

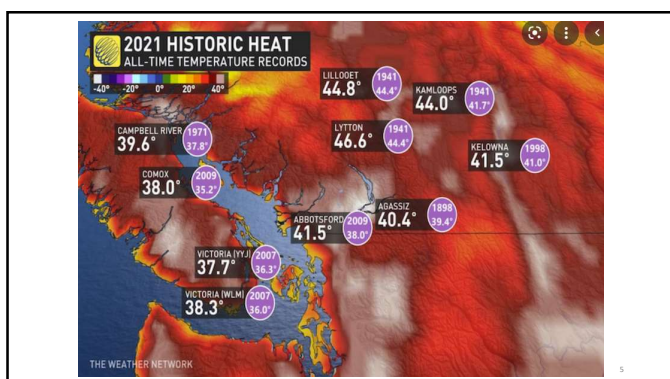
### Disclosures

- No industry-related financial disclosures
- Small stipend from CASCADES (Creating a Sustainable Canadian Health System in a Climate Crisis) a not-for-profit organization funded by Environment and Climate Change Canada for work on the National Advisory Committee on Inhaler Sustainability
- Grant and support from CASCADES and from the South Island Facilities Engagement Initiative for “The Critical Air Project” (sustainable inhalers in inpatient settings)

### Learning Objectives

By the end of this presentation you will be able to:

1. Explain how climate change impacts different patient populations with respect to medication management
2. Identify at least two ways pharmacy practitioners can be better prepared in the context of a changing climate
3. Identify at least two ways pharmacy practitioners can help reduce the impact of pharmaceuticals on the environment

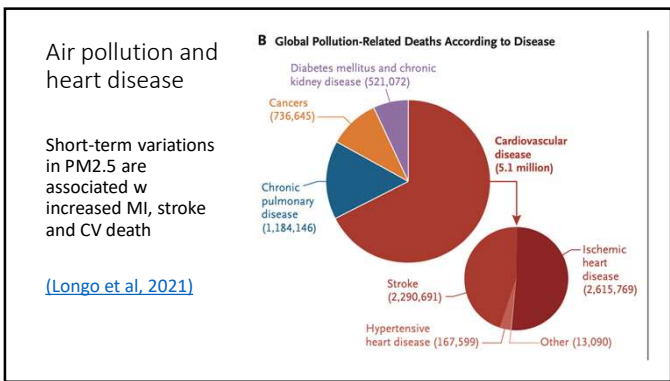
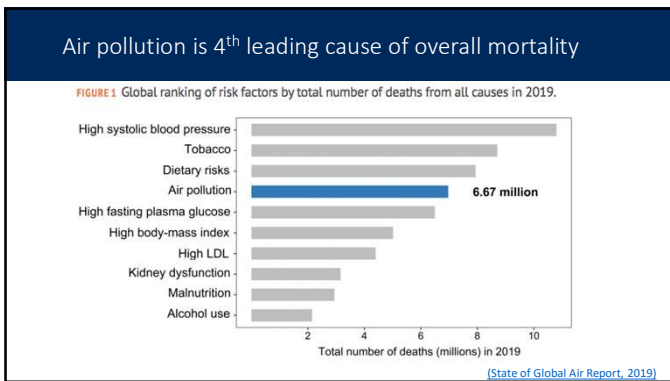


**CLIMATE CHANGES HEALTH IN CANADA**  
Impacts on mental health and probability of traditional food in the north  
Health impact of the 2012 wildfire

- WILDFIRE-RELATED ASTHMA & BRONCHITIS
- FOOD-RELATED DIARRHEA
- ALLERGIES
- TICK-BORNE DISEASE
- HEAT-RELATED RENEWED
- DISPLACEMENT
- RELOCATION & TRENDS FROM COASTAL EROSION

Figure 1. Examples of Impacts of Climate Change on Health and Health Systems in Canada  
The Lancet Countdown, November 2019

- The Climate Crisis is the single greatest threat to humanity in the 21<sup>st</sup> century ([Costello, 2009](#))
- Global trend towards worsening health outcomes – including Canada ([The Lancet Countdown, October 2022](#))



Water line

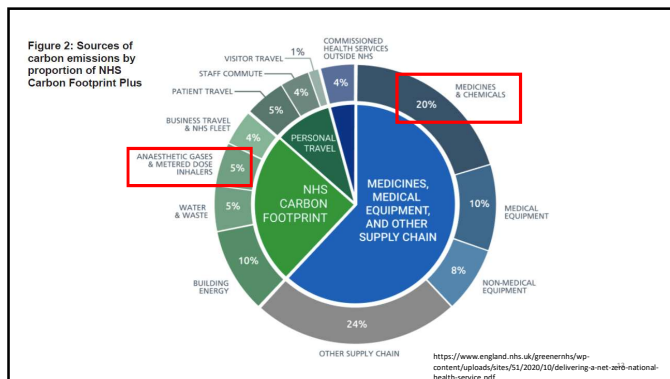
### Island Health hospital nearly needed evacuating Nov 2021

- Critical equipment including generators, oxygen concentrators and electronic mainframes were flooded
- Water line was ~1cm away from affecting hospital power – which would have resulted in mass evacuation

Images provided by Island Health Sustainability Team

### What does Healthcare (including pharmacy) have to do with the climate though?

- The irony of healthcare and the changing climate
- Canada's health care system is responsible for 33 million tonnes of CO2 equivalents yearly ... or **4.6% of the national total!** [\(Eckelman et al, 2018\)](#)
- 25% of total life cycle healthcare GHG emissions in Canada come from prescription and non-prescription drugs [\(Eckelman et al, 2018\)](#)



### Where can pharmacy professionals go from here?

- Disaster Management
- Medications and extreme heat
  - Pharmacodynamics
  - Pharmacokinetics
  - Storage

- Reduce resource use
- Stewardship
- Deprescribing
- Chronic Disease Management
- Proper disposal
- Sustainable inhaler practices
- More...

### What can we do?

INCREASE CLIMATE RESILIENCE OF OUR HEALTH SYSTEMS AND OF OUR PATIENTS  
(ADAPTATION)

PROVIDE HIGH QUALITY, LOW CARBON CARE  
(MITIGATION)

### What we can do

INCREASE CLIMATE RESILIENCE OF OUR HEALTH SYSTEMS AND OF OUR PATIENTS

### Where can pharmacy professionals go from here? Climate Change Adaptation

**Disaster management cycle**

Watson KE. Disaster and Emergency Pharmacy: A Guide to Preparation and Management. Taylor & Francis, 2022.

### Climate Change Adaptation Medication-Specific Considerations

Brief review of Cholinergic/Muscarinic Receptors

M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>
Neural	Cardiac	Glandular / SM
CNS Parietal cells Salivary glands	Heart	Smooth muscle Exocrine glands

Figure: <https://egpat.com/tutorials/cholinergic-agonists/muscarinic-receptors>

### Anticholinergic Medications Interrupting Thermoregulation

M<sub>3</sub> Glandular / SM

Glands Smooth muscle

- Salivary glands
- Lacrimal glands
- Sweat glands**
- Bronchial glands
- GI glands

- Bronchioles
- Eye
- GI smooth muscle
- Vascular endothelium
- Bladder
- Genitalia

• M3 inhibition = impaired sweating → risk of hyperthermia

Figure: <https://egpat.com/tutorials/cholinergic-agonists/muscarinic-receptors>

### Anticholinergic Toxidrome

- Mad as a hatter**  
Altered mental status
- Blind as a bat**  
Mydriasis
- Red as a beet**  
Flushed skin
- Hot as a hare**  
Dry skin (anhidrosis)
- Dry as a bone**  
Dry mucous membranes

Image: <https://www.rishreview.com/blog/spid-review-anticholinergic-toxidrome/>

### Extreme Weather Events and Medications

- Substance Use Disorders medications
  - Related to reduced access
- Increased risk of adverse effects during extreme heat
  - Diuretics
  - SGLT2 inhibitors
  - RAAS inhibitors
  - NSAIDs
- Storage / stability of medications
  - Extreme heat or freezing temperatures
- Increased potential benefit during wildfire
  - Inhalers

Res Social Adm Pharm 2020;16(8):1081  
Ann Emerg Med 2013;62(4):380  
Indian J Med Research 2009;130(2):166

### GPAC Asthma Guidelines – Planetary Health lens

<https://www2.gov.bc.ca/gov/content/health/practitioner-professional-resources/bc-guidelines/external-review>

#### External Review of Guidelines

BC health care professionals and relevant stakeholders are invited to participate as external reviewers for the draft version of the **BC Guidelines**. Peer review is a critical component of the development process. New and existing guidelines have undergone substantive changes and are subject to peer review to make sure they are clearly written, practical, and free of errors.

**Wildfire smoke**  
Wildfire exposure is of particular concern in BC, where the frequency and size of wildfires has increased in recent years.<sup>11</sup> Exposure to wildfire smoke and debris contributes to increased physician visits, emergency room visits, hospitalizations, frequency of respiratory infections, and all-cause mortality.<sup>12,13</sup>

Exposure to wildfire smoke is also associated with increased dispensing of rescue inhalers,<sup>14</sup> a marker for worsening asthma control.

**Wildfire smoke and children with asthma**  
Exposure to wildfire smoke and ash is especially risky for children because their lungs are still developing.<sup>15</sup>

**Minimizing exposure to wildfire smoke**  
During a wildfire, patients with asthma can minimize the risk of exacerbation by:<sup>16</sup>

- Paying attention to local air quality reports (see Air Quality and Wildfire Resources)
- Closing doors, windows, and fireplace dampers
- Using a portable air cleaner in one or more rooms
- Using air conditioners on the recirculation setting so outside air will not be moved inside; and
- Avoiding exercising outdoors.

**Guidelines Currently in External Review:**  
Asthma Diagnosis, Education and Management guideline: Open for External Review until April 10, 2023

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### Extreme heat impacts on medications - Pharmacokinetics

- Increased absorption
  - 1.5-2.5X drug plasma concentrations for some delivery systems
- Transdermal drug delivery systems
  - Eg. nitroglycerin, nicotine, topical NSAIDs
- Subcutaneous drug delivery
  - Eg. insulin

Clin Pharmacokinet 1998;34(4):311-322  
Picture: [www.eartlab.com](http://www.eartlab.com)


### People with pre-existing mental health conditions and climate change

- Psychiatric medications can interfere with ability to
  - Regulate heat
  - Be aware that body temperature is rising
  - Associated with higher risk of injury and death during heat extremes
- More likely to live in poverty or concurrent substance use disorder
- Challenges with coping with heat, following precautions to reduce heat
- More likely to be dependent upon services, infrastructure, medication supply chains

American Psychiatric Association 2017 Available at <https://www.psychiatry.org/patients-families/climate-change-and-mental-health-connection/affects-on-mental-health>  
Southern Med J 2002;95(8):799  
Trends Psychiatry Psychother 2016;28(1):54

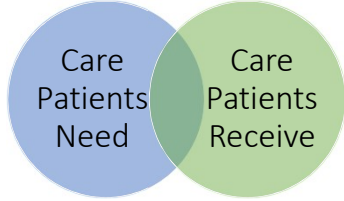


## What we can do



PROVIDE HIGH QUALITY, LOW CARBON CARE

## Current State



Slide borrowed with gratitude From Valeria Stoyanova, MD

## The 60-30-10 rule

**60% of care delivered is evidence-driven** ([Brathwaite et al, 2018](#); [Mangione-Smith, 2007](#); [McGlynn et al, 2003](#); [Runciman et al, 2012](#); [Steel et al, 2008](#))

**30% of care is waste, duplication or low value care that doesn't change clinical outcomes** ([Berwick & Hackbarth, 2012](#); [OECD, 2017](#); [Saini et al, 2017](#))

**10% of care actively causes harm** ([Baker et al, 2004](#); [Brennan et al, 1991](#); [Vincent et al, 2001](#); [Wilson et al, 1995](#); [National Academy of Medicine, 2018](#))

Slide borrowed with gratitude From Valeria Stoyanova, MD

## Pharmacy's Many Contributions to Sustainable Health Systems

**Reduce Demand for Health Services**

- Social Determinants of Health
- Health Promotion
- Disease Prevention
- Chronic Disease Management

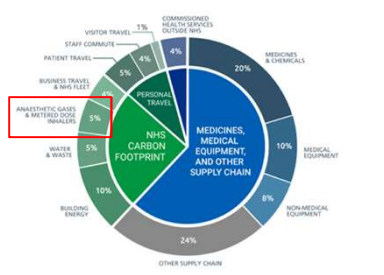
**Match Supply of Health Services to Demand**

- Primary and Community Care Services
- Ensure Appropriateness of Care
- Stewardship Programs

**Reduce Emissions from Supply of Health Services**

- Green Infrastructure and Operations
- Decarbonised Transport
- Circular Economy in Supply Chains
- Coordinated Care Delivery
- Integrated Technology Systems
- Virtual Care

MacNeill A, McGain F and Sherman J. Planetary Health Care: A Framework for Sustainable Health Systems, Lancet Planetary Health 2021



### ARE INHALERS REALLY THAT BIG OF A DEAL...?

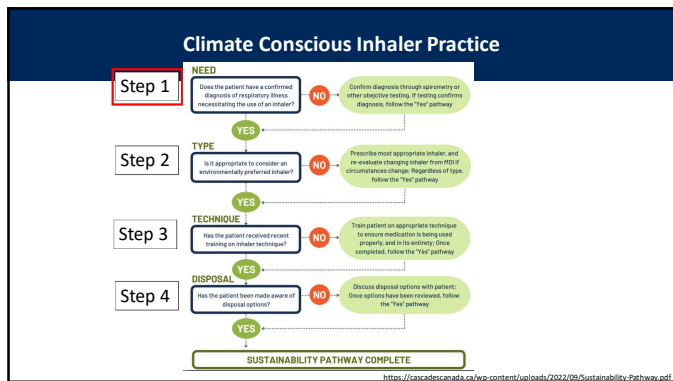
- 3.5% of NHS carbon footprint comes exclusively from Metered Dose Inhalers ([Devlin et al, 2021](#))

## A SINGLE BC HEALTH AUTHORITY'S INHALER USE ANNUALLY IS EQUIVALENT TO...

Driving around the circumference of the earth **979** times



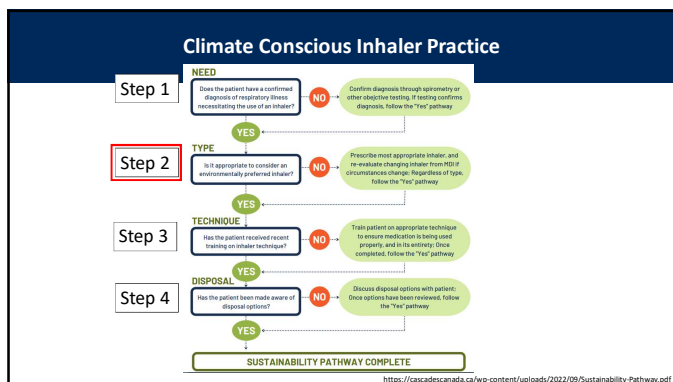
Unpublished data Slide borrowed with gratitude From Valeria Stoyanova, MD



### Reliability of a "Diagnosis" of Asthma

- 1/3 patients labelled with asthma do not have asthma on objective testing<sup>1,2</sup>
- 80% of those with negative test results were on medication for asthma<sup>1</sup>
- If the basis of a patient's diagnosis of asthma has not previously been documented, confirmation with objective testing should be sought<sup>2</sup>

1. Aaron et al. JAMA. 2017; 317(3): 269-279. Re-evaluation of Diagnosis in Adults With Physician-Diagnosed Asthma  
 2. Global Initiative for Asthma (GINA) Guidelines 2020, page 26. Available at [https://ginasthma.org/wp-content/uploads/2020/06/GINA-2020-report\\_20\\_06\\_04-1-wms.pdf](https://ginasthma.org/wp-content/uploads/2020/06/GINA-2020-report_20_06_04-1-wms.pdf)  
 Slide borrowed with gratitude from Kimberly Wittermuth MD



### So Many Inhalers to Choose From!

	MDIs	DPIs		SIMs
		0.4 – 6.8 kg CO <sub>2</sub> emissions / inhaler		
9 – 36 kg CO <sub>2</sub> emissions / inhaler	Diskus	Ellipta	Twisthaler	0.8 – 1.5 kg CO <sub>2</sub> emissions / inhaler
	Turbuhaler	Handihaler	Breezhaler	
	Genuair	Respclick	Inhub	

https://cascaadcanada.ca/resource/tools-templates/inhalers

### What kind of difference can we make?

At time of prescribing  
 Default to or switch to a DPI from MDI

Carbon footprint reduction per inhaler  
 ~ 8-36 kg CO<sub>2</sub>e per inhaler

Carbon footprint reduction per year  
 ~234 kg CO<sub>2</sub>e per patient (daily controller only)  
 ~422 kg CO<sub>2</sub>e per patient (daily controller + 2 doses SABA/day)

**CO<sub>2</sub>e savings Comparisons**

- Gasoline to hybrid car: 500 kg
- Meat-based to plant-based diet: 500 kg
- Avoiding all food waste: 370 kg
- Recycling: 210 kg
- Planting a tree: 35 kg

**Legend:**  
 DPI = Dry Powder Inhaler  
 MDI = Metered-Dose Inhaler  
 SABA = Short Acting Beta-agonist  
 CO<sub>2</sub>e = carbon dioxide equivalent = amount of greenhouse gas emissions X global warming potential

Figure made by Gabrielle Bouque, BSc, PharmD. Reviewed by Brenda Chang. Janson et al., 2020; Wilkinson et al., 2019; British Thoracic Society 2020

### BC PHSA Hospital Formulary inhalers (incomplete list)

SABA	Equivalent km driven by gas-powered car
Salbutamol (VENTOLIN METERED DOSE INHALER) aerosol metered dose	38.8 to 112.6 km (depends on device)
Terbutaline (BRICANYL TURBUHALER) dry powder for inhalation	1.9 km
SAMA	
Ipratropium (ATROVENT METERED DOSE INHALER) aerosol metered dose	58.2 km
LAMA	
Tiotropium (SPIRIVA RESPIMAT) respiratory solution for inhalation, soft mist metered dose	3.1 km
Tiotropium (SPIRIVA HANDIHALER) dry powder for inhalation	1.1 km
Combination LABA/ICS	
budesonide + formoterol (SYMBICORT TURBUHALER) dry powder for inhalation	3 km
fluticasone + salmeterol (WIXELA INHUB or ADVAIR DISKUS) dry powder for inhalation	3.5 to 4.5 km (depends on device)
fluticasone + vilanterol (BRED ELLIPTA) dry powder for inhalation	3.1 km
mometasone + formoterol (ZENHALE METERED DOSE INHALER) aerosol metered dose	139 km

### Inhaler Switching and Shared Decision Making

- Once clinically appropriate inhaler options established, discuss with patient before finalizing decision
- Consider patient-specific factors
  - Ergonomics
  - Familiarity
  - Preferences
  - Lactose content
  - Cost/coverage
- Non-consensual switch associated with poor outcomes

Respiration 2014;88:346-52

### Climate Conscious Inhaler Practice

The flowchart outlines a four-step process for climate-conscious inhaler practice. Step 1 (NEED) asks if the patient has a confirmed diagnosis of respiratory illness necessitating the use of an inhaler. Step 2 (TYPE) asks if it's appropriate to consider an environmentally preferred inhaler. Step 3 (TECHNIQUE) asks if the patient received recent training on inhaler technique. Step 4 (DISPOSAL) asks if the patient has been made aware of disposal options. Each step has a 'YES' path leading to a specific action and a 'NO' path leading to a 'Yes' pathway. The process concludes with 'SUSTAINABILITY PATHWAY COMPLETE'.

<https://cascaदेशin.ca/wp-content/uploads/2022/09/Sustainability-Pathway.pdf>

### Inhaler Technique – What Could Possibly Go Wrong?

The images illustrate common errors in inhaler technique. The first shows a person using a metered-dose inhaler without exhaling fully. The second shows a person using a dry powder inhaler without tilting the head back. The third shows a person using a dry powder inhaler correctly with the head tilted back.

<https://www.nrlfiles.ca/nrlfile/uploads/documents/CPD-Newsletter-Plus-Sept-2015.pdf>

### Again, So Many Inhalers!!

This slide shows a screenshot of the 'Correct Inhaler Usage Resources' website, which lists various inhaler types and brands. It also features a video player for 'BREATHE' with a video titled 'Ellipta' demonstrating proper inhaler use.

<https://cascaदेशin.ca/wp-content/uploads/2022/09/Correct-Inhalers-Usage-Resources-English-1.pdf>

### Climate Conscious Inhaler Practice

This is a duplicate of the flowchart from the top right slide, detailing the four-step process for climate-conscious inhaler practice.

<https://cascaदेशin.ca/wp-content/uploads/2022/09/Sustainability-Pathway.pdf>

### The Importance of Proper Disposal

The bar chart displays absolute emissions per pack (kg CO<sub>2</sub>e/pack) for various inhaler products. The lifecycle phases are: Use phase, Manufacturing, End of life, Distribution, Device manufacturing, and APIs. The 'End of life' phase shows significantly higher emissions for certain products, particularly those with high residual propellant.

**Bottom Line:**  
Inhalers require licensed incineration to degrade residual propellant

<https://pubmed.ncbi.nlm.nih.gov/3169880/>

**Tools / Resources for Practice Change**

<https://cascadescanada.ca/resources/tools-templates/#inhalers>





**CLIMATE CONSCIOUS INHALER PRACTICES IN INPATIENT CARE**

**COMING SOON!**

Why • The Case for Change  
What • The Tools for Change  
How • The Strategy for Change

CaracBI CASCADES Island Health

**What Pharmacy Practitioners Can Do Starting Today**



INCREASE CLIMATE RESILIENCE OF OUR HEALTH SYSTEMS AND OF OUR PATIENTS

PROVIDE HIGH QUALITY, LOW CARBON CARE

*Thank you!*

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