CleanMed ATLANTA 2025

Implementing a multipronged approach to reducing inhaler emissions

Wynne Armand, MD
Associate Director, Mass General Center for the Environment and Health
Assistant Professor, Harvard Medical School

Keaton S. Smetana, PharmD, MBA, FNCS, FCCM
OhioHealth Riverside Methodist Hospital

Gregg Furie, MD, MHS
Medical Director for Climate and Sustainability, Brigham and Women's Hospital
Instructor of Medicine, Harvard Medical School

Jyothi Tirumalasetty, MD
Clinical Assistant Professor
Division of Pulmonary, Allergy, and Critical Care
Stanford University School of Medicine

Overview

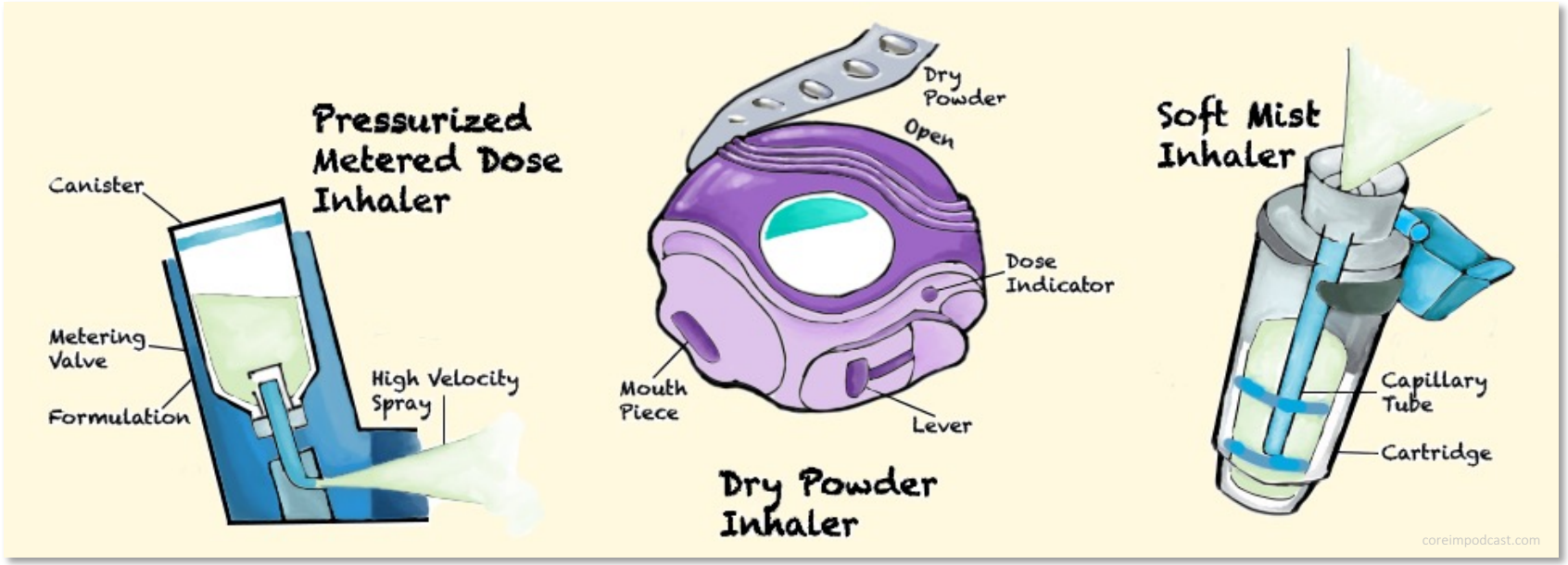
- Introduction and context
- Data measurement and monitoring
- Clinical strategies for reducing inhaler emissions
- Implementing clinical strategies
- Insights from clinical pharmacy
- Questions/Discussion

Introduction and context

CleanMed
ATLANTA 2025

photo: usda.gov

Inhaler device types

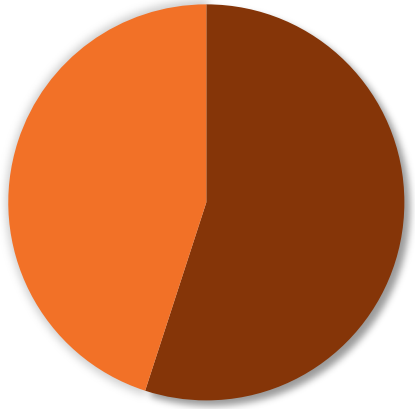


Pressurized metered dose inhaler (MDI)

- Most commonly used inhaled drug delivery device in the US
- Pressurized propellant expels medication from the device into the upper airway
- Used to treat the two most common respiratory conditions: asthma and COPD

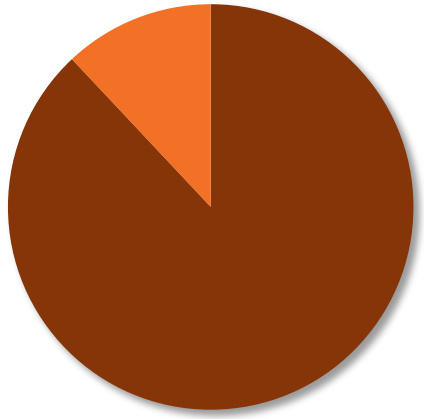
Propellants in MDIs are potent GHGs

- Two hydrofluorocarbon propellants
  - HFA134a: GWP_{100} 1530
  - HFA227ea: GWP_{100} 3600



45% of GSK's total GHG emissions

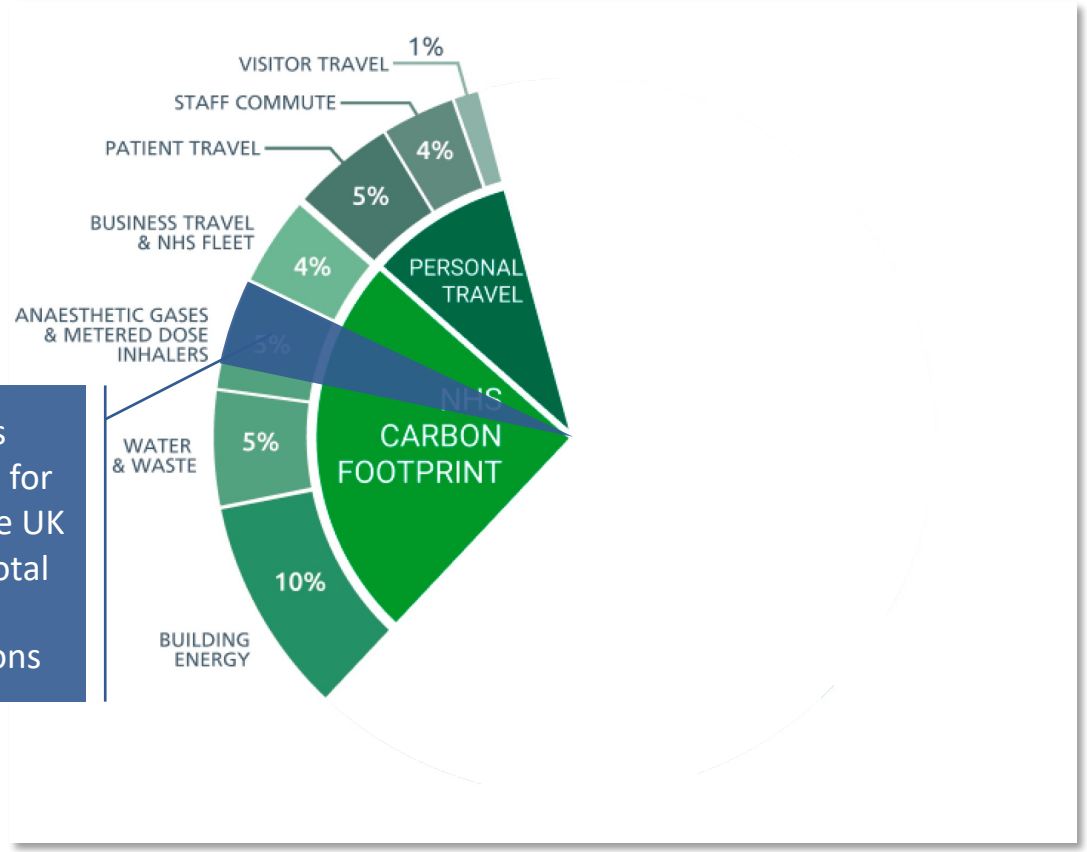
- 144 million MDIs sold in the US in 2020
  - 70% of all inhaled drug delivery devices sold in US
  - 2.5 MMT CO2 Eq
  - Equivalent to ~ 550,000 cars driven for a year



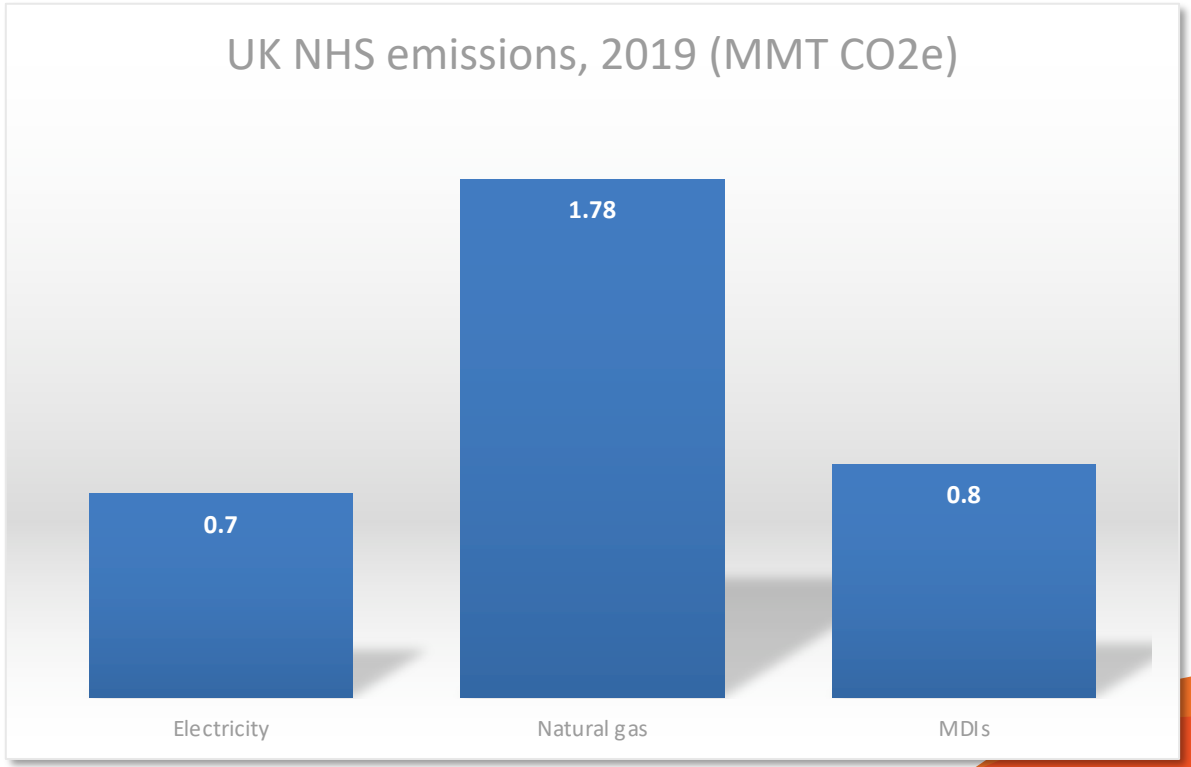
12% of AstraZeneca's total GHG emissions

Market Characterization of the U.S. Metered Dose Inhaler Industry. epa.gov
Our position on: Respiratory Products and Global Warming. gsk.com
www.cdp.net

MDIs make a significant contribution to emissions that are under health systems' direct control

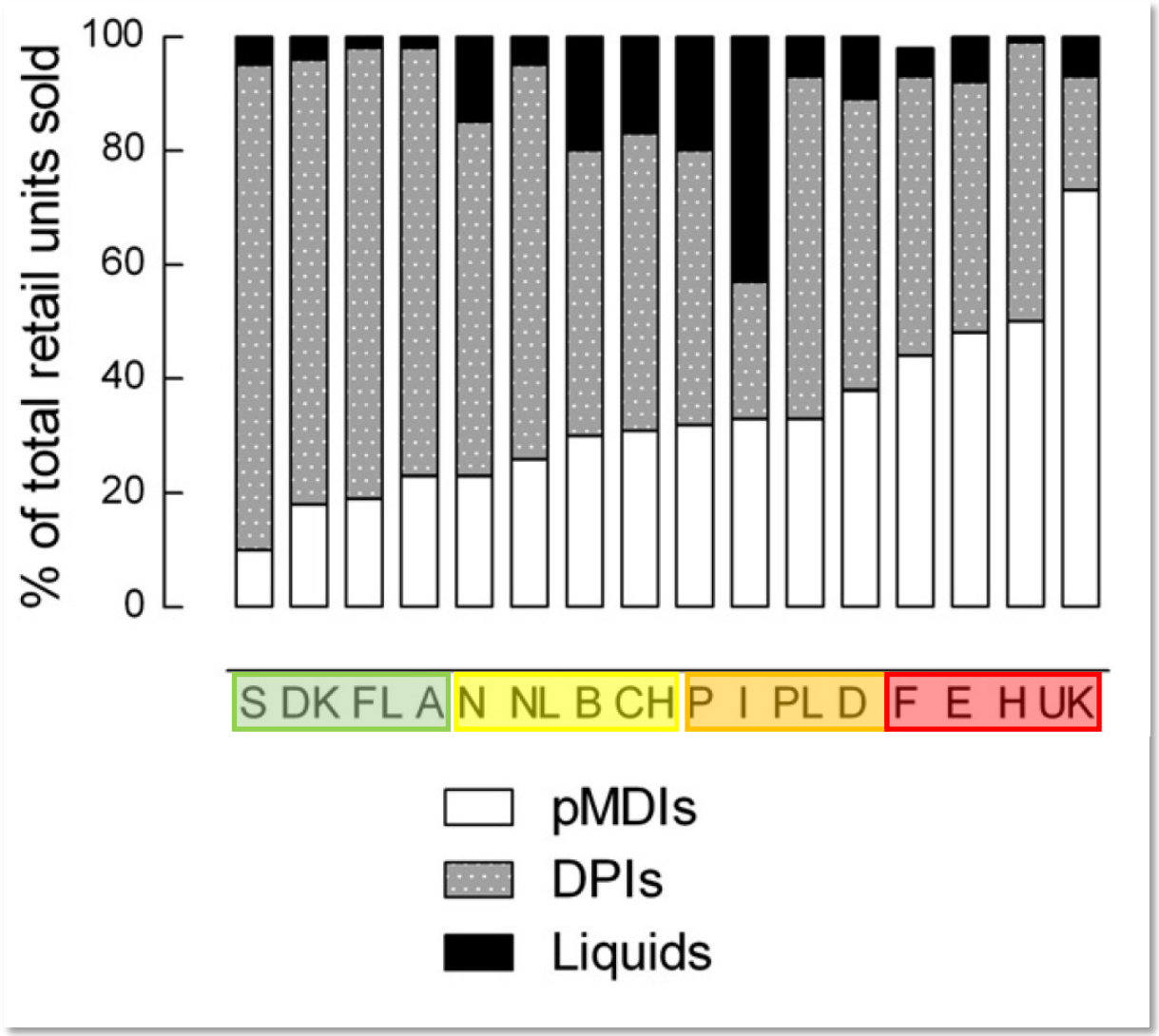


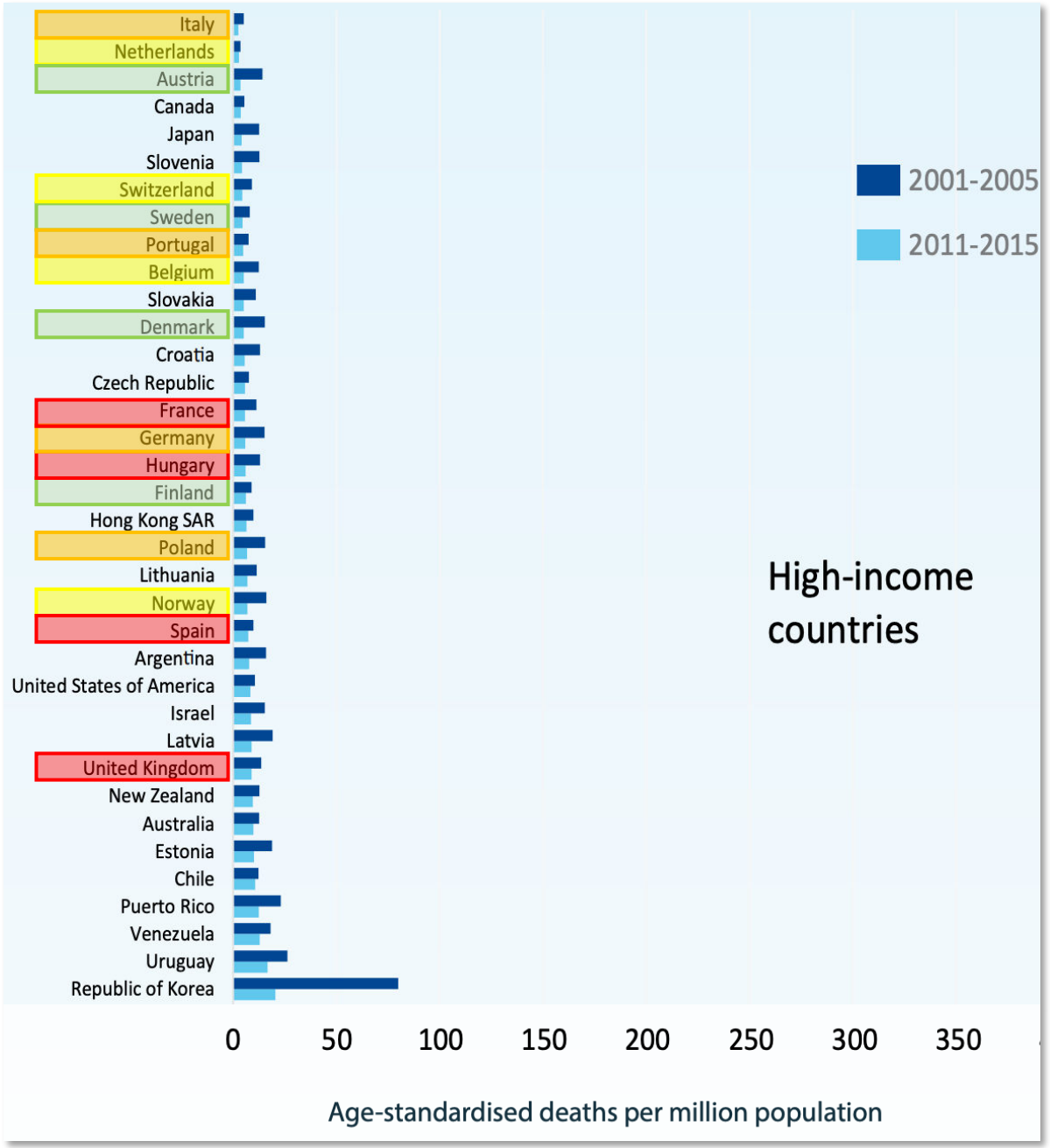
MDIs account for 4% of the UK NHS's total GHG emissions



Tennison I et al. *Lancet Planet Health.* 2021
www.england.nhs.uk/greenernhs/

CleanMed ATLANTA 2025





Lavorini F et al. *Resp Med.* 2011
http://globalasthmareport.org/resources/Global_Asthma_Report_2022.pdf

Pathway to reducing MDI emissions

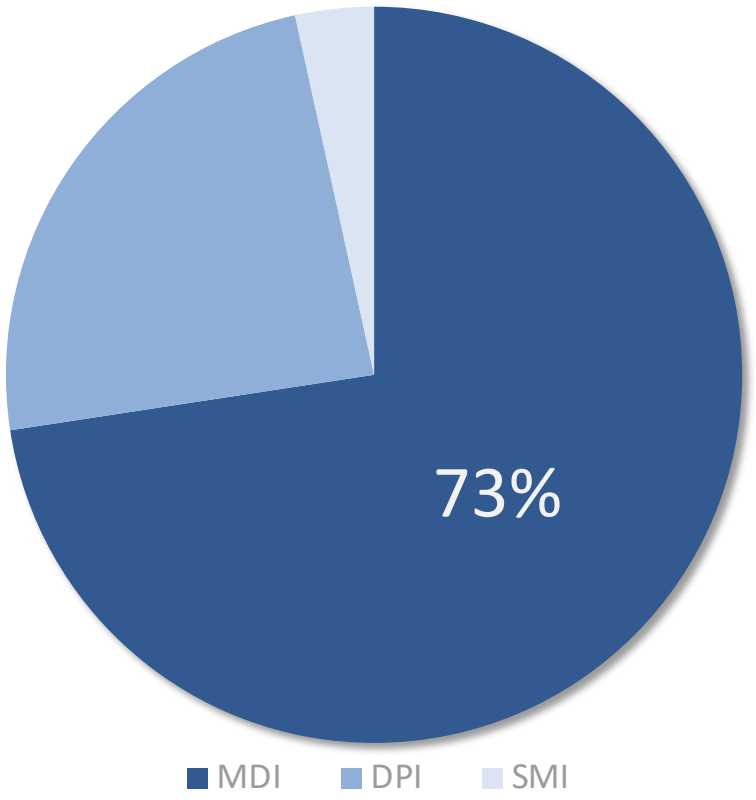
Data measurement and monitoring

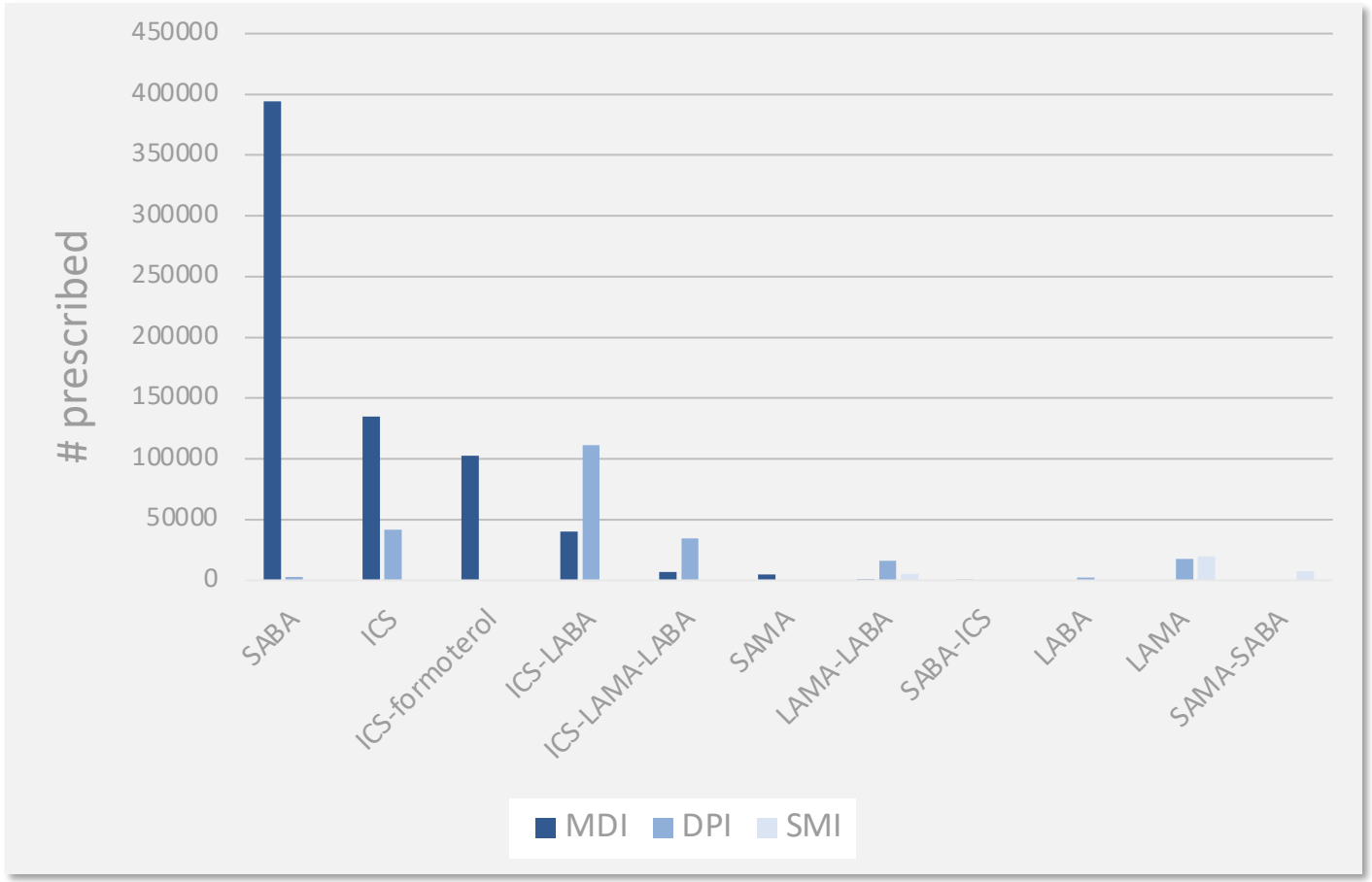
Clinical practice strategies

Implementation of clinical practice strategies

Data measurement and monitoring

2023 MGB inhaler prescriptions, by device type and class





Clinical strategies

GHG Emissions and Costs of Inhaler Devices in the US

We assessed individual emissions and costs and total yearly emissions and costs for US brand-name inhalers prescribed to Medicare Part D and Medicaid beneficiaries in 2022.

Medicare Part D and Medicaid account for approximately 40% of US retail prescription drug spending.

Tirumalasetty et al. *JAMA.* 2024;332(12):1017–1019.

GHG Emissions and Costs of Inhaler Devices in the US


RESEARCH LETTER

CLIMATE CHANGE AND HEALTH

Greenhouse Gas Emissions and Costs of Inhaler Devices in the US

JAMA Published online August 29, 2024

- Inhalers prescribed to CMS beneficiaries in 2022 accounted for 1.15 MMT CO_2e emissions.
- Nearly all inhaler-related emissions 1.13 MMT (98.3%) came from metered-dose inhalers.
- Metered dose inhalers made up 70% of claims (49 million claims).

Stanford MEDICINE | School of Medicine

Tirumalasetty et al. *JAMA.* 2024;332(12):1017–1019.

Inhaler Prescriptions and Emissions in the US

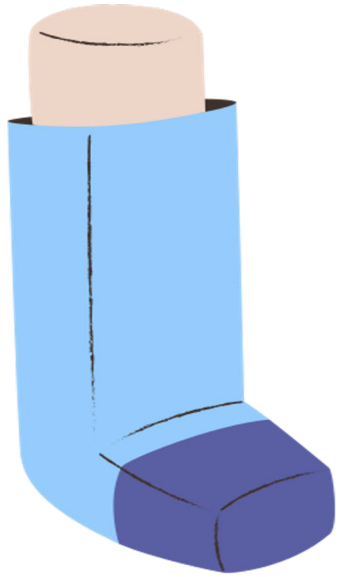
- The largest contribution of emissions arose from short-acting beta agonists.
- Albuterol alone made up 72% of MDI claims (35.3 million claims).
- Dry-powder inhalers accounted 24.5% of total inhaler claims.
- Soft-mist inhalers were prescribed the least (5.2% of total claims).

RESEARCH LETTER

CLIMATE CHANGE AND HEALTH

Greenhouse Gas Emissions and Costs of Inhaler Devices in the US

JAMA Published online August 29, 2024



Stanford MEDICINE | School of Medicine

Tirumalasetty et al *JAMA.* 2024;332(12):1017–1019.

US Metered Dose Inhaler Individual Emissions

RESEARCH LETTER

CLIMATE CHANGE AND HEALTH

Greenhouse Gas Emissions and Costs of Inhaler Devices in the US

JAMA Published online August 29, 2024

Table. Estimated Greenhouse Gas Emissions, Costs, and Number of Claims of US Inhalers by Device Class Among Medicare Part D and Medicaid Beneficiaries in 2022

Inhaler brand name (generic name), No. of inhalations, medication category	Estimated CO_2e per inhalation, g	Estimated CO_2e per inhaler, kg[a]	Mean Medicare Part D cost per claim, $[b]	No. of Medicare Part D claims[c]	Mean Medicaid cost per claim, $[b]	No. of Medicaid claims[c]
Metered-dose inhaler (n = 14)						
Advair HFA (fluticasone/salmeterol), 120, ICS/LABA	170.8	20.5	608.71	632 024	447.40	451 414
Alvesco (ciclesonide), 60, ICS	180.0	10.8	154.43	215 905	416.20	72 286
Asmanex HFA (mometasone), 120, ICS	400.0	48.0	287.79	26 421	199.58	78 250
Atrovent HFA (ipratropium), 200, SAMA	100.0	20.0	571.74	235 718	464.75	159 409
Bevespi Aerosphere (glycopyrrolate/formoterol), 120, LAMA/LABA	148.3	17.8	544.85	127 443	419.57	33 802
Breztri Aerosphere (budesonide/glycopyrrolate/formoterol), 120, ICS/LAMA/LABA	148.3	17.8	792.09	579 924	612.77	57 737
Dulera (mometasone/formoterol), 120, ICS/LABA	400.8	48.1	444.37	231 005	331.80	462 616
Flovent HFA (fluticasone), 120, ICS	170.8	20.5	374.31	1 126 151	263.46	2 869 186
ProAir HFA (albuterol sulfate), 200, SABA	63.5	12.7	97.91	7 532 750	84.15	8 791 641
Proventil HFA (albuterol sulfate), 200, SABA	49.5	9.9	125.13	3 651 614	91.32	2 524 937
Symbicort (budesonide/formoterol), 120, ICS/LABA	318.3	38.2	526.80	3 729 724	385.69	1 819 765
QVAR Redihaler (beclomethasone), 120, ICS	138.3	16.6	321.46	150 586	246.37	356 947
Ventolin HFA (albuterol sulfate), 200, SABA	143.5	28.7	74.12	6 535 681	62.48	6 234 078
Xopenex HFA (levalbuterol), 200, SABA	114.0	22.8	103.57	217 873	78.09	102 550

Emissions from one Dulera inhaler equivalent to driving 122 miles in a gasoline powered passenger vehicle.

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

US Dry Powder Inhaler Individual Emissions

Inhaler brand name (generic name), No. of inhalations, medication category	Estimated CO_2e per inhalation, g	Estimated CO_2e per inhaler, kg[a]	Mean Medicare Part D cost per claim, $[b]	No. of Medicare Part D claims[c]	Mean Medicaid cost per claim, $[b]	No. of Medicaid claims[c]
Dry-powder inhaler (n = 19)						
Advair Diskus (fluticasone/salmeterol), 60, ICS/LABA	15.0	0.898	581.60	1 629 000	443.31	842 908
AirDuo Digihaler (fluticasone/salmeterol), 60, ICS/LABA	13.2	0.790	546.07	1012	474.12	2046
AirDuo RespiClick (fluticasone/salmeterol), 60, ICS/LABA	13.2	0.790	409.77	665	414.80	2281
Anoro Ellipta (umeclidinium/vilanterol), 30, LAMA/LABA	26.1	0.784	601.99	1 439 975	463.28	283 984
ArmonAir Digihaler (fluticasone), 60, ICS	13.2	0.790	313.36	244	261.27	198
Arnuity Ellipta (fluticasone), 30, ICS	25.7	0.771	310.67	285 882	224.84	133 874
Asmanex Twisthaler (mometasone), 120, ICS	6.6	0.790	375.14	42 555	243.76	51 726
Breo Ellipta (fluticasone/vilanterol), 30, ICS/LABA	25.9	0.776	527.66	2 705 981	413.19	191 333
Duaklir Pressair (aclidinium/formoterol), 60, LAMA/LABA	13.2	0.790	1136.30	62	924.82	38
Flovent Diskus (fluticasone), 60, ICS	13.9	0.833	333.79	144 378	240.37	79 390
Incruse Ellipta (umeclidinium), 30, LAMA	24.6	0.739	474.33	1 051 785	371.25	222 231
ProAir Digihaler (albuterol sulfate), 200, SABA	4.0	0.790	175.35	2970	166.17	4931
ProAir RespiClick (albuterol sulfate), 200, SABA	4.0	0.790	90.78	87 492	74.05	52 589
Pulmicort Flexhaler (budesonide), 120, ICS	6.5	0.790	336.81	139 283	240.27	84 390
Serevent Diskus (salmeterol), 60, LABA	12.2	0.732	631.52	75 323	447.06	33 462
Spiriva HandiHaler (tiotropium), 30, LAMA	26.3	0.790	791.99	1 181 232	552.61	586 303
Trelegy Ellipta (fluticasone/umeclidinium/vilanterol), 30, ICS/LAMA/LABA	26.3	0.790	850.64	3 926 585	637.96	400 362
Tudorza Pressair (aclidinium), 60, LAMA	13.2	0.790	883.29	16 444	586.58	10 327
Wixela Inhub (fluticasone/salmeterol), 60, ICS/LABA	15.0	0.898	298.63	1 094 388	172.58	324 920

RESEARCH LETTER

CLIMATE CHANGE AND HEALTH

Greenhouse Gas Emissions and Costs of Inhaler Devices in the US

JAMA Published online August 29, 2024

Tirumalasetty et al. *JAMA.* 2024;332(12):1017–1019.

RESEARCH LETTER

CLIMATE CHANGE AND HEALTH

Greenhouse Gas Emissions and Costs of Inhaler Devices in the US

JAMA Published online August 29, 2024

US Soft Mist Inhaler Individual Emissions

Inhaler brand name (generic name), No. of inhalations, medication category	Estimated CO_2e per inhalation, g	Estimated CO_2e per inhaler, kg[a]	Mean Medicare Part D cost per claim, $[b]	No. of Medicare Part D claims[c]	Mean Medicaid cost per claim, $[b]	No. of Medicaid claims[c]
Soft-mist inhaler (n = 4)						
Combivent Respimat (albuterol/ipratropium), 120, SABA/SAMA	6.5	0.775	643.65	752 921	485.26	297 617
Spiriva Respimat (tiotropium), 60, LAMA	12.9	0.775	672.75	1 325 200	511.05	471 801
Stiolto Respimat (tiotropium/olodaterol), 60, LAMA/LABA	12.9	0.775	642.62	602 405	468.84	156 307
Striverdi Respimat (olodaterol), 60, LABA	12.9	0.775	378.04	13 315	255.21	3512

Putting It All Together

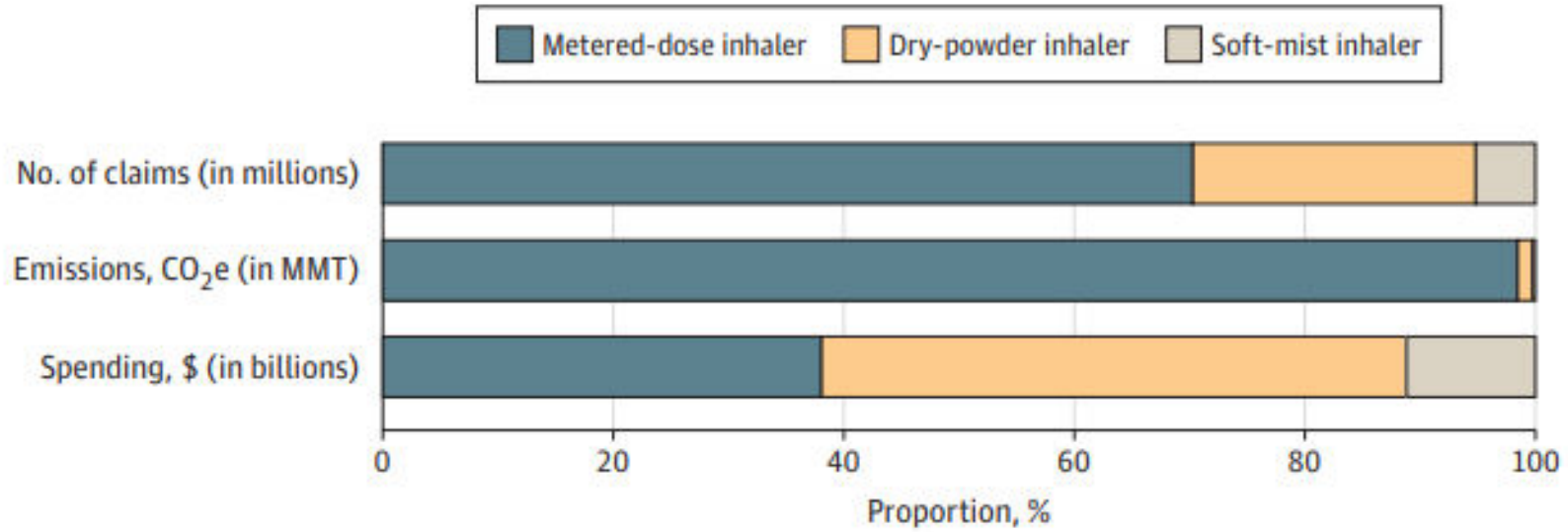
RESEARCH LETTER

CLIMATE CHANGE AND HEALTH

Greenhouse Gas Emissions and Costs of Inhaler Devices in the US

JAMA Published online August 29, 2024

Figure. Claims, Estimated Greenhouse Gas Emissions, and Spending for All Inhalers Filled by Medicare Part D and Medicaid Beneficiaries in 2022 by Device Class



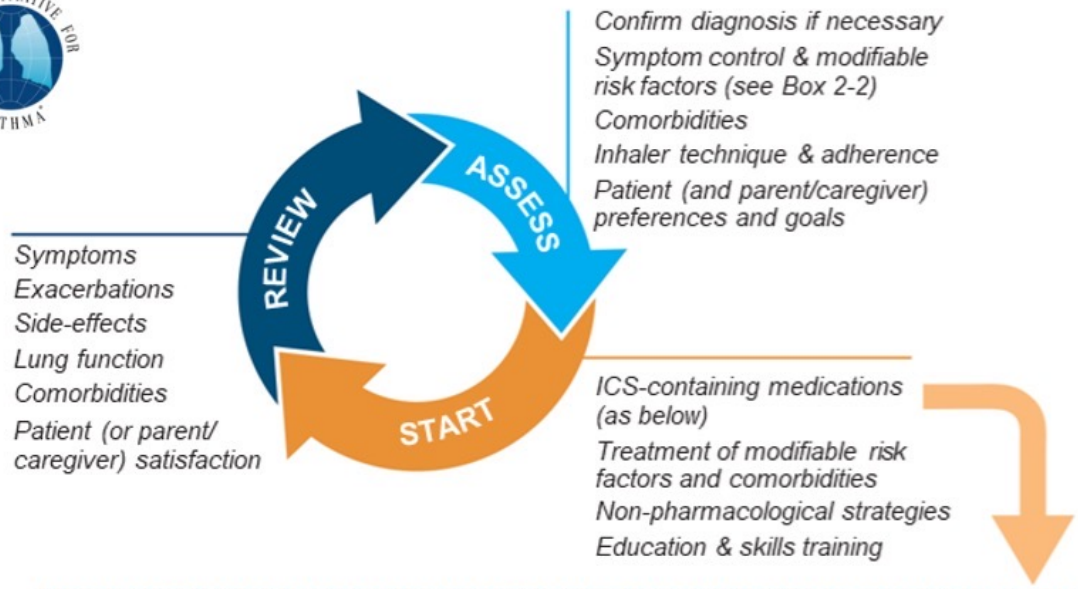
Number of claims, estimated greenhouse gas emissions, and spending for inhalers by device class are shown for Medicare Part D and Medicaid beneficiaries from January 2022 through December 2022. CO_2e indicates carbon dioxide equivalent; MMT, million metric tons.

MDIs=70% of claims and 38% of spending
$7.5 billion

DPIs= 25% of claims and 51% of spending
$10 billion

GINA 2024 – STARTING TREATMENT

in adults and adolescents 12+ years with a diagnosis of asthma



These recommendations are based on the (little) available evidence and consensus

IF the patient has:	START WITH:	TRACK 1 (preferred)	OR	TRACK 2	
Daily symptoms, waking at night once a week or more and low lung function, or recent exacerbation	YES →	Medium dose ICS-formoterol maintenance and reliever (MART)		Medium/high dose ICS-LABA + as-needed SABA (or ICS-SABA)	**STEP 4** …. *Short course of OCS may also be needed for patients presenting during an exacerbation*
NO ↓ Symptoms most days, or waking at night once a week or more, or low lung function	YES →	Low dose ICS-formoterol maintenance and reliever (MART)		Low dose ICS-LABA + as-needed SABA (or ICS-SABA)	**STEP 3**
NO ↓ Symptoms less than 3–5 days a week, with normal (or mildly reduced) lung function	YES →	As-needed-only low dose ICS-formoterol		Low dose ICS + as-needed SABA (or ICS-SABA)	**STEP 2** …. *In patients with symptoms 1–2 days a week or less, adherence with daily ICS would be very poor, so taking low-dose ICS whenever SABA is taken could reduce the risk of exacerbations*
				Take low dose ICS whenever SABA is taken	**STEP 1**

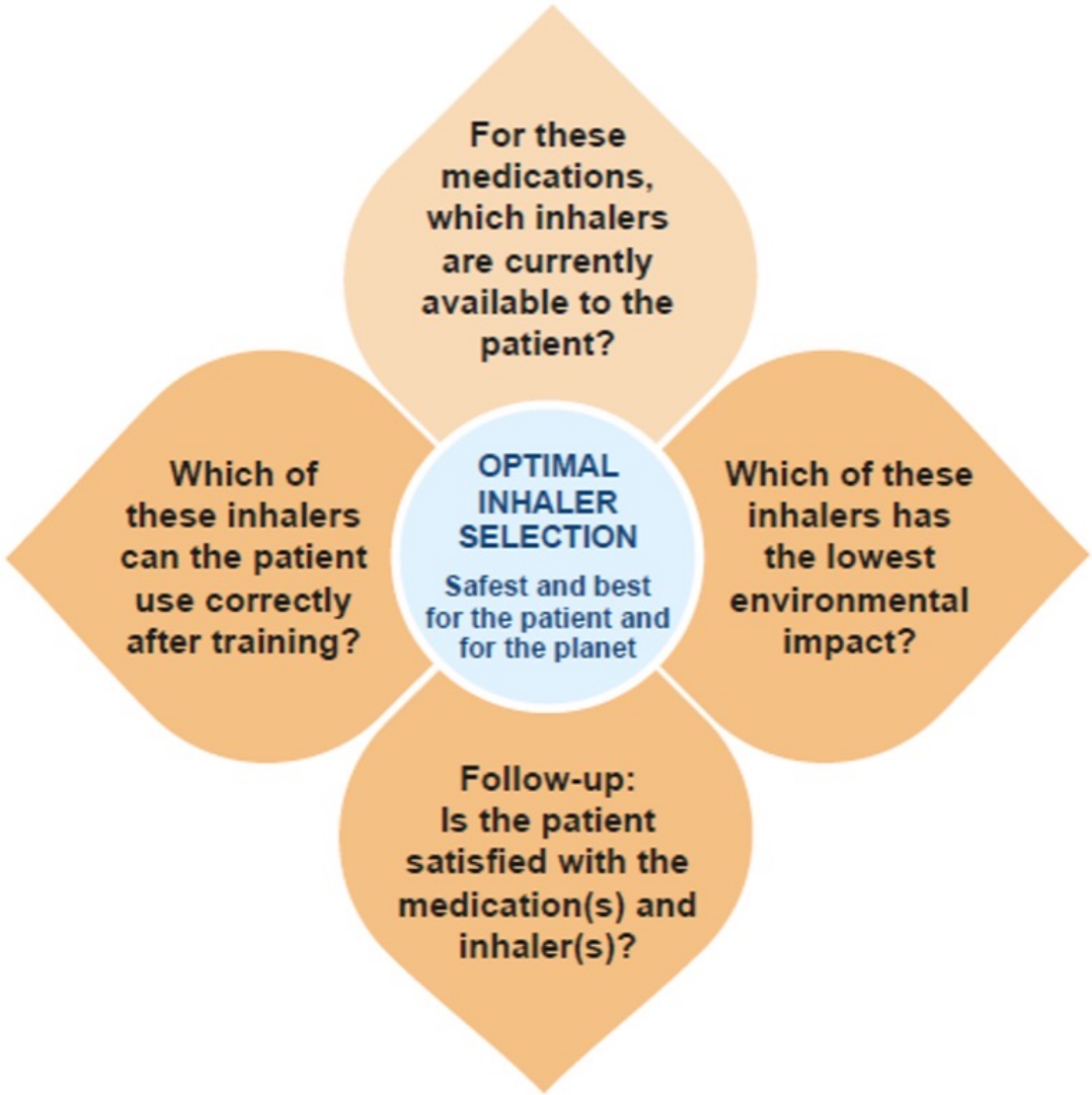
Inhaler choice and environmental considerations

- Inhaled corticosteroids markedly reduce the risk of asthma exacerbations and death
  - But limited availability and access in low and middle income countries
- Many inhaler types available, with different techniques
- Some inhalers are not suitable for some patients. For example:
  - DPIs are not suitable for children ≤5 years and some elderly
  - pMDIs difficult for patients with arthritis or weak muscles
  - Capsule devices are difficult for patients with tremor
- Most patients don't use their inhaler correctly
  - More than one inhaler → more errors
- Incorrect technique → more symptoms → worse adherence → more exacerbations → higher environmental impact
- Propellants in current pMDIs have 25x global warming potential compared with dry powder inhalers
  - New propellants are being developed but not yet approved
- Choice of inhaler is important!

Inhaler choice and environmental considerations

- First, what is the right medication for this patient?
  - Control symptoms and reduce exacerbations
  - Urgent healthcare and hospitalization have a heavy environmental burden
- Which inhaler(s) can the patient access for this medication?
  - Low/middle income countries often have limited choice and access
  - Cost of inhalers is a major burden
- Which of these inhalers can the patient use correctly?
  - Incorrect technique → more exacerbations
- What are the environmental implications of these inhaler(s)?
  - Manufacture
  - Propellant (for pMDIs)
  - Recycling potential
- Is the patient satisfied with the treatment and the inhaler?
  - Consider the patient's environmental priorities
  - Avoid 'green guilt', which may contribute to poor adherence
  - Check inhaler technique frequently

For this patient, which is the right class of medication?



Lowering Inhaler-Related Emissions in the US – Lack of MART Options

- Dry powder Symbicort available in Europe/Canada but not in US, making it difficult to implement inhaler decarbonization in the US while following GINA guidelines.
- DPIs in US more expensive and often not preferred under many insurance plans – exception is generic fluticasone-salmeterol (Wixela Inhub).

Lowering Inhaler-Related Emissions in the US – Higher Costs

- DPIs in US more expensive and often not preferred under many insurance plans – exception is generic fluticasone-salmeterol (Wixela Inhub).
- In those who cannot be on GINA track 1 preferred treatment – consider DPIs, lower emissions MDIs, and SMIs if out-of-pocket cost acceptable.

Lowering Inhaler-Related Emissions in the US – Short Acting Bronchodilator Choice

- Consider DPI albuterol – ProAir Respiclick or lower emissions albuterol HFA.
- Brand/generic Ventolin HFA has approximately 3 times the emissions of brand/generic Proventil HFA.

Proventil HFA:
9.9 kg CO_2e emissions per inhaler

Ventolin HFA:
28.1 kg CO_2e emissions per inhaler

Is Inhaler Therapy Indicated?

- Does the patient have a confirmed diagnosis of asthma that requires long-term use of an inhaler?
- Asthma and COPD guidelines recommend pulmonary function testing to demonstrate airflow obstruction.
- Avoid automatic refills this those without a confirmed diagnosis.

Better Asthma and COPD Control

- Provide preventative care and more frequent follow up for asthma and COPD patients with frequent exacerbations.
- Consider stepping up treatment to improve control.
- Refer to an allergist or pulmonologist to consider biologics.

The Future of Inhaler Propellants

Next generation propellants with low or “zero” emissions propellants coming.

HFA 152a a new, low global warming potential (LGWP) medical propellant, developed for Ventolin.

Lower emissions Ventolin (GSK) in phase III trials in the US currently.

Aztra Zeneca has completed phase III trials for LGWP propellant for Breztri in Europe.

Honeywell’s Solstice Air (HFO-1234ze) has 99.9% less GWP than propellants currently used in inhaled respiratory medicines.

These inhalers will come with new patents on old medications and higher prices!

Implementation of clinical strategies

Implementation of clinical strategies

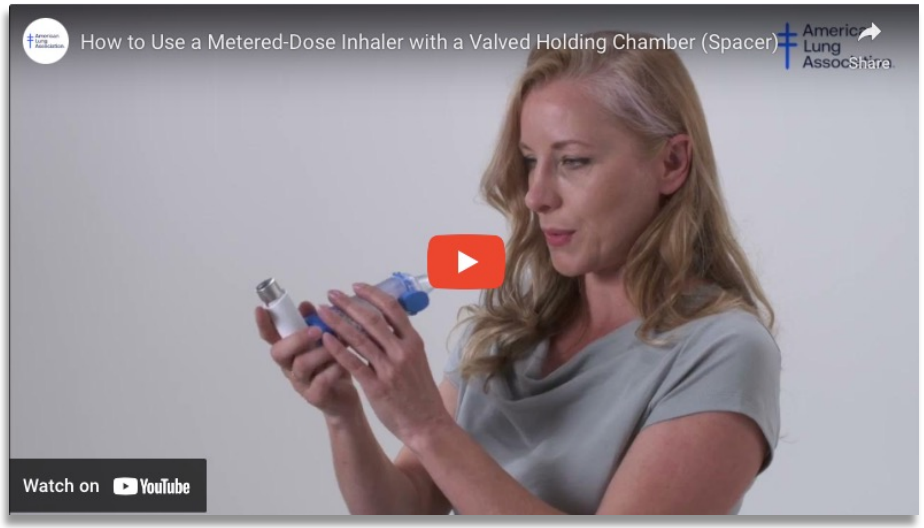
- Multidisciplinary team
- Education
- Clinical support tools

Implementation of clinical strategies

- **Multidisciplinary representation**
  - Physicians
    - Internal Medicine
    - Pediatrics
    - Allergy
    - Pulmonology
    - Urgent Care and Emergency Medicine
  - Pharmacy
    - Health Plan (Formulary)
  - Respiratory Therapy
  - Information Technology (eCare)
- Education
- Clinical support tools

Implementation of clinical strategies

- Multidisciplinary team
- **Education**
  - Patients
  - Clinicians
- Clinical support tools



PCOI Primary Care Office InSite
https://oi.mgh.harvard.edu

Massachusetts General Hospital
Brigham and Women's Hospital
Newton-Wellesley Hospital
Salem Hospital
Community Physicians Organization

A RESOURCE FOR MASS GENERAL BRIGHAM CLINICIANS AND STAFF

Climate & Extreme Weather

- Air Pollution and Your Health PG
- Climate Change and Your Health PG
- Climate Change and Your Stress PG
- Emergency Kit, How to Build (Americares) PG
- Extreme Weather Prep (CREW) PG
- Floods (Americares) PG
- Heat Action Plan (Americares) PG
- Heat and Health Conditions (Americares) PG
- Heat and Medications (Americares) PG
- s) PG
- r (Americares) PG
- s (CREW) PG
- PG
- d (CREW) PG

Pulmonary

Asthma

- Asthma PG
- Asthma Action Plan (incl. trigger avoidance) PG
- Asthma Control Test PG
- Asthma Diary PG
- Inhaler: How to Use Your Dry Powder Inhaler/Diskus PG
- Inhaler: How to Use Your Metered Dose Inhaler PG
- Patient self-assessment form for f/u visits
- Peak Flow Meter, How to Use PG
- Routine Medicines for Asthma PG

Air Pollution and Your Health PG

Implementation of clinical strategies

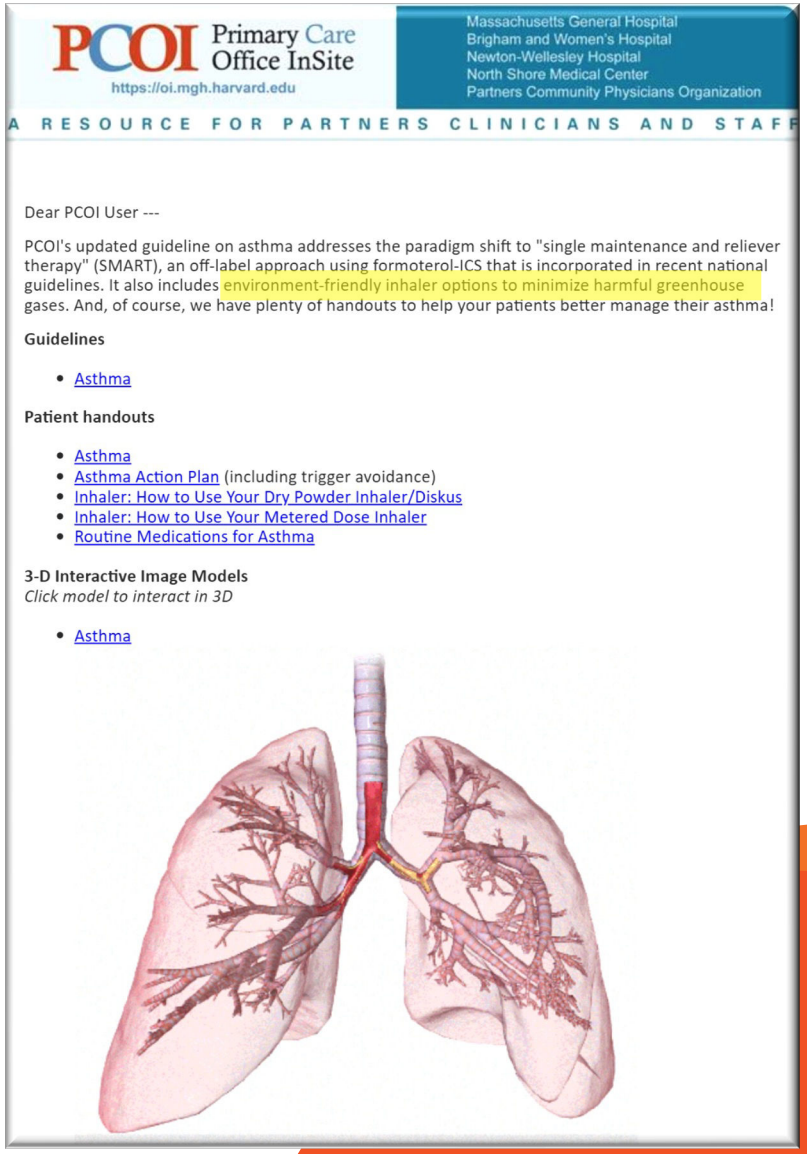
- Multidisciplinary team
- **Education**
  - Patients
  - Clinicians
- Clinical support tools

A note about greenhouse gases

The propellants currently used in HFA metered dose inhalers (MDIs) are potent greenhouse gases and have 20- to 30-fold higher carbon footprint than alternatives like dry powder inhalers (DPIs). Some options to consider, in addition to robust education regarding prevention, allergen/irritant/pollution avoidance:

- Whenever equal treatments are available in multiple formations, if feasible with considerations for cost and patient abilities (patients need inspiratory force for DPI use), avoid current HFA MDIs.
- If HFA MDI is prescribed, choose the lower gram canister of equivalent actuations to deliver the same amount of medication but with less HFA propellant, and ensure proper use with spacer. For example, the albuterol formulations often vary in grams (6.7g, 8.5, 18g), but deliver the same amount of albuterol per actuation and contain the same number of actuations. In these cases, the difference in weight is mostly HFA propellant.
- Choose inhalers with actuation counters, if possible, and confirm proper inhaler technique and spacer use.

Ultimately, good control of asthma is not only best for the patient, but also better for the environment.



Implementation of clinical strategies

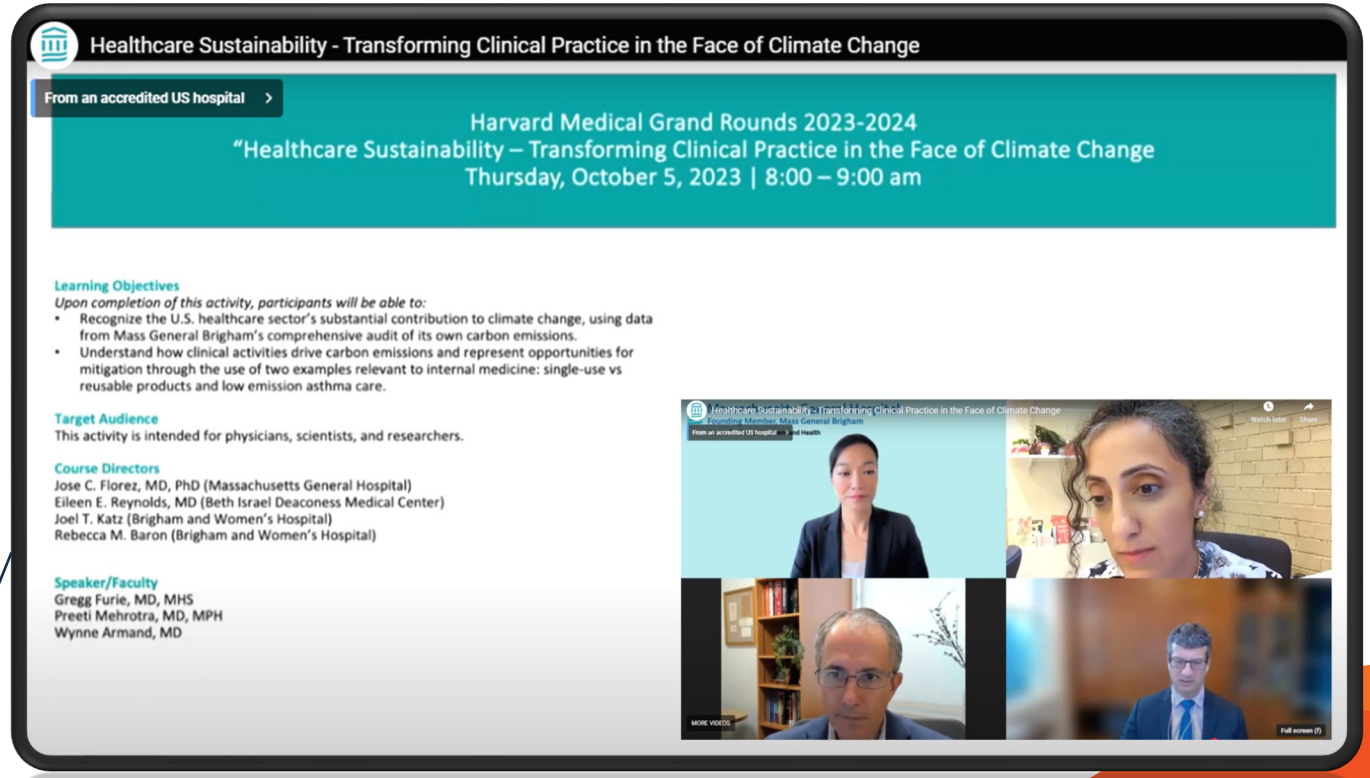
- Multidisciplinary team
- **Education**
  - Patients
  - Clinicians
- Clinical support tools

8 Actions
to
Reduce MDI-Associated Emissions

1. Do not prescribe albuterol or ipratropium for URIs or acute bronchitis in patients without a history of asthma or COPD.
2. Prescribe dry powder inhalers (DPIs) or soft mist inhalers (SMIs) instead of MDIs for appropriate patients.
3. When prescribing albuterol MDIs, choose 6.7 g or 8.5 g canisters rather than the 18 g canister when possible. The 18 g canister is associated with 2 to 3 times greater emissions and has roughly the same climate impact as an automobile driven for 65 miles
4. Prevent excessive albuterol use by optimizing inhaled corticosteroid-containing asthma regimens for patients with poorly controlled asthma. Use of three or more albuterol canisters per year is a marker of poor disease control.
5. Limit albuterol prescriptions to 3 devices (or 1 device with 2 refills) in order to more-easily identify patients using excessive amounts of albuterol.
6. Do not prescribe two puffs of a metered-dose inhaler when the same dose of medication can be delivered with one puff (ie, one puff fluticasone propionate 220 mcg/inh vs two puffs flucticasone propionate 110 mcg/inh).
7. Confirm the diagnosis of COPD with pulmonary function testing before committing a patient to long-term therapy. A diagnosis of asthma should ideally be confirmed with pulmonary function testing prior to committing a patient to long term therapy. However, a diagnosis of probable asthma can be made in patients with characteristic symptoms for whom spirometry is not readily available or who do not have airflow obstruction at the time of pulmonary function testing.
8. Ensure proper inhaler technique.

Implementation of clinical strategies

- Multidisciplinary team
- **Education**
  - Patients
  - Clinicians
- Clinical support tools



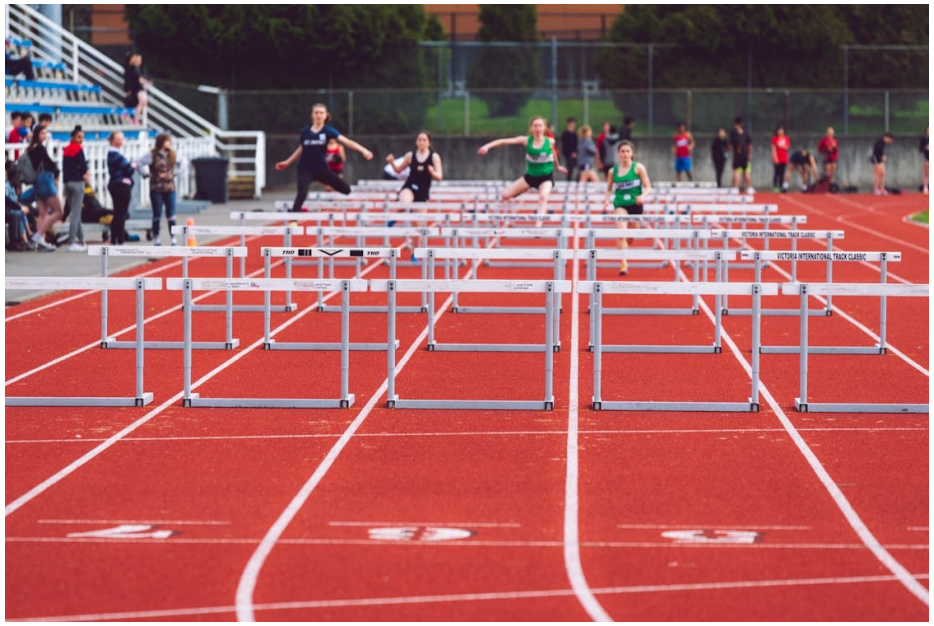
HARVARD MEDICAL SCHOOL
Brigham and Women's Hospital
Founding Member, Mass General Brigham
Massachusetts General Hospital
Founding Member, Mass General Brigham
Beth Israel Lahey Health
Beth Israel Deaconess Medical Center

Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**

Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**



Hurdles

- Individualization
  - Patient and disease
  - Costs and formularies
- IT support
  - Slow
  - Costs
- Governance

Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History

Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History

- Real-time recommendations and guidance that pop up in EHR at point of care
- Customizable, triggered by patient data
- Promote evidence-based practices
- Improve quality and safety
- Reduce errors and complications
- Enhance clinical decision-making
- Alert fatigue

Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History

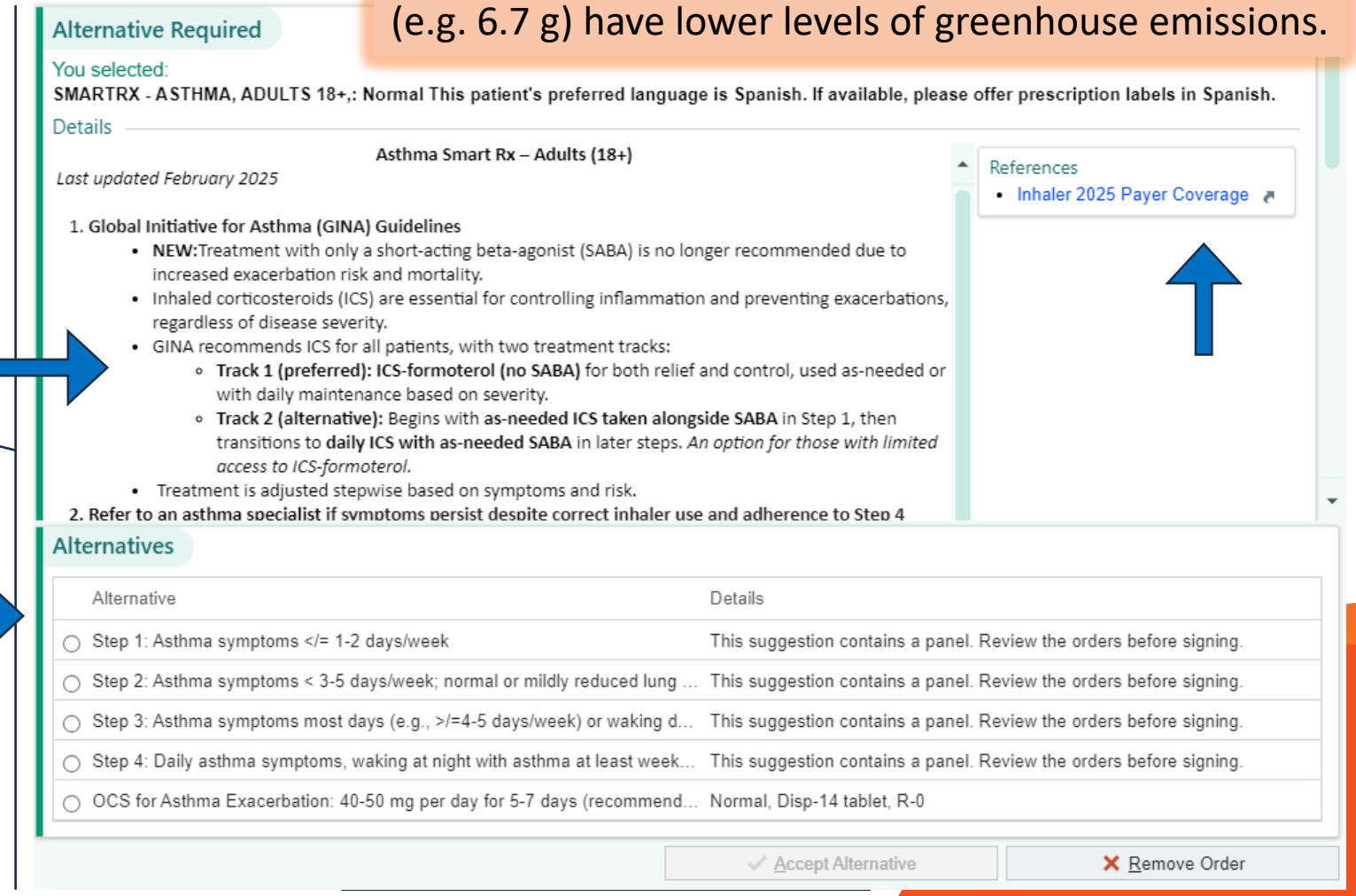
- EHR feature to streamline prescription process for prescribers
- Up-to-date information to reduce errors
- Optional for prescribers
- Synonyms trigger Smart Rx in orders

Accolate	LABA
Advair	Levalbuterol
AirDuo	MART therapy
AirDuo Respiclick	Mometasone
Airsupra	Montelukast
Albuterol	Proair
Alvesco	Proair Respiclick
Arnuity Ellipta	Proventil
Asmanex	Pulmicort
Asthma	Pulmicort Flexhaler
Beclomethasone	Qvar
Breo Ellipta	Qvar Redihaler
Breyna	SABA
Budesonide	Salmeterol
Ciclosenide	SMART therapy
Dulera	Spiriva
Fluticasone	Symbicort
Fluticasone furoate	Tiotropium
Fluticasone propionate	Ventolin
ICS	Vilanterol
Inhaler	Wixela Inhub
Inhaled steroid	Xopenex
Formoterol	

Implementation of clinical strategies

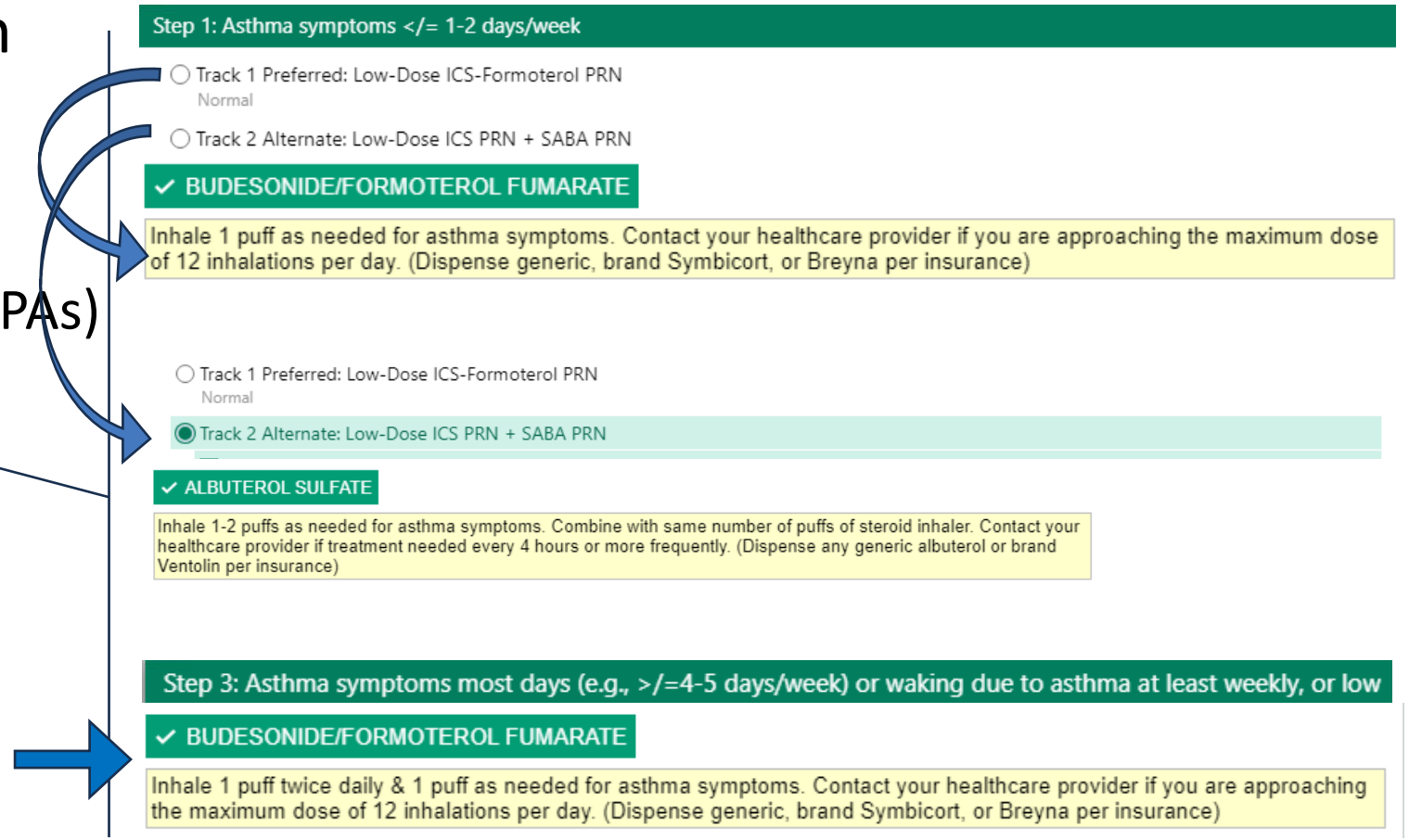
- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History

Dry powder inhalers (DPIs) and smaller SABA canisters (e.g. 6.7 g) have lower levels of greenhouse emissions.



Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History



Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History

- Text expanders
  - Few characters swapped for longer phrase or template
  - Can pull in data
  - Drop-down options available
- Can be used in any field where text is produced within EHR
- Personal, department, or system-wide customization (greater governance)

.ASTHMAACTIONPLAN
Include drop-down selection of MART/AIR:
GREEN ZONE: Doing Well
YELLOW ZONE: Asthma is Getting Worse
RED ZONE: Medical Alert!

Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History

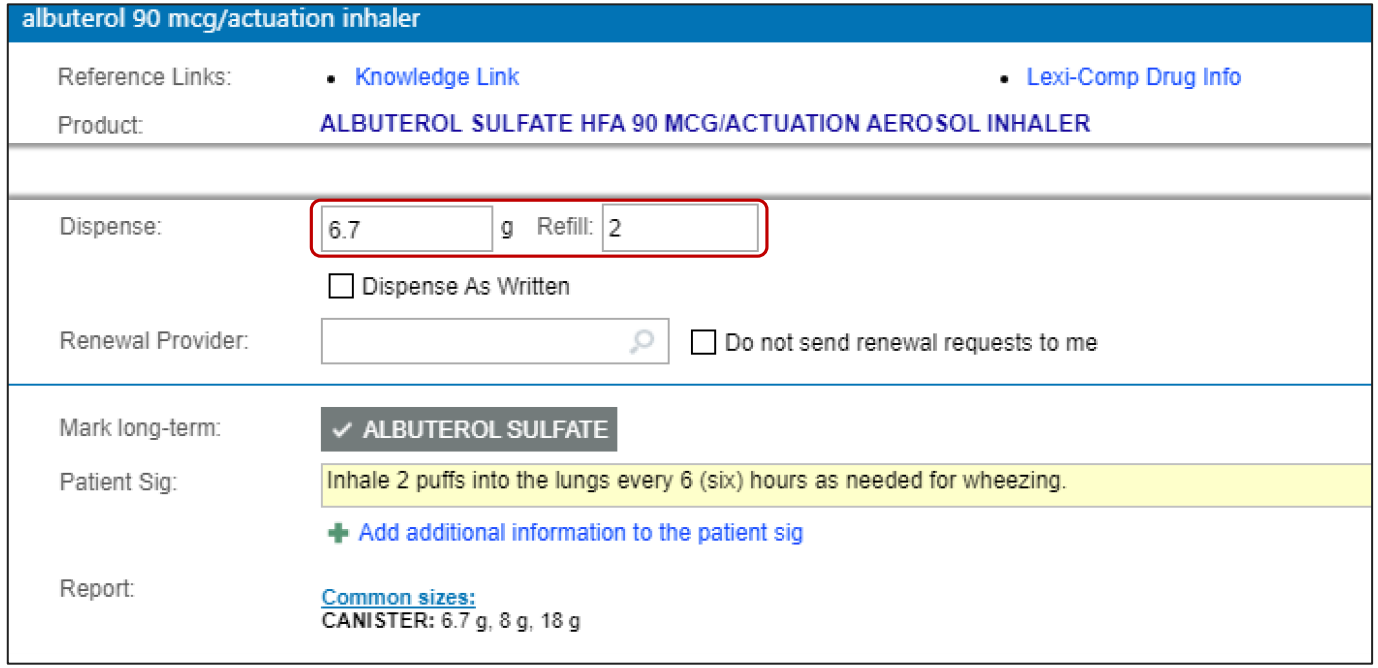
- Group together orders, meds, labs, etc. based on health condition or visit type
- Reduces manual entry
- Supports consistent patient care
- Integrates other Epic tools
- Requires significant IT support

Asthma Smart Set components for visit encounter:

- Smart Rx - inhaler
- Peak Flow Meter prescription
- Pulmonary Function Test (PFT)
- Patient Education/Instruction
  - Asthma Action Plan Smart Phrase
  - Inhaler use/disposal (After Visit Summary)
- Clinical documentation Assessment/Plan

Implementation of clinical strategies

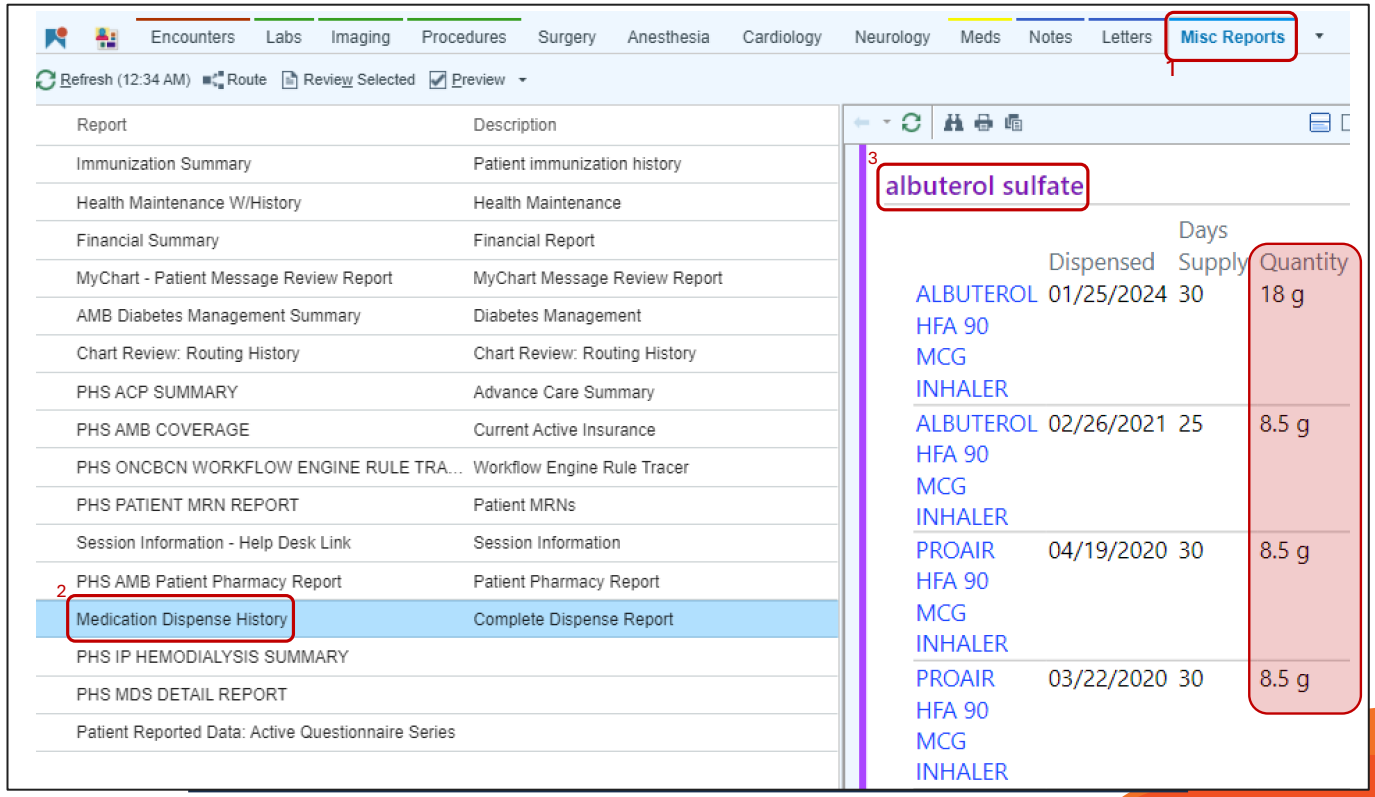
- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History



- Nudge health professionals in clinical choices
- Potentially faster, fewer clicks
- Insurance formularies vary and not always up to date

Implementation of clinical strategies

- Multidisciplinary team
- Education
- **Clinical support tools**
  - Best Practice Alerts (BPAs)
  - Smart Rx
  - Smart Phrases
  - Smart Set
  - Prescribing defaults
  - Dispense History



- Confirms adherence
- Overuse identification, population-level opportunities
- Limitations: eg, out-of-pocket payment

Insights from clinical pharmacy

CleanMed
ATLANTA 2025

Do you know how your inhalers are disposed of after patient use?

Do you know how your inhalers are disposed of after patient use?

Is ‘sustainability’ listed as a criterion in a P&T formulary review?

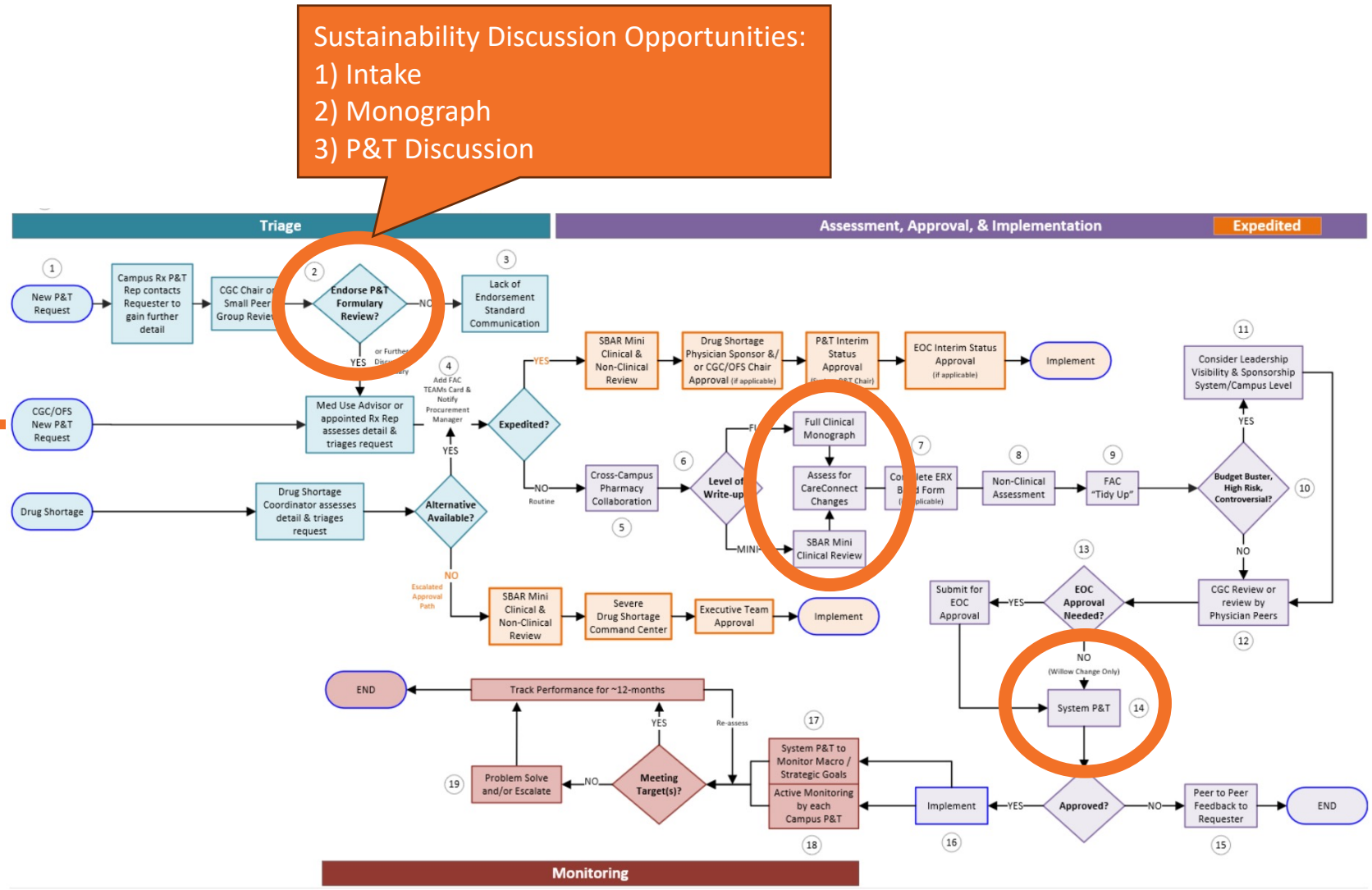
Pharmacy & Therapeutics Committee (P&T)

- Maintain drug formulary
- Expedite drug requests as needed
- Comprehensive, evidence-based vetting
- Address drug shortages
- Minimize medication errors
- Steward high-risk, high-cost therapies
- Guide clinical pharmacist medication management

A Complex System with a Missing Lens

P&T Process in current state

- Clinical Efficacy
- Safety
- Cost-Effectiveness
- Availability



MDI Vs Nebulizer

Inhaler Type	Propellant Use	CO2e Impact	Ease of Use	Time to Administer	Cost	Common Pitfalls
Metered-Dose Inhaler (MDI)	Yes HFA-134a, 227ea	High 12 - 25 kg CO2e per inhaler	**Moderate** requires coordination	**Fast**	$	Poor technique
Nebulizer	No	**Very Low**	**Easy passive delivery**	Long 10–15 min	$	Not portable Needs power Poor technique

Assumptions

500 Bed Hospital

- 20% patients on albuterol (n=100)
- Dose = 4x / day
- Administration Time = 20 minutes
- RT Salary = $80,000

Impact

20 NEW Respiratory Therapists

- 400 treatments daily
- ~130 hours / day

Cost

$1.64M

Talent shortage is a big concern for the future. A big reason for that? Retirement plus fewer and fewer incoming RTs.

Troubling trends in respiratory therapy

92,474

RTs will leave the profession by 2030[2]

27%

decline in respiratory care education program enrollment since 2010[2]

The State of Respiratory Therapy: A 2021-2022 Report. American Association for Respiratory Care

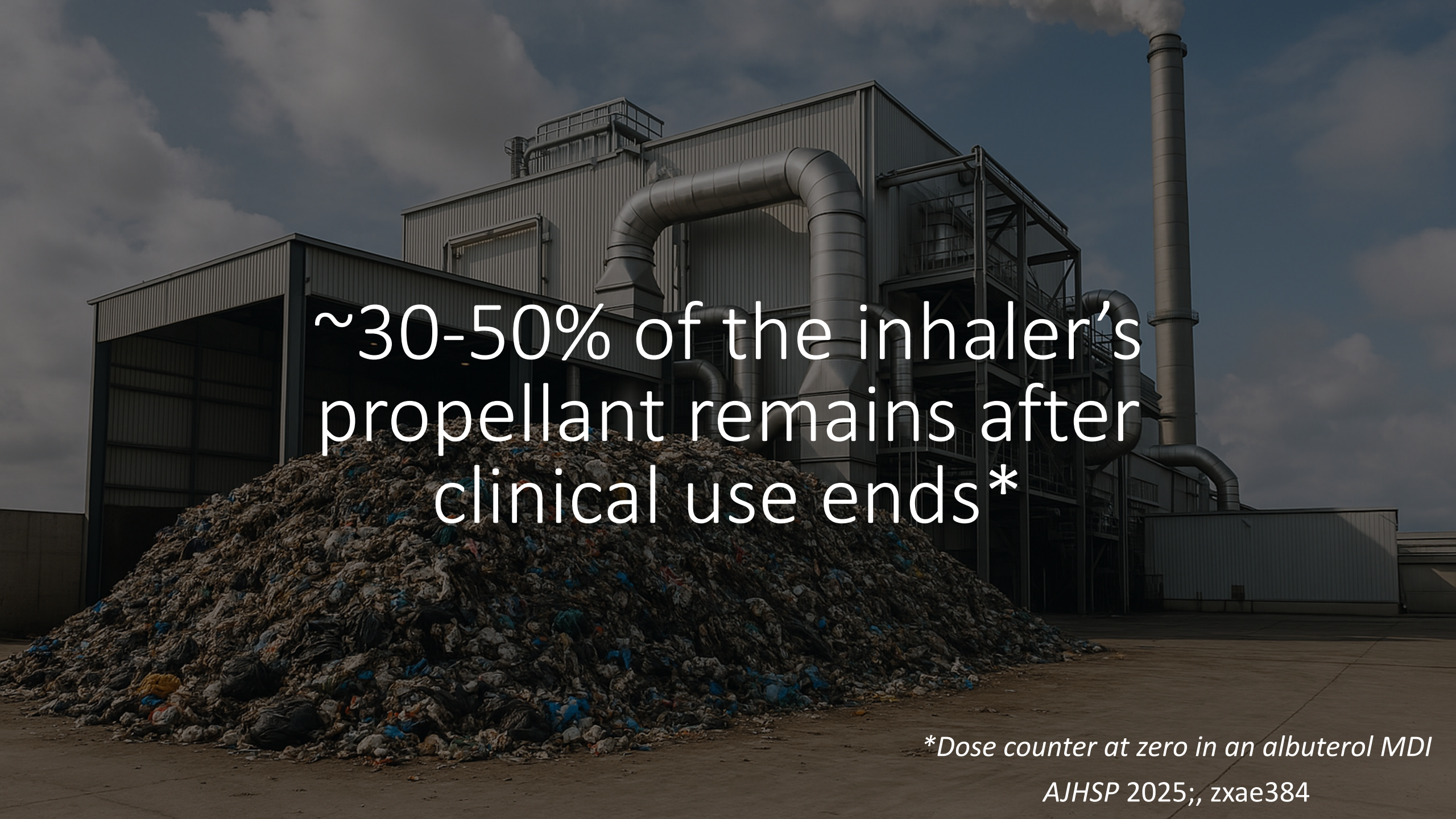
How does your institution dispose of inhalers?

Replacing Your PROAIR HFA Device

- **When the dose counter on the actuator says the number 20,** the color of the numbers will change to red. The red numbers are to remind you to refill your prescription or ask your doctor for another prescription for PROAIR HFA. When the dose counter reaches **0**, the background color will change to solid red.
- **Throw the PROAIR HFA inhaler away** as soon as the dose counter says **0** or after the expiration date on the PROAIR HFA packaging, whichever comes first. You should not keep using the inhaler after 200 sprays even though the canister may not be completely empty. You cannot be sure you will receive any medicine after using 200 sprays.
- **Do not use the inhaler** after the expiration date on the PROAIR HFA packaging.

This Patient Information and Instructions for Use has been approved by the U.S. Food and Drug Administration.

Marketed by Teva Respiratory, LLC
Frazer, PA 19355



~30-50% of the inhaler's propellant remains after clinical use ends*

**Dose counter at zero in an albuterol MDI*

AJHSP 2025;, zxae384

Disposal Pathways & Environmental Impact

Why aren't inhalers currently recycled in the U.S.?

- **Pressurized canisters = explosion risk in standard recycling**
- **No national infrastructure for inhaler recycling exists**
- **GSK "Complete the Cycle" discontinued 2020**

Take-Back Programs in Europe

Take AIR (Murphy et al)

- **12-month pilot collected 1800 inhalers (UK)**
- **Diverted 119 tonnes of CO2e by recovery and recycling of HFAs**

What's the best available disposal method today?

- **Medical waste incineration to destroy residual HFA propellant**
- **>1200 F (650 C)**

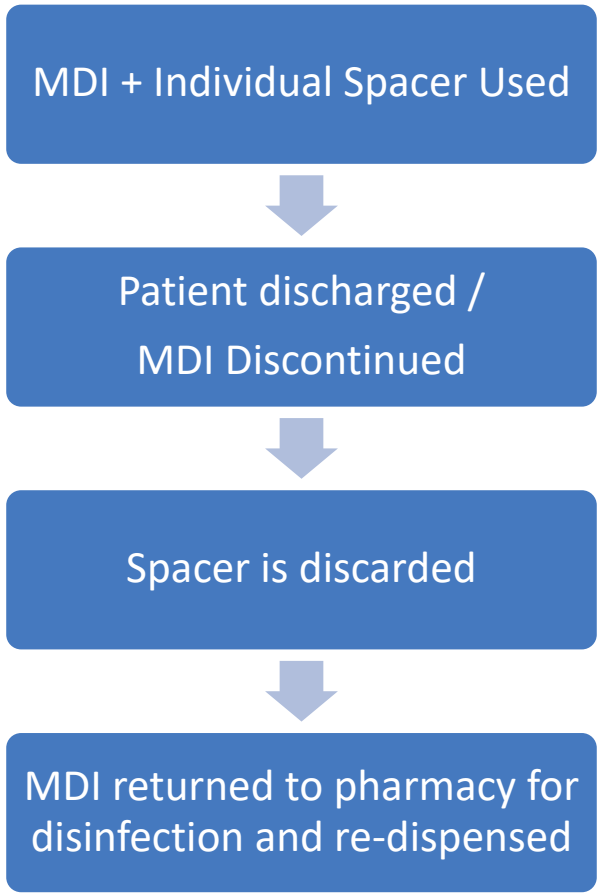
Murphy et al. 2023 Jan 21;33:5.

Common Canister

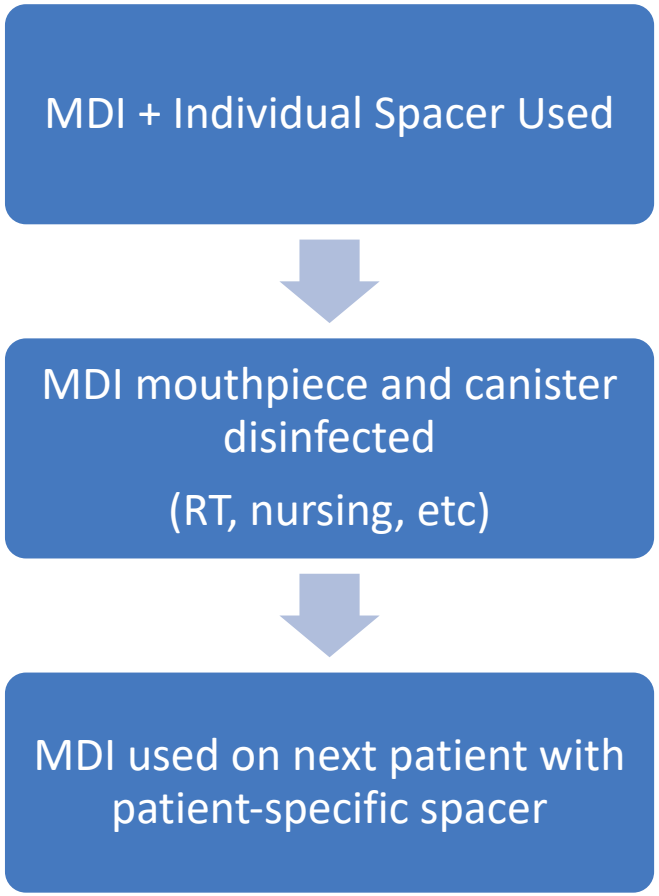
Using a single MDI canister to administer the medication to multiple patients.

The medication is delivered utilizing a patient specific spacer with a one-way valve.

Method 1 – Pharmacy Disinfection



Method 2 – Point of Care Disinfection

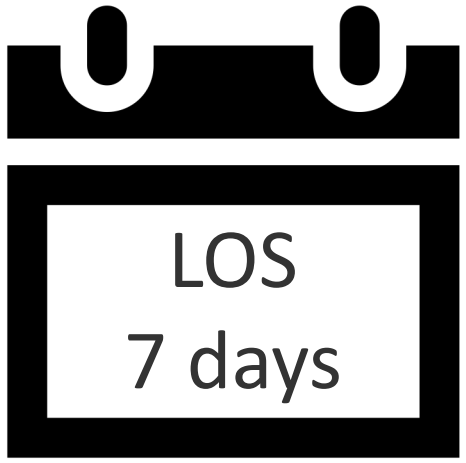


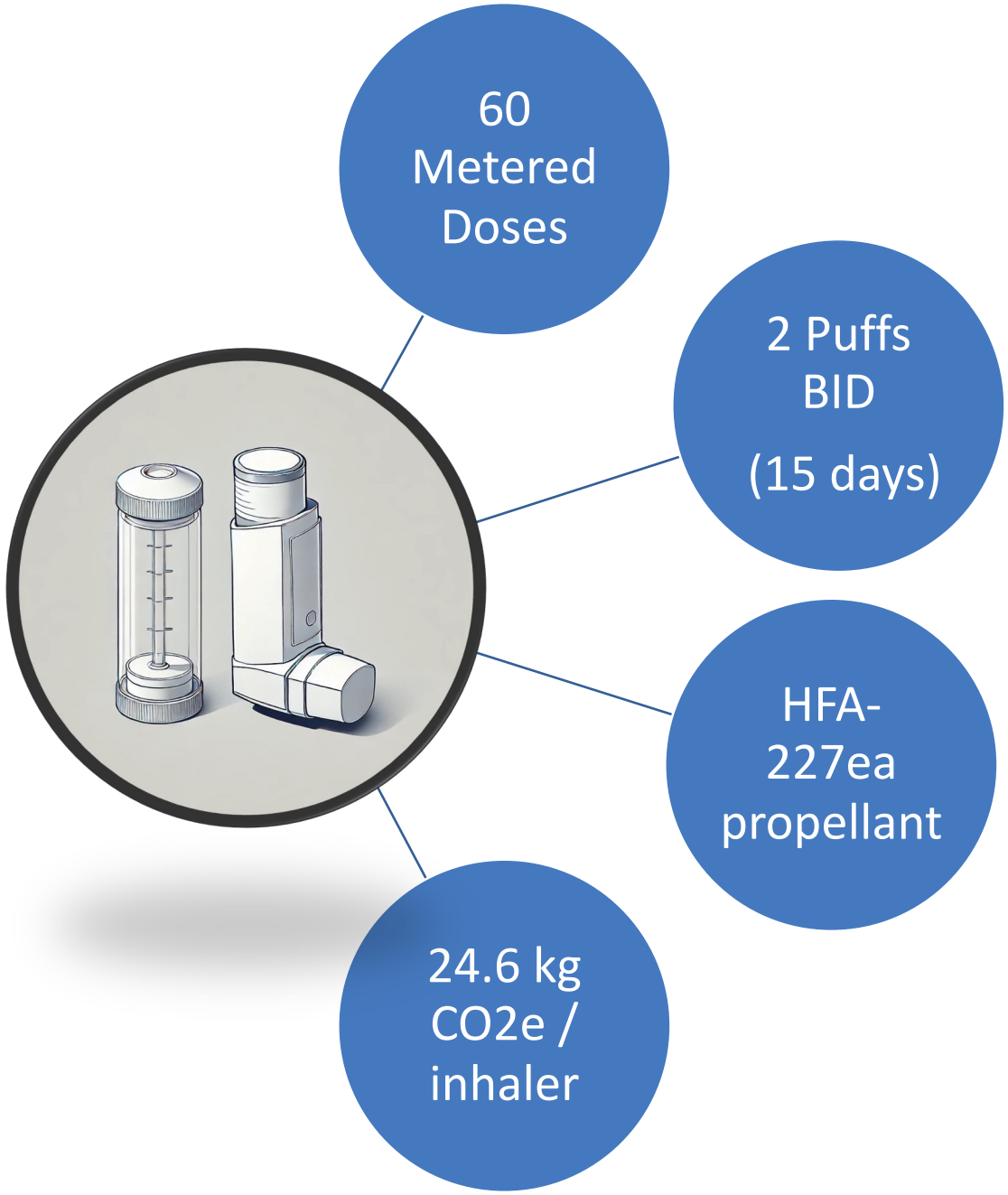
Excludes: Mechanically ventilated patients, isolation patients, emergency department, MDIs that don't work with a spacer, hospice patients, behavioral health patients, neutropenic patients, procedural areas

Stakeholders to Engage

- Nursing
- Respiratory Therapy
- Infection Prevention
- Providers
- Supply chain / Materials management
- EHR/IT
- Sustainability
- Finance
- P&T Representative(s)
- Billing / Revenue Integrity

Use & Disposal Scenario





Single Use / Landfill

CO2e: 24,600 kg
Inhalers: 1,000

Common Canister / Landfill

CO2e: 11,340 kg
Inhalers: 500
Emissions: ⬇50%

Sustainability vs Simplicity

Single Use / Incineration

CO2e: 12,300
Inhalers: 1,000
Emissions: ⬇50%

Common Canister / Incineration

CO2e = 5,855 kg
Inhalers: 500
Emissions: ⬇75%

Final Takeaways

Best immediate strategy:

Use incineration over landfilling inhalers to prevent residual HFA emissions.

Better formulary alignment:

Purchase lowest weighted inhalers (eg 6.7g vs 18g)

Common canister model:

Strong environmental benefits but requires infection control & resource management.

Interdisciplinary collaboration is key to successfully reducing our carbon footprint

Summary

CleanMed ATLANTA 2025

CleanMed
ATLANTA 2025

Questions and Discussion