Presentation 6 – Lea Steele & Christine Rasmussen

Health Outcomes in Relation to Petroleum Combustion Exposures During the Gulf War

Summary of Epidemiologic Findings

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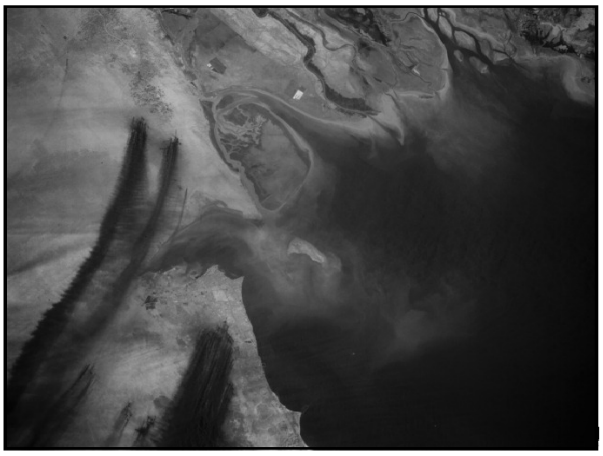

Epidemiologic Findings: Combustion Products and Health Outcomes

- General information: health effects of components of oil well smoke, jet fuel
- Epidemiologic findings in Gulf veterans in relation to:
  - Exposure to oil well fires
  - Exposure to tent heaters

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Toxicants Found in Oil Fire Smoke

- Ozone (O_3)
- Nitrogen Dioxide (NO_2)
- Sulfur Dioxide (SO_2)
- Carbon Monoxide (CO)
- Hydrogen Sulfide (H_2S)
- VOCs: Volatile organic compounds *(benzene, toluene, etc.)*
- PAHs: Polycyclic aromatic hydrocarbons *(anthracene, pyrene, etc.)*
- Particulate matter *(PM_{10}, $PM_{2.5}$, ultrafine particles)*
- Metals *(cadmium, chromium, lead, nickel, mercury, vanadium)*
- Acidic gases/aerosols *(hydrochloric acid, nitric acid, sulfuric acid)*

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Identified Health Effects of Oil Smoke Contaminants

Ozone	acute lung irritant; chronic structural damage
Nitrogen dioxide	deep lung irritant
Sulfur dioxide	upper airway irritant
Carbon monoxide	neurological, neurocognitive effects
Hydrogen sulfide	acute and chronic neurological effects

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Identified Health Effects of Oil Smoke Contaminants

VOCs	respiratory, neurological, cardiac, bone marrow effects, genotoxic, carcinogenic
PAHs	carcinogenic
Particulates	respiratory, cardiac effects
Metals	respiratory, neurological, gastrointestinal, hematological
Acidic gases/aerosols	acute respiratory effects

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Identified Health Effects of JP-8 Jet Fuel Exposure

AFIERA, 2001	Significantly elevated symptoms: dizziness, weakness, numbness/tingling, headache, blurred vision, cognitive problems, chemical allergy, SOB Measured performance deficits: - Postural sway - Neurocognitive testing - EBCC (eye blink classical conditioning) tests
Other studies	Impaired neurocognitive function, postural balance, EBCC

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Exposure to Petroleum Combustion Products in the Gulf War

Epidemiologic Findings

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Petroleum Combustion Exposures in the Gulf War: How Many Were Exposed?

Study	Population	Findings
Kang, 2000	11,441 US Gulf veterans	65% reported exposure to smoke from oil well fires 80% reported exposure to diesel, kerosene, petro fumes 30% consumed food contaminated w/ oil, smoke
Unwin, 1999	3,284 UK Gulf veterans	72% reported oil well fire smoke exposure 78% reported exposure to exhaust from heaters 84% reported exposure to diesel/petrochem fumes
Cherry, 2001	7,971 UK Gulf veterans	61% reported oil well fire exposure

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Exposure to Oil Well Fire Smoke: Short-term symptoms

Study	Population	Findings
Navy Prev. Med. after action report	2,700 Marines, March 1991	Marines with extended exposure to oil fires had higher rates of respiratory and GI symptoms Wheezing OR = 3.08 (1.92-4.95) Cough OR = 1.54 (1.17-2.02) Diarrhea OR = 2.19 (1.70-2.83) Naus/vomiting OR = 1.91 (1.21-3.01)
Petrucelli, 1999	1599 Army troops	While in Kuwait, personnel had sign. elevated rates of cough, respiratory irritation, burning eyes, SOB, higher rates associated with proximity to oil well fires. After return to Germany, only excess rate of cough persisted.

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Exposure to Oil Well Fire Smoke: Chronic Symptoms

Study	Outcome	Exposure	Findings
Cherry, 2001 (7,971 UK vets)	symptom score	sfr number of days exposed	sign. correlated w/ overall symptom severity no correlation with respiratory symptom score
Proctor, 1998 (220 New England vets)	symptoms (in groups)	sfr	no correlation between exposure and cardiac, neurological, or pulmonary symptoms

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Exposure to Oil Well Fire Smoke: **Symptom Complexes**

Study	Exposure	Outcome	Findings
Iowa Study, 1997 (1,896 Iowa vets)	s/r smoke, combustion products	cogn dysf symps FMS symps depression symps	sign prev diff (p<0.001) sign prev diff (p<0.001) sign prev diff (p<0.001)
Nisenbaum, 2000 (1,163 Air Guard vets)	s/r	mild-mod CMI severe CMI	OR = 1.29 (0.92-1.81) OR = 1.62 (0.79-3.35)
Spencer, 2001 (1,119 OR, WA vets)	eye irritation from burning oil wells	CMI	1-5 days: OR = 2.64 (1.34-5.20) 6 + days: OR = 4.47 (2.07-9.63)

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Exposure to Oil Well Fire Smoke: **Symptom Complexes**

Study	Exposure	Outcome	Findings
Unwin, 1999 (3,284 UK vets)	s/r	CMI	OR = 1.8 (1.5-2.1)
Wolfe, 2002 (945 Army vets)	s/r oil fire smoke odor	CMI	OR = 2.1 (1.4-3.2)
Gray, 2002 (11,868 Seabees)	modeled self-report	GWI	Bivariate: OR = 1.54 (1.31-1.80) Multivar: OR = 0.44 (0.26-0.73) Bivariate: OR = 2.22 (1.85-2.66) (s/r) Multivar: OR = 1.23 (0.91-1.65) (s/r)
Kang, 2002	consumed food contaminated with oil, smoke	Neuro symp factor	73% cases vs. 21% controls

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Gulf Veterans vs. Not Deployed: **Diagnosed Conditions**

Study	Exposure	Outcome	Findings	
Unwin, 1999 (3,284 UK vets)	PGW vs. nondeployed	self-reported medical dx	Asthma Bronchitis	OR = 1.8 (1.4-2.4) OR = 1.7 (1.2-2.3)
Iowa Study, 1997 (1,896 Iowa vets)	PGW vs. nondeployed	symptoms suggesting dx	Asthma Bronchitis	sign. prev difference sign. prev difference
Steele, 2001 (2,031 Kansas vets)	PGW vs. nondeployed	self-reported medical dx	Asthma Bronchitis	OR = 2.08 (1.02-4.26) OR = 2.61 (1.53-4.47)
Gray, 2002 (11,868 Seabees)	PGW vs. nondeployed	self-reported medical dx	Asthma	OR = 1.82 (1.23-2.69)
Goss-Gilroy, 1997 (Canadian vets)	PGW vs. nondeployed	symptoms suggesting dx	Asthma Bronchitis	OR = 2.64 (1.97-3.55) OR = 2.81 (2.22-3.55)
Kelsall, 2004 (1,456 Australian vets)	PGW vs. nondeployed	self-reported medical dx	Asthma Bronchitis	OR = 1.2 (0.8-1.8) OR = 1.1 (0.9-1.5)

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Exposure to Oil Well Fire Smoke: **Diagnosed Conditions**

Study	Exposure	Outcome	Findings	
Gray, 2002 (11,868 Seabees)	CHPPM models	self-reported medical diagnoses	Asthma Bronchitis	OR = 1.82 (1.23-2.69) OR = 1.49 (1.18-1.87)
Lange, 2002 (1,560 Iowa veterans)	s/r CHPPM models	symptoms of asthma, bronchitis	Asthma Bronchitis Asthma, Bronchitis: ORs= 0.77-1.26	ORs = 1.77-2.83 (s/r) ORs = 2.14-4.78 (s/r)
Kelsall, 2004 (1,456 Australian vets)	s/r exposure to "SMOIL"	self-reported medical diagnoses	Asthma Bronchitis	OR = 1.82 (1.23-2.69) OR = 1.49 (1.18-1.87)

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Exposure to Oil Well Fire Smoke: Diagnosed Conditions

Study	Exposure	Outcome	Findings
Smith, 2002 (405,142 active duty)	modeled, 6 exposure levels	hospitalizations	Overall, greater exposure associated with lower rates of hospitalization in most categories, with the exception of skin diseases (RR=1.35) and injuries (RR=1.11)
	exposed vs. not exposed		Asthma RR=0.90 (0.74-1.0) Chr. bronchitis RR=0.78 (0.33-1.57) Emphysema RR=1.36 (0.62-2.99) Resp. neoplasms RR=1.10 (0.56-2.17) Other resp dx RR=1.45 (0.86-2.46) Isch heart disease RR=0.82 (0.68-0.99)
Cowan, 2002 (873 cases, 2464 controls from CCEP)	strand CHPPM models	dx asthma	(next presentation)

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Exposure to Tent Heaters and Fuels:

Study	Outcome	Exposure	Findings
Proctor, 1998 (220 Army vets)	symptoms (groups)	smoke from tent heaters	Sign. correlated with cardiac, neurological, and pulmonary symptoms (p<0.001)
Wolfe, 2002 (945 Army vets)	CMI	heater in tent	OR=1.6 (1.0-2.5)
Spencer, 2001 (1,119 ORNA vets)	CMI	diesel heater kerosene heater potbelly heater cleaned heaters contact with fuel	OR = 1.78 (0.93-3.42) OR = 1.92 (0.93-4.00) OR = 2.31 (1.14-4.66) OR = 2.41 (1.29-4.52) OR = 3.76 (1.99-7.12)
Unwin, 2002 (3,284 UK vets)	CMI	exhaust from heaters diesel/petro fumes	OR = 1.9 (1.6-2.2) OR = 2.1 (1.7-2.5)
Gray, 2002 (11,868 Seabees)	GWI	jet fuel burned in tent heaters	OR = 2.12 (1.81-2.49) (unadj) OR = 1.11 (0.93-1.39) (saturated)

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Summary of Epidemiologic Findings: General Points

- **Results differ by how exposure is assessed**
  - Self reported: yes/no vs. graded exposures
  - Self-reported exposure vs. modeled exposure
  - Unadjusted vs. adjusted estimates (possible confounding)
- **Results differ by health outcome of interest**
  - Respiratory symptoms, other defined symptoms types
  - Multisymptom illness complexes (vary with definition)
  - Diagnosed medical conditions

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Summary of Epidemiologic Findings

- 65-80% of Gulf vets report some exposure to oil fire smoke during deployment; duration and intensity vary
- ~ 80% of Gulf vets report exposure to other petrochemical fumes, exhaust from tent heaters
- 30% report eating food contaminated with oil or smoke

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Summary of Epidemiologic Findings

- Deployment to the Gulf War is associated with:
  - excess rates of respiratory symptoms
  - excess self-reported diagnoses of asthma and bronchitis (generally ~ twice the rate of nondeployed)

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Summary of Epidemiologic Findings

- Among veterans who served in the Gulf War, self-reported exposure to oil fire smoke associated with:
  - Short-term (but not chronic) respiratory symptoms
  - Symptoms of/self-reported asthma (ORs~1.8 - 2.8), chronic bronchitis
  - Chronic multisymptom conditions (ORs~1.5 - 4.5) (possible dose-response effect—proximity and duration)

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Summary of Epidemiologic Findings

- Modeled exposure to oil fire smoke associated with:
  - *Mixed findings*

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Summary of Epidemiologic Findings

- Exposure to tent heaters is associated with:
  - Cardiac, neurological, and pulmonary symptoms
  - Chronic multisymptom illness (ORs ~ 2.0)
- Jet fuel: little information from Gulf veteran epidemiologic studies

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