Airway, Digestive, and Mental Health Comorbidities in WTC Responders and Survivors

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Learning Objectives

- Identify the groups of individuals affected by the 9/11 terrorist attack and environmental disaster and their range of exposures
- Describe acute and longer-term aerodigestive and mental health impacts on populations exposed to the WTC disaster
- Describe the benefits of a patient-centered, multidisciplinary program in managing 9/11 exposure-related medical and mental health comorbidities

Populations With Potential WTC Dust Exposure

Rescue and Recovery Workers

- Rescue and Recovery Workers
  - First responders
    - Members of the Fire Department of New York (FDNY)
    - Members of the New York Police Department
  - Rescue and Recovery
    - Construction workers, volunteers, and other personnel who worked on the pile, did "bucket brigade" or activities to find survivors, put out the fires, demolished and removed the damaged buildings
    - Cleanup workers who cleaned the surrounding residential and commercial buildings and streets

Populations With Potential WTC Dust Exposure

Community "Survivors"

- Community members, under the Zadroga Act, now called "Survivors"
  - Building evacuees who worked in the towers and collapsing buildings
  - Local workers who worked in commercial spaces, buildings, or street (street vendors)
  - Local residents who lived in the surrounding areas
  - Students and teachers in the surrounding nursery, elementary, middle and high schools, and colleges
  - Passers-by who were in the area as tourists, commuters, or on other business on 9/11

Chemical Constituents of WTC Dusts

- Combustion of jet fuel
- Combustion products of plastics, metals, woods, insulation, fluorescent lights, computer and video monitors
- Particulate matter
  - Calcium sulfate (gypsum)
  - Calcium carbonate
  - Crystalline silica
- Fibers
  - Fibrous glass
  - Gypsum fibers
  - Chrysotile asbestos
- Organic pollutants
  - Polycyclic aromatic hydrocarbons
- Hydrocarbons
  - Napthalene
  - Polychlorinated biphenyls (PCBs)
  - Dioxins
  - Benzene
- Heavy metals
  - Mercury
  - Lead
- Alkaline pH 9-11
  - The larger the size, the more alkaline the pH

Banauch GI, et al. *Curr Opinion Pulm Med*. 2005;11:160-168.[1]

Exposures to These Dusts Resulted in Particulate Matter in the Lungs

- Inhalation of dusts resulted in lung deposition of particles often of large size, consistent with overwhelming normal protective pulmonary mechanisms
  - Bronchoalveolar lavage in firefighter several weeks after the event showed large particles in alveolar space[a]
  - On day 1, less than 20% of FDNY reported wearing a mask, of any type, most of the time[b]
  - Sputum collected 10 months after 9/11 still contained WTC dust[c]
  - Pathologic specimens of lung biopsies in "Survivor" population showed particles with characteristics consistent with WTC dust[d]

a. Rom WN, et al. *Am J Respir Crit Care Med*. 2002;166:797-800[2]; b. Prezant DJ, et al. *MMWR Morb Mortal Wkly Rep*. 2002;51:6-8[3]; c. Fireman EM, et al. Environ Health Perspect. 2004;112:1564-1569[4]; d. Caplan-Shaw CE, et al. *J Occup Environ Med*. 2011;53:981-991.[5]

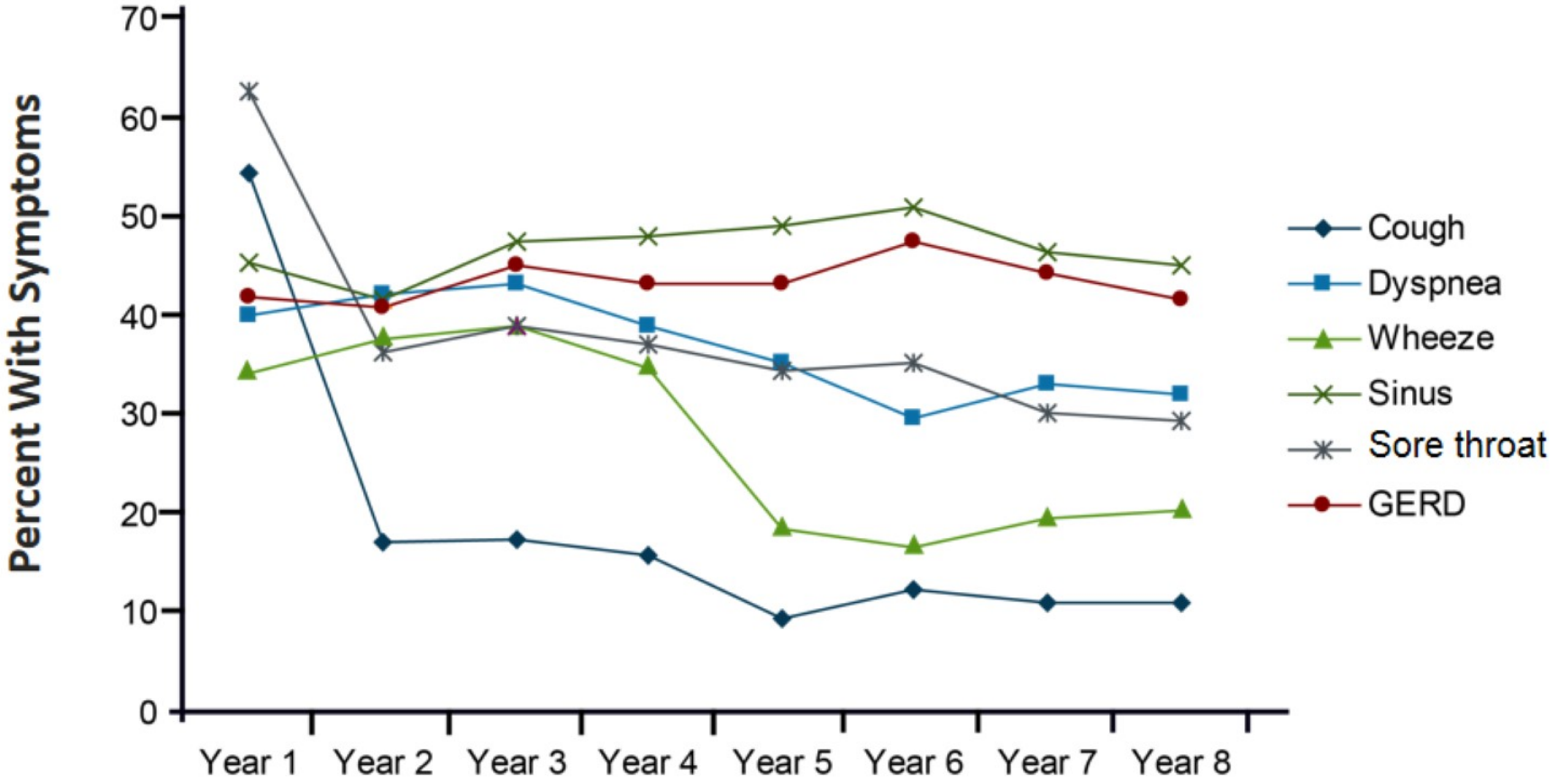
Potential Types of Acute or Chronic Environmental Exposures to WTC Dust

- Acute exposures
  - Caught in the initial debris or WTC dust clouds created by the collapsing buildings or heavy dust in the air on 9/11
  - Direct exposures to horrors of the disaster
  - Exposures to horrors of the disaster strongly correlate with acute environmental exposures
- Chronic exposures
  - Participation in rescue and recovery work
  - Participation in cleanup activities of surrounding buildings
  - Exposure to resuspended dust in local streets in months after 9/11
  - Exposure to resuspended dust and fumes from uncleaned or incompletely cleaned residential or commercial buildings, including recycling from ventilation systems as well as persistent fires

Pietrzak RH, et al. *J Psychiatr Res*. 2012;46:835-842.[6]

Respiratory Symptom Time Trends

Cross-sectional analysis (N = 11,315)

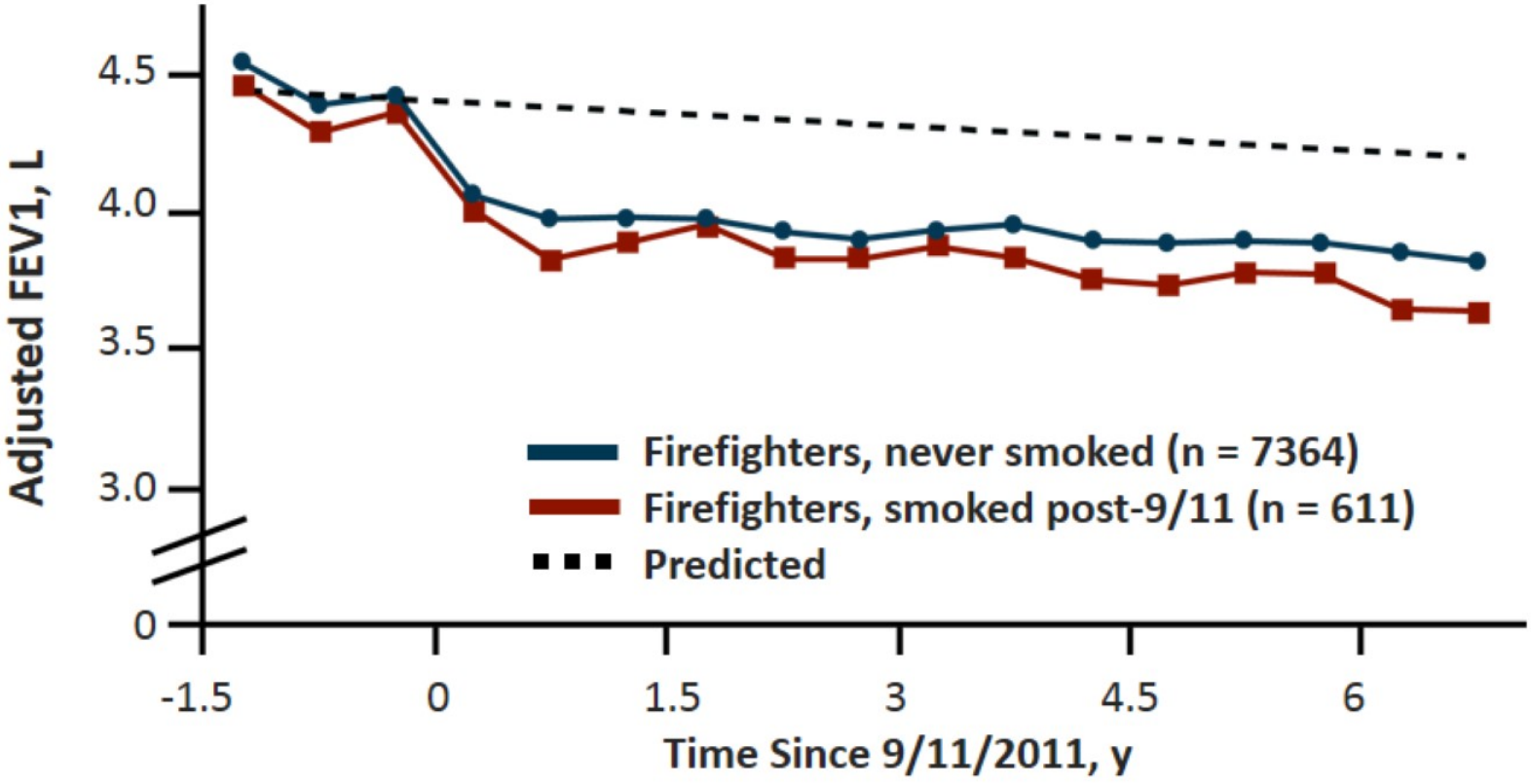


Not shown: + significant exposure response effect: arrival time duration.

Webber MP, et al. *Environ Health Perspect*. 2009;117:975-980.[7]

Lung Function in Firefighters Who Smoked

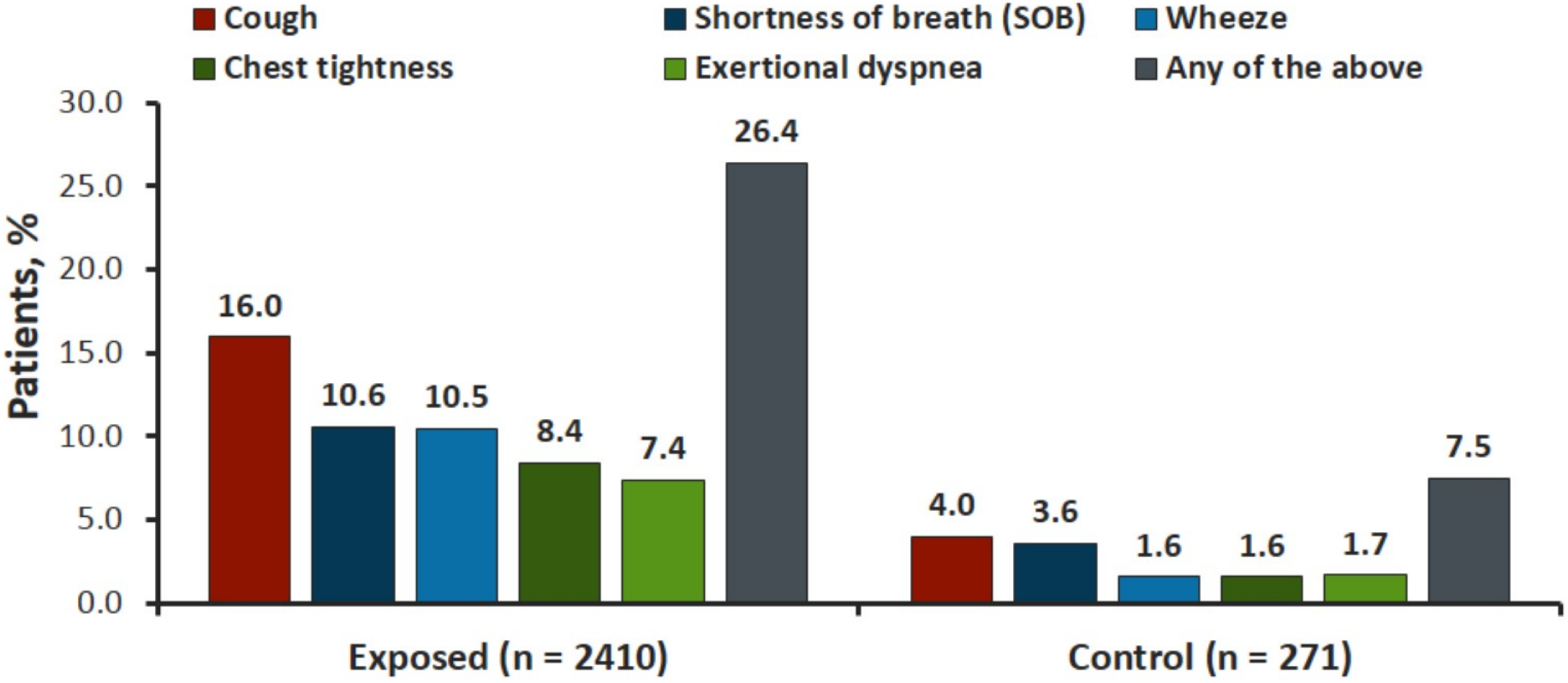
Decline September 11, 2001, to 2008



For both Fire & EMS (not shown), main impact was 9/11 exposure.

Aldrich TK, et al. *N Engl J Med*. 2010;362:1263-1272.[8]

New-Onset Respiratory Symptoms Increased in Previously Normal Exposed Residents



Symptom frequency > 2 days per week in the past 4 weeks.

*Effect still statistically significant after adjusting for age, gender, education, smoking, and race.

Reibman J, et al. *Environ Health Perspect*. 2005;113:406-411.[9]

WTC Health Registry

Risk Factors and Self-Report Event Exposures

- A total of 71,437 people enrolled in the WTCHR, for 17.4% coverage of the estimated eligible exposed population (nearly 410,000).
- Many reported:
  - Being in the dust cloud from the collapsing WTC towers (51%),
  - Witnessing traumatic events (70%)
  - Sustaining an injury (13%)
- After 9/11, 67% of adult enrollees reported new or worsening respiratory symptoms, 3% reported newly diagnosed asthma.
- Newly diagnosed asthma was most common among rescue and recovery workers who worked on the debris pile (4.1%).

Farfel M, et al. *J Urban Health*. 2008;85:880-909.[10]

Common Physical Illnesses/Complaints

- Respiratory problems
  - Asthma or asthma like symptoms
  - Shortness of breath
  - Chronic cough
  - Upper respiratory/lower respiratory problems
  - Obstructive sleep apnea
- GERD
  - Acid and nonacid reflux
- Musculoskeletal
- Sarcoidosis
- Select cancers

Common Mental Health Disorders

- Posttraumatic stress disorder
- Anxiety
- Depression
- Substance misuse (ie, tobacco, alcohol, cannabis)
- Adjustment disorders
- Symptoms common to these conditions:
  - Insomnia
  - Irritability
  - Attention/concentration

PTSD Diagnostic Criteria

A. Stressor
B. Intrusion symptoms
C. Avoidance
D. Negative alterations in cognition and mood
E. Alterations in arousal and reactivity
F. Duration
G. Functional significance
H. Exclusion of medication, substance use, or other illness
   - Delayed onset > 6 mo after traumatic event

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 2013.[11]

Case Study #1

WTC Survivor: Mary (38 years old)

- On 9/11, the patient was working on the 42nd floor of one of the WTC towers. She heard a commotion and smelled smoke but did not know what was going on. Her senior advisor told her to stay put, but she was scared and decided to leave her office. Most of her officemates did not leave.
- She had difficulty making it down the stairs. Once outside the building, she ran uptown. She had only gone a few block, when the towers collapsed, and she was caught in cloud of dust created by the collapse.
- It was so dark that she could not see in front of her and she tripped and fell down. She thought she was going to die and was very panicked. Someone grabbed her, pulled her up, and helped her walk to the Brooklyn Bridge. She walked home to Brooklyn, covered in dust.

Case Study #1 (cont)

WTC Survivor: Mary (38 years old)

- 1 mo later she developed nasal congestion, sinus fullness, shortness of breath, and severe acid reflux. She sought extensive medical care for these symptoms but currently has the following:
  - Daily nasal congestion and sinus fullness
  - Daily cough that embarrasses her in public
  - Chest tightness daily with minimal activity, wheezing only 1x/wk
  - Dyspnea on exertion and can only walk 5 blocks, after which she has to stop
- Although her workplace relocated, she couldn't return to work. She was afraid to go in tunnels or use public transportation. She tried to get a local job, but because of her cough, no one wanted to work next to her.
- She is currently unemployed.
- She has recurring nightmares.
- This person is a community member/survivor who carries a diagnosis of chronic sinusitis, chronic asthma, acid reflux, PTSD, and depression.

Interplay of Mental and Physical Health

- Respiratory symptoms can cause psychological distress or function as triggers/reminders of the traumatic event
- (Mis)perception of asthma and panic/anxiety symptoms
- (Mis)perception of deconditioning/fatigue and depressive symptoms
- Survivor guilt

a. Friedman SM, et al. *Am J Ind Med*. 2013;56:1251-1261[12]; b. Kotov R, et al. *Psychosom Med*. 2015;77:438-448[13]; c. Leikauf J, et al. *Psychiatr Serv*. 2013;64:1173-1176.[14]

Common Factors Associated With Comorbid Lower Respiratory Symptoms and PTSD Among Responders and Survivors

- Intense exposure to dust cloud on 9/11
- Work exposure measures
- Exposure to dust in workplace or home
- Lack of social support
- Pre-9/11 diagnosed depression
- Education level
- Net effect: more than 40% experience significant disability

Friedman SM, et al. *Am J Ind Med*. 2013;56:1251-1261.[12]

Co-occurrence of Lower Respiratory Symptoms and PTSD

- Evidence in all impacted populations
  - Rescue, recovery, and cleanup workers
  - Registry responders
- Variability among specific populations
  - Fewer police than nontraditional responders had probable PTSD and respiratory symptoms, but pulmonary function similar
  - PTSD and respiratory symptoms moderately correlated in both groups
  - Exposure more strongly associated with respiratory symptoms than PTSD or lung function

a. Pietrzak J, et al. Psychiatric Res. 2012;46:835-842.[6] b. Friedman SM, et al. *Am J Ind Med*. 2013;56:1251-1261.[12]

Acute Exposure-Related Stressors

- 3 exposures associated with greater PTSD risk in both responders and civilians:
  - Physical injury on 9/11
  - Witnessing horror (death and destruction)
  - Loss of loved ones and colleagues

Liu B, et al. *PLoS ONE*. 2014;9:e101491.[15]

Longer-Term Psychological Triggers

- Development of a chronic and/or disabling medical Illness
- Continuous exposure to toxins and images of disaster
- Loss of home, job, income, social supports
- Current events (direct or indirect exposure)
  - Hurricane Sandy; Newtown, CT, shootings; colleagues getting sick; Boston Marathon bombing; etc.

Recommended Treatment

Mary

- Full medical evaluation (upper/lower respiratory; GI); treatment based on guidelines
- Comprehensive mental health evaluation
- Treatment involves both mental health and medical treatment (multidisciplinary) as well as benefits counseling
- Continued management of chronic conditions
- Provided at Clinical Centers of Excellence

Case Study #2

WTC FDNY Fire Lieutenant: Brian (40 years old)

- On 9/11 he is commanding 5 firefighters. Sends 3 to the left and 2 to the right as they enter the Marriott Hotel (next to the Towers). During the collapse, he and the 2 to the right are blown free. The 3 to the left die; body parts never recovered.
- Digs himself out of the rubble that day and goes to emergency department, where he complains of cough, irritated eyes, sore throat, and ringing in his ears. Signs himself out of hospital to try and get back to the site to find his men.
- For 2 weeks he spends every day searching, but never finds anyone; he complains of persistent cough, wheezing, shortness of breath, chest tightness.
- Improves a little after a brief vacation. But over next 10 months, he presents to WTC site intermittently in search of victims.

Case Study #2 (cont)

WTC FDNY Fire Lieutenant: Brian (40 years old)

- One night he awakens screaming in profuse sweat. His wife forces him to go the WTC Health Program. He receives a full evaluation for medical complaints, but he never mentions the nightmares, his inability to focus on anything other than the WTC, fear about entering lower Manhattan, and his overwhelming guilt about the loss of his 3 colleagues and his inability to find their bodies.
- 2 years later after treatment for some of his physical conditions the body parts of one of his men are found and identified by the Chief Medical Examiner. This precipitates worsening of his nightmares and mental health symptoms, including his excessive drinking.

WTC Cough Syndrome and Probable PTSD in Firefighters

- "World Trade Center Cough" includes lower respiratory symptoms:[a]
  - Cough
  - Shortness of breath
  - Air hunger
  - Intermittent wheeze
  - Sinusitis
  - Acid reflux
  - Decreased lung function
    - Decreased FEV1 & FVC
    - Preserved ratio and DLCO
  - 3-4 years after 9/11 (N = 5363)[b]
    - WTC Cough syndrome 22.1%
    - Probable PTSD 10.2%
  - Moderate association between WTC cough syndrome and probable PTSD[b]

a. Prezant DJ, et al. *N Engl J Med*. 2002;347:806-815[16]; b. Niles JK, et al. *Chest*.2011;140:1146-1154.[17]

FDNY Pulmonary Function Pre-WTC vs Post-WTC Longitudinal FEV1 Decline

- WTC-exposed workers experienced a substantial reduction in adjusted average FEV1 during the year after 09/11/2001 (372 mL; 95% confidence interval, 364-381 mL; $P < .001$) that persisted years later
- This exposure-related FEV1 decrement equaled 12 yr of aging-related FEV1 decline.
- Exposure intensity assessed by initial arrival time at the WTC site correlated linearly with FEV1 reduction in an exposure intensity-response gradient ($P = .048$).
- No association between lung function decline (FEV1) and probably PSTD[b]

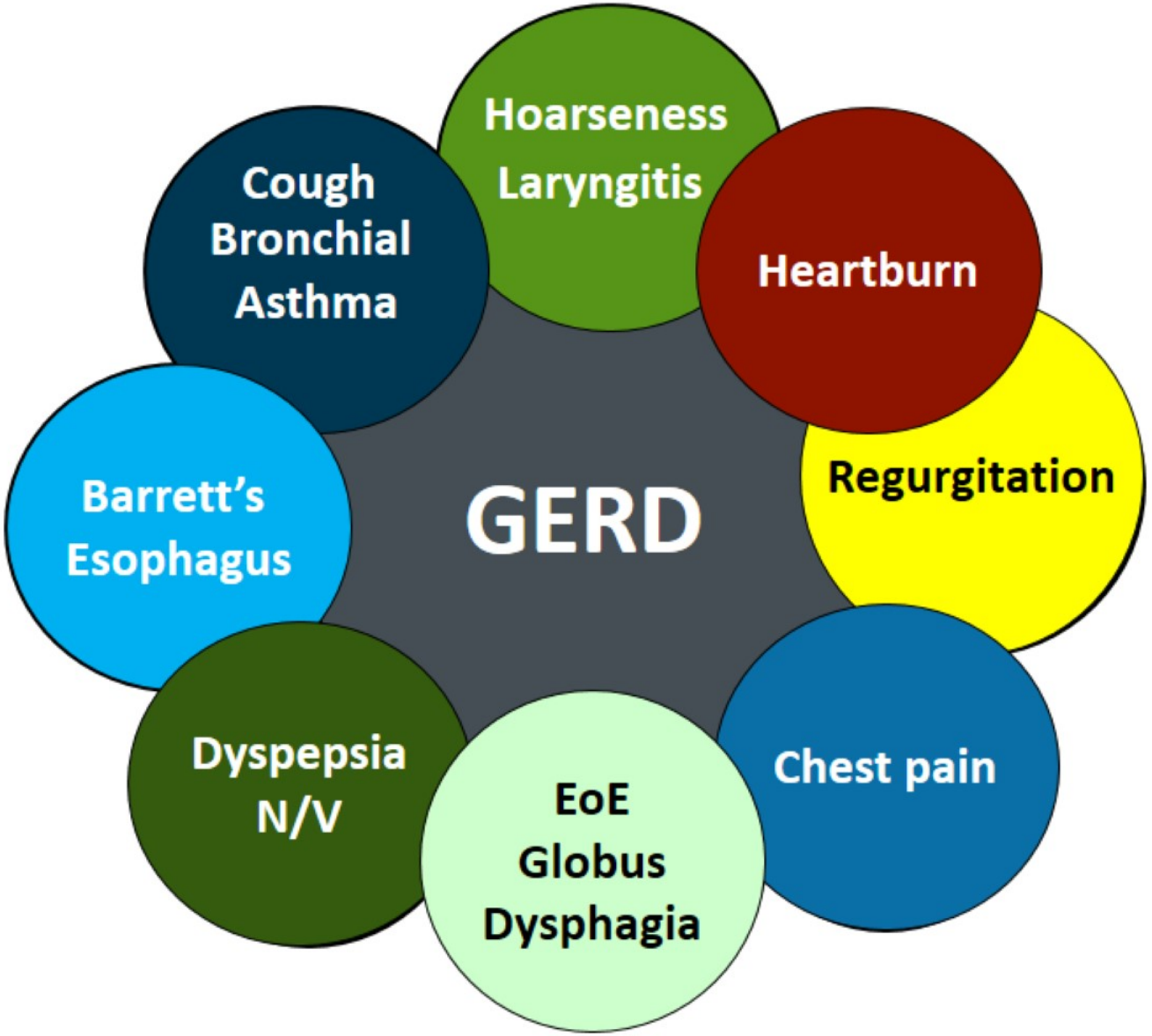
a. Banauch GI, et al. *Am J Respir Crit Care Med*. 2006;174:312-319[18]; b. Niles JK, et al. *Chest*. 2011;140:1146-1154.[17]

Recommended Treatment

Brian

- Screening/monitoring; find abnormalities
- Engage him; do not accept response that mental health is fine
- Comprehensive diagnostic plan
- Comprehensive treatment planning for asthma, GERD, sinusitis, and mental health; address family issues

GERD in WTC Exposed Population



9-Year Cumulative Incidence of Illnesses in WTC Rescue and Recovery Workers (N = 27,449)

- Asthma: 27.6%
- Sinusitis: 42.3%
- GERD: 39.3%
- Abnormal spirometry: 41.8% (low FVC in 75%)
- PTSD: police 9.3%; others 31.9%
- Panic disorder: police 8.4%; others 21.2%
- Depression: police 7%; others 27.5%

Wisnivesky JP, et al. *Lancet*. 2011;378:888-897.[19]

Factors Associated With Poor Control of 9/11-Related Asthma

- Among 2445 registry participants, 33.7% had poorly controlled symptoms and 34% had very poorly controlled symptoms in 2011-2012.
- Dose-response relationship between number of mental health conditions and poorer asthma control
- GERD and obstructive sleep apnea significantly associated with poor or very poor control

Jordan H, et al. *J Asthma*. 2015 May 21. [Epub ahead of print].[20]

Multidisciplinary Approach in Clinical Centers of Excellence

- Pulmonologists
- Occupational medicine
- Gastroenterologists
- Ear, nose, and throat
- Oncologists
- Nurses
- Nurse practitioners
- Psychiatrists
- Psychologists
- Social workers
- Administrative staff
- Outreach and retention staff

WTC Health Program

"Responders" WTC Workers Monitoring and Treatment Program

- Those involved in rescue, recovery, debris removal ("Responders"), and volunteers
- Medical/mental health **screening, monitoring, and treatment** program
- Presence of symptom **is not** necessary to be program eligible

"Survivors" WTC Environmental Health Center

- "Survivors" includes community members (local workers, residents, students, cleanup workers)
- Medical/mental **treatment** program for WTC-related medical and mental health symptoms and cancers
- Medical and mental health monitoring program for those certified in the program
- Presence of symptom or cancer **is** necessary to be program eligible

Lessons Learned

- High rates of comorbid medical and mental health conditions in rescue workers and survivors with environmental disaster exposure
- Comorbid conditions impact chronicity of disease and treatment and planning
- Long-term surveillance and treatment of rescue workers and survivors is necessary to better characterize impact and inform clinical practice

Lessons Learned Referral to WTC Health Program for Multidisciplinary Approach

- Integration of mental and physical health care
  - Decreases barriers to treatment, including stigma
  - Sensitizes both medical and mental health teams
  - Supports long-term relationship with clinical center
    - Enhances surveillance
    - Provides opportunities to support well-being with proactive monitoring and consistent treatment
    - Improves management of both chronic and acute-on-chronic conditions
  - Recognizes mental health burden of chronic physical illnesses

Abbreviations

DLCO = diffusion capacity

FDNY = New York City Fire Department

FEV1 = forced expiratory volume in 1 second

FVC = forced vital capacity

GERD = gastroesophageal reflux disease

PTSD = posttraumatic stress disorder

WTCHR = World Trade Center Health Registry

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