



Financial and Environmental Implications of Wasted Inhaler Doses in Medical Inpatients at a Tertiary and Community Hospital: A Retrospective Review

Alison Bentley, PharmD^{1,2,3}; Valeria Stoyanova, MDCM, FRCPC, CEF, MHPE^{2,4}; Kyle McWilliams, B.Sc.(Pharm), ACPR⁴; Nadia McTaggart, B.Sc.(Pharm), ACPR²; Celia Culley, B.Sc.(Pharm), ACPR, PharmD²

¹NRGH, Nanaimo, BC; ²RJH, Victoria, BC; ³University of British Columbia Faculty of Pharmacy, Vancouver, BC, ⁴SPH, Victoria, BC



Background

A variety of respiratory conditions rely on inhaled medications for symptom relief, reduction in hospitalizations and decreased mortality ^{1,2,3,4}. Inhaler devices commonly used in Canada include MDIs, DPIs, SMI's.

Financial/Environmental Cost

- Inhalers are supplied as bulk items that provide ~30-day supply of medication, the average length of hospital stay in Canada is 7 days ⁵. This translates to ~24% of doses used during hospitalization, leaving the rest for waste
- MDIs contain HFCs as a propellant that are released with each actuation and slowly leak out of the device overtime if improperly disposed of ⁶ (i.e. not incinerated)
- HFCs are potent GHGs that have been shown to be up to 3200 times (depending on the type of HFC) more potent than carbon dioxide in their effect on global warming ⁷
- Although MDIs are generally the main cause for most GHG emissions related to an inhaler's life cycle (including manufacturing, use and disposal), DPI's and SMI's are not benign and have their own environmental implications associated with their life cycle ⁶

Study Objectives and Outcome Measures

Study Objective: To better understand the magnitude of wasted inhaler doses and to quantify financial and environmental impacts corresponding with each inhaler delivery device at Island Health

Primary Outcome:

- To quantify wasted inhaler doses (MDI, DPI and SMI) at three inpatient wards during the months of January, March and August

Secondary Outcomes:

- To quantify the associated cost of wasted inhaler doses
- To assess the relative difference in wasted doses between each inhaler delivery device
- To assess the frequency of an inhaler device being dispensed yet never used
- To assess the frequency of duplicate inhaler dispenses without an indication
- To quantify the equivalent GHG emissions released from each dispensed inhaler

Methods

- Multicenter, retrospective chart review**
- Pharmacy Informatics (RxIT) generated report of eligible patients
 - This was limited to those who had an inhaler dispensed from the pharmacy and did not include patients who received an inhaler from ward stock
- Data collected from paper medical records

Inclusion/Exclusion Criteria

Inclusion

- Patients with one or more inhalers dispensed during their admission, and
- Admitted to either the medicine-surgery ward at a community hospital (SPH), a respiratory ward or a medicine ward at a tertiary hospital (RJH) in Victoria, BC, and
- Admitted during the months of August 2021, January 2022 or March 2022

Exclusion:

- Patients who did not have an inhaler dispensed from pharmacy during admission
- Patients who used their own inhaler
- Aged < 18 years

Abbreviations

- MDI: Metered Dose Inhaler
- DPI: Dry Powder Inhaler
- SMI: Soft Mist Inhaler
- HFC: Hydrofluorocarbons
- GHG: Greenhouse Gas
- MAR: Medication Administration Record
- SPH: Saanich Peninsula Hospital
- RJH: Royal Jubilee Hospital
- NRGH: Nanaimo Regional General Hospital

Results

Characteristics (Total Number of Participants; n = 132)

Age (years)	Mean: 72 years
Median Length of stay (days)	10
Primary Reason for Admission [#participants (%)]	Respiratory: 70 (53%)
Previously on an inhaler as per provider documentation? [#participants (%)]	Yes: 54 (40.9%) No Documentation therefore uncertain: 67 (50.8%)
Inhaler Dispensed in Hospital [#participants (%)]	<div><div>Tiotropium SMI: 47 (35.6%)</div><div>Salbutamol: 43 (32.6%)</div><div>Budesonide-Formoterol: 27 (20.5%)</div><div>Ipratropium: 17 (12.9%)</div><div>Fluticasone: 15 (11.4%)</div><div>Fluticasone-Salmeterol MDI: 13 (9.8%)</div><div>Salmeterol: 11 (8.3%)</div><div>Tiotropium DPI: 10 (7.6%)</div><div>Fluticasone-Salmeterol DPI: 7 (5.3%)</div><div>Budesonide: 6 (4.5%)</div><div>Beclomethasone: 1 (0.8%)</div></div> <div>MDI: 71 (53.8%) DPI: 56 (42.4%) SMI: 48 (36.4%)</div>

In this study, 22,956 actuations (211 inhalers) were dispensed for 132 patients

Out of these, **18,843* (82%)** actuations were **wasted** resulting in a cost of **\$5,290.74**

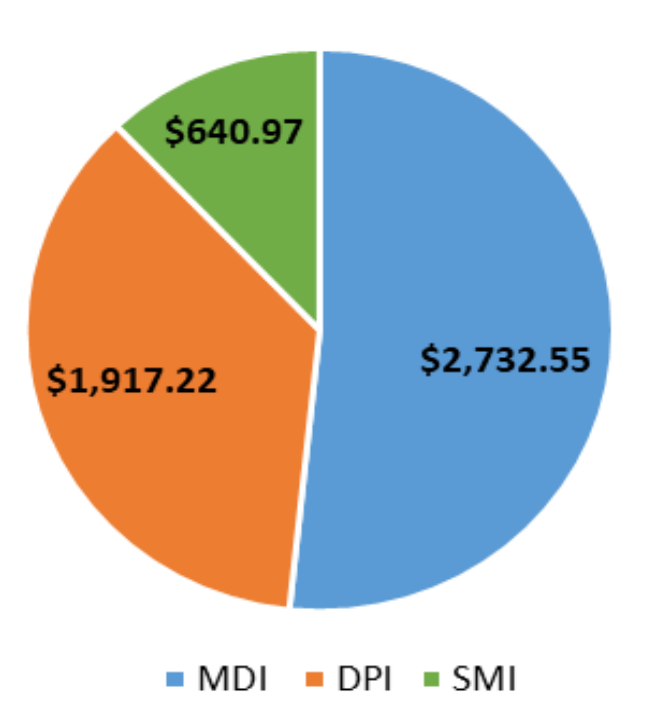


Figure 1. Cost of Wasted Actuations*

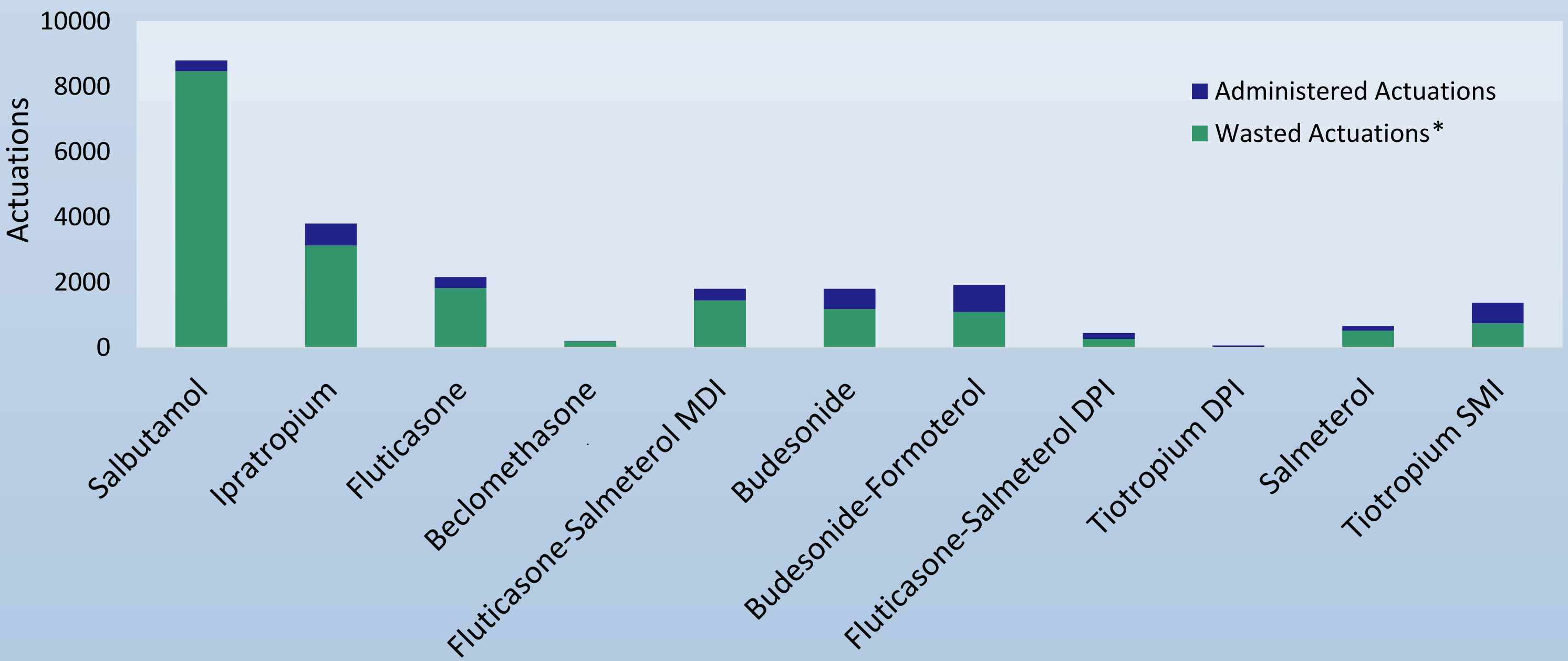


Figure 2. Administered and Wasted Actuations by Medication and Delivery Device

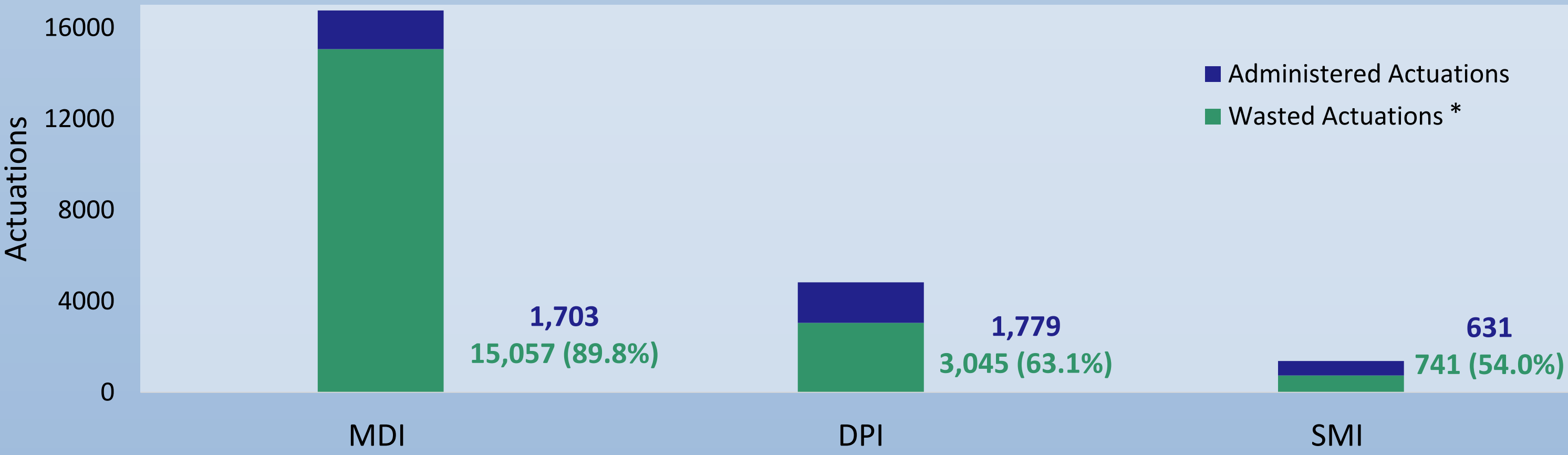


Figure 3. Administered and Wasted Actuations by Inhaler Delivery Device

22 participants (17%) had at least one inhaler dispensed yet no doses were documented on their MAR

16 participants (12%) had a duplicate inhaler dispensed during their admission

The following inhalers did not have dispense data during specified study months and therefore were not included in this study: ciclesonide MDI, fluticasone-vilanterol DPI, fluticasone-umeclidinium-vilanterol DPI, mometasone DPI, mometasone-formoterol MDI or tiotropium-olodaterol SMI. This was due to formulary status, restrictions or lack of availability/supply
*Numbers represent waste under the assumption that if zero doses were documented on the patients MAR, all were wasted

Results (Continued)

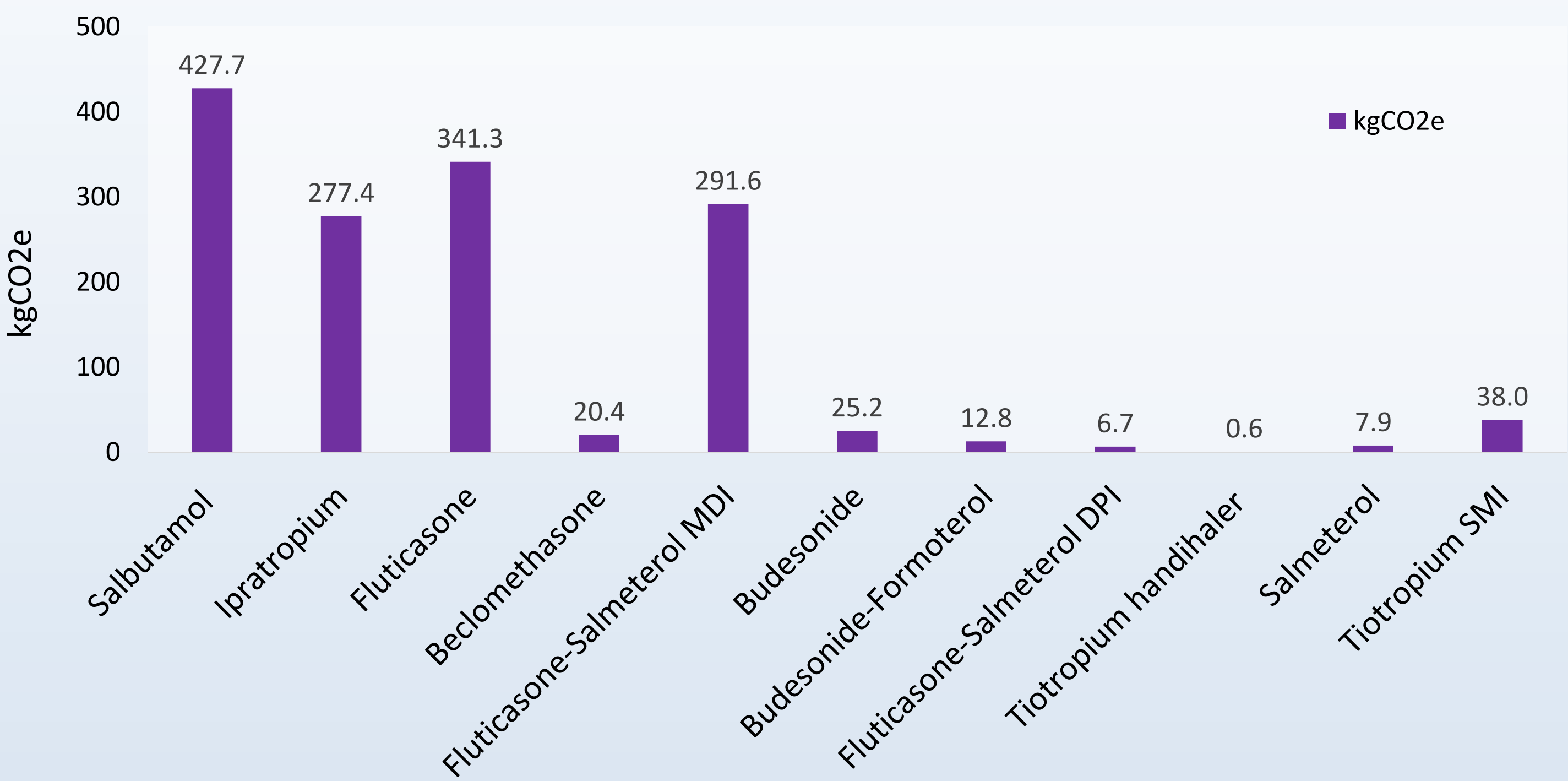
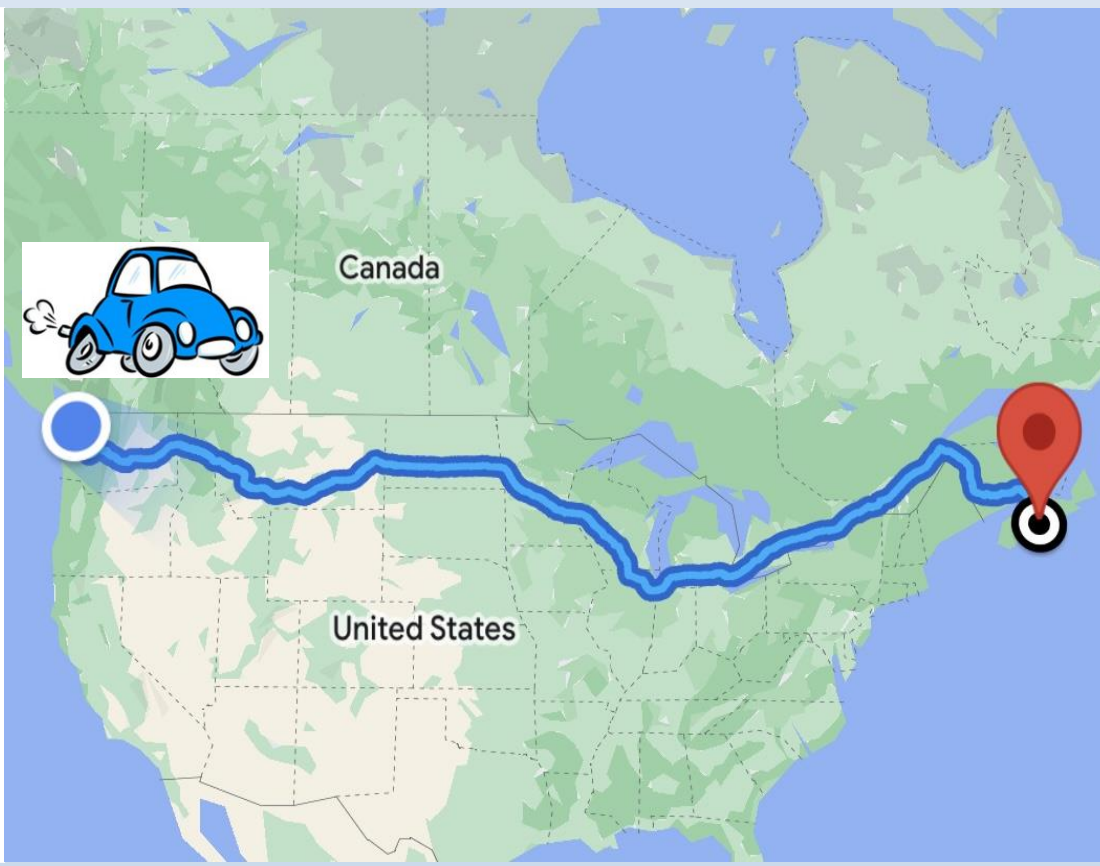


Figure 4. Greenhouse Gas Emissions Released from Each Inhaler

211 inhalers dispensed = **1,449 kgCO₂e** emitted

This can be equated to driving **5,910 km ...** or **from Victoria, BC to Halifax, NS** in a typical gas-powered car



Discussion

- Our study found that 82% of all dispensed actuations were wasted*
- Salbutamol resulted in the most waste and GHG emissions with 96.3% of available actuations wasted, a number similar to previously published literature ⁸
- Salbutamol was dispensed 44 times to 43 (33%) participants, 35 were prescribed as needed, 19 of which had zero doses documented on their MAR
- DPIs and SMI's resulted in less wastage and GHG emissions compared to MDIs ranging from 26.2% wasted (tiotropium DPI) to 77.9% wasted (salmeterol)
- As per our hospital formulary, inhalers are dispensed with the following actuations available: **MDI: 120-200****, **DPI: 60*****, **SMI: 28**
- In this study, 59% of patients were admitted for < 14 days which outlines the anticipated impact multi-dose inhaler formulations have and will continue to have when dispensed in hospitals

Limitations:

- Unable to capture ward stock data
- Inhaler(s) were commonly left at patient's bedside
- Inhaler dispenses for prolonged patient stays outside of study months were not captured
- Unable to accurately determine if all or zero actuations were wasted when no doses were documented on MAR

*Numbers represent waste under the assumption that if zero doses were documented on the patients MAR, all were wasted
**Fluticasone was dispensed as a 60 actuation format for 4 participants
***Budesonide dispensed with 200 actuations available, 3 participants were dispensed fluticasone-salmeterol with 28 actuations, tiotropium DPI was dispensed with 5 capsules

Conclusion and Next Steps

Conclusion: Our study identified consequential and meaningful waste of inhalers in an inpatient setting. Taking into account the major limitation of not capturing ward stock data, the numbers represented in this study likely underestimate the amount of use/waste of inhalers. Our study clearly outlined both financial and environmental losses from these wasted doses.

Next Steps: Identification of patients prescribed inhalers that are included as ward stock medications and evaluate associated wastage, cost and emissions. Practice changes are needed at Island Health to decrease future waste, cost and environmental impact of inhalers.