WORLD TRADE CENTER HEALTH PROGRAM

Shanksville


New York City


Pentagon

Development of the Inventory of 9/11 Agents

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Monitoring and Treatment 9.11 WTC Health Program

Inventory of 9/11 Agents

- The Inventory categorizes hazards as:
  - chemical hazards
  - physical hazards
  - biological hazards
  - other hazards (includes experiences that might cause psychological harm)
- Lists agents and experiences to which responders, recovery workers, and survivors were possibly exposed
- Does not provide information on the magnitude of exposure
- Not all people would have been exposed to all of the agents on this Inventory

Definition of 9/11 agent

The WTC Health Program had previously defined 9/11 agents as:

> *Chemical, physical, biological, or other hazards reported in a published, peer-reviewed exposure assessment study of responders or survivors who were present in the New York City disaster area, or at the Pentagon site, or the Shanksville, Pennsylvania site, as those locations are defined in 42 C.F.R. § 88.1.*

- too limited in scope

Definition of 9/11 agent

The **Inventory** is based on the following definition of 9/11 agents:

> *Chemical, physical, biological, or other hazards reported in a published, peer-reviewed exposure assessment study of responders, recovery workers, or survivors who were present in the New York City disaster area, or at the Pentagon site, or the Shanksville, Pennsylvania site, as those locations are defined in 42 C.F.R. § 88.1, as well as those hazards not identified in a published, peer-reviewed exposure assessment study, but which are reasonably assumed to have been present at any of the three sites.*

Development of the Inventory

- Agents identified in the First Periodic Review of Cancers were reviewed and included when they met the definitional criteria
- A contractor identified 9/11 agents based on the original definition of "9/11 agent"
  - Identified 9/11 agents from a catalog of studies provided by the Program
  - Developed and conducted a literature search to find additional studies that may identify 9/11 agents
- The Program reviewed the methods and results provided by the contractor and harmonized and corrected results based on new definition
- Agents included in the Inventory are those identified to date. The Inventory will be updated as additional information about hazards is obtained

Chemical Hazards

A. Identified in the Peer-Review Literature

1. Air and Settled Dust Studies
    a. Methods
        - Detected in personal or area air samples or settled dust or wipe samples
        - Samples must have been collected at one of the 9/11 disaster areas during the attack, response, or recovery periods
        - Concentration or amount identified on the sample must have been greater than the lower limit of detection (LOD) of the sampling and analytical method

Chemical Hazards

A. Identified in the Peer-Review Literature

1. Air and Settled Dust Studies

b. Exclusions

- Several studies that were not independently peer-reviewed or reported on chemicals identified in other studies.
- One study reporting concentrations in water runoff

c. Uncertainties

- When a chemical that has a metal component is identified, then the chemical is identified and reported on the Inventory
- If only the metal is identified, the Program considers it the 9/11 agent unless more information is available

Chemical Hazards

A. Identified in the Peer-Review Literature

2. Biological Monitoring Studies

a. Methods

- Study must report on persons exposed during the attack, response, or recovery periods and compare them to an appropriate non-exposed group
- Biomarker level in the exposed group must be significantly greater ($p<0.05$) than in the non-exposed group
- Half-life was considered when establishing whether exposure may have occurred during the attack, response, or recovery

Chemical Hazards

A. Identified in the Peer-Review Literature

2. Biological Monitoring Studies

b. Exclusions

- Studies that did not sufficiently document that a chemical was present at the site during the attack, response, or recovery

Chemical Hazards

B. Reasonably Assumed to Have Been Present

- Based on the best available evidence and the professional judgment of the Program's Science Team
- Includes chemical hazards that are typically found at implosion and demolition sites, related to fires, found in rescue operations, and at Disaster Medical Assistance Team stations (for example, the Science Team reviewed information about common gases and vapors in fires)

Table 1. Chemical Hazards (349 agents)

#	Chemical	CAS	Source	Synonyms
1	(E)-2-(6-Nonexnoxy)-tetrahydropyran	55305-36-7	Lioy et al. [2002]	
2	1,1,1-Trichloroethane	71-55-6	COPC [2003]	Methylchloroform; Trichloroethane; Methyl chloroform; Chlorothene; Inhibisol
3	1,1,2,2-Tetrachloroethane	79-34-5	COPC [2003]	S-Tetrachloroethane; Acetylene tetrachloride; Bonoform;
4	1,1,2-Trichloroethane	79-00-5	COPC [2003]	Vinyltrichloride; Ethane, 1,1,2-trichloro-; Beta-Trichloroethane; Vinyl trichloride
5	1,1-Dichloroethane	75-34-3	COPC [2003]	Ethylidene chloride; Ethylidene dichloride; Ethane, 1,1-dichloro-; Dichloroethane
6	1,1-Dichloroethylene	75-35-4	COPC [2003]	1,1-Dichloroethene; 1,1-DCE; Vinylidene chloride
7	1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	Yiin et al. [2004]	Dibenzofuran, 1,2,3,7,8-pentachloro-;1,2,3,7,8-Pentachlorodibenzo[b,d]furan
8	1,2,3-Triphenyl-3-vinyl-cyclopropene	---	Lioy et al. [2002]	
9	1,2,4-Trichlorobenzene	120-82-1	COPC [2003]	Benzene, 1,2,4-trichloro-; Unsym-Trichlorobenzene; Hostetex L-pec;
10	1,2,4-Trimethylbenzene	95-63-6	Geyh et al. [2005]; COPC [2003]	Pseudocumol; Psi-cumene
11	1,2-Benzphenanthrene	218-01-9	Offenberg et al. [2004]	Chrysene; Benzo[a]phenanthrene; 1,2-Benzophenanthrene; 1,2-Benzphenanthrene
12	1,2-Dichlorobenzene	95-50-1	COPC [2003]	O-Dichlorobenzene; Chloroben; O-Dichlorbenzol
13	1,2-Dichloroethane	107-06-2	COPC [2003]	1,2-dichloroethane; Ethylene dichloride; Ethylene chloride; Ethane, 1,2-dichloro
14	1,2-Dichloroethylene, trans-	540-59-0	COPC [2003]	Trans-1,2-Dichloroethene; (E)-1,2-Dichloroethylene; (E)-1,2-Dichloroethene; Trans-Dichloroethylene
15	1,2-Dichloropropane	78-87-5	COPC [2003]	Propylene dichloride; Propane, 1,2-dichloro-; Propylene chloride;

Physical Hazards

A. Identified in the Peer-Review Literature

Literature searches did not produce exposure assessment studies that identified physical hazards that meet the criteria for inclusion

B. Reasonably Assumed to Have Been Present

Based on the best available evidence and the professional judgment of the Program's science team, they include:

- solar radiation, heat stress conditions, cold stress conditions
- slip, trip, fall, noise, vibration
- hazards that are typically found at implosion and demolition sites and related to fires

Table 2. Physical Hazards

#	Agent	Source
1	Cold Stress	Reasonably assumed to have been present
2	Heat Stress	Reasonably assumed to have been present
3	Solar radiation	Reasonably assumed to have been present
4	Noise	Reasonably assumed to have been present
5	Vibration	Reasonably assumed to have been present
6	Fire and Hot surfaces	Reasonably assumed to have been present
7	Explosion	Reasonably assumed to have been present
8	Slip	Reasonably assumed to have been present
9	Trip	Reasonably assumed to have been present
10	Fall (including fall from height)	Reasonably assumed to have been present
11	Struck by	Reasonably assumed to have been present
12	Caught in	Reasonably assumed to have been present
13	Needlestick	Reasonably assumed to have been present
14	Radio Frequency	Reasonably assumed to have been present

Biological Hazards

A. Identified in the Peer-Review Literature

Literature searches did not produce exposure assessment studies which identified biological hazards that meet the criteria for inclusion

B. Reasonably Assumed to Have Been Present

Based on the best available evidence and the professional judgment of the Program's science team; they include bloodborne pathogens.

Table 3. Biological Hazards

#	Agent	Source
1	Bloodborne Pathogens	Reasonably assumed to have been present

Other Hazards

A. Identified in the Peer-Review Literature

a. Methods

- Experiences that might cause psychological harm are traumatic or stressful exposures
- Included experiences significantly associated ($p<0.05$) with an increased risk for a health outcome after adjustment for other mental health exposures and compared to an appropriate control group

b. Exclusions

- Studies that failed to achieve statistical significance
- Studies that reported only crude, unadjusted analyses

Other Hazards

A. Identified in the Peer-Review Literature

b. Exclusions (continued)

- Meta-analyses and reviews that included only exposures reported in other published papers
- Studies that did not differentiate between individuals who were unexposed to the 9/11 attacks and those exposed

c. Uncertainties

- Certain social support factors (e.g., lack of family support) can modify an individual's 9/11 experience; but they are not considered psychologically harmful 9/11 experiences and were excluded from the Inventory.

Table 4. Other Hazards (26 hazards)

#	Experience	Source
1	Sustained injury on 9/11	DiGrande et al. [2008]; DiGrande et al. [2011]; Brackbill et al. [2009]; Gargano et al. [2016]; Perrin et al. [2007]; Hoven et al. [2005]; Cone et al. [2015]; Pietrzak et al. [2014]
2	Present in a WTC building on 9/11	DiGrande et al. [2008]; Brackbill et al. [2006]
3	Caught in dust cloud on 9/11	DiGrande et al. [2008]; Brackbill et al. [2009]; Pietrzak et al. [2012]; Wisnivesky et al. [2011]; Perrin et al. [2007]; Hoven et al. [2005]; Pietrzak et al. [2014]
4	Time of evacuation from WTC building on 9/11	DiGrande et al. [2011]
5	Firefighter who worked on 9/11 at WTC	Berniger et al. [2010a]; Berniger et al. [2010b]
6	Involved in search and rescue in Sept/Oct 2001	DiGrande et al. [2008]; Ahern et al. [2002]; Brackbill et al. [2009]; Pietrzak et al. [2012]; Perrin et al. [2007]; Galea et al. [2003]; Pietrzak et al. [2014]; Stellman et al. [2008]
7	Increased duration of work in search/rescue/recovery/clean-up	Brackbill et al. [2009]; Berniger et al. [2010a]; Berniger et al. [2010b]; Stellman et al. [2008]; Wisnivesky et al. [2011]; Perrin et al. [2007]; Pietrzak et al. [2014]
8	Firefighter with supervisor responsibilities at WTC site	Berniger et al. [2010a]; Berniger et al. [2010b]
9	Worked on the 9/11 pile	Wisnivesky et al. [2011]; Pietrzak et al. [2014]
10	Performed work tasks at WTC not common to profession	Perrin et al. [2007]
11	Displacement from home	Galea et al. [2002]; DiGrande et al. [2008]
12	Lived below Canal Street on 9/11	Ahern et al. [2002]; DiGrande et al. [2008]; Galea et al. [2003]

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