Carcinogens and Asthma-Related Chemicals: A Review of TURA Data

Molly Jacobs, Lowell Center for Sustainable Production, University of Massachusetts Lowell

Outline

- Asthma
  - Primer on Asthma
  - TURA data analysis
    - Data sources
    - Data trends
    - Recommendations
- Carcinogens
  - TURA data analysis
    - Review of carcinogen data sources
    - Data trends

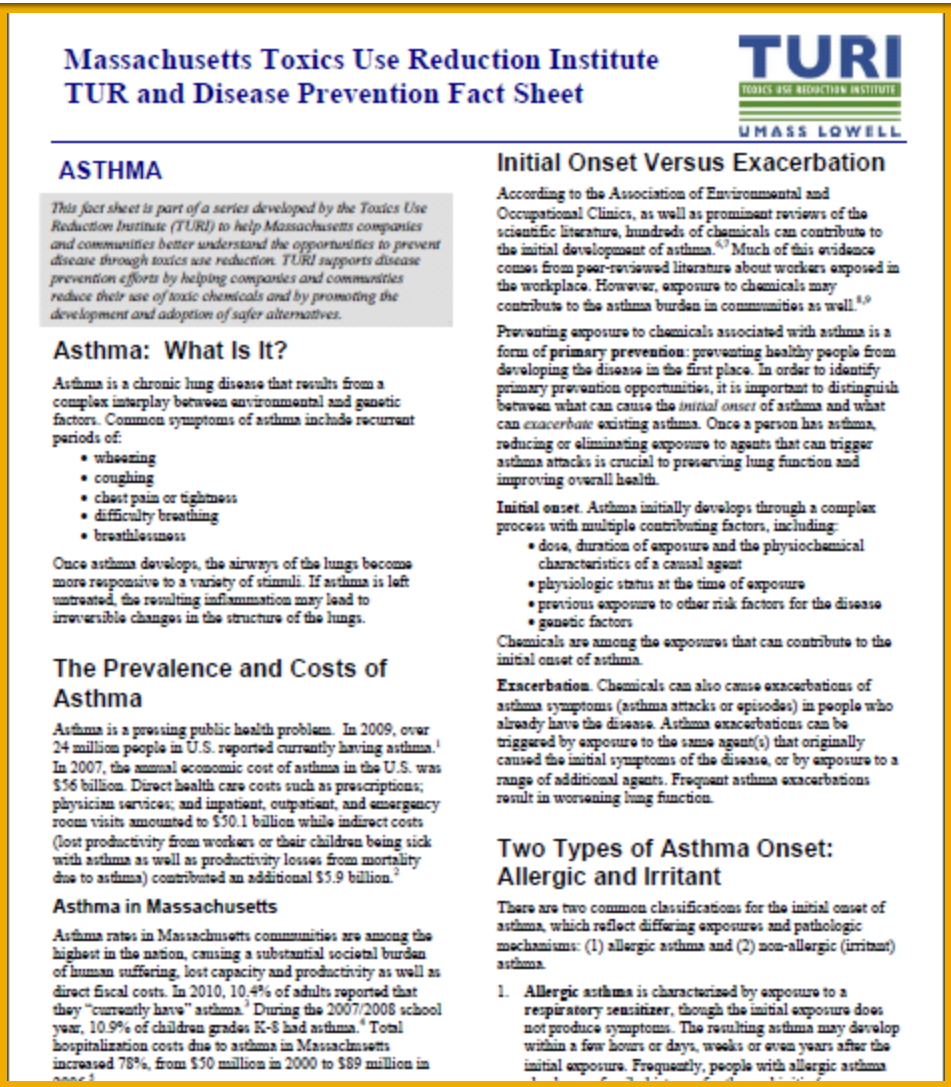
The Boston Globe "Scourge of Asthma is Acute in New England" 4/26/2011

- MA has among the highest prevalence of asthma in the nation
- Nationally: since 1980's, asthma prevalence has more than doubled
- In 2010, 10.4% of adults & 9.3% of children currently have asthma
- 6.2% of current adults cases are work related
- 4th leading cause of work absenteeism and 7th leading cause of presenteeism (lost work productivity due to illness)
  - asthma presenteeism costs: 72.5% of total asthma costs

Chemicals: Causes of Initial Onset and Exacerbation of Asthma

- Hundreds of chemicals found to initiate asthma in occupational settings
  - Some of these likely capable of initiating asthma in non-occupational settings
  - These same chemicals can also exacerbate existing asthma
  - Responses vary by individual
- Asthma prevention and control programs focus:
  - medications; some environmental trigger reduction [secondary prevention]
- Missed primary prevention opportunity:
  - promoting safer alternatives research & supporting technical assistance to industry

Asthma-Related Chemicals: Report & Fact Sheet



Massachusetts Toxics Use Reduction Institute
TUR and Disease Prevention Fact Sheet

TURI
TOXICS USE REDUCTION INSTITUTE
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ASTHMA

This fact sheet is part of a series developed by the Toxics Use Reduction Institute (TURI) to help Massachusetts companies and communities better understand the opportunities to prevent disease through toxics use reduction. TURI supports disease prevention efforts by helping companies and communities reduce their use of toxic chemicals and by promoting the development and adoption of safer alternatives.

Asthma: What Is It?

Asthma is a chronic lung disease that results from a complex interplay between environmental and genetic factors. Common symptoms of asthma include recurrent periods of:

- wheezing
- coughing
- chest pain or tightness
- difficulty breathing
- breathlessness

Once asthma develops, the airways of the lungs become more responsive to a variety of stimuli. If asthma is left untreated, the resulting inflammation may lead to irreversible changes in the structure of the lungs.

The Prevalence and Costs of Asthma

Asthma is a pressing public health problem. In 2009, over 24 million people in U.S. reported currently having asthma.[1] In 2007, the annual economic cost of asthma in the U.S. was $56 billion. Direct health care costs such as prescriptions; physician services; and inpatient, outpatient, and emergency room visits amounted to $50.1 billion while indirect costs (lost productivity from workers or their children being sick with asthma as well as productivity losses from mortality due to asthma) contributed an additional $5.9 billion.[2]

Asthma in Massachusetts

Asthma rates in Massachusetts communities are among the highest in the nation, causing a substantial societal burden of human suffering, lost capacity and productivity as well as direct fiscal costs. In 2010, 10.4% of adults reported that they "currently have" asthma.[3] During the 2007/2008 school year, 10.9% of children grades K-8 had asthma.[4] Total hospitalization costs due to asthma in Massachusetts increased 78%, from $50 million in 2000 to $89 million in

Initial Onset Versus Exacerbation

According to the Association of Environmental and Occupational Clinics, as well as prominent reviews of the scientific literature, hundreds of chemicals can contribute to the initial development of asthma.[6,7] Much of this evidence comes from peer-reviewed literature about workers exposed in the workplace. However, exposure to chemicals may contribute to the asthma burden in communities as well.[8,9]

Preventing exposure to chemicals associated with asthma is a form of **primary prevention**: preventing healthy people from developing the disease in the first place. In order to identify primary prevention opportunities, it is important to distinguish between what can cause the *initial onset* of asthma and what can *exacerbate* existing asthma. Once a person has asthma, reducing or eliminating exposure to agents that can trigger asthma attacks is crucial to preserving lung function and improving overall health.

Initial onset. Asthma initially develops through a complex process with multiple contributing factors, including:

- dose, duration of exposure and the physiochemical characteristics of a causal agent
- physiologic status at the time of exposure
- previous exposure to other risk factors for the disease
- genetic factors

Chemicals are among the exposures that can contribute to the initial onset of asthma.

Exacerbation. Chemicals can also cause exacerbations of asthma symptoms (asthma attacks or episodes) in people who already have the disease. Asthma exacerbations can be triggered by exposure to the same agent(s) that originally caused the initial symptoms of the disease, or by exposure to a range of additional agents. Frequent asthma exacerbations result in worsening lung function.

Two Types of Asthma Onset: Allergic and Irritant

There are two common classifications for the initial onset of asthma, which reflect differing exposures and pathologic mechanisms: (1) allergic asthma and (2) non-allergic (irritant) asthma.

1. **Allergic asthma** is characterized by exposure to a **respiratory sensitizer**, though the initial exposure does not produce symptoms. The resulting asthma may develop within a few hours or days, weeks or even years after the initial exposure. Frequently, people with allergic asthma

Asthma-Related Chemicals Master List : Data Sources

1. **Association of Occupational and Environmental Clinics** (AOEC) Occupational agents shown to cause asthma (de novo)

1.

2. **Collaborative on Health and the Environment's Toxicant Disease Database:** Comprehensive literature review ranking the strength of evidence (strong, good, limited)

1. **Institute of Medicine** (IOM) Evidence associated with indoor air quality and asthma onset and exacerbation in non-occupational environments

1. **Malo and Chan-Yeung** comprehensive literature review in Bernstein's 2006 edition of *Asthma in the Workplace*

Master List of Asthma-Related Chemicals

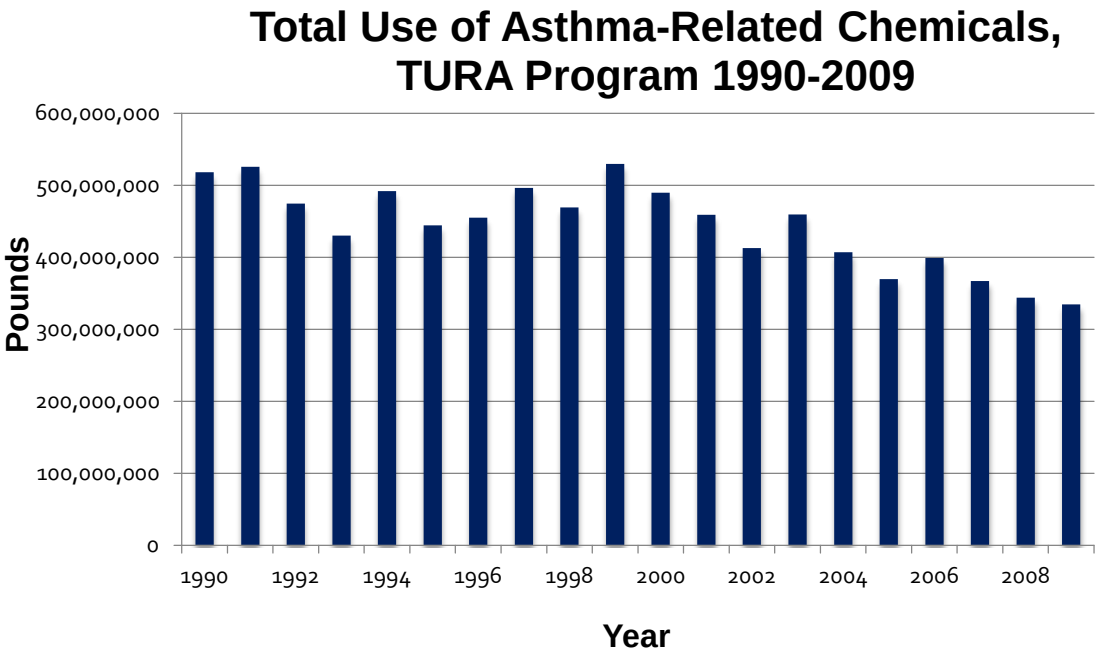
- ~70 asthma-related chemicals reportable under TURA
  - See TURI's asthma fact sheet (copies available)
- ~100 chemicals not on TURA list of reportable agents but associated with asthma
  - Examples:
    - Glutaraldehyde
    - Methyl 2-cyanoacrylate

Chemicals not on TURA list of reportable agents = missed opportunity to provide TUR planning

Asthma-Related Chemicals on TURA More Hazardous Chemicals List

- Benzene *(evidence limited)*
- Chlorine
- Chloroform *(evidence limited)*
- Chromic Acid
- Chromium Compounds
- Dibromochloropropane *(evidence limited)*
- Ethylene Oxide
- Formaldehyde
- Hydrazine
- Methylene diisocyanate
- Nickel compounds
- Phenols (NOS)
- Phosgene
- Sulfuric Acid
- Toluene diisocyanate

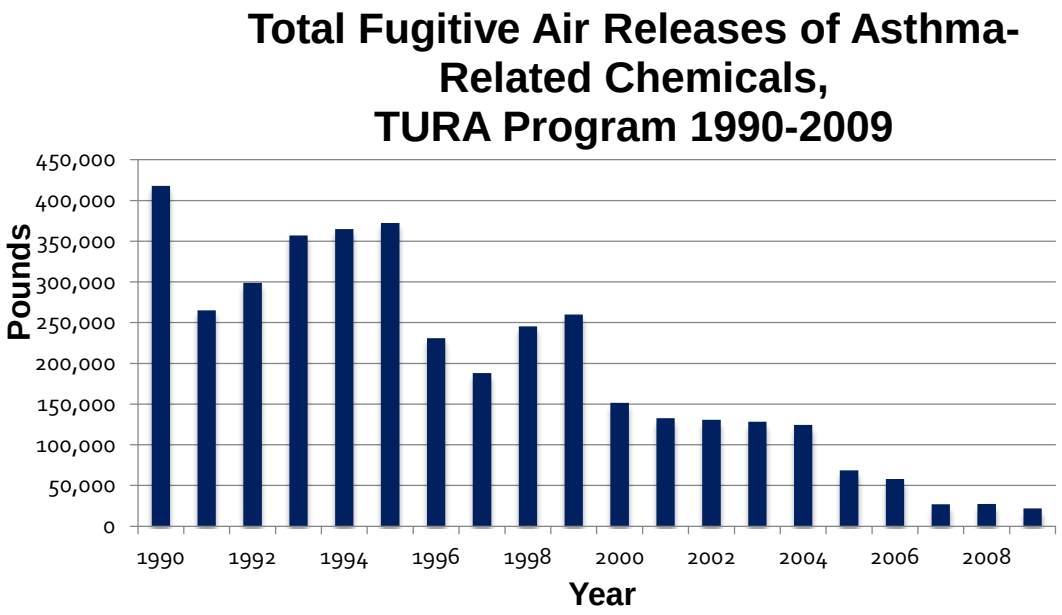
Trends: Use of Asthma-Related Chemicals (1990-2009)



Total Use (1990-2009) declined 35%

- 5 asthma-related chemicals **used** in the greatest amounts:
  1. Styrene Monomer
  2. Sulfuric acid
  3. Ammonia
  4. Diisocyanates
  5. Nickel & compounds

Trends: Fugitive Air Releases of Asthma-Related Chemicals (1990-2009)

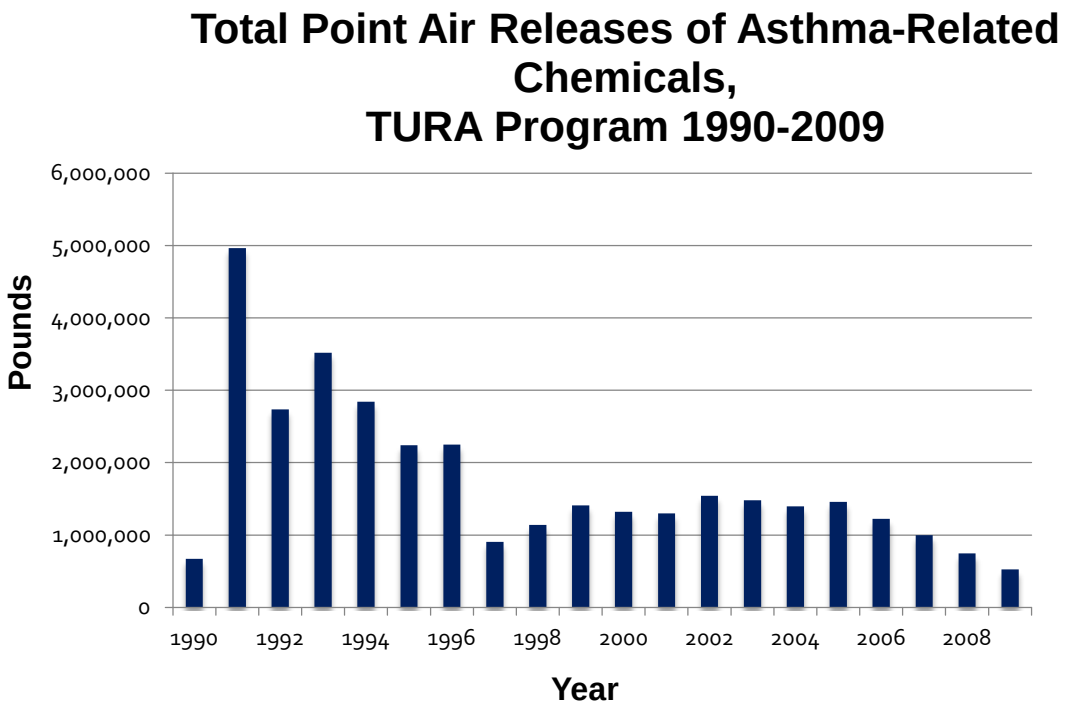


Total Fugitive Air Emissions (1990-2009) declined 95%

- 5 asthma-related chemicals **released as fugitive air emissions** in the greatest amounts:

1. Ammonia
2. Sulfuric acid
3. Acetic Acid
4. Styrene Monomer
5. Nitrogen Dioxide

Trends: Point Source Air Releases of Asthma-Related Chemicals (1990-2009)



Total Point Source Air Emissions (1990-2009) declined 22%

- 5 asthma-related chemicals **released as point air emissions** in the greatest amounts:
  1. Sulfuric acid
  2. Ammonia
  3. Formaldehyde
  4. Acetic Acid
  5. Styrene Monomer

Use & Environmental Release of Carcinogens Under TURA: Specific Aim

1. To assess the extent to which industrial carcinogens are being used and released by facilities that report to TURA
2. To identify how the TURA program can better serve cancer prevention

Key Recommendations Relevant for TURA planners

- Share TUR lessons-learned with industry sectors that do not report under TURA, especially health care
- Continue policy, research and technical assistance to promote safer alternatives to carcinogens

Carcinogen Master List

- Sources
  - International Agency for Research on Cancer (IARC)
  - EPA Integrated Risk Information System (IRIS)
  - National Toxicology Program (NTP) 12th Report on Carcinogens

Carcinogen Master List

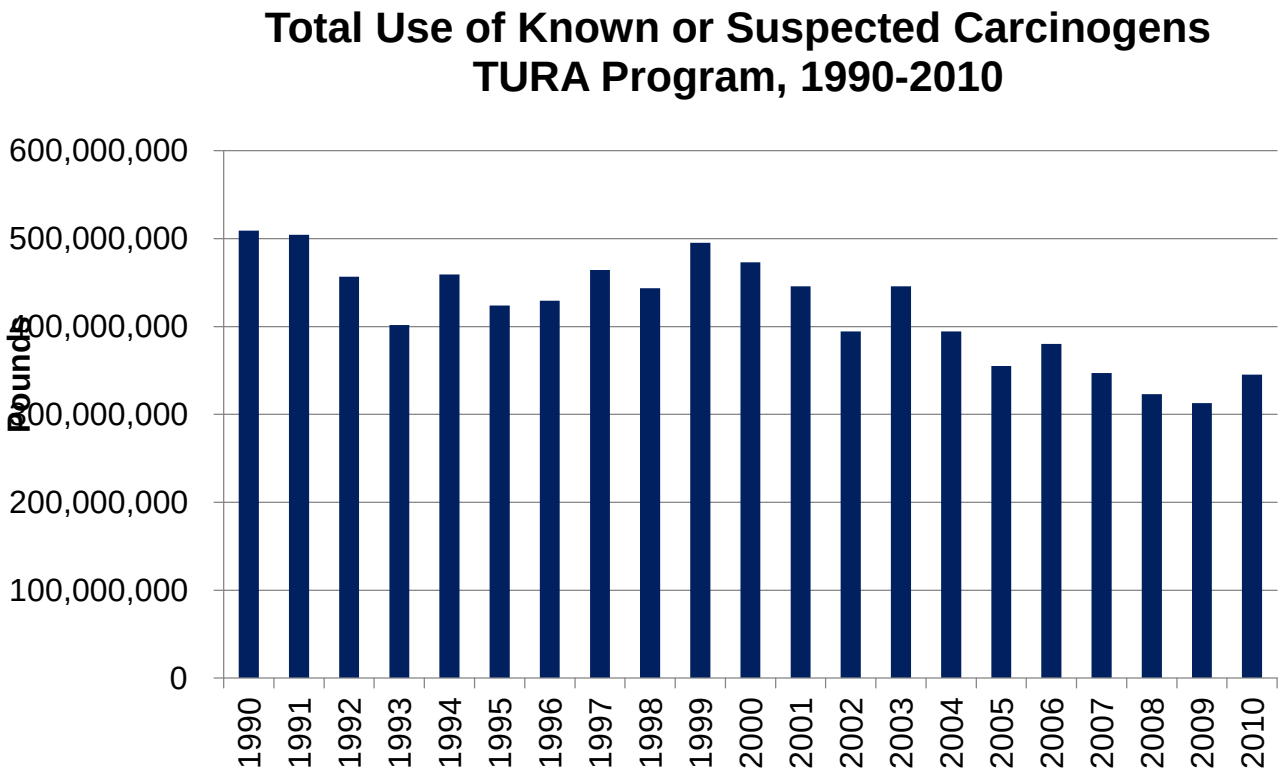
Considered chemicals categorized as carcinogens based on the following authoritative lists:

- IARC: Groups 1 (known), 2A (probable)
- IRIS: Group A (human carcinogen), B1 (probable human carcinogen with limited human evidence), B2 (probable human carcinogen with sufficient evidence in animals and inadequate or no evidence in humans)
- NTP: known, reasonably anticipated to be a human carcinogen

Carcinogen Master List

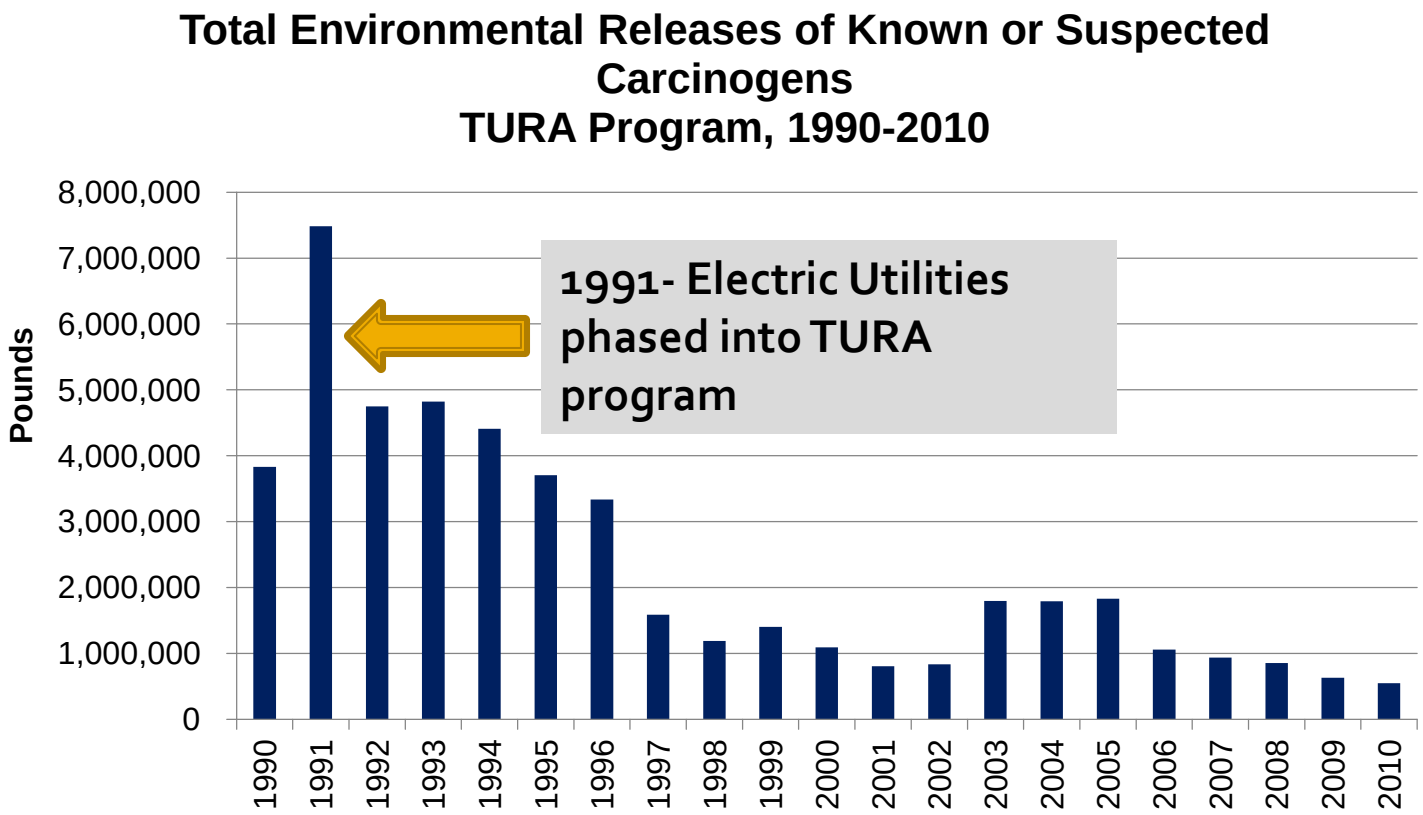
- 302 substances or exposure circumstances known or suspected to cause cancer in humans
  - Of these, 187 are reportable under TURA
    - 74 carcinogens have been reported under the TURA program 1990-2010
  - 29 carcinogen not currently reportable under TURA

Trends: Use of Carcinogens (1990-2010)



Total Use (1990-2009) declined 32%

Trends in Environmental Releases of Carcinogens (1990-2010)



Total Environmental Releases (1991-2009) declined 93%

Carcinogen List for Specific Cancer Types

- For the 74 carcinogens that have been reported by TURA filers (1990-2009), generated a cancer-site specific list for 11 cancer types:

1. bladder
2. brain and other central nervous system (CNS)
3. breast
4. kidney
5. leukemia
6. liver
7. lung
8. NHL
9. pancreatic
10. prostate
11. testicular.

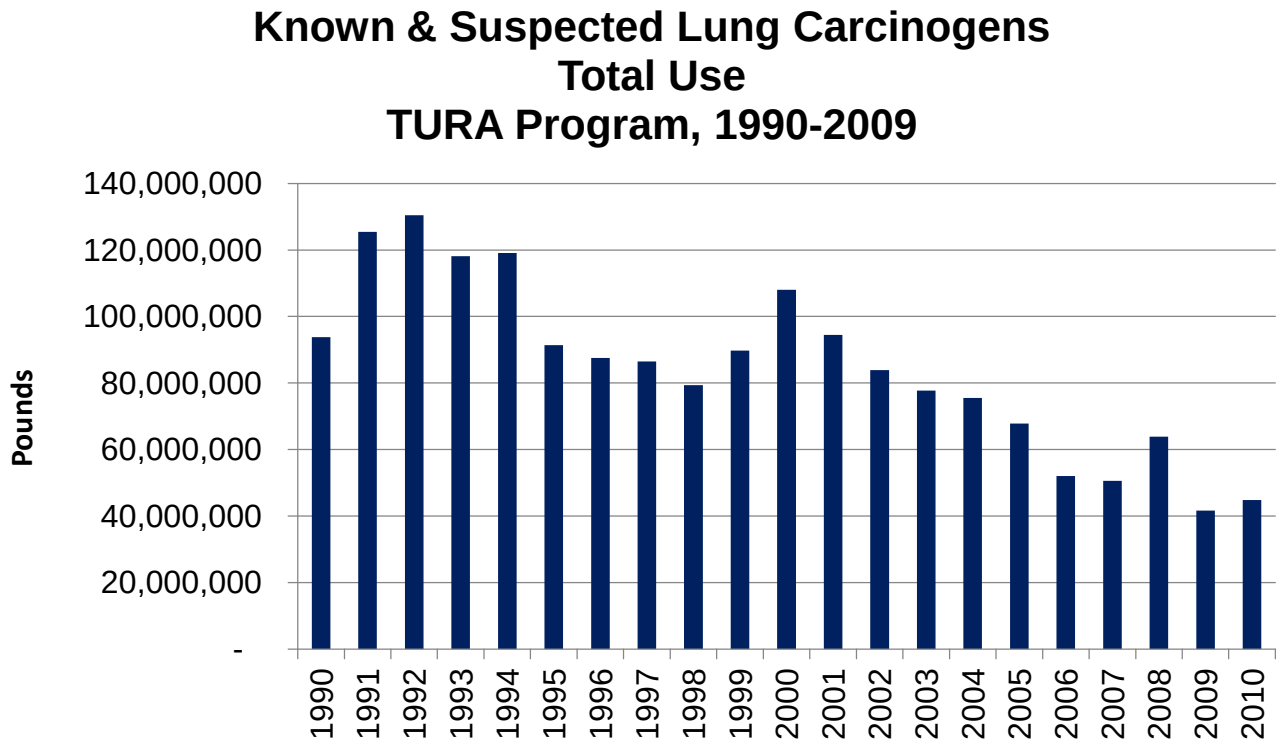
Cancer-Site Specific Data Sources

1. Siemiatycki and colleagues' (*Environ Health Perspect* 2004;112(15):1447-59) cancer site list of occupational carcinogens based on IARC monographs
2. Appendix F of the President's Cancer Panel 2010 report
3. Cogliano and colleagues' (*J Natl Cancer Inst* 2011;103(24):1827-39) site specific list of agents based on IARC monographs
3. The National Toxicology Program's 12th Report on carcinogens
4. Rudel and colleagues' (*Cancer* 2007;109(12 Suppl):2635-66) list of chemicals that increased mammary gland tumors in animal studies

Known or Suspected Carcinogen for Specific Cancer Types: Lung Cancer

- 1,2-Dibromo-3-chloropropane
- 1,3-Butadiene
- 4,4'-Methylene bis(2-chloroaniline)
- Acetaldehyde
- Acrylamide
- Acrylonitrile
- Arsenic and compounds
- Benzene
- Benzotrichloride
- Cadmium and compounds
- Hexavalent chromium and compounds
- Creosotes
- Methylene chloride
- Dioxin and dioxin compounds
- Epichlorohydrin
- Ethylene dichloride
- Ethylene oxide
- Formaldehyde
- Hydrazine
- Lead and compounds
- Nickel and compounds
- Nitrobenzene
- *o*-Aminoazotoluene
- Polycyclic aromatic compounds
- Polychlorinated biphenyls
- Silica, crystalline
- sulfuric acid mists/fumes
- Styrene monomer

Trends in Known & Suspected Lung Carcinogen Use (1990-2010)

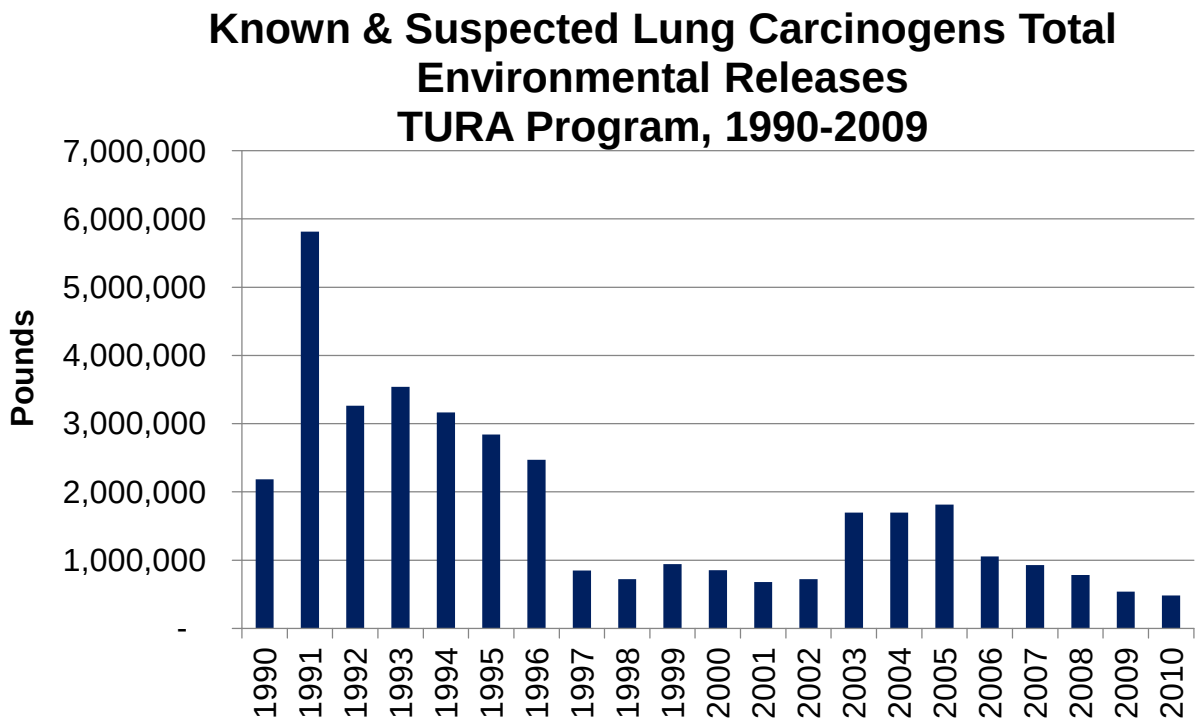


Top 3 chemicals used in the greatest amounts:

1. Styrene
2. Sulfuric acid
3. Lead & compounds

Total Use declined 31%. When styrene excluded (excluded in chart above), use declined 52%

Trends in Known & Suspected Lung Carcinogen Environmental Releases (1990-2010)



Top 3 chemicals released:

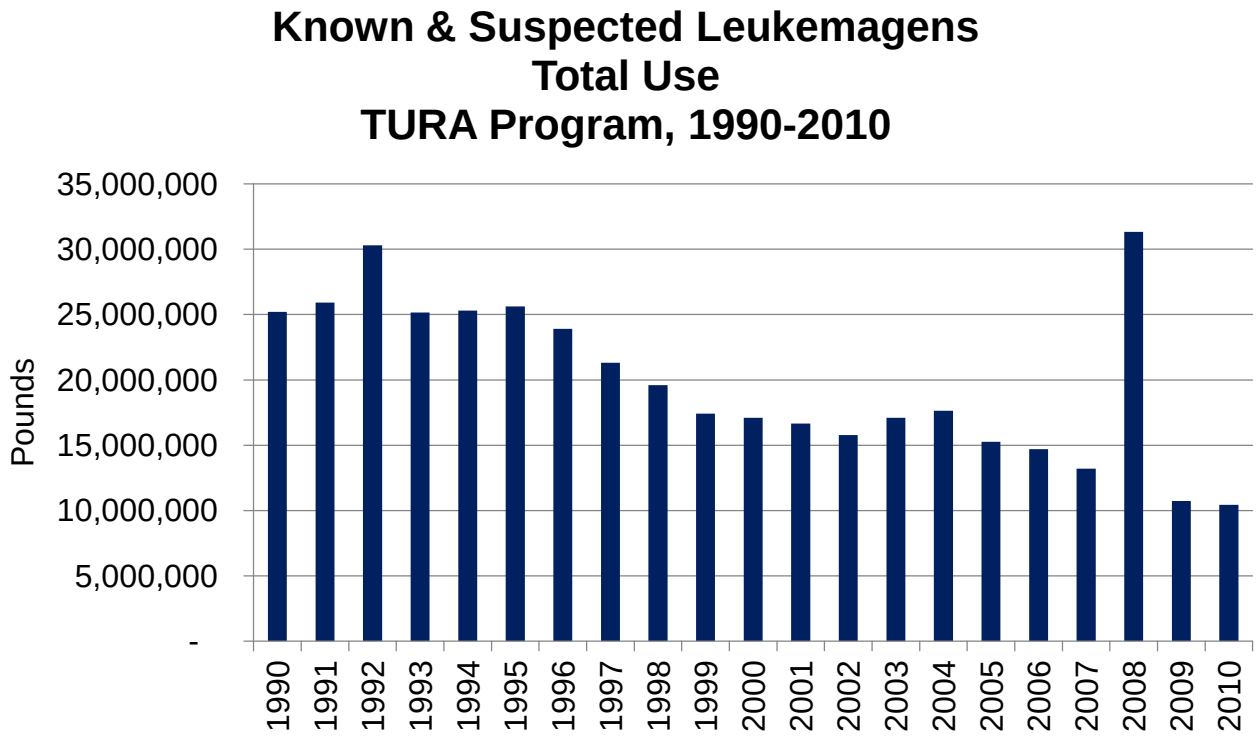
1. Sulfuric acid
2. Methylene chloride
3. Lead & compounds

Total environmental releases declined 92%.

Known or Suspected Carcinogen for Specific Cancer Types: Leukemia

- 1,3-Butadiene
- 2-Methylaziridine
- 3,3'-Dichlorobenzidine dihydrochloride
- Acetaldehyde
- Arsenic compounds
- Benzene
- Cadmium compounds
- Carbon tetrachloride
- *p*-Dichlorobenzene
- Methylene chloride
- Ethylene dichloride
- Ethylene oxide
- Ethylene thiourea
- Formaldehyde (gas)
- Hydrazine
- Lead and compounds
- Polychlorinated alkanes
- Polychlorinated biphenyls
- Styrene monomer
- Trichloroethylene

Trends in Known or Suspected Use of Leukemogens (1990-2010)

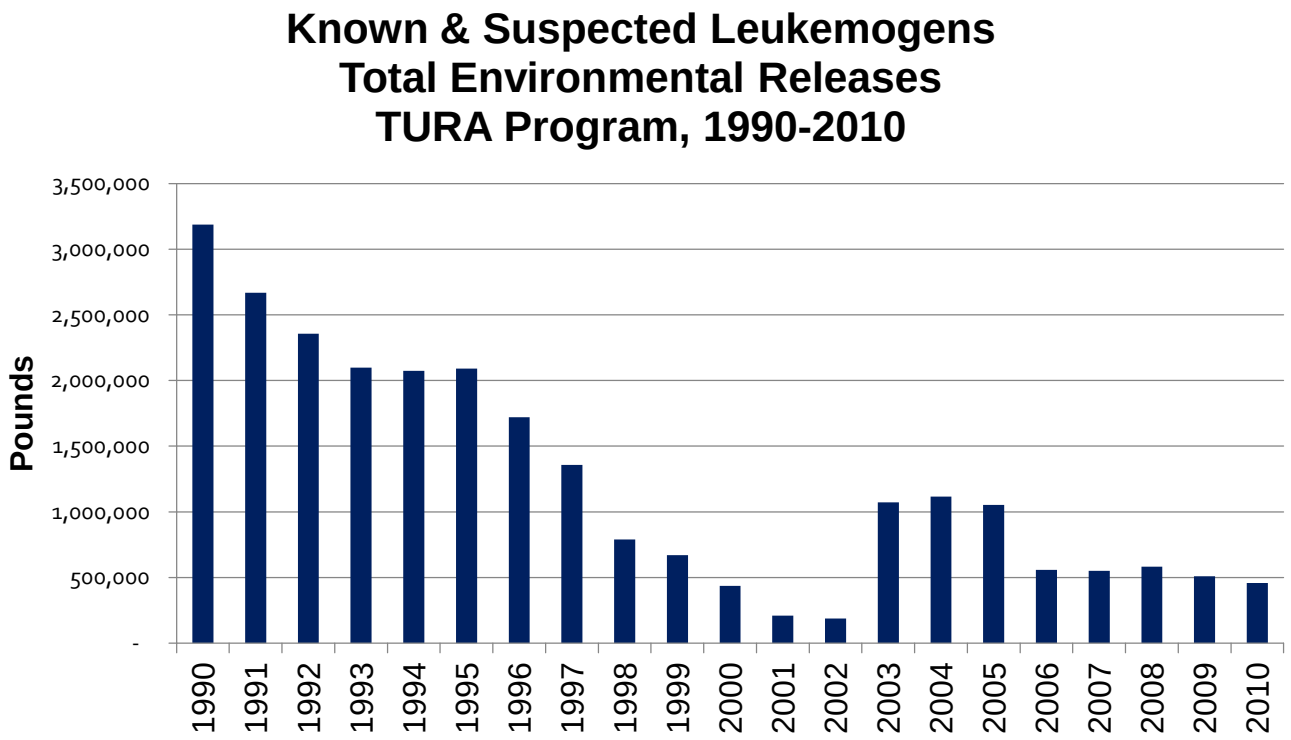


Top 3 chemicals used in the greatest amounts:

1. Styrene
2. Lead & compounds
3. Formaldehyde

Total Use declined 28%. When styrene excluded (excluded in chart above), use declined 59%

Trends in Known & Suspected Leukmogen Environmental Releases (1990-2010)



Top 3 chemicals released:

1. TCE
2. Methylene chloride
3. Lead & compounds

Total environmental releases declined 87%.

Cancer Type Specific Carcinogen Analysis: Overall Trends

- Use: All 11 cancer types showed declines
  - Declines ranged from 26% decline for breast/mammary gland carcinogens to 88% for testicular carcinogens.
  - The specific cancers with the least decline were highly influenced by the use of styrene monomer
- Environmental Releases: All 11 cancer types showed declines except bladder cancer
  - Declines ranged from 78% for both lung carcinogens and brain/CNS carcinogens, to 97% for carcinogens associated with four cancer types: breast/mammary gland, liver, pancreas and prostate.
  - Bladder: 18% overall increase (driven by reporting changes for lead), but 60% decline since 2004

Key Recommendations

- Research the ~29 known and suspected carcinogens not currently reportable under TURA, and consider whether they should be added to the TURA list of Toxic or Hazardous Substances
- Explore the reasons for the increase in use/generation of dioxin and compounds, ethylene oxide and toluene diisocyanate and prioritize TUR technical assistance strategies for these facilities

Key Recommendations, cont.

- Prioritize TUR technical assistance activities for the known and suspected carcinogens that consistently emerged as drivers of the site specific use and environmental release trends, including÷
  - Styrene
  - Formaldehyde
  - Cadmium and compounds
  - Polycyclic aromatic compounds
  - Methylene chloride
  - Trichloroethylene
  - Lead and compounds

Key recommendations, cont.

- Partner with the Department of Public Health to incorporate TUR strategies and priorities into educational efforts about environmental carcinogens targeting medical providers.
- Prioritize TUR activities among small businesses that are important users of known and suspected carcinogens

Key Recommendations Relevant for TURA planners

- Share TUR lessons-learned with industry sectors that do not report under TURA, especially health care
- Continue policy, research and technical assistance to promote safer alternatives to carcinogens