Climate Change and Cancer

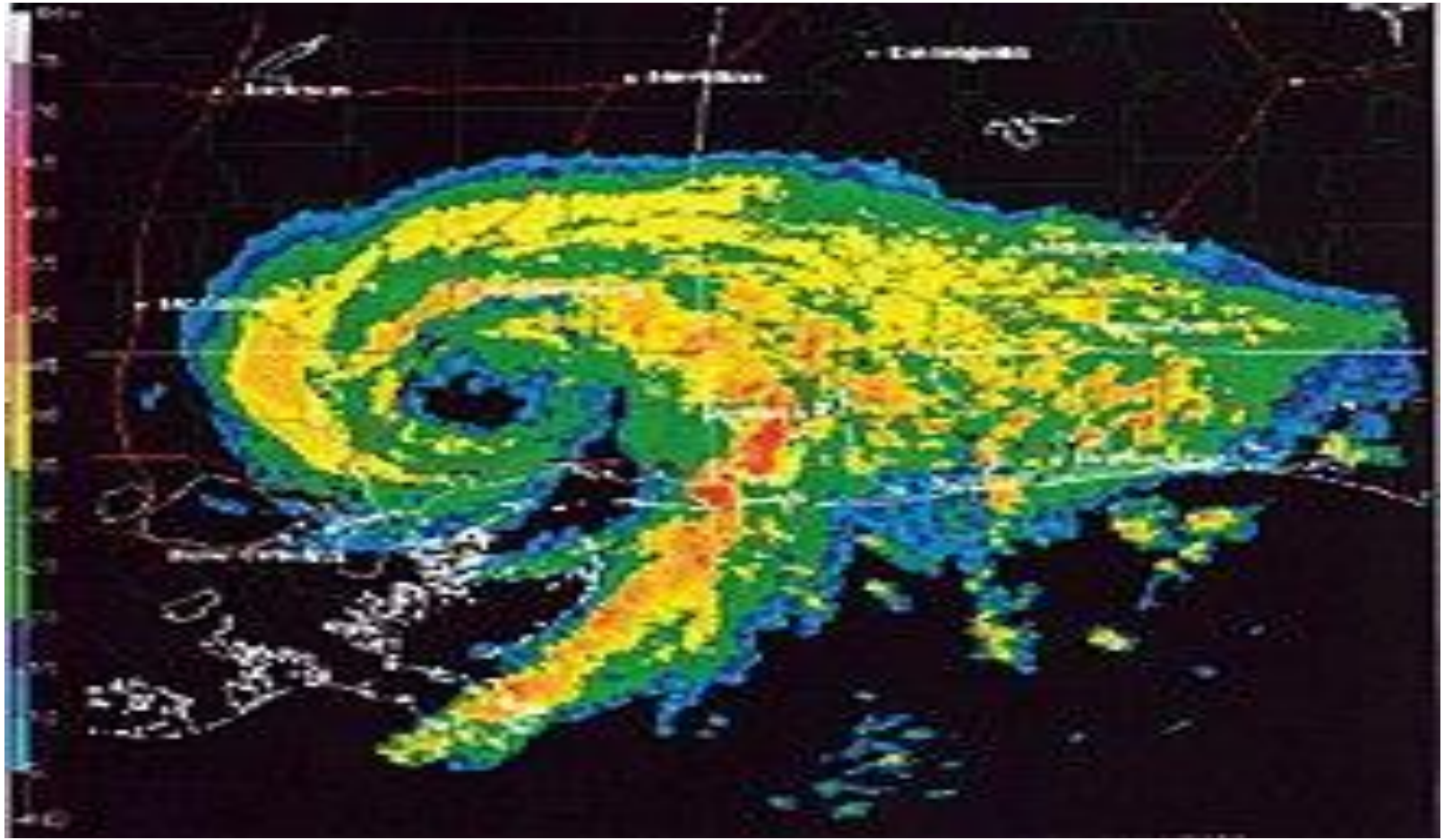
Eric Bernicker, MD FASCO

CommonSpirit Health

ROCKY MOUNTAIN ONCOLOGY SOCIETY

Disclosures

None



Tropical Storm Allison 2001

Rainfall: Allison dropped over 40 inches of rain in Texas, with 28 inches falling in a 12-hour period near downtown Houston.

Flooding: Allison flooded over 70,000 homes, destroyed 2,744 homes, and caused severe damage to hospitals and businesses.

Deaths: 23 people died in Texas, including 18 who drowned and 3 who were electrocuted.

Damage: Allison caused $9 billion in damage in Texas, and $5 billion in property damage in Harris County alone.

Homelessness: 30,000 people became homeless

RMOS
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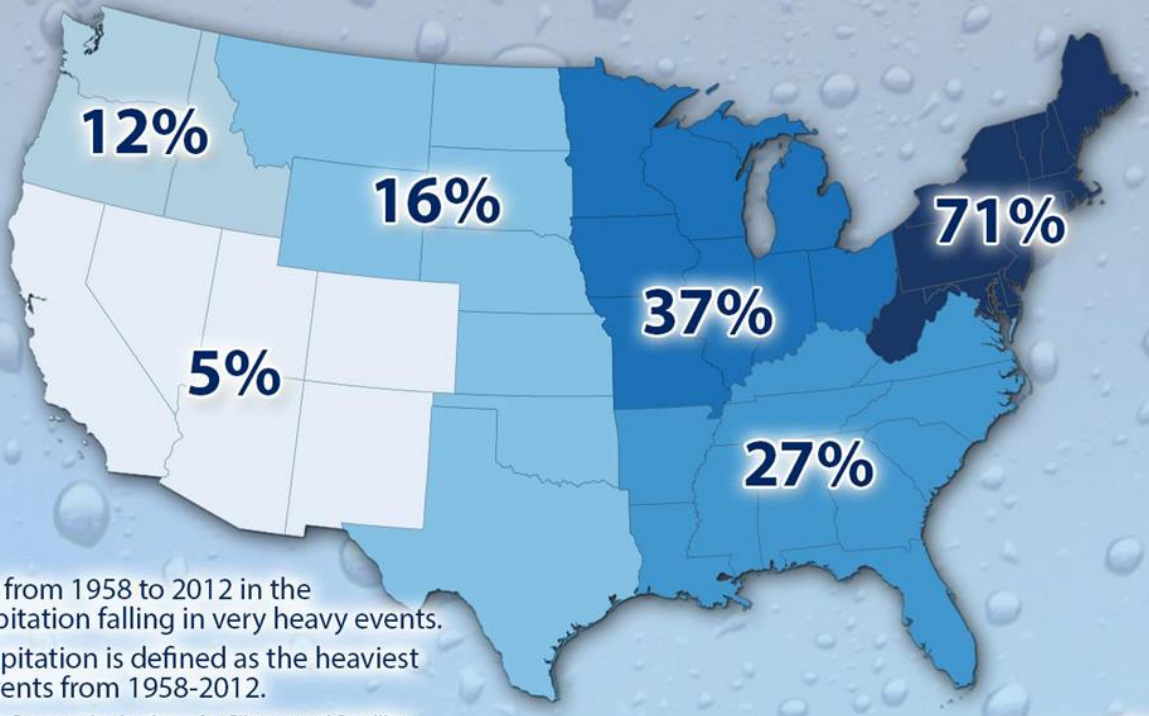
Heavy Downpours Increasing



Percent increase from 1958 to 2012 in the amount of precipitation falling in very heavy events.

Very Heavy Precipitation is defined as the heaviest 1% of all daily events from 1958-2012.

Source: Kenneth Kunkel, Cooperative Institute for Climate and Satellites, North Carolina State University and NOAA NCDC

- Increase in heavy rain events (top 1%) since 1958
- Big regional variations

CLIMATE CENTRAL

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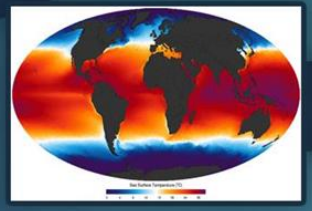
Facilities Impacted by Hurricanes

American Hospital Association (AHA) + FEMA (2016-2020)

https://www.ahadata.com/

Espinel Z, Shultz JM, Aubry VP, Abraham OM, Fan Q, Crane TE, Sahar L, **Nogueira LM**. *Protecting Vulnerable Patient Populations from Climate Hazards: The Role of the Nations' Cancer Centers*. J Natl Cancer Inst. 2023 Jul 25:djad139.

HURRICANES & CLIMATE CHANGE
What we know



Warmer water = more fuel

Heavier rain

Higher storm surge

CLIMATE CENTRAL

Exposure to Carcinogens

Climate Change - Hurricane Harvey's unprecedented precipitation

Houston Ship Chanel

Arkema Chemical Plant

Extreme Weather Events

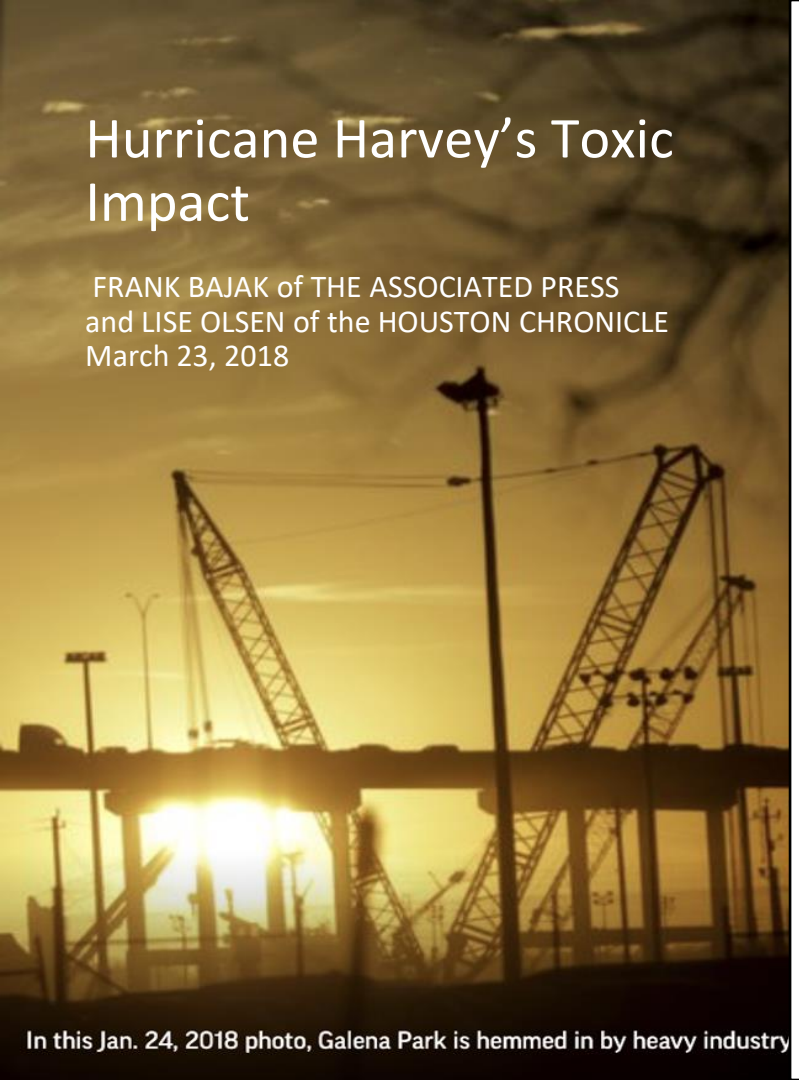
3.5 times more likely

Risser MD, Wehner MF. *Attributable human-induced changes in the likelihood and magnitude of the observed extreme precipitation during hurricane Harvey*. Geophys Res Lett. 2017;44:12-457

Nogueira LM, Crane TE, Ortiz AP, D'Angelo H, Neta G. *Climate Change and Cancer*. Cancer Epidemiol Biomarkers Prev. 2023 May 15;OF1-OF7

Hurricane Harvey's Toxic Impact

FRANK BAJAK of THE ASSOCIATED PRESS
and LISE OLSEN of the HOUSTON CHRONICLE
March 23, 2018



In this Jan. 24, 2018 photo, Galena Park is hemmed in by heavy industry

- More than 100 toxic releases
- Over 365 tons of hazardous chemical released from 40 sites
- A chemical plant northeast of Houston exploded and burned for days
- 13 Superfund sites damaged and flooded; a concrete cap meant to contain pollutants was damaged by the rushing floodwaters, releasing chemicals into the river

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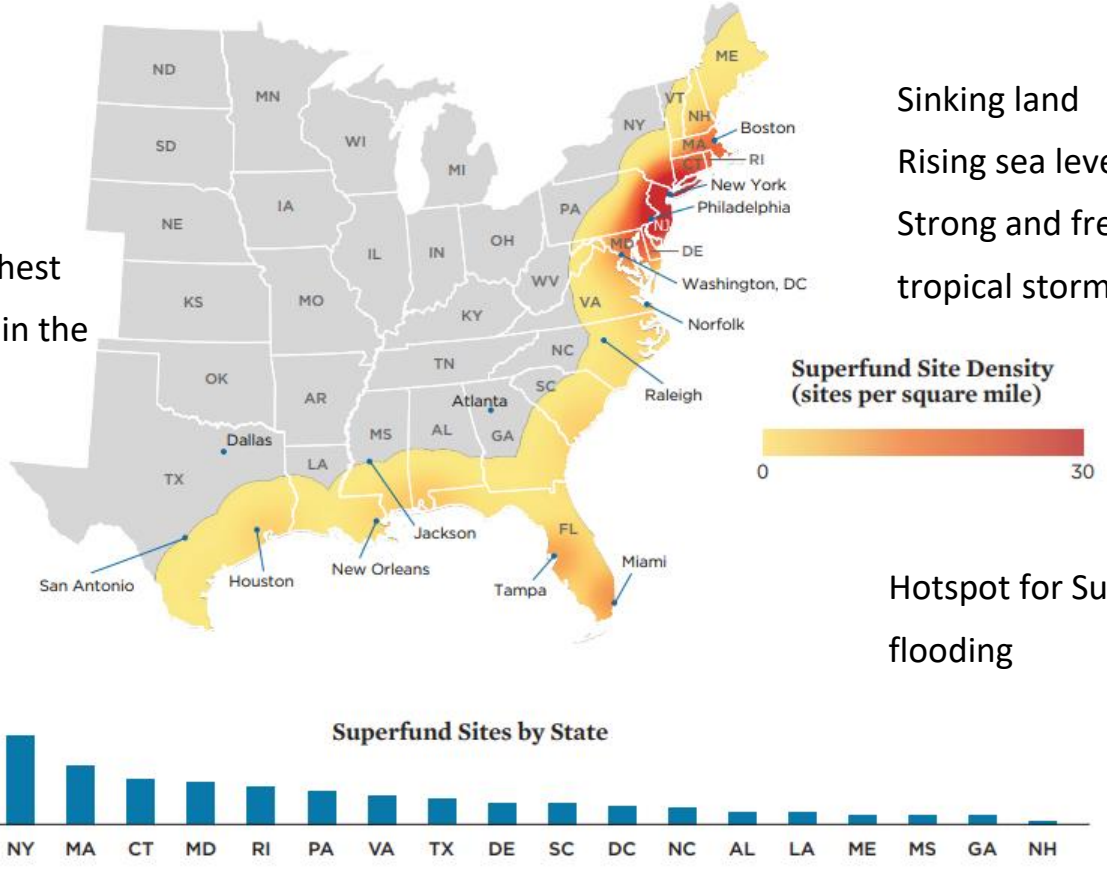
Florida has one of the highest density of superfind sites in the US



All states along the East and Gulf Coasts have Superfund sites close to the coastline. Florida, New Jersey, and New York are particular hotspots. Flooding of any of these sites could cause extensive health damage to surrounding communities.

Sinking land

Rising sea levels

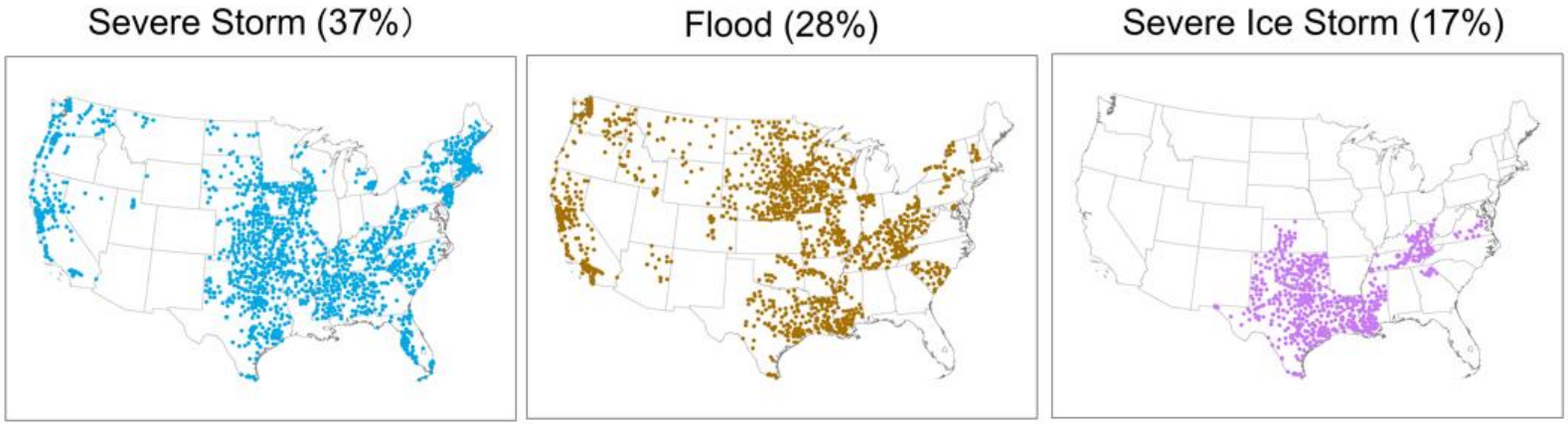
Strong and frequent extreme tropical storms

Hotspot for Superfund site flooding

https://www.ucsusa.org/sites/default/files/2020-07/a-toxic-relationship.pdf

Facilities Impacted by Extreme Weather Events

American Hospital Association (AHA) + FEMA (2016-2020)



Espinel Z, Shultz JM, Aubry VP, Abraham OM, Fan Q, Crane TE, Sahar L**, Nogueira LM**. *Protecting Vulnerable Patient Populations from Climate Hazards: The Role of the Nations' Cancer Centers.* J Natl Cancer Inst. 2023 Jul 25:djad139.

Facilities Impacted by Extreme Weather Events

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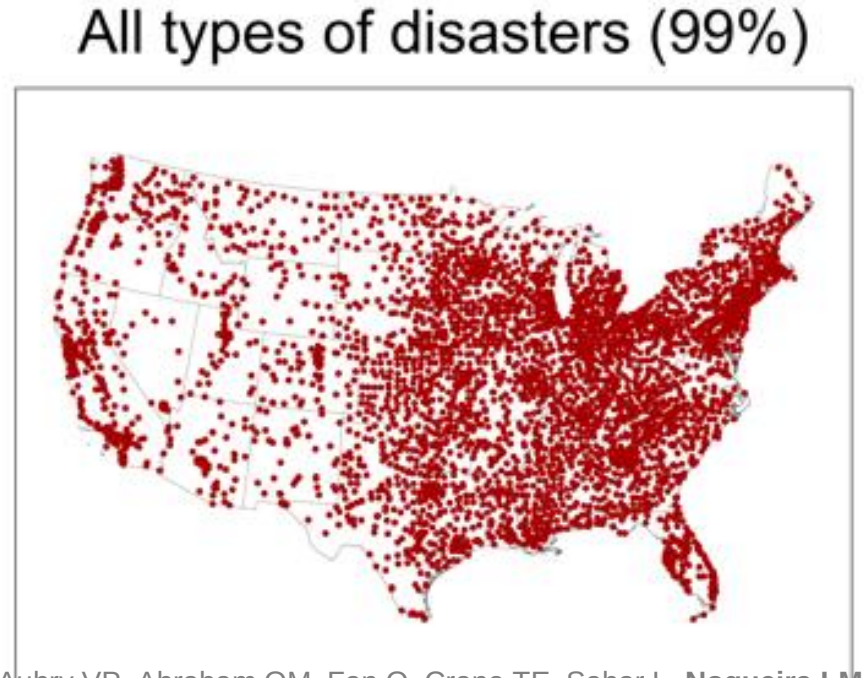

What can we do?

Espinel Z, Shultz JM, Aubry VP, Abraham OM, Fan Q, Crane TE, Sahar L, **Nogueira LM**. *Protecting Vulnerable Patient Populations from Climate Hazards: The Role of the Nations' Cancer Centers*. J Natl Cancer Inst. 2023 Jul 25:djad139.

The Big Questions

- How does the climate crisis affect cancer and cancer care?
- How does cancer care affect the climate?
- What can we all do as healthcare professionals?

Health Consequences of burning fossil fuels

Injuries, fatalities, impact on infrastructure

Asthma, Cardiovascular & pulmonary dx, Lung cancer

Heat related illness and death, cardiovascular failure

Malaria, dengue, encephalitis, hantavirus, Lyme disease, West Nile virus

Forced migration, civil conflict, mental health, access to care

Respiratory allergies, asthma

Malnutrition

Cholera, cryptosporidiosis, campylobacter, leptospirosis

Image Source: CDC

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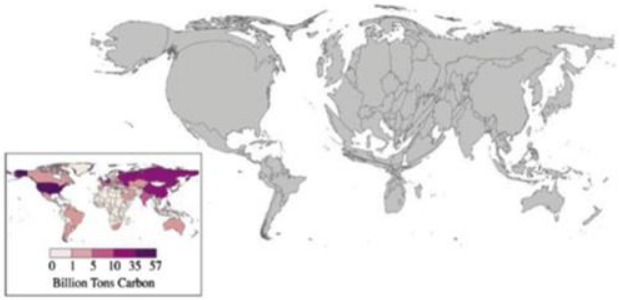
The Impacts of Climate Change are Inequitable

Undepleted Cumulative CO2 Emissions 1950-2000



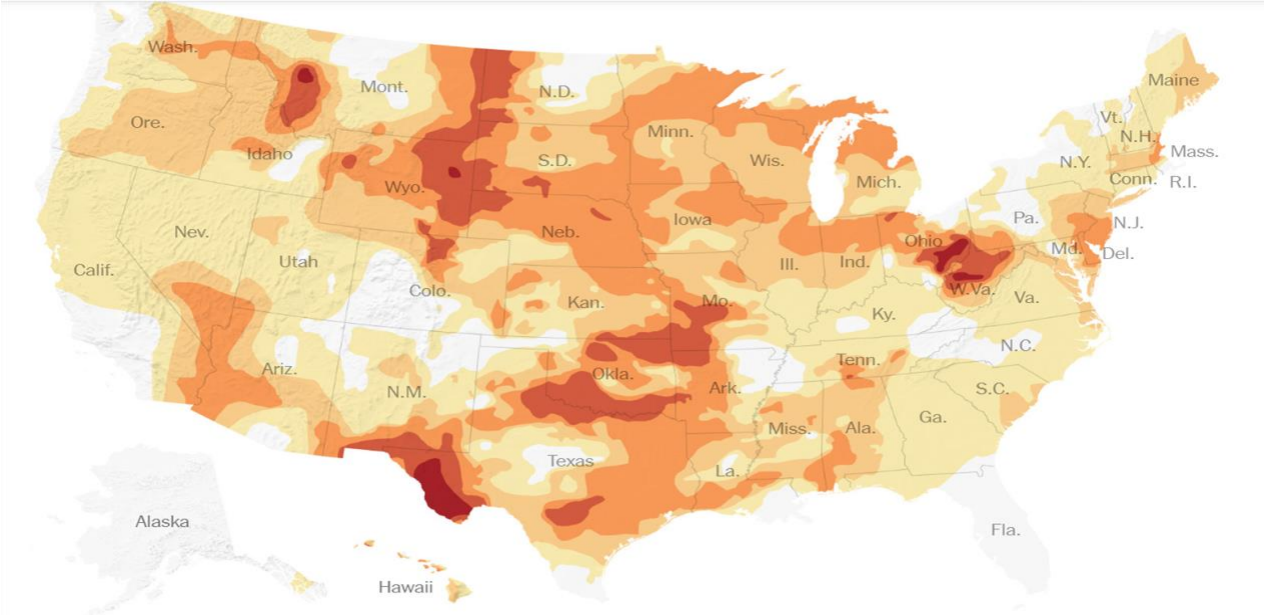
92% of excess emissions come from the Global North

Regional Distribution of Climate Sensitive Health Effects: Malaria, Malnutrition Diarrhoea, Flood Fatalities

$152tn extracted from the Global South by the Global North since 1960

Patz JA et al. Ann Glob Health 2014 80:332-44.
Deivanayagam TA & Osborne RE. doi 10.1371/journal.pgph.0001684

All but 2 US States are in drought



The New York Times

A Month's Worth of Rain Falls in a Single Day in Parts of Spain

The deluge flooded streets, breached rivers and destroyed crops along the Mediterranean coast. There could be more rain still to come.

Intensity of the IV Fluid Shortage at US Hospitals Remains Very High

Colorado’s IV fluids shortage isn’t over yet

Shortage of IV fluids leads to canceled surgeries

In Western North Carolina, Helene's Devastation Is Threatening Health Care Access

Dozens of volunteer doctors, nurses and psychologists traveled to the region to treat people whose routines, including medical appointments, were disrupted by the storm.

Health Impacts of hurricanes and other extreme weather events

- Limited access to food and safe water
- Contamination of water and food sources
- Increased risk from infectious diseases
- Disruption of services
- Reduced ability to access health care,
- Growing burden from unaddressed other medical issues
- Mental health issues

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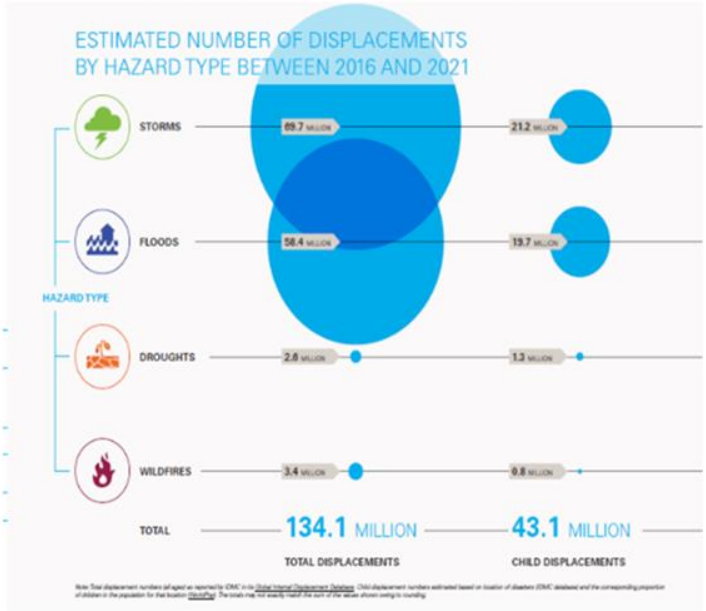
Taken from KFF's Issue Brief "Public Health in Puerto Rico after Hurricane Maria

Image: LA Times

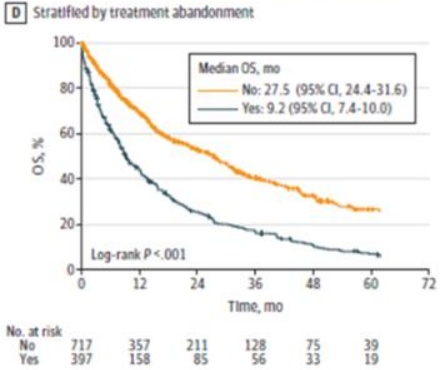
Disrupted Cancer-Care Increases Suffering

Climate Change Related Displacement 2016-21



Cancer Outcomes in Syrian Refugees in Southern Turkey

Kutluk T et al. JAMA Network Open 2023; 6(5)e2312903



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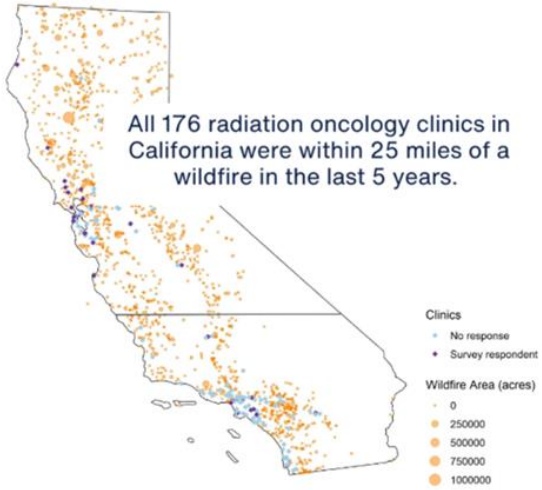
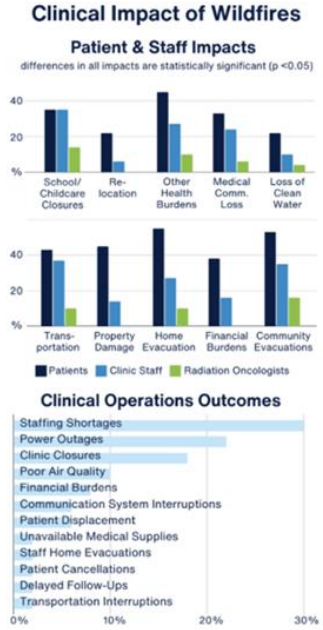
Disruptions of care



60%

Respondents Affected By Wildfires



From: **Association Between Declared Hurricane Disasters and Survival of Patients With Lung Cancer Undergoing Radiation Treatment**

JAMA. 2019;322(3):269-271. doi:10.1001/jama.2019.7657

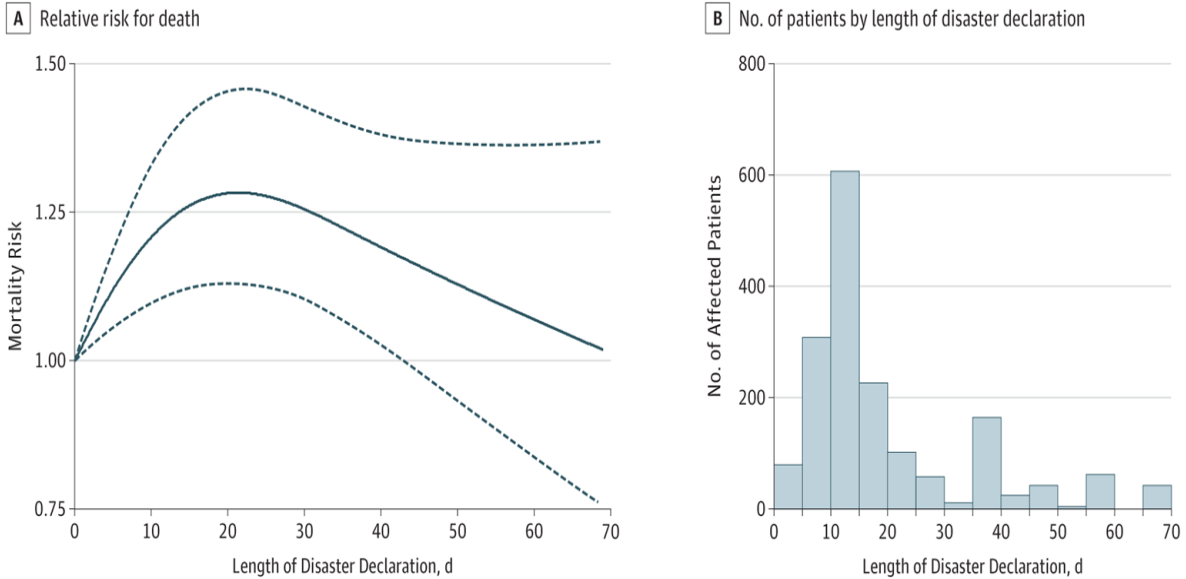


Figure Legend:

Association Between Length of Hurricane Disaster Declaration and Risk of Death in Patients With Lung Cancer Undergoing Radiation In panel A, cubic spline regression modeled a 1-unit increase in the number of days the declaration lasted and the overall survival, adjusted for sex, race/ethnicity, income, geographic region, health insurance, comorbidities, tumor size, tumor spread to lymph nodes, facility type, driving distance to facility, receipt of concomitant chemotherapy, number of treatment sessions (fractions) received, and radiation treatment start month and year (2004-2009 and 2010-2014). Only the 1734 patients who were affected by a hurricane

Increased Causal Factors (from Hiatt et al Lancet Oncology 2020)

Etiology	Prevention	Detection, Treatment
Increased Exposure to cancer Risk factors: Air pollution, chemical toxins, UV radiation, food supply disruption, infectious disease	Changes in risk and maintenance of recommended health behaviors: diet, physical activity, sun protection	Disruption to all aspects of screening, diagnosis and treatment that rely on the function of health systems

Climate change threatens the quantity and quality of our food supplies

Drops in Crop Yield	Nutrient change in crops	Pollinator declines
Coral reefs collapse	Fisheries collapse	Decrease in milk and meat production

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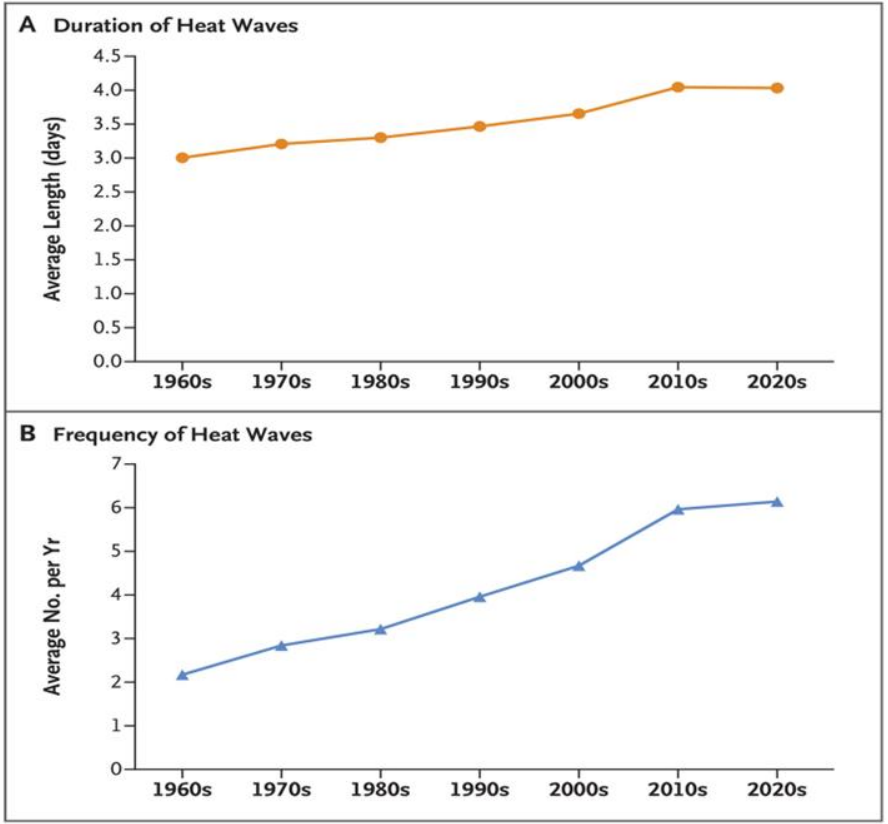
HEAT

Increase in the Frequency and Duration of Heat Waves over Time in the United States. Bell et al NEJM 2024



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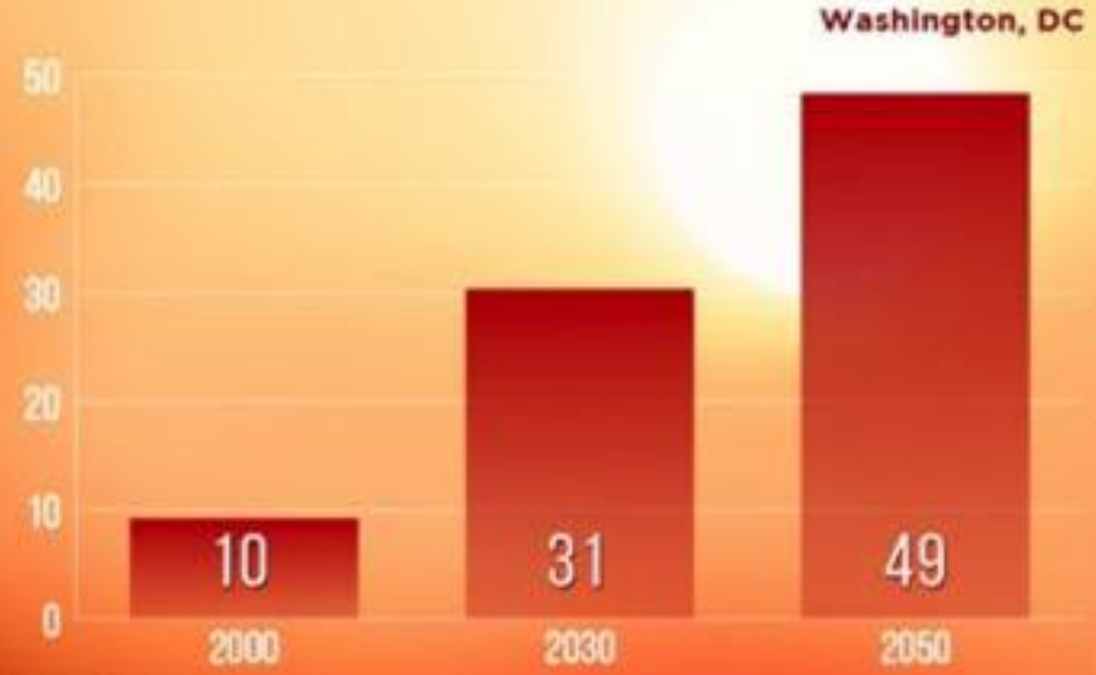
MORE DANGER DAYS

HEAT INDEX ABOVE 105°



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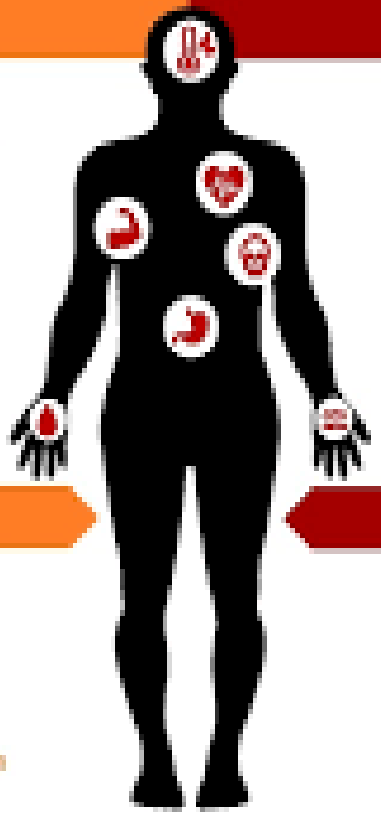
HEAT EXHAUSTION

- 37°C to 40°C (98.6°F to 104°F)
- Headache, Fatigue, Dizziness
- Muscle Cramps
- Nausea
- Pale, Moist Skin
- Weak Pulse

HEAT STROKE

- > 40°C (>104°F) and above
- Confusion, Unconsciousness
- Seizures
- Vomiting
- Warm, Dry Skin
- Fast and Strong Pulse
- Rapid Heart Rate

Coma and Death Possible!



First Aid Guide

- Move to a cool place and rest
- Remove excess clothing
- Fan skin
- Place cool cloths on skin
- Drink cool water if fully conscious

First Aid Guide

- Call local emergency number
- Move to a cool place and rest
- Remove excess clothing
- Drench skin with cool water
- Place ice bags on the armpits

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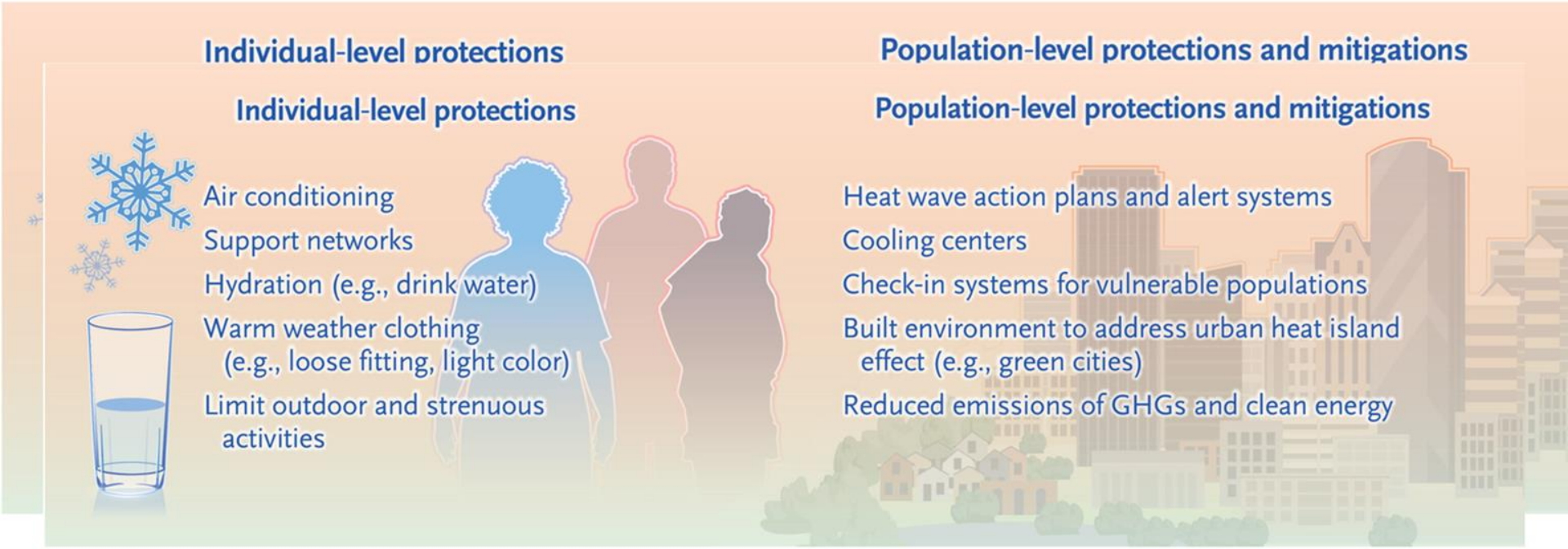
Protective Measures for Heat; Bell et al NEJM 2024



Strategies for Mitigation and Adaptation to the High Vulnerability of Patients With Cancer to Heatwave-Related Morbidity and Mortality (Hassan et al JCO 2023)

TABLE 1. Strategies for Mitigation and Adaptation to the High Vulnerability of Patients With Cancer to Heatwave-Related Morbidity and Mortality

Entity	Theme	Risks	Adaptation and Mitigation Strategies
Health systems	Preparedness	Physical vulnerability (eg, older age, and ongoing chemotherapy)	Workflows and infrastructure for timely detection and response
	Response		Development of appropriate triage and treatment protocols
	Data collection		Improve understanding of health hazards of heatwaves
	Public health campaigns		Communication of the adverse health effects of imminent heatwaves
	Vulnerability mapping	Social vulnerability (eg, urban heat islands)	Identify vulnerable populations, facilitate heat prevention activities, and distribute adequate support and resources
	Sustainability efforts		Climate mitigation to minimize emissions from the health care system
	Infrastructure planning		Incorporation of environmentally responsible and equity-centered efforts into current and future institutional and municipalities infrastructure and processes
Health care providers	Patient education	Physical and social vulnerability	Culturally and linguistically appropriate heatwave counseling
Education	Trainee competency		Include the health hazards of climate change and adaptation and mitigation strategies in training programs for all health-related professions
Pharmaceutical companies	Drug development	Physical vulnerability	Prioritize the development of thermostatic medications
	Drug interactions		Improve provider and patient education about medication interactions
	Adverse event monitoring		Improve reporting of drug interactions and adverse events

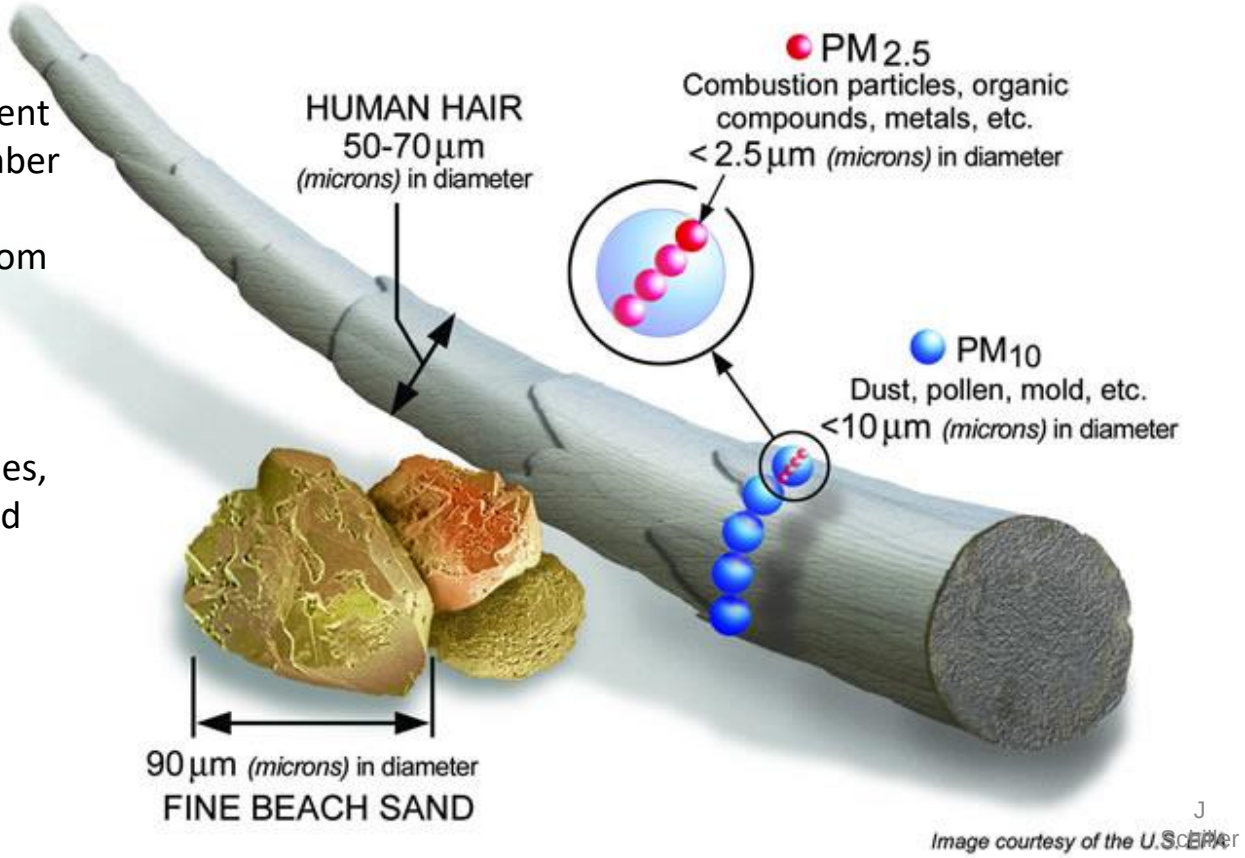
Air Pollution/Fires

Unprecedented Wildfires

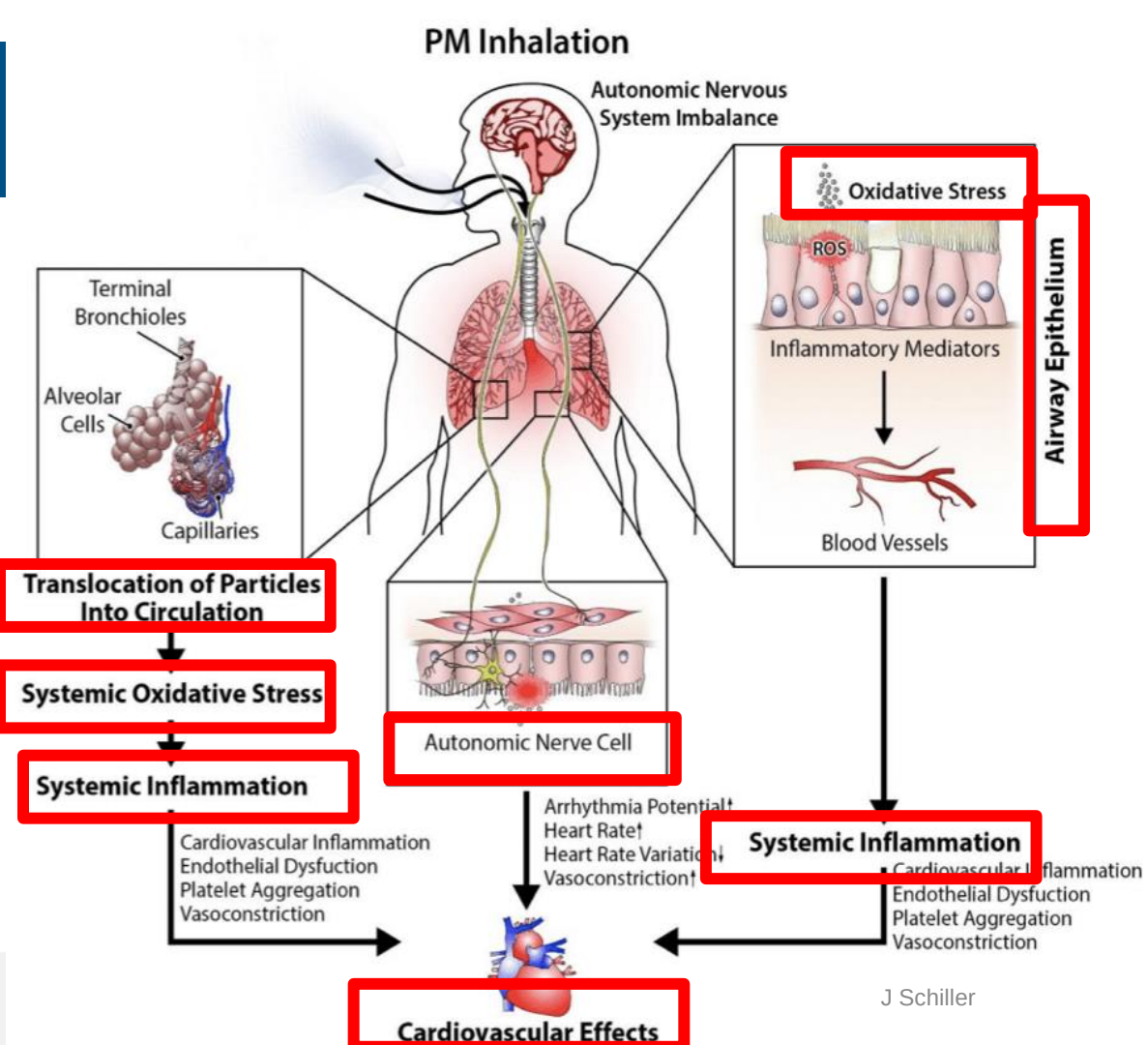
Particulate Matter

Particulate matter comes in different sizes (coarse and fine) from a number of sources including:

- Small particles: Dust, etc. from construction, mining and agriculture; Pollen
- Fine particles **(PM 2.5)**: Burning fossil fuels in factories, power plants, and diesel- and gasoline-powered motor vehicles; fires



PM 2.5 Mechanism of Injury



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- Impaired respiratory function
  Chronic cough
  Lung Disease
  - Bronchitis
  - Asthma
    COPD
    Pneumonitis
- Cardiovascular disease
  Lung cancer
- Systemic effects

VCCA Virginia Clinicians for Climate Action

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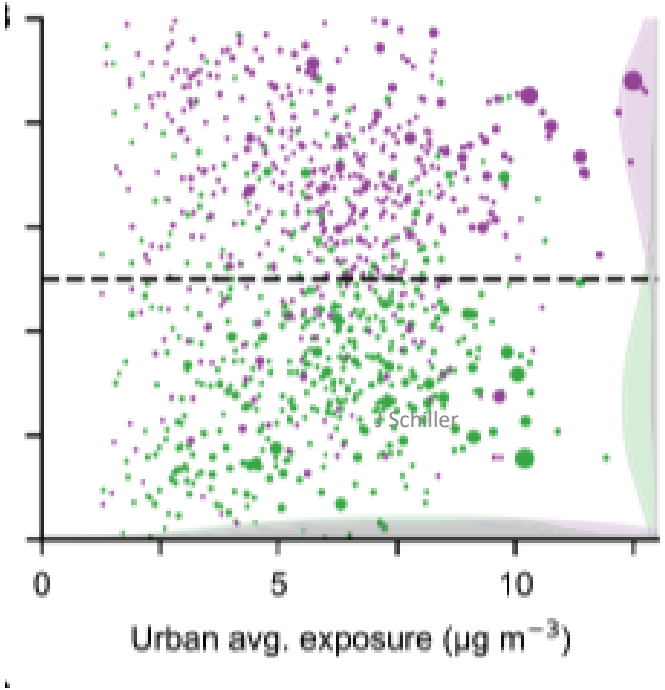
$PM_{2.5}$ polluters disproportionately and systematically affect people of color in the United States

Tessum et al., Sci. Adv. 2021; 7 : eabf4491 28 April 2021



- Within individual states
- Within individual urban and rural areas
  Across incomes
  Across exposure levels
  Largest sources of disparities varies widely by source type and locations
  - Industry
    Light duty gasoline vehicles
    Construction
    Heavy duty diesel vehicles

People of color

Whit
e

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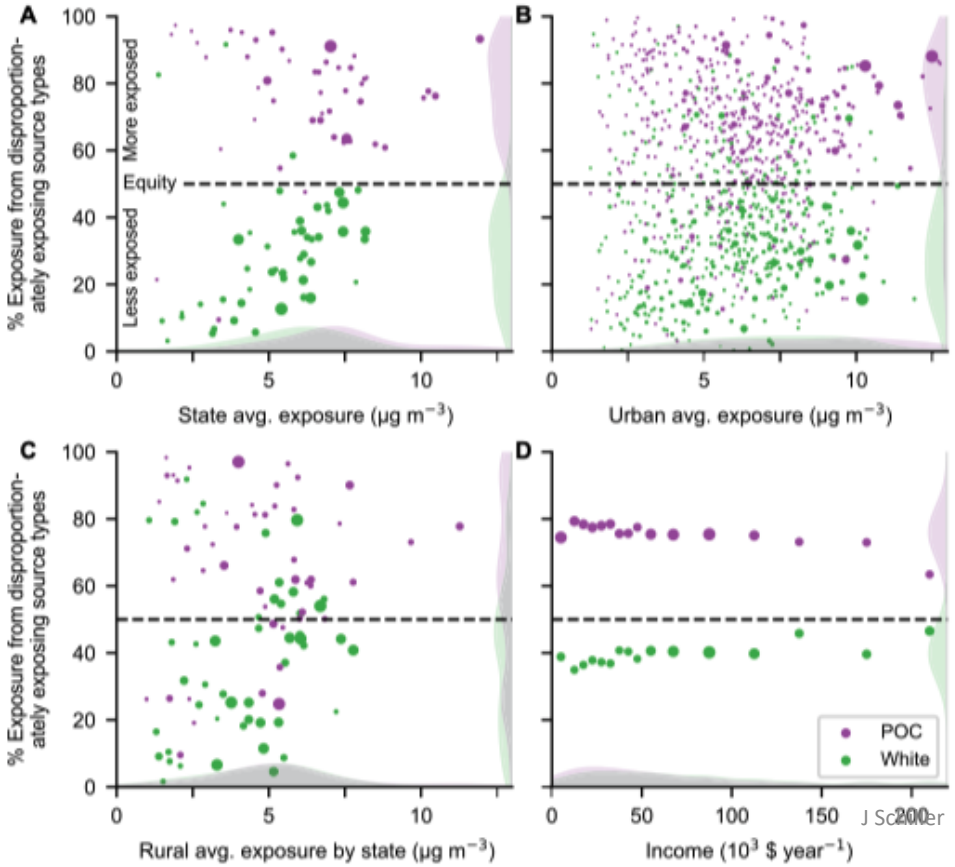

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    Light duty gasoline vehicles
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People of color

Whit e

J Scanner

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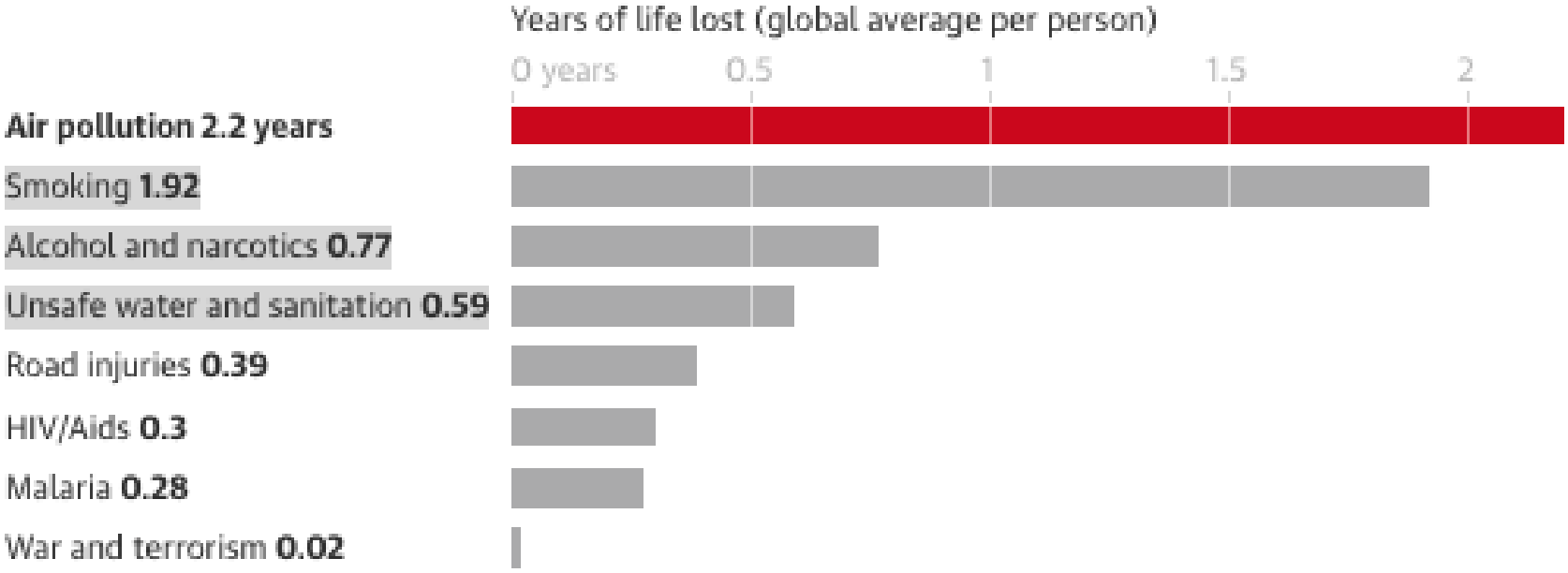
Air pollution shortens lives more than any other external cause



Guardian graphic | Source: AQLI, University of Chicago, 2021

Estimated Hazard Ratios Associated with mcg/^{m3} increase of PM 2.5

Coleman N, et al Cancer Causes & Control (2020) 31:767–776

National Health Interview Survey and mortality follow-up

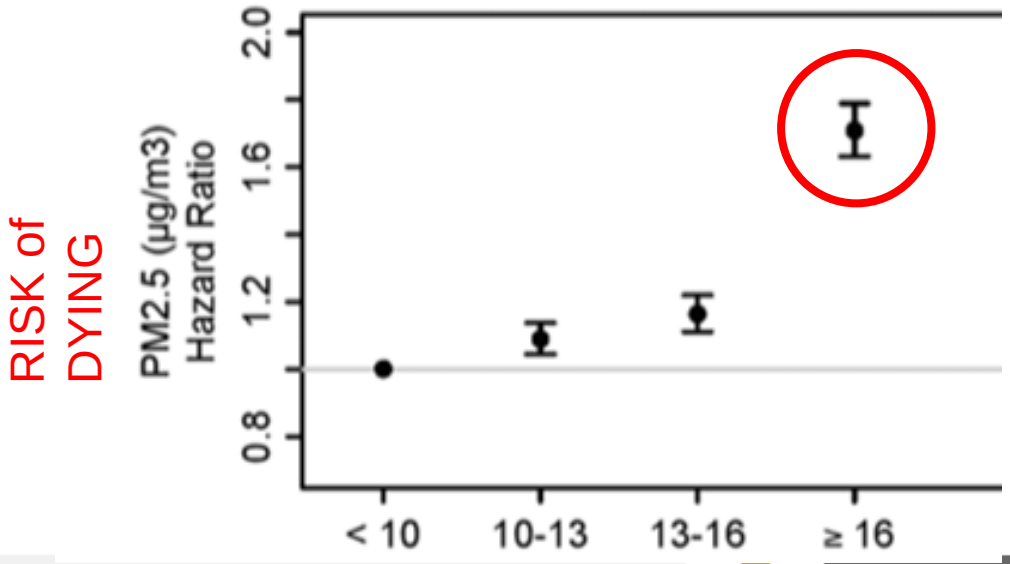
- 635,539 individuals surveyed from 1987 to 2014.

HR (95% CI)	Full cohort	Never-smoker cohort
All Cancers	1.15 (1.08- 1.22)	1.19 (1.06-1.33)
Lung cancer	1.13 (1.0-1.26)	1.73 (1.2-2.49)
Non-lung cancers	1.15 (1.07-1.26)	1.15 (1.02-1.30)

Air Pollution Shortens Lung Cancer Survival

Eckel SP, et al. Thorax 2016;71:891–898.

Risk of Dying with Localized Exposure

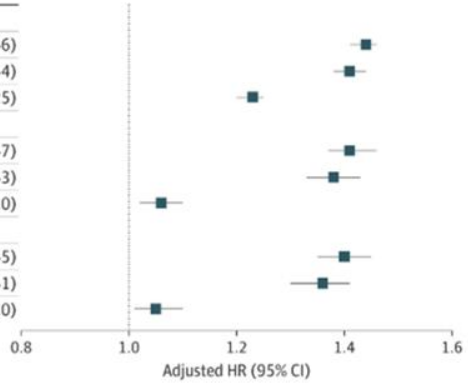


JAMA Network

Association of Wildfire Exposure While Recovering From Lung Cancer Surgery With Overall Survival

JAMA Oncol. 2023;9(9):1214-1220. doi:10.1001/jamaoncol.2023.2144

Stage	Unadjusted HR (95% CI)	Adjusted HR (95% CI)[a]
Stage I		
0-3 mo	1.59 (1.57-1.62)	1.44 (1.41-1.46)
4-6 mo	1.55 (1.53-1.58)	1.41 (1.38-1.44)
7-12 mo	1.37 (1.35-1.40)	1.23 (1.20-1.25)
Stage II		
0-3 mo	1.54 (1.50-1.58)	1.42 (1.38-1.47)
4-6 mo	1.50 (1.45-1.55)	1.38 (1.33-1.43)
7-12 mo	1.16 (1.12-1.20)	1.06 (1.02-1.10)
Stage III		
0-3 mo	1.56 (1.51-1.60)	1.40 (1.35-1.45)
4-6 mo	1.52 (1.47-1.57)	1.36 (1.30-1.41)
7-12 mo	1.17 (1.13-1.22)	1.05 (1.01-1.10)



Mortality Risks for Individuals Exposed to Wildfire Within 3, 6, and 12 Months From Hospital Discharge Following Non–Small Cell Lung Cancer Surgery by Stage at Diagnosis, National Cancer Database 2004-2019[a]Adjusted for sex, cancer stage, comorbidities, facility type, health insurance coverage type, tumor size, lymph node involvement, geographic region, era, and metropolitan category. HR indicates hazard ratio.

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Wildfire Exposure and Lung Cancer Survival

Among individuals discharged from the hospital following lung cancer surgery

NASA HEALTH AND AIR QUALITY APPLIED SCIENCES TEAM
Connecting NASA Data and Tools with Health and Air Quality Stakeholders

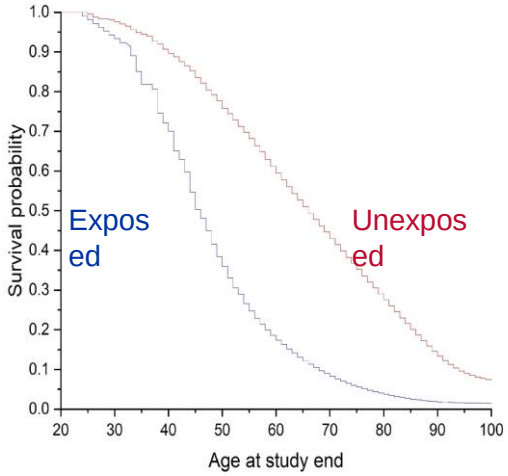
National Aeronautic and Space Agency (NASA)
https://appliedsciences.nasa.gov/what-we-do/disasters/fires

Exposure to wildfire goes beyond inhaling wildfire smoke

Stress associated with potentially having to evacuate, threat to property and life, water and soil contamination

https://pubmed.ncbi.nlm.nih.gov/33189165/

Cancer patients are a vulnerable population to climate hazards



Zhang D, Xi Y, Boffa D, Liu Y, **Nogueira LM**. *Wildfire exposure while recovering from lung cancer surgery decreases long-term survival*. JAMA Oncology 2023 Sep 1;9(9):1214-1220.

Table 2. Mortality Risk for Individuals Exposed to Wildfires Since Hospital Discharge Following Non–Small Cell Lung Cancer Surgery, National Cancer Database 2004-2019

Time from surgery to wildfire exposure	Hazard ratio (95% CI)	
	Crude	Adjusted[a]
0-3 mo	1.58 (1.56-1.59)	1.43 (1.41-1.45)
4-6 mo	1.54 (1.52-1.56)	1.39 (1.37-1.41)
7-12 mo	1.29 (1.27-1.31)	1.17 (1.15-1.19)

[a] Adjusted for sex, cancer stage, comorbidities, facility type, health insurance coverage type, tumor size, lymph node involvement, geographic region, era, and metropolitan category.

Wildfires have a higher long-term impact on health in the east than the west

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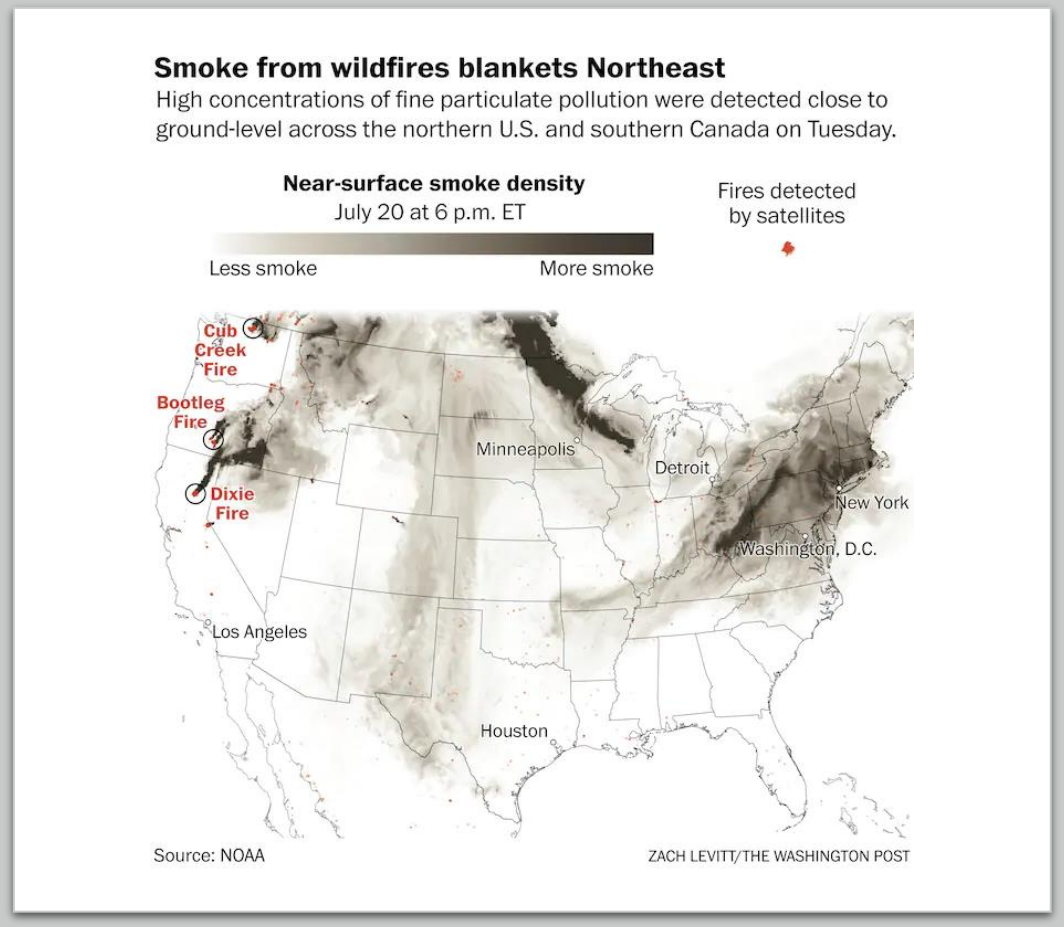
•https://www.washingtonpost.com/weather/2021/10/20/wildfire-smoke-deaths-eastern-us/



After the fire

United States, west-coast wildfires

Excess Deaths in the elderly

***per million people* 2015 – 2020**

Sources: Stanford Institute for Economic Policy Research; National Interagency Fire Centre

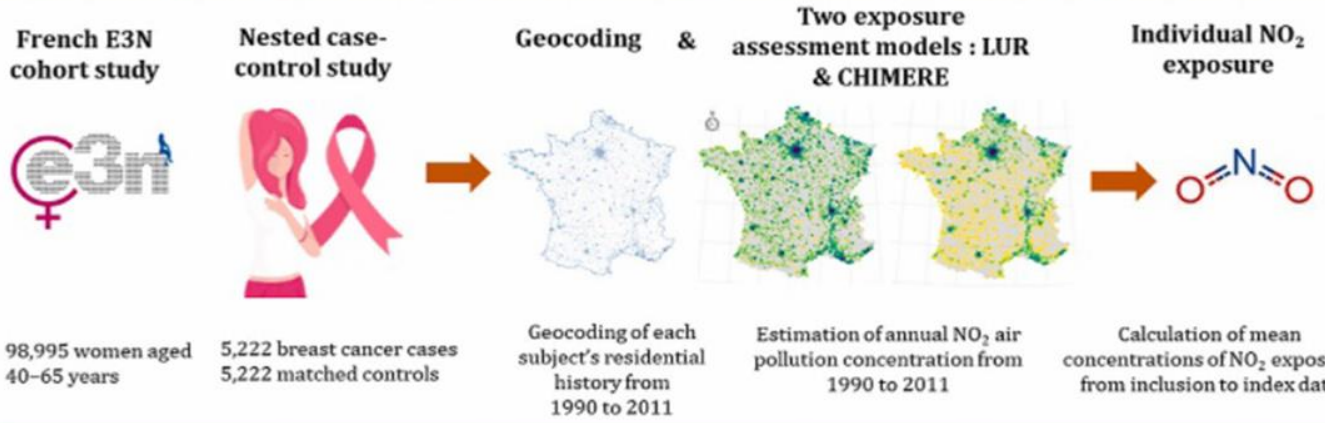
*Over 65 years old

The Economist

Source: https://www.economist.com/graphic-detail/2020/10/14/this-is-the-worst-fire-season-the-american-west-has-ever-seen

Daily Climate Toxicity in the Global North
Fossil Fuel Pollution Increases Breast Cancer Risk

Long-term exposure to nitrogen dioxide (NO_2) air pollution and breast cancer rsk: A nested case-control within the French E3N cohort study



1st Epidemiological study investigating long-term exposure to NO_2 over up to 22 year, and its association with breast cancer risk

↗ NO_2 exposure ⇨ ↗ Risk of overall breast cancer | ↗ Risk of post-menopausal and ER-positive breast cancer | Consistent associations for the two models

Amadou A et al. Environmental Pollution 2023. 317:120719

Wu H et al. Nat Rev Genet 2023. 24:332-44.

NOTE: Breast cancer risk per 10 μg/m³ satellite-based $PM_{2.5}$ Cox proportional hazard models using age scale, and

Air Pollution and Breast Cancer Incidence in the Multiethnic Cohort Study (Wu et al JCO 2024)

Demographic/Lifestyle Factors	Breast Cancers	HR (95% CI)	*P*	$P_{heterogeneity}$
Education				
Low (high school or less)	1,598	1.40 (1.09 to 1.79)	.009	
High (some college or more)	1,846	1.19 (0.95 to 1.47)	.13	.48
nSES				
Low (quintiles 1-3)	2,288	1.21 (0.97 to 1.50)	.09	
High (quintiles 4-5)	1,176	1.35 (1.05 to 1.73)	.02	.93
Family history of breast cancer				
No	2,710	1.36 (1.13 to 1.65)	.001	
Yes	542	0.97 (0.67 to 1.42)	.89	.046
Smoking				
Never	1,876	1.35 (1.07 to 1.69)	.01	
Former	1,045	1.29 (0.97 to 1.71)	.08	
Current	491	0.93 (0.60 to 1.46)	.76	.69
BMI, kg/m²				
<25	1,159	1.19 (0.90 to 1.55)	.23	
25-<30	1,261	1.22 (0.92 to 1.61)	.17	
≥30	1,034	1.54 (1.13 to 2.09)	.006	.27
Menopause status				
Premenopause	420	1.57 (0.79 to 3.12)	.20	
Natural menopause	1,710	1.49 (1.18 to 1.90)	.001	
Surgical menopause	1,314	1.14 (0.90 to 1.45)	.28	.30

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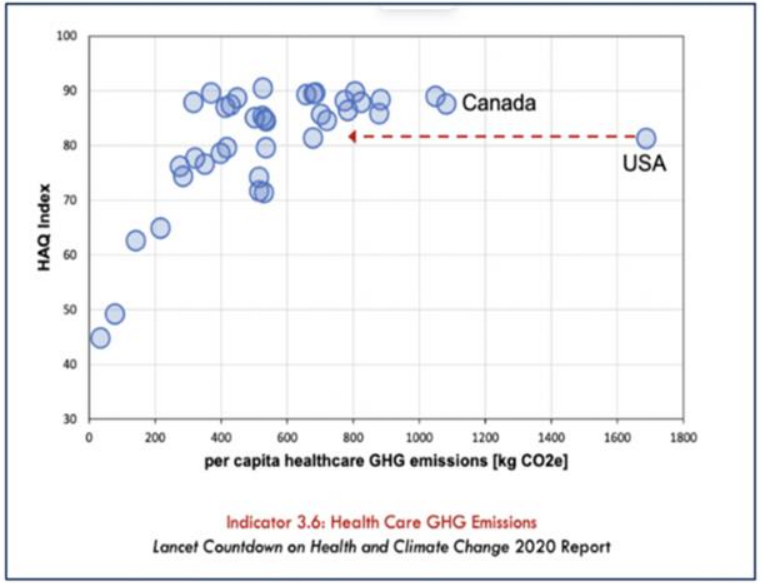
HealthCare, Carbon Footprints and Choosing Wisely

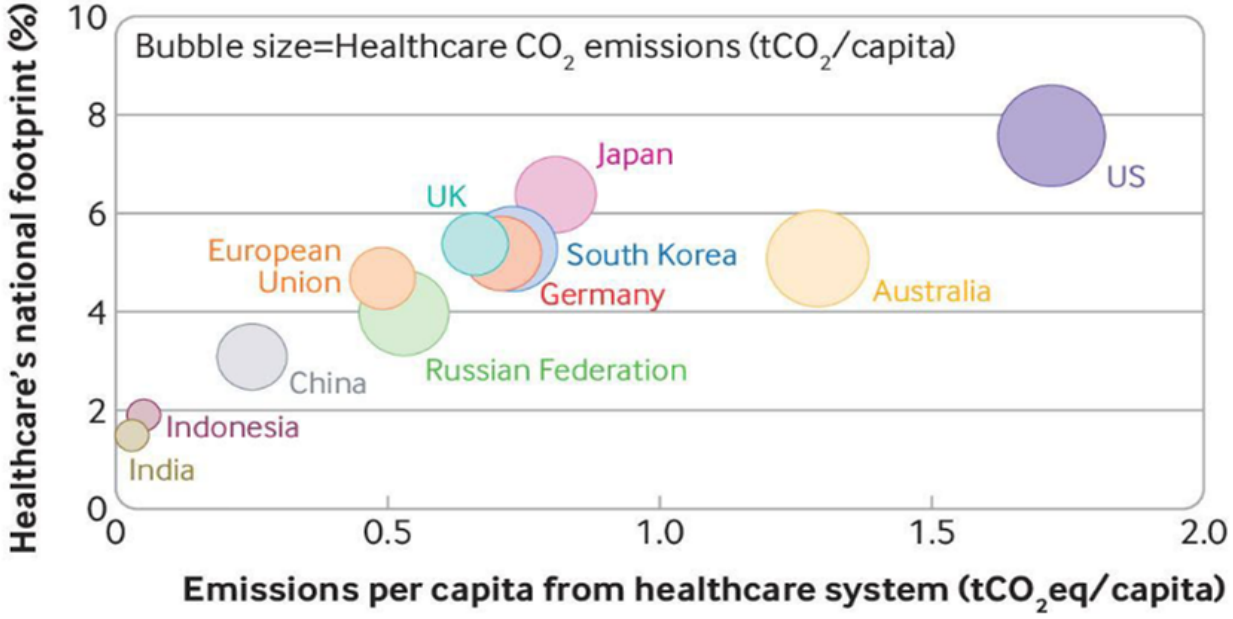
Healthcare Contributes to Climate Change (GHG)

- Healthcare accounts for 8.5 - 10% of U.S. emissions and 5% of global emissions
- If the **U.S. healthcare sector** were a nation, it would rank 13th in the world for emissions (ahead of UK)



Indicator 3.6: Health Care GHG Emissions
Lancet Countdown on Health and Climate Change 2020 Report

Modern Healthcare is not Climate Change Engaged



National healthcare emissions and percentage carbon footprint of selected countries, 2019.

Braithwaite J et al. BMJ 2023;382:bmj-2023-076963
Patz JA et al. Ann Glob Health 2014 80:332-44;
Weadick CS et al. J Cancer Policy 2023

Carbon footprint of Healthcare 4% of global emissions (#5)

15% Medical Schools integrate Climate change in curriculum (2020 survey)

12% of physicians have ecofavorable footprints

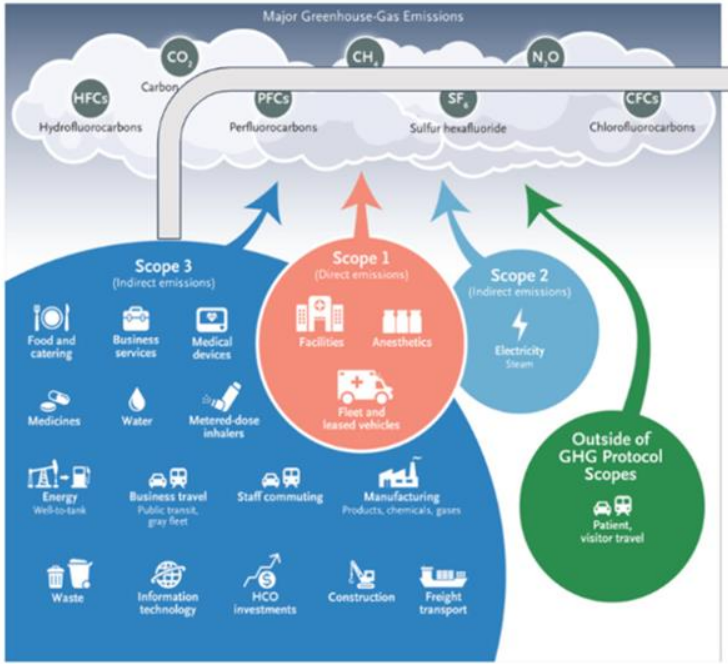
Carbon footprint of radiology 1% of global emissions

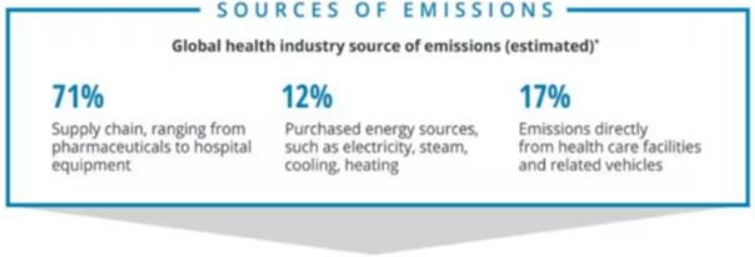
Carbon footprint of US Healthcare = 100% UK annual emissions

thebmj

RMOS ROCKY MOUNTAIN ONCOLOGY SOCIETY

Where is **8.5-10%** coming from?





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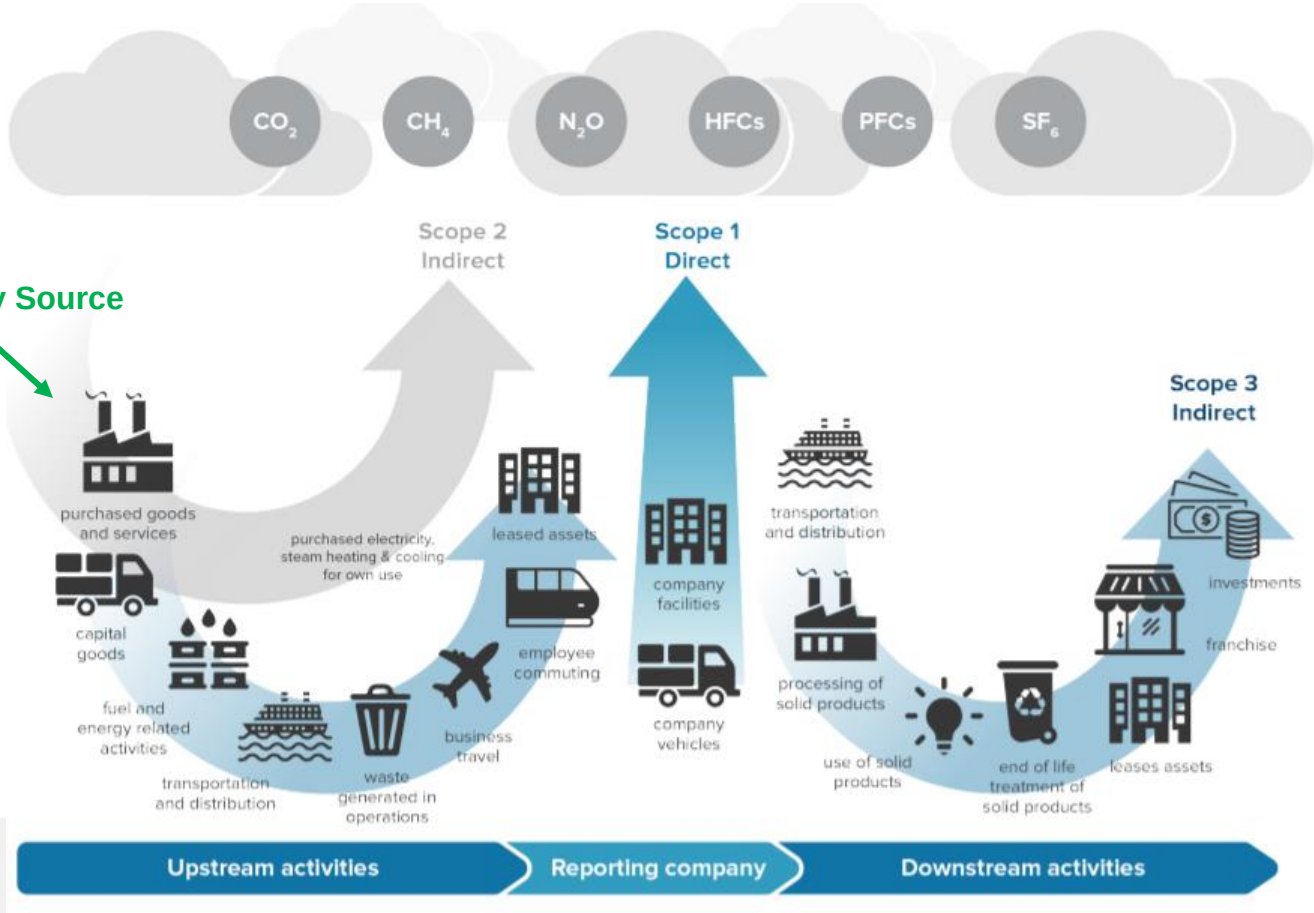
Healthcare System Emissions

Clean Energy Source

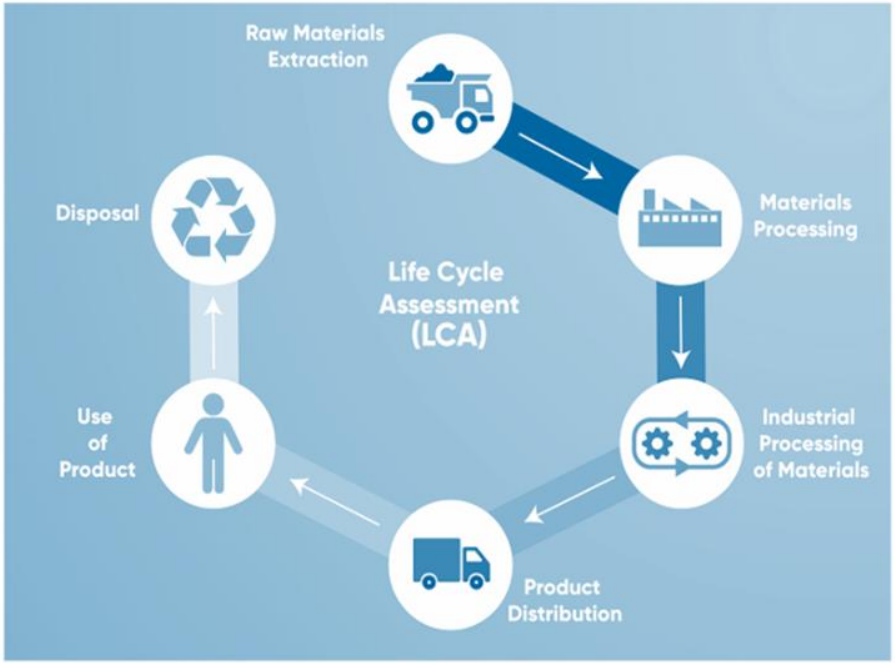


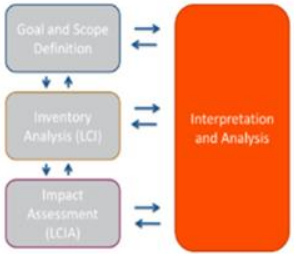
Hospitals produce significant **waste**

Context: Americans throw out 4.9 pounds of trash per person every day

Life Cycle Assessment (LCA)

A **tool** used to quantify the environmental emissions (or impacts) of a product or process throughout its life cycle





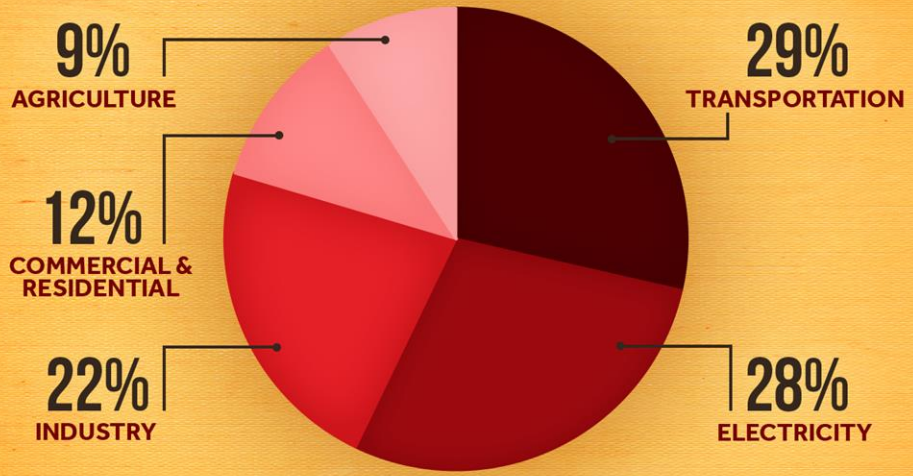
Results: Energy Use

Building Energy

- HVACs: median 11,424 kWh, **~96%** of total building energy use
  - Natural Gas: 71.3% of HVAC energy use, while electricity contributes 25.3%
  - **Min impact from capital equipment**
    - LINACs: approx. 4% of total building energy use, with minimal contribution from computers, etc.

	Breast	
HVAC		% of total energy use
Electricity (kWh)	3,294	25.29%
Natural gas (converted to kWh)	9,283	71.29%
Equipment		
Linacs (kWh)	438	3.37%
Computers (kWh)	1.2	0.01%
CT Scanner (kWh)	5.3	0.04%
Electrometer (kWh)	1.92E-18	0.00%
Total	**13,021**	

GREENHOUSE GAS SOURCES
UNITED STATES EMISSIONS BY SECTOR



Source: U.S. EPA 2017 (released 2019)

CLIMATE CENTRAL

What can we do?

Select US Public Policy Positions on Climate Change and Health

Society	Year	Policy/Position Statement
American Society for Radiation Oncology	2023	ASTRO Climate Change Statement[67]
American Medical Association	2022	AMA Adopts a New Policy Declaring Climate Change a Public Health Crisis[68]
International Association for the Study of Lung Cancer	2022	Air Pollution and Lung Cancer—The IASLC Position Statement[69]
American Psychiatric Association	2019	American Psychiatric Association: Position Statement on Mental Health and Climate Change[70] American Psychiatric Association: Action Proposal on Divestment[71]
American College of Preventive Medicine	2019	American College of Preventive Medicine—Climate Change Policy Recommendations[72]
Infectious Disease Society of America	2018	IDSA Policy on Preparing for the Infectious Diseases Complications Related to Climate Change[73]
American Academy of Dermatology	2018	American Academy of Dermatology | Position Statement On Climate and Health[74]
American College of Emergency Physicians	2018	Policy Statement: Impact of Climate Change on Public Health and Implications for Emergency Medicine[75]
American College of Physicians	2016	Climate Change and Health: A Position Paper of the American College of Physicians[76]
American Academy of Pediatrics	2015	American Academy of Pediatrics—Global Climate Change and Children's Health[77]

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Emergency Preparedness Plan

Individual patient level:

How to create a portable medical card

How to pre-register for special need shelters

Items to be included in an emergency supply kit

How to request additional medication

Table 2 Potential examples of hypofractionation alternatives to conventional fractionation regimens

Disease site	Conventional fractionation (# of fractions)	Hypofractionation (# of fractions)
Breast	25	15 or 16 5
Prostate	37	20 5
Lung	30-35	1-5
Central nervous system (brain metastases)	10	1-5
Rectal	25	5
Palliative	10	1-5

Reduced number of fractions (treatment doses) represented compared with conventional fractionation, representing a reduced number of visits to the hospital for patients, the number of times the beam is turned on, and the number of quality assurance checks etc. for patients undergoing hypofractionated treatment, with the associated carbon savings[5 6 7 8 9 22 23]

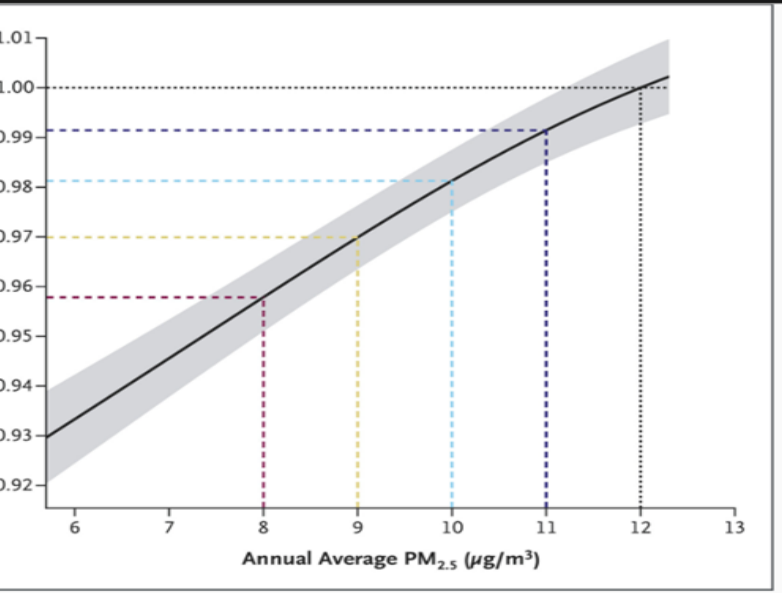
Alternative trastuzumab dosing schedules and association with health care greenhouse gas emissions.

- Three alternative dosing strategies (6-month adjuvant treatment duration, extended-interval dosing, and both) using streamlined life-cycle analysis.
- Adoption of 6-month adjuvant trastuzumab reduced expected per-patient GHG emissions in the adjuvant setting by 10%
- Adoption of both 6-month adjuvant trastuzumab and every 4-week trastuzumab dosing reduced GHG emissions by 4.5%, 18.7%, and 14.6% in the neoadjuvant, adjuvant, and metastatic settings, respectively.

/10.1056/NEJMsa2300523

RE 2

ure–Response Curve for $PM_{2.5}$ Exposure and Mortality among the Full Medicare Population.



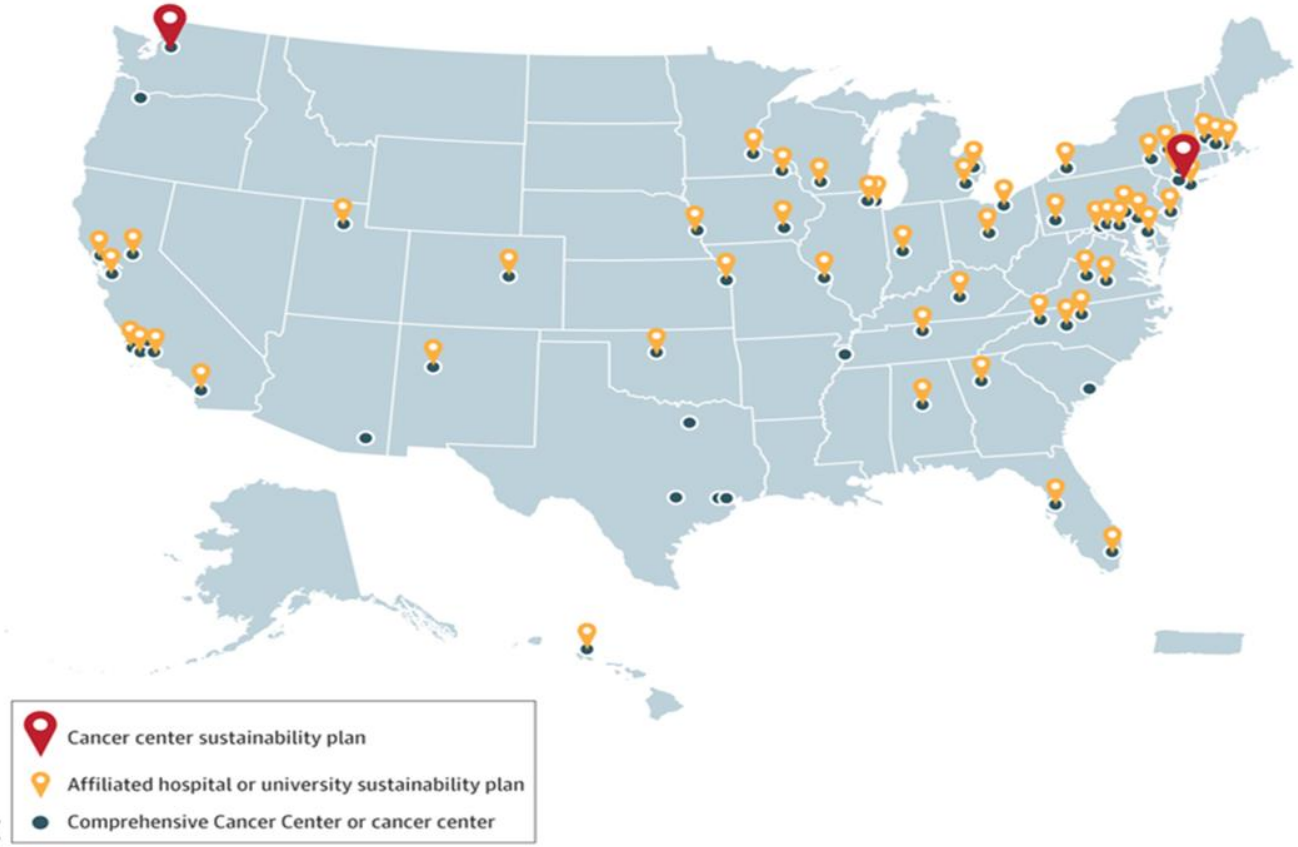
Exposure–Response Curve for $PM_{2.5}$ Exposure and Mortality among the Full Medicare Population.

Shown are the point estimate (solid line) and 95% confidence interval (gray shaded area) of the hazard ratio for death corresponding to decreases in annual average $PM_{2.5}$ exposure (to 6 to 11 μg per cubic meter) with respect to 12 μg per cubic meter on average for the full population. Estimates below 6 μg per cubic meter are not shown in order to focus attention on plausible ranges for $PM_{2.5}$ pollution policy. Confidence intervals were not adjusted for multiplicity; therefore, they should not be used in place of hypothesis testing.

ALL FIGURES

Show all

Map of Environmental Sustainability Plans at National Cancer Institute–Designated Centers (Lichter et al JAMA Network Open 2023)



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Special Articles

Climate Change and Cancer Care: A Policy Statement From ASCO

Eric Bernicker, MD[1]; Steve D. Averbuch, MD[2]; Stephen Edge, MD[3]; Jasmine Kamboj, MD[4]; Fadlo R. Khuri, MD[5]; Jennifer Young Pierce, MD, MPH[6]; Joan Schiller, MD[7]; Bhawna Sirohi, MBBS[8]; Alexandra Thomas, MD[9]; Allyn Moushey, MSW[10]; Jonathan Phillips, MPH[10]; and Carolyn Hendricks, MD[11]

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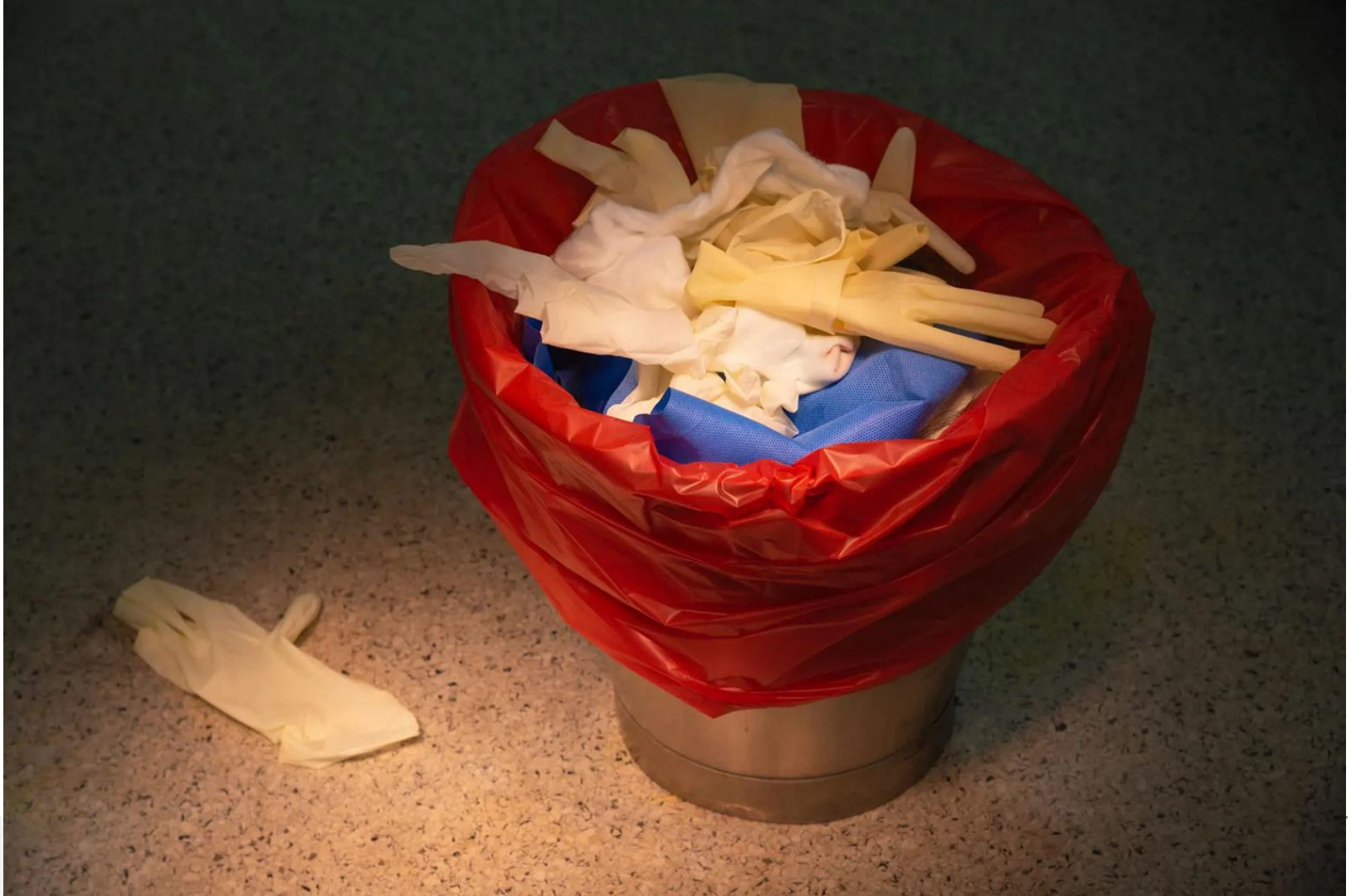
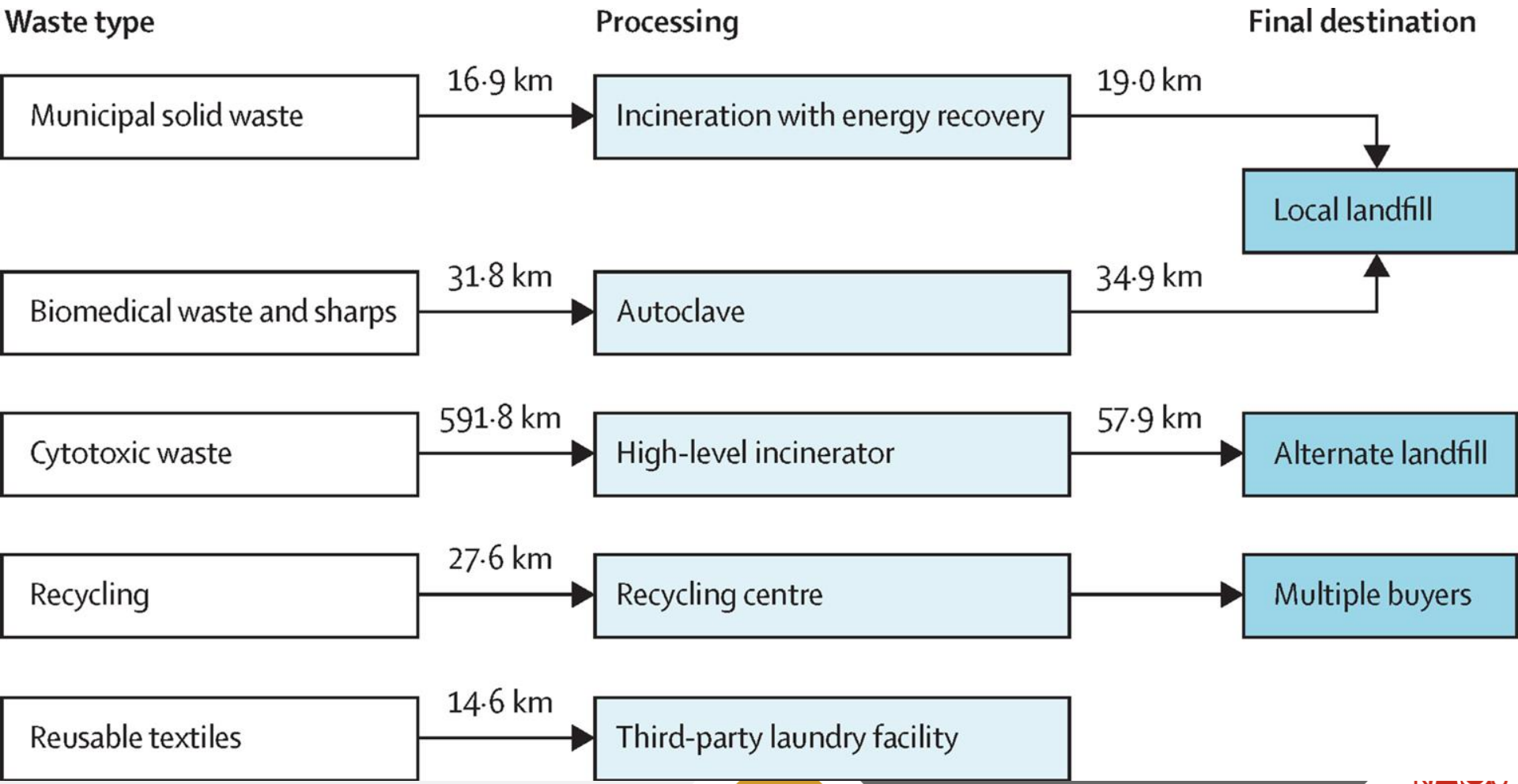
View Online Article

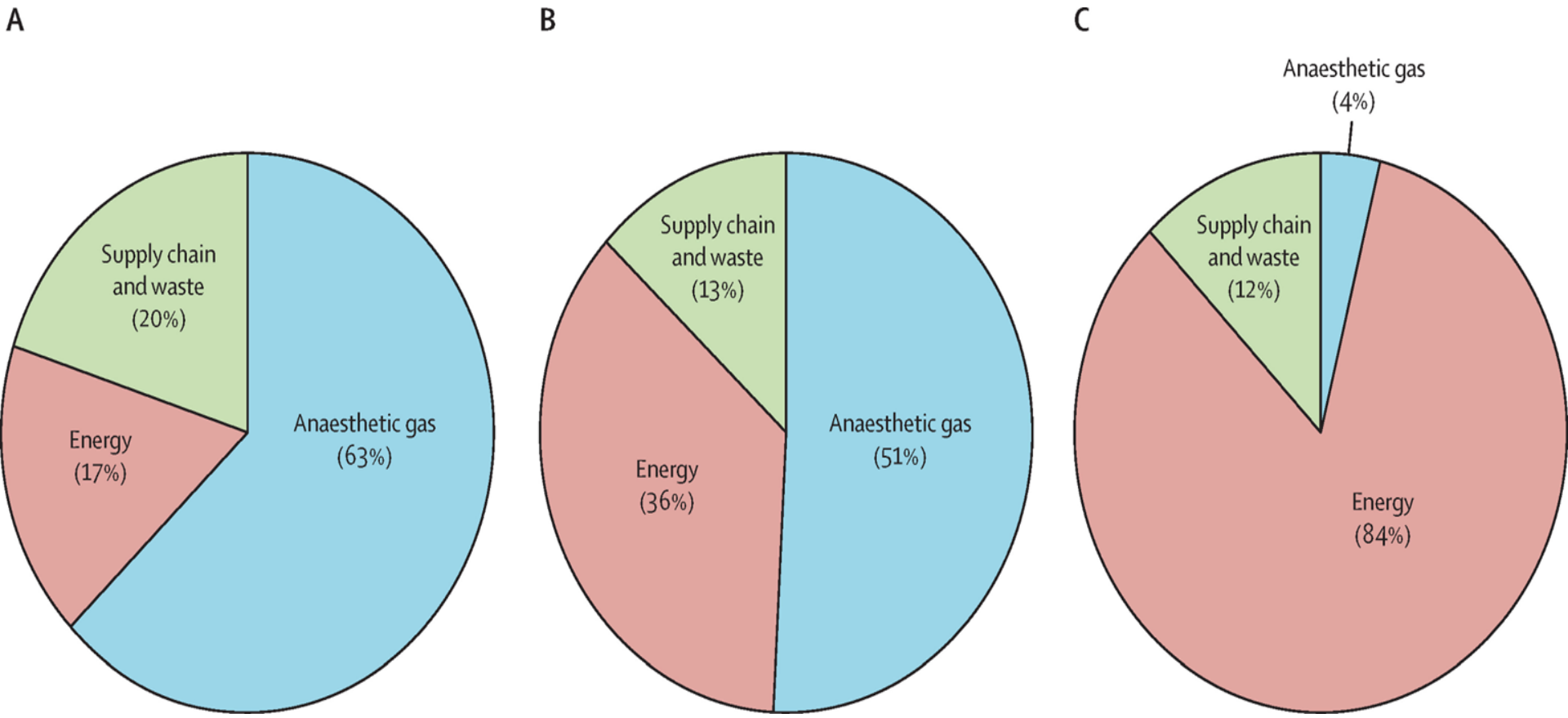
INTRODUCTION

There is incontrovertible and increasing evidence that the changing climate because of the production and burning of fossil fuels has impact on health care delivery and outcomes around the world. Recently, global publications and professional medical societies, including the American Medical Association, have called for action and declared climate change a public health crisis that threatens the health and well-being of all people.[1] The intent of this statement is to affirm ASCO's commitment to addressing the impact of climate change on cancer, with a focus on specific actions guided by our mission pillars of research, education, and quality toward improved cancer prevention, outcomes, and equitable cancer care across the globe.

ASCO represents almost 50,000 global physicians and other health care professionals specialized in cancer treatment, diagnosis, and prevention. ASCO members are dedicated to conducting research that leads to improved patient outcomes and are committed to ensuring that evidence-based practices for the prevention, diagnosis, and treatment of cancer are eq-




Waste type
Processing
Final destination
Municipal solid waste
16·9 km
Incineration with energy recovery
19·0 km
Local landfill
Biomedical waste and sharps
31·8 km
Autoclave
34·9 km
Cytotoxic waste
591·8 km
High-level incinerator
57·9 km
Alternate landfill
Recycling
27·6 km
Recycling centre
Multiple buyers
Reusable textiles
14·6 km
Third-party laundry facility


A
Supply chain and waste (20%)
Energy (17%)
Anaesthetic gas (63%)
B
Supply chain and waste (13%)
Energy (36%)
Anaesthetic gas (51%)
C
Anaesthetic gas (4%)
Supply chain and waste (12%)
Energy (84%)

Annual greenhouse gas emissions from volatile anaesthetics (MacNeill et al Lancet Planetary Health 2017

	Volume purchased (L/year)			CO_2e (kg/year)		
	VGH	UMMC	JRH	VGH	UMMC	JRH
Desflurane	535·7	532·8	0	1 983 073	1 972 412	0
Isoflurane	34·2	176·4	222	26 297	135 636	170 31
Sevoflurane	132	115·5	217	24 907	21 793	40 898
Total	.	.	.	2 034 277	2 129 841	211 21

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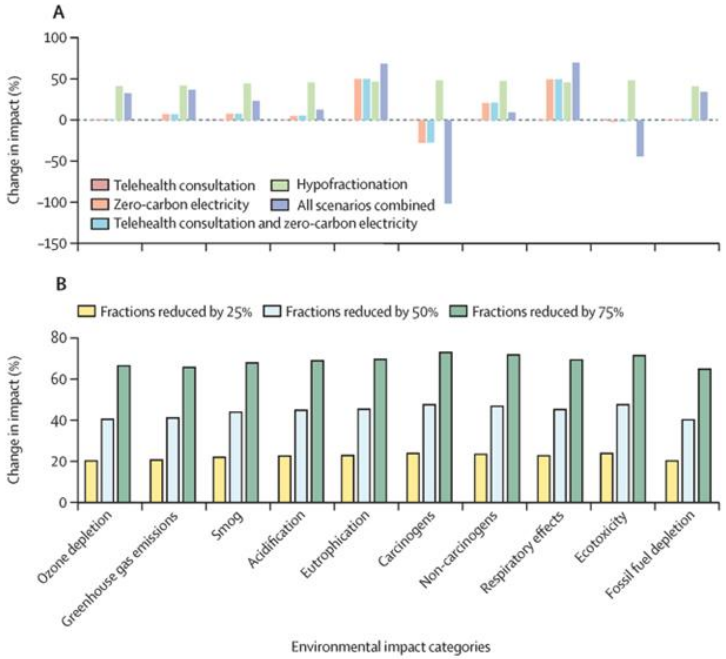
Effect on impact of various counterfactuals (Lichter 2024)



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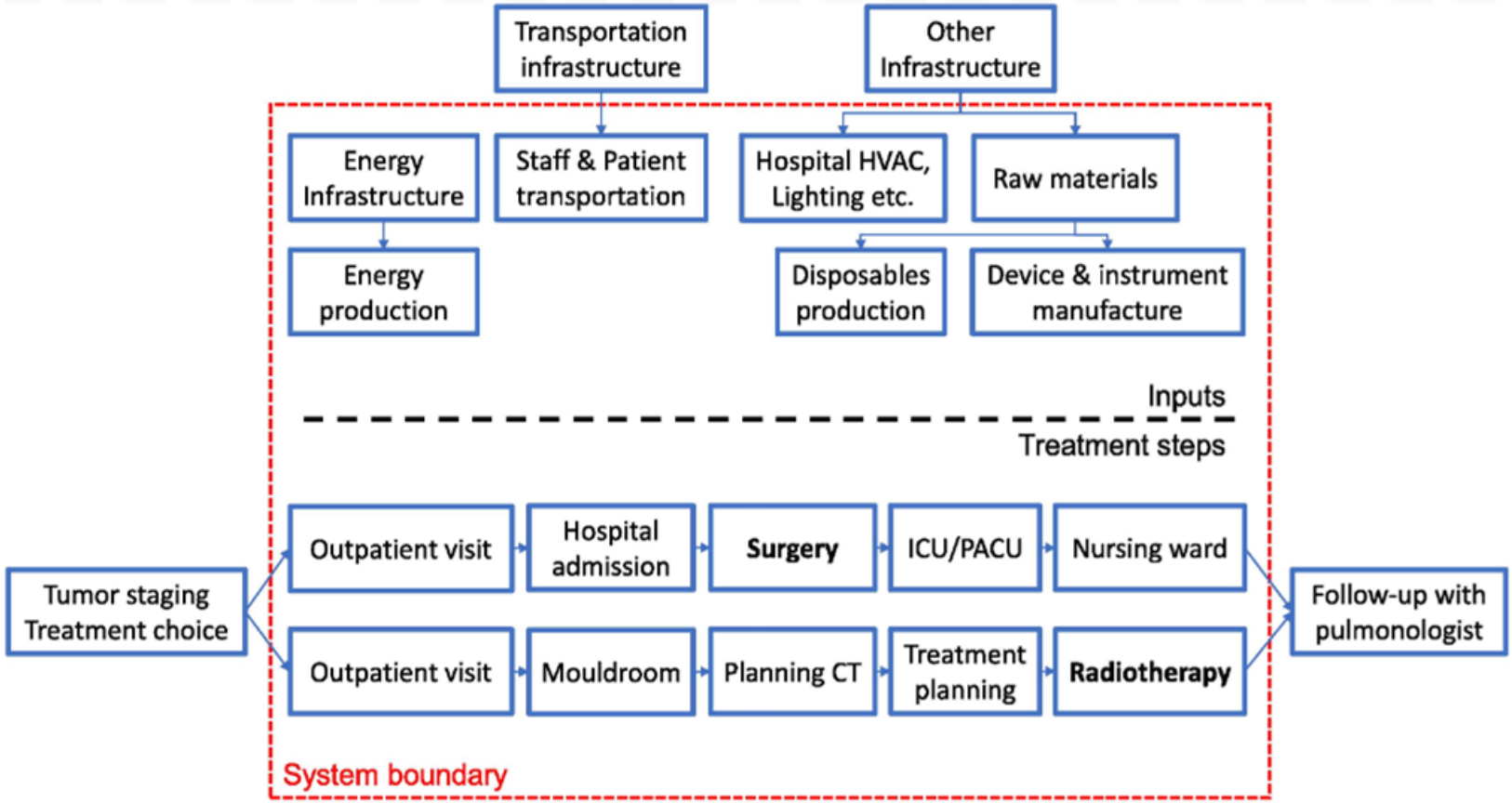
ROCKY MOUNTAIN ONCOLOGY SOCIETY

Projected national greenhouse gas emission reductions resulting from adoption of hypofractionated external beam radiotherapy for breast and genitourinary cancer (Lichter et al Lancet Oncol 2024

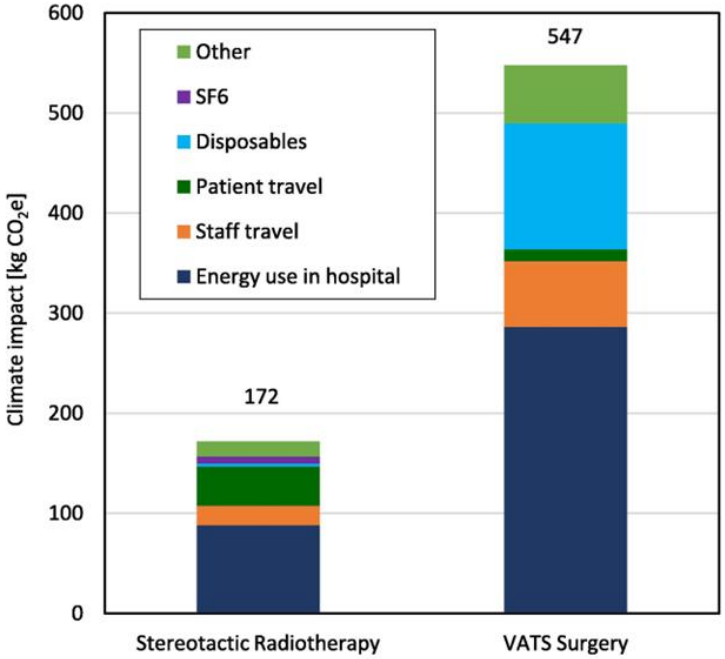
	Emissions (kg CO2e)	Reduction in emissions compared with standard
Breast cancer (n=44 898)		
Standard (25–33 fractions)	677 830 402	NA
Hypofractionation scenario 1 (15 fractions)	390 289 112	42·42%
Hypofractionation scenario 2 (five fractions)	205 126 563	69·74%
Genitourinary cancer (n=11 598)		
Standard (28 or 38–45 fractions)	237 381 407	NA
Hypofractionation scenario 1 (20 fractions)	128 636 967	45·81%
Hypofractionation scenario 2 (five fractions)	54 229 745	77·16%

LCA to Evaluate the Environmental Impact of XRT and Inform Treatment Decisions in Early-Stage BrCA (Larios et al IJROBP 2023)

- Cohort of 50 patients receiving mod-hEBRT) to 42.4 Gy in 16 fractions (n = 25) and ultra-hEBRT to 26 Gy in 5 fractions (n = 25)
- Total emissions associated with delivering a full course of mod-hEBRT versus ultra-hEBRT averaged 502 kg CO2-eq and 264 kg CO2-eq
- The largest contributors to total emissions in each group were patient and staff transportation (301.8 vs 196.4 kg CO2-eq and and LINAC equipment and utilization (175 vs 55.2 kg CO2-eq,


Transportation infrastructure
Other Infrastructure
Energy Infrastructure
Staff & Patient transportation
Hospital HVAC, Lighting etc.
Raw materials
Energy production
Disposables production
Device & instrument manufacture
Inputs
Treatment steps
Tumor staging Treatment choice
Outpatient visit
Hospital admission
Surgery
ICU/PACU
Nursing ward
Outpatient visit
Mouldroom
Planning CT
Treatment planning
Radiotherapy
Follow-up with pulmonologist
System boundary

Climate impact of early-stage NSCLC treatment (Kaas et al, Radiotherapy and Oncology 2024



ASCO Policy Recommendations to Address Impact of Climate Change : Research

Public and private research funders should encourage research into climate change and fossil fuels with respect to their impact on cancer through RFIs, grants, and other mechanisms
Public and private research funders should support work to explore the impact of and potential solutions to cancer disparities and health inequities related to climate change
Public and private research funders should support studies on emissions (including scope 3 emissions) and carbon footprint from the health care sector

ASCO Policy Recommendations to Address Impact of Climate Change : Stakeholder Recommendations

Convene virtual roundtables and other opportunities to identify remaining knowledge gaps and define a research agenda to better understand the impact of climate change in oncology, with explicit focus on cancer incidence, outcomes, care delivery, and cancer health equity. These opportunities should be aimed at both domestic and international audiences, wherever appropriate
Health systems should seek to implement geographically appropriate climate resiliency plans, using best practices identified in sources such as the US Climate Resilience Toolkit. These resources should include information for low-resource settings both domestically and internationally
Continuing medical education should additionally seek to improve cancer care providers' knowledge of the science of climate change; the risks that climate change poses to cancer incidence, outcomes, and care delivery; and how to counsel patients on how to protect themselves from the health risks posed by climate change
Health systems should work with industry partners to identify opportunities to create cost-neutral efficiencies to minimize the carbon footprint of cancer care, such as a life cycle analysis (sourcing to waste) of all aspects of cancer care delivery and ways to reduce environmental impact while maintaining or improving quality of care
Identify opportunities, where appropriate, to include recommendations in clinical practice guidelines for reducing the carbon footprint of cancer care
Institutions and organizations should work with industry partners to develop strategies to decrease the carbon footprint of national and international meetings

ASCO Policy Recommendations to Address Impact of Climate Change : Regulatory

HHS and the OCCHE should continue investing in resources and supports to help communities and cancer care providers accelerate their work to reduce carbon emissions and increase climate resilience
CMS should update the Emergency Preparedness rule to include oncology-specific considerations