

# Respiratory Health Effects from Particulate Matter Exposures in SWA



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# Outline

- **Novel Environment Conditions in SWA**
- **Background and Prior Studies**
- **Research Results PM 10 and airborne metals: Meehan, Ross, Rose and Baird**
- **Conclusions**

*Disclaimer: Opinions are those of R. Meehan and not those of the DOD, USN, or NCF*

# Source of Information

- **Author's experience:** Gulf War 1991 (FH 6 ICU physician) OEF 2008 (Al Anbar as NMCB 17 Battalion Surgeon), CO-Director National Jewish Autoimmune Lung Center 2003 , and **CHPPM study investigator with Coleen Baird, Ron Ross and Cecile Rose**
- **NJH Working group** with Cecile Rose “Post Deployment Respiratory Health Issues”, February 19, 2010
- **Publications:** DOD publications and Peer reviewed references

*1. Military Medicine Supplement July 2011 vol 176 1-110)*

# Sand, Dust, and Wind

- Dust Storms 20-50 days/year Iraq
- Fine particles < 2.5 microns easily lodge in terminal airways where macrophage clearance is needed.
- Increased inhalation ingestion due to: high temp, low humidity, increased minute ventilation with exercise and increased mouth breathing
- PM 10 of <150 ug/m<sup>3</sup> considered safe by EPA and National Ambient Air Quality Standards, yet CHPPM's Deployment Environmental Surveillance program in Iraq recorded levels which exceeded these levels 84% of time in Iraq (mean 360ug/M<sup>3</sup> and highest 46,000 ug/M<sup>3</sup>)<sup>1</sup>
- 1. *Heller JM DOD-NIOSH Particulate Matter Research Workshop Meeting proceedings Sept 2005*



# Burn Pits Balad Iraq, Jan – 2003 April 2007 \*



- Polycyclic Aromatic Hydrocarbons:
  - acenaphthylene, anthracene,
  - Benzo(pyrene/anthracene/pyrene/perylene,
  - fluoroanthene b and K), dibenzanthracene, fluorene,
  - naphthalene, pyrene, chrysene, fluoranthene,
  - indeno pyrene, phenanthrene
- Volatile Organic Compounds:
  - acetone, acrolein, benzene, carbon disulfide, chlorodifluoromethane, chloromethane, ethylbenzene, hexane hexachlorobutadiene, xylene, methylene chloride, pentane, propylene, styrene, toluene
- Toxic Organic Halogenated Dioxins and Furans- 17 different compounds

*\*USACHPPM Report no. 47-MA-08PV-08/AFIOH*

*\*USACHPPM fact sheet 64-007-0707 and VA Benefits Administration April 2010 Training*

*VA Letter 10-03 “Environmental Hazards in Iraq, Afghanistan and Other Military Installations”*

# Occupational Hazards

- Exhaust from **engines and fuel space heaters**
- Gases from **weapons** firing
- **Solvents** used to clean weapons
- Chemicals and metals from **painting** vehicles and equipment
- **Greases and oil** from vehicle maintenance repair
- **Detergents** used to clean equipment
- **Fuels** and refueling operations
- **IED Blast** closed spaces
- **Toxic smoke, gases, fumes**



*CHPPM Template for Health Risks of Deployment*

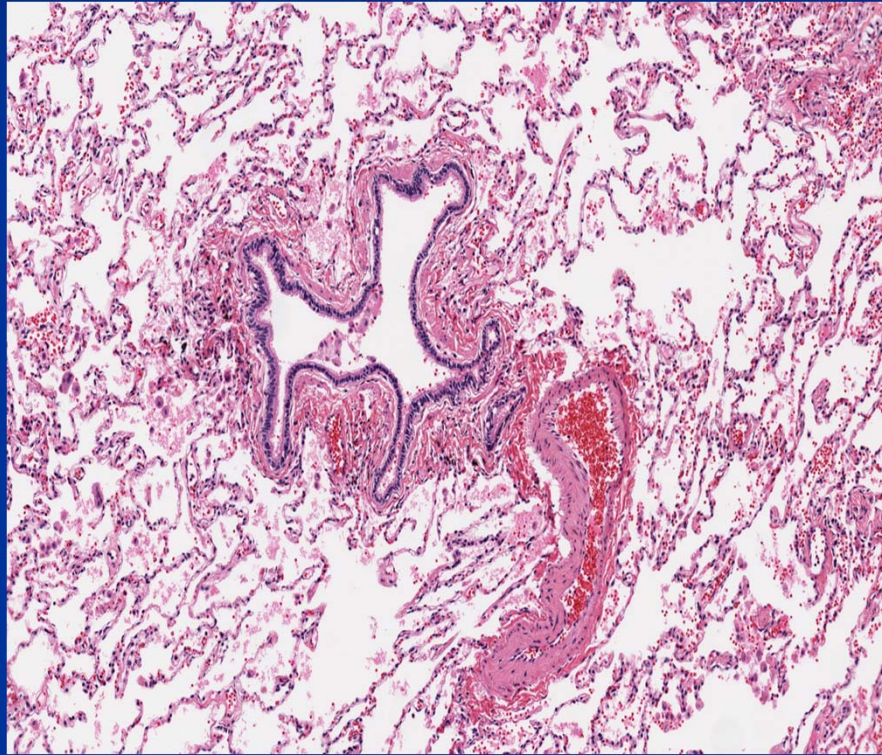
# Enviromental Air Pollution

- Location of Air Pollution Sources
  - Burning or Damaged Buildings
  - Open Burning/Waste Disposal
  - Vehicle/Generator Exhaust
- Contaminants
  - Dust, Silica, Asbestos, Lead
  - Organic Vapors and Organic Gases
- Industrial Facilities

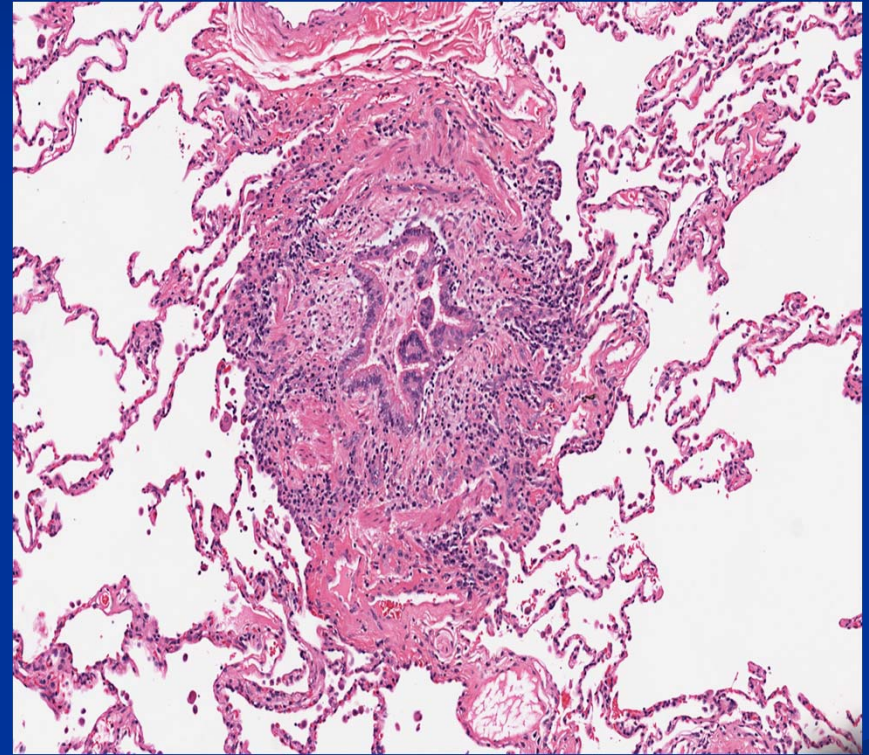


*CHPPM Template for Health Risks of Deployment*

## Normal bronchiole



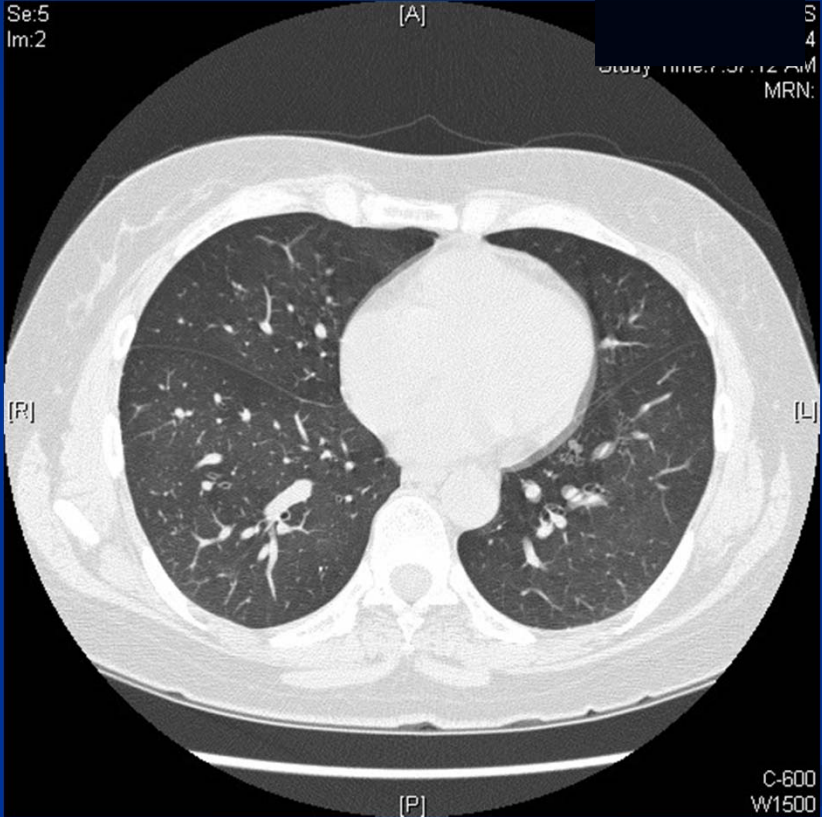
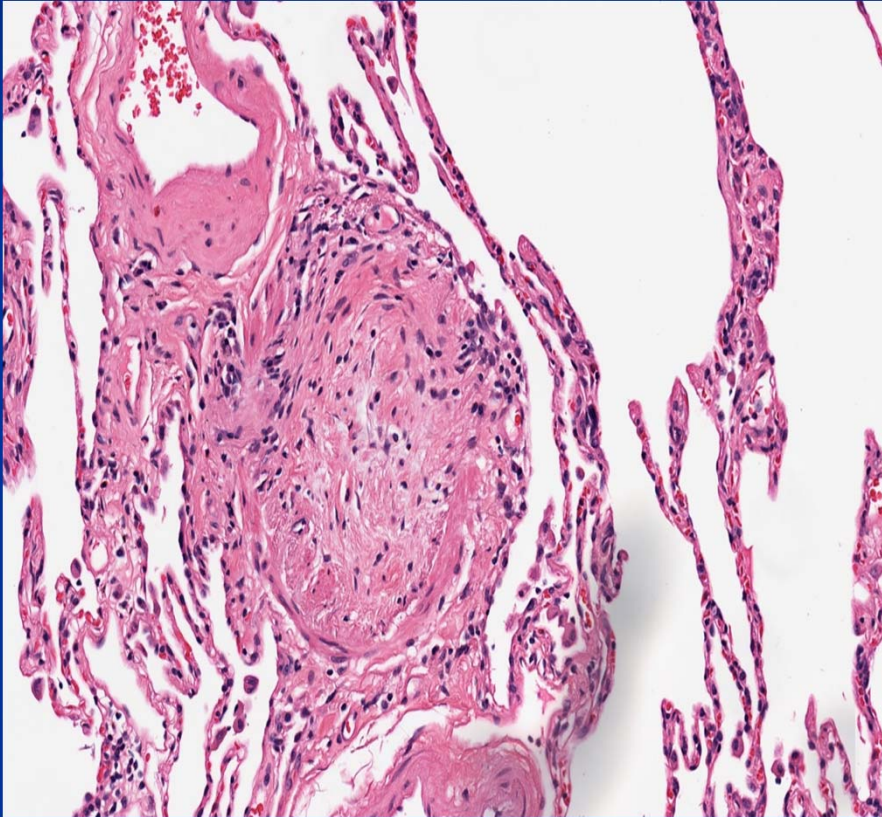
## Constrictive bronchiolitis





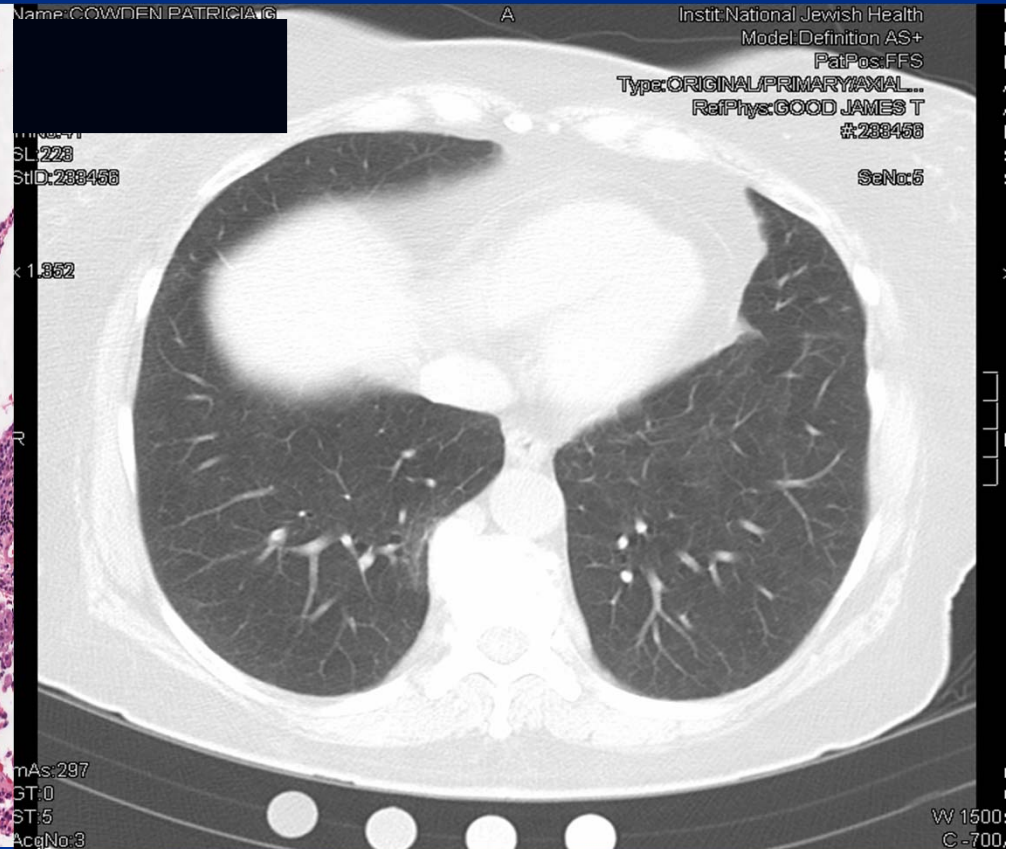
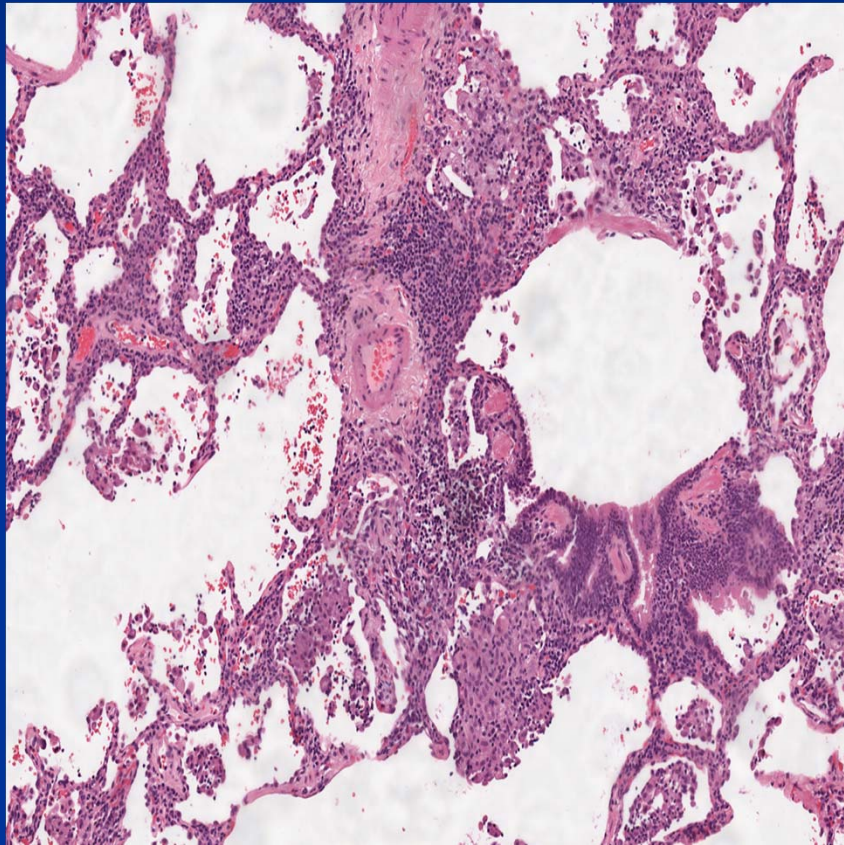
# Obliterative bronchiolitis

# CT



# Subacute HP

# CT



# Historical Overview of Military Pulmonary Illnesses Associated with Inhalation Exposure

- Gulf War “**Kuwait Oil Fires**” 1991
- OIF
  - **Eosinophilic Pneumonitis**
  - Mishraq State **Sulfur Mine Fire** 2003 and **CB** (RF Miller-Vanderbilt)
  - **VA Asthma Studies** (AM Szema-Stony Brook Northport VA)
  - **Self-reported symptoms: PDHRA and Millennium Cohort Studies**
- **WTC** results

# Gulf War '90-'91 Operation “Desert Shield” and “Desert Storm”

- Feb - Nov 1991, 605 of 854 Kuwait Oil rigs burned, exposing 694,00 troops down wind to high amounts of airborne particulates
- Kuwait Oil Fire Biologic Surveillance Initiative (KOF-BSI) IRB- approved CHPPM led cohort study pre, during, and post deployment of 3,000 troops (questionnaires, MTF log, particulate measurements, urine testing) concluded not a cause of Gulf War Syndrome
- Increased self-report of respiratory symptoms (1)
- No higher incidence of hospitalization rates for respiratory ICD-9 codes in DOD MTF 1991-1999 among 405,142 Active duty US Military (2)

1. *Petrucelli BP et al J Occ Environmental Med 1999; 41:433-43*

2. *Smith T, Heller et al Am J Epidemiol 2002:155;908-17*

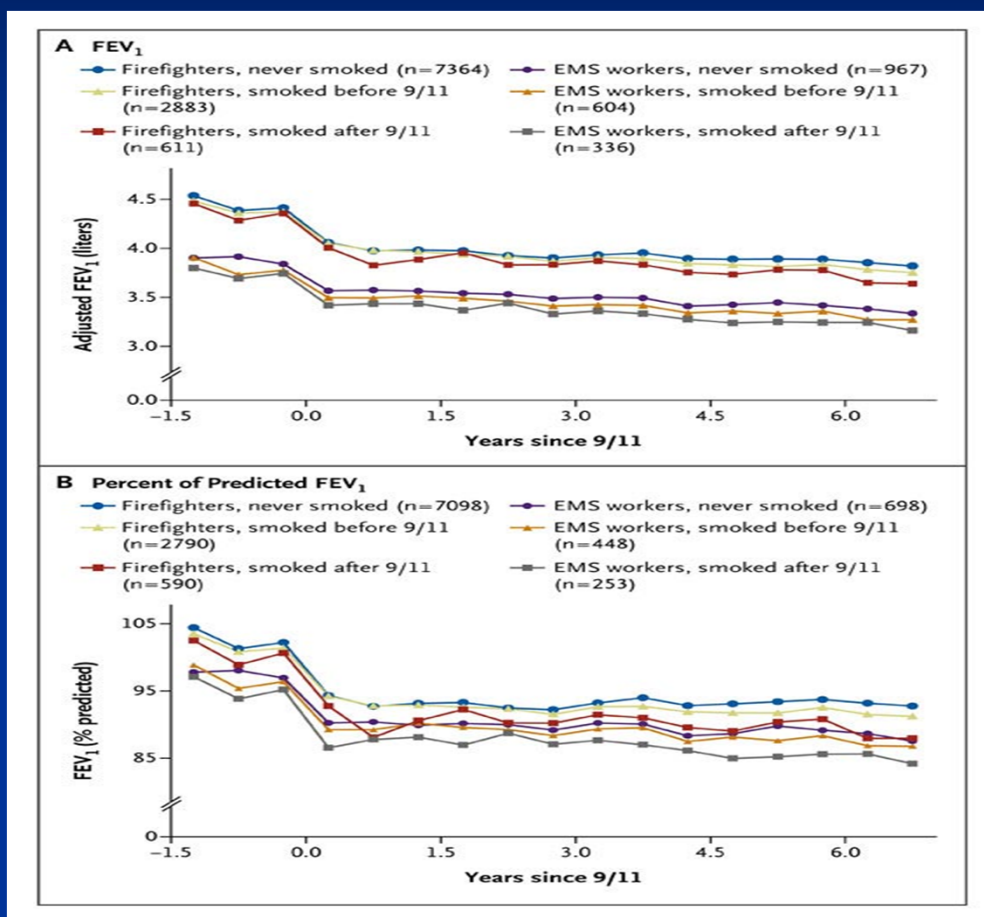
2001 NYC This Generation's "Pearl Harbor"



## WTC Results\*

- 10,870 firefighters and 1,911 EMS rescue workers participating in pre vs. post-spirometry study.
  - Post WTC attack, a 439 ml fall in FEV1 (10%) was noted first 12 months, with no improvement over the following 6 years (declines of 600 ml for Firefighters and 500ml for EMS) vs. average loss of FEV/yr this age group is 30 ml (180 ml/6 years)
  - While firefighters and EMS workers and smokers/non smokers had similar declines, the baseline values of FEV 1 were higher for firefighters vs. EMS, as well as non-smokers vs. smokers
  - Demographics similar to our Seabees (age 40 FF and 37 yrs for EMS and 31% were smokers).
- \*Aldrich TK, Gustave J, Hall et al N Engl J M 2010; 362:1263-72

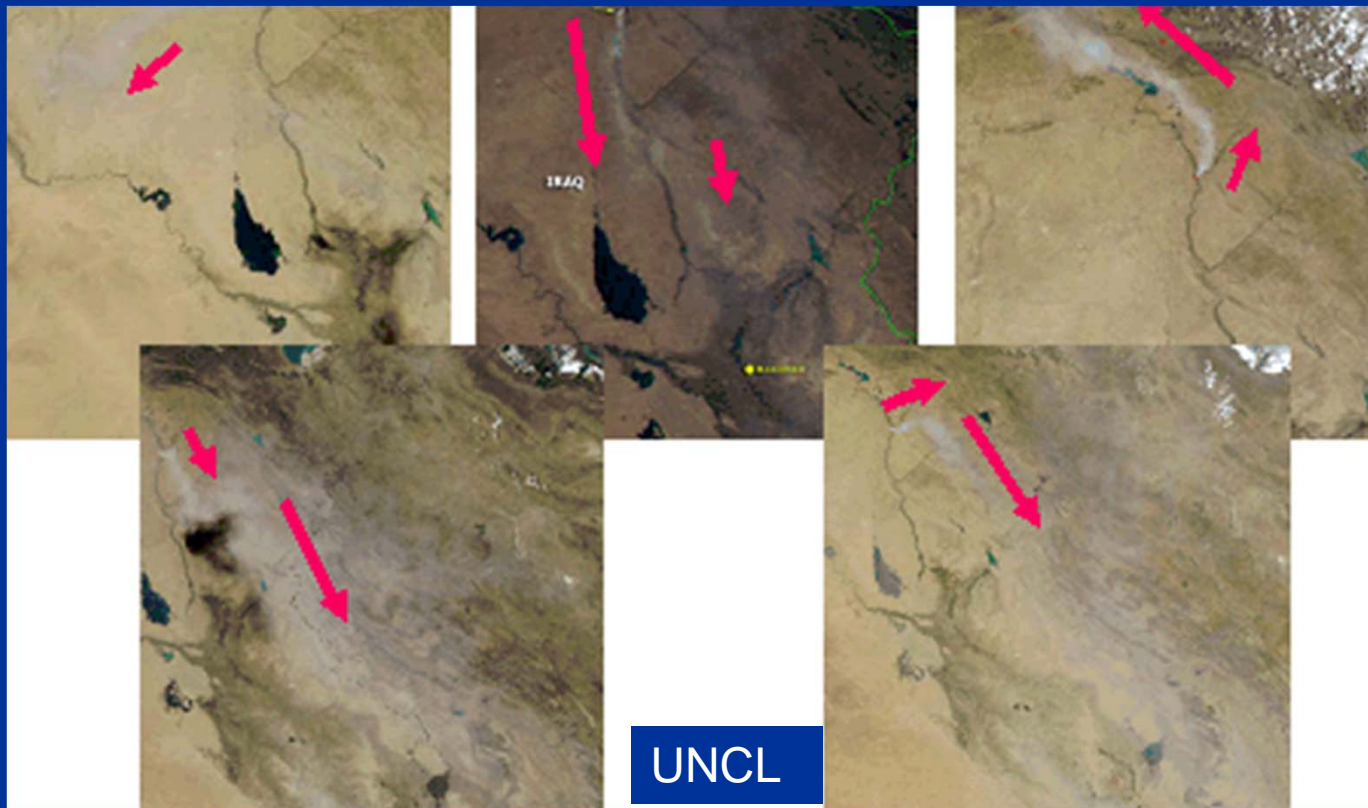
# Lung Function in Fire fighters and Emergency-Medical-Services (EMS) Workers, According to Smoking Status



# Misraq Sulfur Plant, Iraq

- Fire burns for ~ 3 weeks (24 June– 15 July 2003) producing 42 million tons of sulfur dioxide ( $\text{SO}_2$ ) per day and hydrogen sulfide ( $\text{H}_2\text{S}$ ) also released.

- 





# Mishraq State Sulfur Mine Fire 2003 and constrictive bronchiolitis

- 80 soldiers from Ft Campbell KY (101<sup>st</sup> Airborne) referred to Vanderbilt for unexplained SOB
  - 49 had VATS BX and all were abnormal;  
38 constrictive bronchiolitis, 2 each had hypersensitivity pneumonitis, sarcoidosis, and respiratory bronchiolitis;  
3 other diagnosis\*
  - 10 soldiers had no exposure to sulfur fire, yet had indistinguishable findings on bx
  - 24 of the 49 soldiers were disabled, one died at FU

*\*King MS, Eisenberg R, Newman J et al Bob Miller Constrictive Bronchiolitis in Soldiers Returning from Iraq and Afghanistan N Engl J Med 2011;365:222-30*

# Eosinophilic Pneumonia in US Military \*

- 18 cases AEP during 13 months 2003 - 2004 in Iraq 12, Kuwait 2, Djibouti 2, Qatar 1, Uzbek
  - 2 died (resp. failure during MEDEVAC, other of nosocomial infection) and 12 required VENT support
  - Age 19 - 47, all smokers, and 14 started during deployment, negative work-up for viral/parasite/CTD, and 94% reported fine dust exposure
  - All had alveolar infiltrates, peripheral EOS (850-6,600), 6 had BAL (25-74% EOS)
  - All rapidly MEDEVAC, 3 improved without CS
  - Prevalence 9/100,000

\* *Shorr AF, Scoville SL et al JAMA 2004;292:2997-05*

# Post-Deployment **Self-Reported Health Status**

## 1. **Gulf War**

Deployed vs. non-deployed reported higher rates of asthma (7.2% vs. 4.1%) and bronchitis (3.7% vs. 2.7%) on phone interviews of 3,695 subjects

## 2. **Millennium Cohort Study**

35,324 deployed vs. 10,753 non-deployed, OIF/OEF Vets  
baseline 2001-2003 vs. follow-up 2004-2006

- a. Increase reported respiratory symptoms 14% vs. 10% independent of smoking status, yet no difference in asthma/chronic bronchitis (1%) or asthma (1%)

*1. Persian Gulf Study Group JAMA 1997; 227:238-245*

*2. Smith B, Wong C, Smith T et al Am J Epidemiology 2009; 170:1433-1442*

# Post-Deployment Self-Reported Health Status

**PDHA Results** from Sept '07 to Aug '08  
from 367,000 OIF/OEF deployers:

- “Fair to poor” increased from 3% pre to 13% post deployment
- AC vs. RC post-deployment; worse health (22% vs. 33%) and higher exposure concerns (22% vs. 34%)

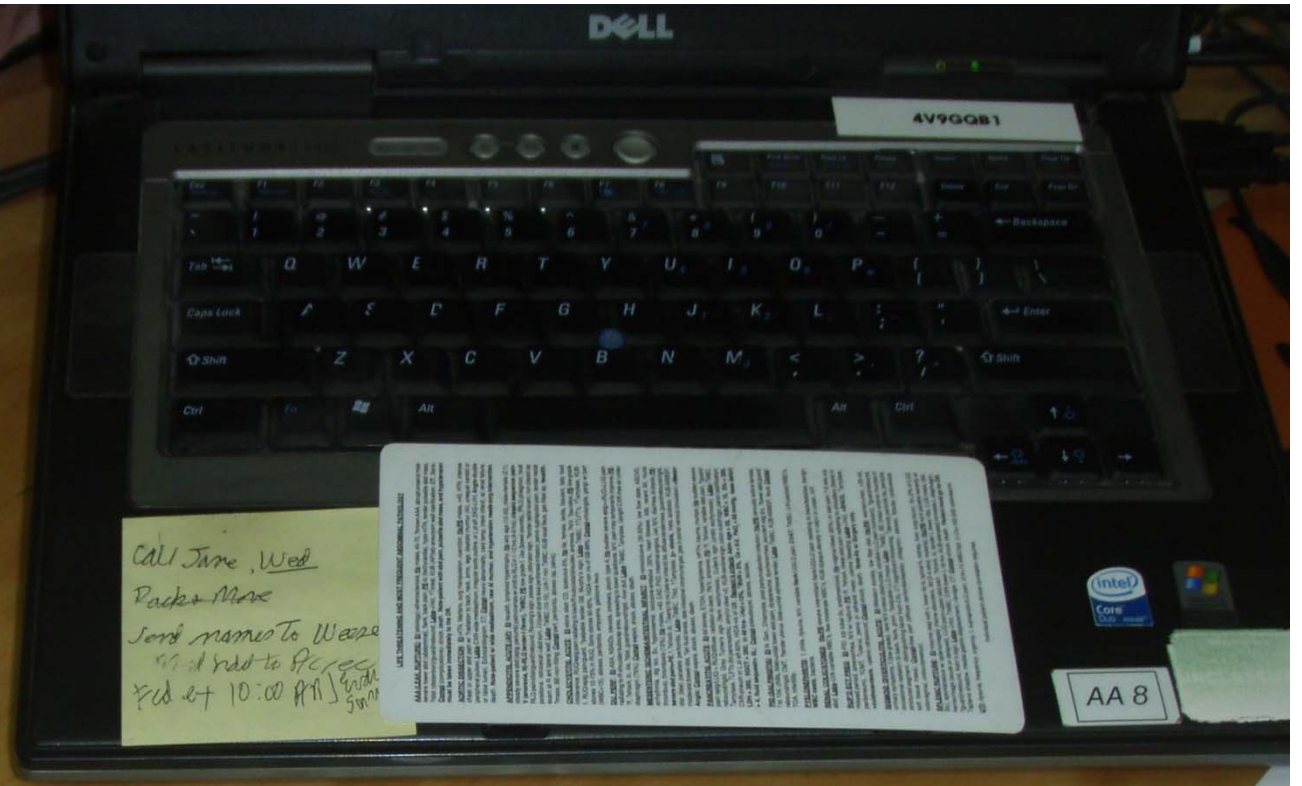
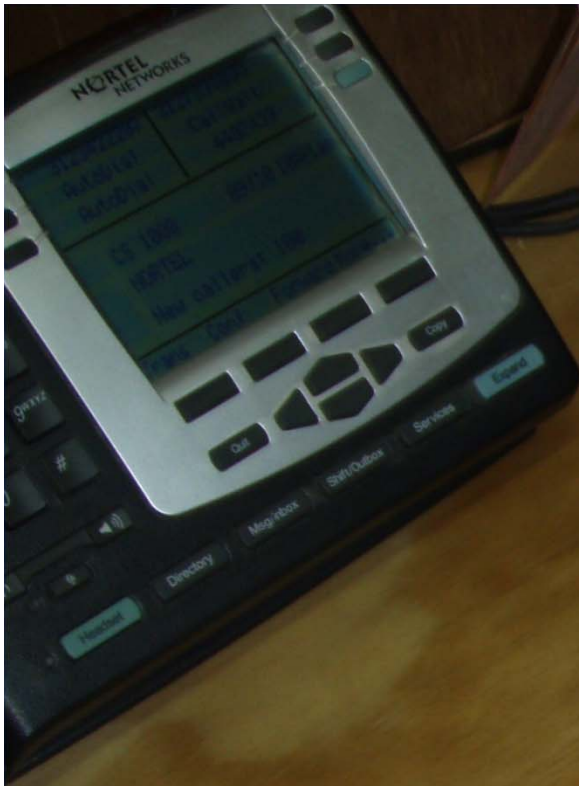
*MSMR Sept 2008 Vol 15 No 7 24-28*

# PM 10 Levels and Airborne Metals Al Anbar

## ■ Methods

- Airmetrics MiniVol Air Sampler every 6 days for 24 hrs, April-Aug 2008, Al Asad Airbase, Iraq. Calibration confirmed by Col Ross on site and author operated data recorded
- PM 10 samples obtained on quartz filter discs and sealed cassettes, mailed to CHPPM for analysis





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# PM 10 Levels and Metals Values

## ■ Results:

- PM 10 levels average 190.92 ug/M3 with range of 13.1 to 576.8 ug/M3
- Detection of following metals were low
  - < 0.6980 ug/M3      Zinc
  - < 0.2792 ug/M3      Manganese and Vanadium
  - < 0.1396 ug/M3      Antimony, Lead
  - < 0.0698 ug/M3      Arsenic, Beryllium, Cadmium, Chromium



# Clinical Impact

- No MEDEVACs, hospitalizations or loss of duty from respiratory illness among 500 Seabees, despite high PM 10 level exposure
- One new onset asthma developed in only one Seabee and one Seabee with stable asthma (controlled with inhalers) did not have any exacerbations
- BAS visits for respiratory complaints was highest in the first month (only MSK injuries were greater), then fell to negligible levels remainder of 7 month deployment

# Adverse Respiratory Health Effects of Deployment

- Deployed VA pts < 1 yr had higher incidence of asthma 6.6%, than non-deployed VETS 4.3 % (1)
- Among VA patients from NY those deployed to Iraq or Afghanistan were 8 times more likely to have respiratory symptoms requiring spirometry than non deployers. (2)
- An association was observed between PM10 levels and respiratory infections in Bosnia (3), but not confirmed by CHPPM studies in Iraq

1. Szema et al. *New onset asthma among soldiers serving in Iraq and Afghanistan. Allergy Asthma Proc* 2010;31: 67-71
2. Szema et al *Respiratory Symptoms Necessitating spirometry among Soldiers with Iraq/Afghanistan War Lung Injury JOEM* 2011:00
3. *Hastings DL and Jardine S Mil Med* 2002;167:296-303

# Limitations on Post Deployment Respiratory Illness Data

- In theater data on illness reporting is difficult to interpret, as different services use different reporting systems, and many military personnel may report respiratory symptoms due to fear of job restriction, DeMob, or peer pressure
- Case definitions of post-deployment pulmonary disorders not standardized and may require VATS BX
- Compensation might influence subjective symptom reporting, or prevent many from accessing DOD healthcare providers (fear of discharge)

# Conclusions

- Airborne particulate exposures in Iraq frequently exceed OSHA and 2004 MEG (Military exposure guidelines)
- Despite exposure to high levels of PM 10 levels in Al Anbar during a 7 month deployment, respiratory symptoms or illnesses did not impact operational effectiveness nor lead to higher rates of respiratory illnesses in the short term
- OIF/OEF veterans rate themselves as having worse health post deployment and adverse health effects from inhalation exposure (dust, burn pits etc) is a major concern
- Airborne Exposures during deployment may contain novel chemicals and may increase risk of unusual pulmonary disorders among **susceptible** personnel
- 2.0 million deployed veterans have some differences from general populations: all were healthy prior to deployment, younger (age 22 AD vs. 37 RC), more fit, less obese and excluded if pre-existing illness (i.e., asthma), but higher % smoke (22 vs. 34% verify)

# Future Needs

- **Accurate risk exposure:** individual electronic mini-exposure dosimeters for airborne toxicants (chem, bio, industrial, dust). GPS tracking of members (location and duration) without compromising security
- **Epidemiology studies:**
  - **DOD Cohort studies: Deployers vs. Non-Deployers.** VA Longitudinal studies needed, since most leave service and lost to FU.
  - **Improve Clinical data merge DOD EMR (including in theater MTF data) with VA EMR and include PDHRA and pre-deployment baselines values (spirometry and run times)**
  - **Expand pre deployment serum and cells (DNA) repository which could be invaluable national resource for genetic susceptibility to diseases and gene environment interactions from 1 million healthy individuals**

## **Improved Clinical Outcomes:**

Need better case definition of deployment lung injury

Uniform evaluation of Vets with unexplained SOB

Pre deployment spirometry to assess severity of airflow obstruction

Multicenter consortiums (DOD,VA and Academic) of patient data



- Exposure to elevated PM 10 and especially PM 2.5 levels lead to greater ER admissions and deaths from cardiovascular and respiratory conditions (2)

- *2. Weese CB and Abraham JH. Inhalation Toxicology 2009; 21:291-296 for review*

# Research Into Particulate-Induced Lung Injury

- Mice exposed to diesel exhaust particles result in increased pulmonary dendritic cells in BAL, migration to mediastinal lymph nodes where enhanced differentiation of effector T cells and increased production of IL-4, IL-13, IL-10 and IFN gamma (*Provost S et al J Immunology 2010:184:426-432*)
- Systemic effects: increased risk of RA noted in 90,000 Nurses Health Study if live < 50 m from high traffic exposure area (*Hart JE et al Environmental Health Perspectives 2009; 117:1065-1069*)