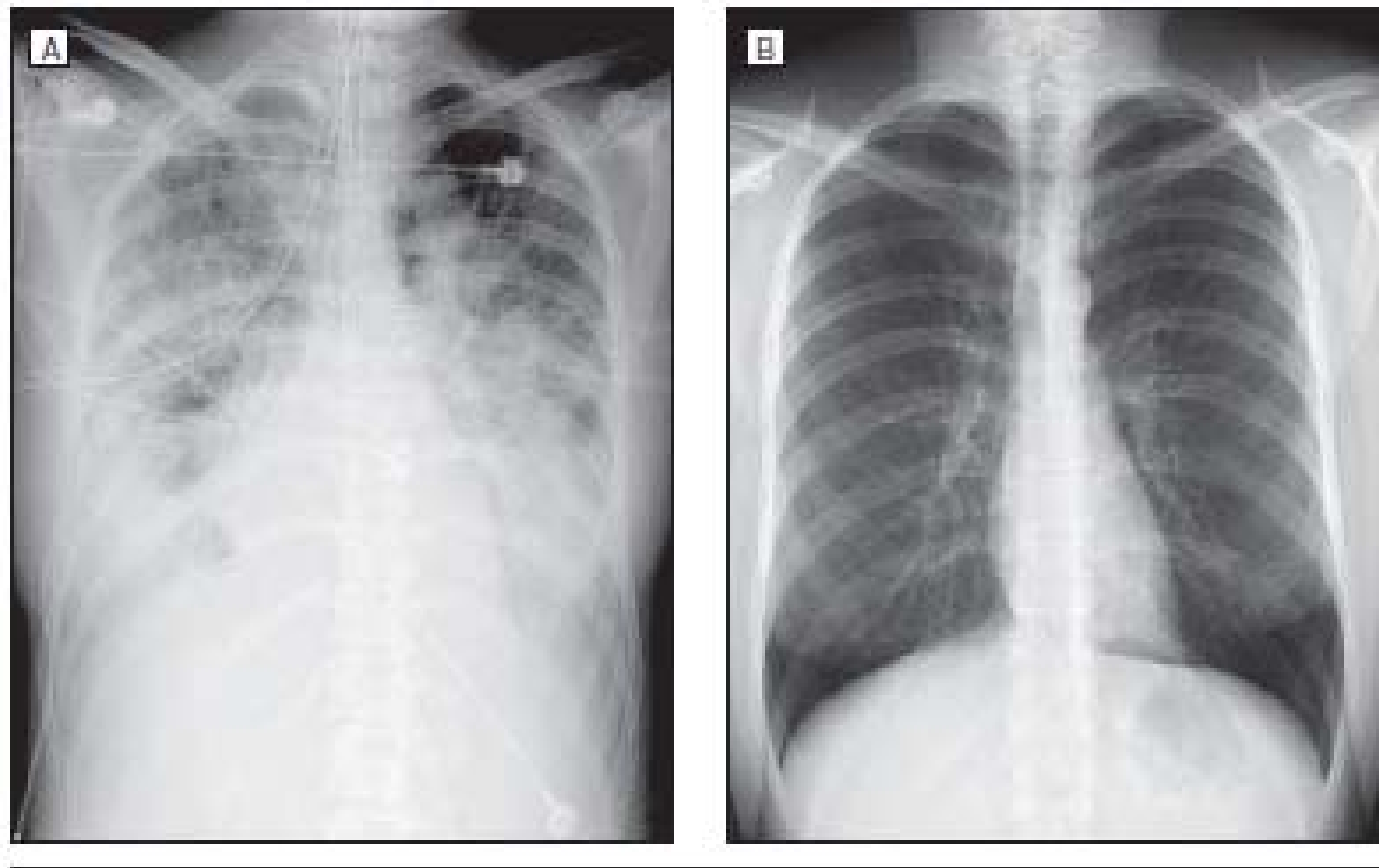
Constrictive Bronchiolitis

Table 3. Pathological Features of Biopsy Samples Obtained from 38 Soldiers with Constrictive Bronchiolitis.

Variable	No. of Patients
Bronchiolar luminal constriction*	38
Predominant constrictive stroma	
Smooth muscle	7
Fibrous tissue	3
Mixed	28
Pigment deposition	37
Polarizable material within pigment	36
Peribronchiolar inflammation	34
Hypertensive-type arterial change	28
Respiratory bronchiolitis	27
Prominent bronchial-associated lymphoid tissue	19
Mucus plugging	13
Eosinophils in bronchiolar wall	7
Luminal granulation	2
Obliteration of bronchioles	0

* On average, luminal constriction was observed in 64% of sampled terminal and respiratory bronchioles (95% confidence interval, 57.6 to 71.0 on non-parametric bootstrap analysis).

Acute Eosinophilic Pneumonia



Shorr, et. al. JAMA 2004; 292 (24): 2997-3005.

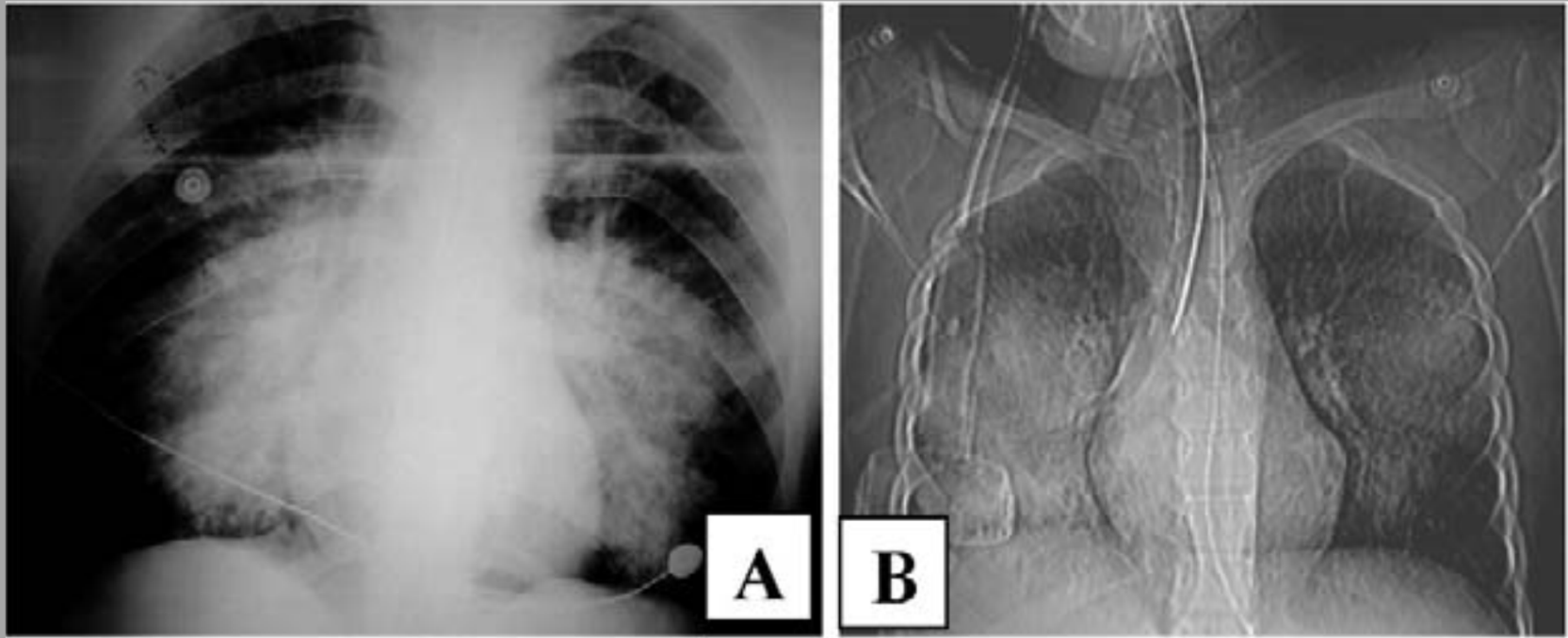
Blast Lung Injury

- Fatal blast lung injury can occur in the absence of any other external signs of trauma.
 - Symptoms could be delayed but may include: respiratory distress, restlessness, hemoptysis, cyanosis and hypoxemia.

Blast Lung Injury

- The lung is highly susceptible for primary blast injury.
- Sequence of injury from blast explosions:
 - Tissue damage from the blast short wave
 - Material propelled into the casualty
 - Casualty propelled against other objects
 - Heat, chemicals and toxins delivered by the explosive device
 - Systemic inflammatory response to the injury

Blast Lung Injury



Blast Lung Injury

- 805 enlisted Army National Guard and Reserve soldiers deployed to Iraq or Afghanistan
 - 15.2% reported exposure to 1 blast
 - 9.4% exposed to 2
 - 7.7% exposed to 3
 - 28.5% exposed to 5 or more blasts

Blast Lung Injury

- Mackenzie et. al. *Phil. Trans. R. Soc. B* 2011 366.
 - 107 cases referred to this hospital for care of blast lung injury between July 2008 to January 2010
 - 2 cases considered for ECMO-both able to be managed with HFOV
 - No fatalities as a result of lung injury

Tobacco and the military

- Smoking is one of the best predictors of military training failure
- Smokers are more likely to perform poorly on military fitness evaluations
- Rates of smokeless tobacco have increased from 11.7% to 13.6% since 1998.

Tobacco and the Military

Group	Any Smoking	Heavy Smoking**
All Branches	30.0%	9.5%
Army	33.3%	12.5% [†]
Navy	31.2%	9.3%
Marine Corps	31.0%	9.8%
Air Force	24.6% [†]	6.6% [†]

Smoking Rate in the United States Armed Forces (2008)*

* Heavy smoking is defined in the Department of Defense survey as one or more packs per day.

** Smoking rates are adjusted to account for differences between the groups in key demographics. This allows for comparison of smoking rates among groups.

† Rate is significantly different when compared to other branches.

Tobacco and the Military

- Increase in tobacco use among young enlisted military members
- Military is an important market for tobacco industry



Tobacco and the Military

- Tobacco is often seen as a method to combat stress, boredom and to avoid weight gain
- More than half of active smokers increased their tobacco consumption during deployment

Tobacco and the Military

- Tobacco costs Department of Defense \$1.6 billion per year
 - Tobacco related medical care
 - Increased hospitalization
 - Lost days of work
- Veterans affairs spent over \$5 billion in 2008 to treat COPD

Management of Deployment Related Pulmonary Diseases



TABLE 1. Recommended Components of Pre- and Postdeployment Medical Surveillance

Standardized questionnaire eliciting

Smoking history

Pertinent medical history

Respiratory symptoms

Spirometry (before and after bronchodilator)

Exercise capacity evaluation (Physical Readiness Test) including 1- or 2-mile run times

Rose, et al. JOEM 2012; 54(6):746-751.

Management of Deployment Related Pulmonary Diseases

TABLE 2. Findings on Postdeployment Medical Testing That Should Prompt Diagnostic Referral

Persistent (more than 3 months), unexplained cough, shortness of breath, or wheezing/chest tightness
Any abnormal spirometry pattern (below the lower limit of normal)
Excessive decline in forced expiratory volume in 1 s or forced vital capacity, defined as a 15% or more decrease in either parameter between pre- and postdeployment testing, even if spirometry is within the normal range
A 10% or more decline comparing pre- and postdeployment spirometry if new onset respiratory symptoms are also reported
Excessive decline in Physical Readiness Test compared with predeployment testing

Management of Deployment Related Pulmonary Diseases

TABLE 3. Recommended Approach to Diagnostic Testing for Postdeployment Patients Referred for Further Evaluation

Comprehensive medical questionnaire, including full occupational exposure history

Physical examination, with particular attention to cardiopulmonary findings and body mass index

Full pulmonary function tests (lung volumes, DLCO, pre- and postbronchodilator spirometry)

Methacholine challenge

High-resolution computed tomography—prone and supine, expiratory views

Maximum exercise tolerance testing with arterial blood gases and full metabolic exercise

Consider referral for surgical lung biopsy to assess constrictive bronchiolitis on a case-by-case basis

DLCO, diffusion capacity for carbon monoxide.

Future Concerns

- Difficult diagnosis
- Additional research in inhalational exposures
- Education
- COPD