

MORE THAN A DRIP:

USING A PLANETARY HEALTH LENS TO QUANTIFY THE CARBON FOOTPRINT OF BIOEQUIVALENT ANTIMICROBIALS PRESCRIBED INTRAVENOUSLY

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Land Acknowledgement

We acknowledge with gratitude, that we are gathered on the traditional, ancestral and unceded territories of the **Musqueam, Squamish and Tsleil-Waututh** First Nations who have nurtured and cared for the lands and waters around us for all time.

Acknowledgement

The project team is grateful to CSHP-BC for the Pharmacy and Sustainable Environment Grant (SAVING) which helped fund this work

Learning objectives



Describe IV to oral conversion and identify antimicrobials that are highly bioavailable



Describe the benefits to patients and the healthcare system for using oral highly bioavailable antimicrobials over their IV counterparts.



Describe the environmental benefits of using oral highly bioavailable antimicrobials over their IV counterparts.



Identify the contraindications to using oral antimicrobial therapy

Canadian Healthcare Sector's Contribution to National Greenhouse Gas (GHG) Emissions



Canadian healthcare services have a significant environmental footprint, which contributes to an increasing global burden of disease

- a) True
- b) False



What proportion of Canadian healthcare emissions come from medications?

- a) 5%
- b) 10%
- c) 25%

What is the difference in carbon footprint?

Ciprofloxacin 400 mg **IV** Q12H x 1 week vs

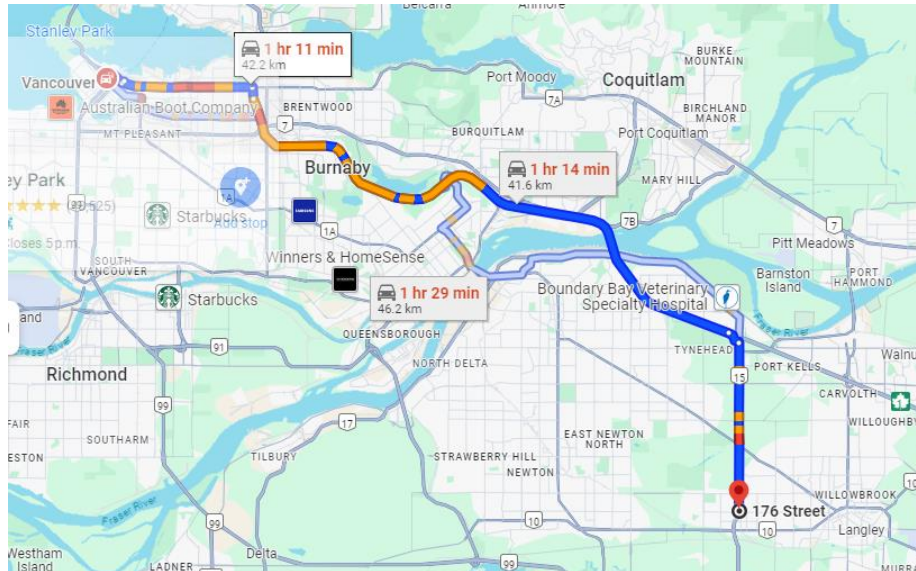
Ciprofloxacin 500 mg **PO** BID x 1 week

- a) ~10 x higher
- b) ~25 x lower
- c) ~50 x higher
- d) ~100 x higher

Cipro 400 mg IV Q12H x 7 days



~Vancouver to Cloverdale (~43 km)



Background

- 4.6% of Canadian greenhouse gas (GHG) emissions come from healthcare; **25% of which come from medications**
- Identifying prescribing options with a **lower carbon footprint** while maintaining **good clinical outcomes** is critical
- Significantly **higher carbon footprint** for intravenous (IV) versus oral (PO) bioequivalent antimicrobials related to the drug delivery systems
- Antimicrobials with high bioavailability (bioequivalent) offer **no additional benefit** when given IV, except when PO administration is not feasible

Known benefits of using PO antimicrobials



Easier for patients to take



line-related adverse effects



workload



hospital length of stay



cost

² Ramirez JA, et al. *Arch Intern Med.* 2001; 161:848–50

³ Rojo D, et al. *J Hosp Infect.* 1999; 42:135–41.

⁴ Sevinc F, et al. *J Antimicrob Chemother.* 1999; 43:601–6.

⁵ Mertz D, et al. *J Antimicrob Chemother.* 2009; 64:188–9.

Which antimicrobials have high oral bioavailability (or are bioequivalent)?

Antimicrobial	Bioavailability	Antimicrobial	Bioavailability
1. Azithromycin	37%*	6. Levofloxacin	99%
2. Ciprofloxacin	70-80%	7. Metronidazole	100%
3. Clindamycin	90%	8. Moxifloxacin	90%
4. Fluconazole	90%	9. Trimethoprim-sulfamethoxazole	80-100%
5. Linezolid	100%	10. Voriconazole	96%

*Note: Despite low bioavailability, azithromycin has enhanced tissue penetration and a long half-life


Contraindications to oral therapy

Parameter	Examples
Unable to take antimicrobial orally	Not tolerating other medications, fluids and/or food orally or enterally in hospital for at least 12 hours NPO Nasogastric/oral gastric tube to suction Active gastrointestinal bleeding Difficulty swallowing Loss of consciousness without NG/OG present Recurring emesis
Poorly functioning gastrointestinal tract	Documented ileus or GI obstruction Short GI transit time (e.g. malabsorption syndromes, partial or total gastrectomy, short bowel syndrome)
Shock	Septic shock Receiving vasopressors
Significant drug-drug or drug-enteral formulation interactions that may alter absorption	Ciprofloxacin interactions with continuous enteral feeding formulations (if enteral nutrition cannot be held 1-2 hours before and after administration) Any drug interactions known to increase or decrease antimicrobial concentrations that can lead to toxicity or therapeutic failure

Finally, patients eligible for SAT should not have an infection for which only IV therapy is indicated

Study Objectives

To quantify our IV use of bioequivalent antimicrobials when PO administration is feasible



Determine the carbon footprint and antimicrobial costs associated with the unnecessary use of IV highly bioavailable antimicrobials

Methods

- Retrospective chart review
- Vancouver General Hospital
- Inclusion Criteria: Received **IV highly bioavailable antimicrobials** on 5 dates between August 2023 to April 2024
- Exclusion Criteria: None
- Data Collection: Relevant patient data
- Outcomes:
 - Primary: **Proportion of patients receiving IV bioequivalent antimicrobials when they could have received PO**
 - Secondary: **GHG emissions** and antimicrobial **costs**

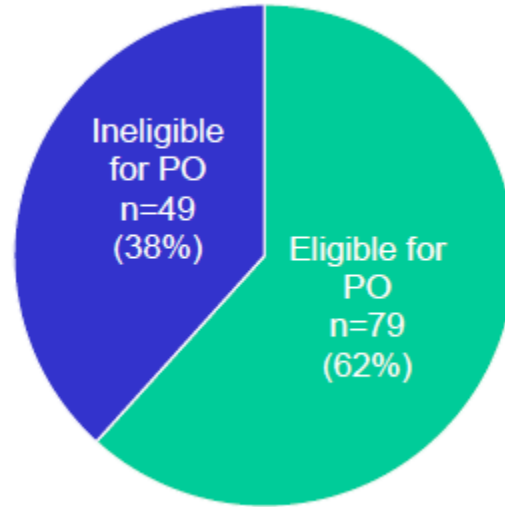
Baseline Characteristics

Average Age, Years (SD)	58 (18)
% Males	41
Type of Infection (%)	
• Intraabdominal	36 (28)
• Respiratory	25 (19)
• Transplant [prophylaxis]	19 (15)
• Unclear	19 (15)
• Other*	29 (23)
Antimicrobial† (%)	
• Metronidazole	101 (47)
• Fluconazole	30 (14)
• Ciprofloxacin	24 (11)
• Other	61 (28)
Medical Service (%)	
• Intensive Care Unit (ICU)	41 (32)
• General Surgery	37 (29)
• Internal Medicine	21 (16)
• Other	29 (23)

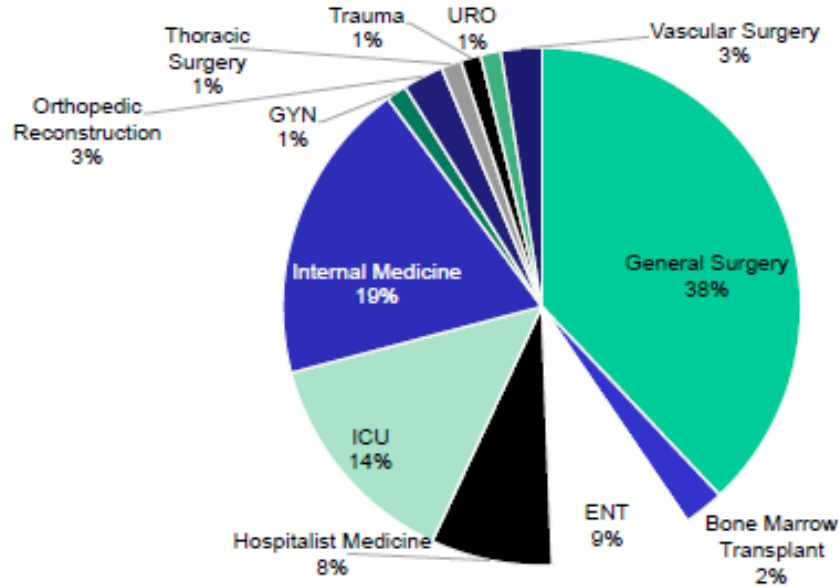
* Includes oropharyngeal, skin & soft tissue, bone & joint, line infection, urinary tract infection and febrile neutropenia

†n=216 doses

Proportion of patients receiving IV when PO was feasible



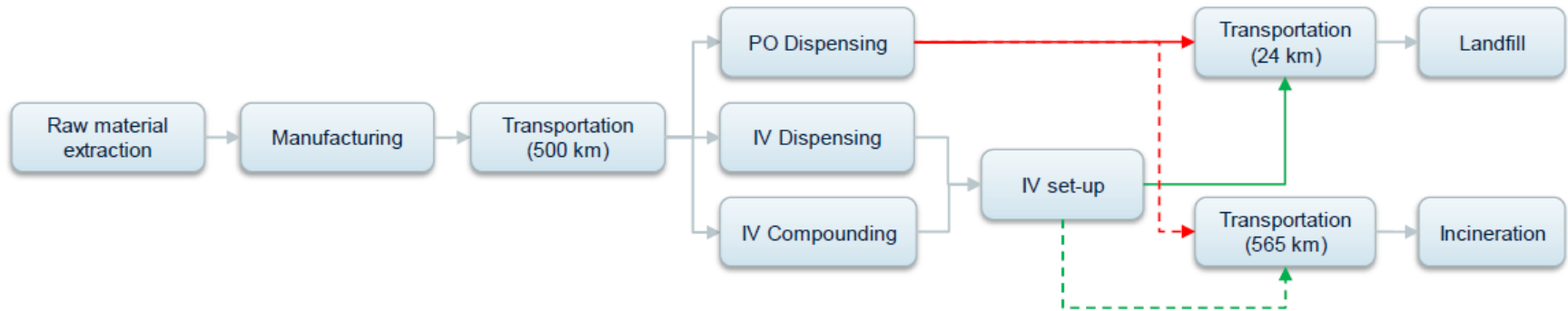
Patients eligible for PO switch by medical service



Carbon footprint



- This study focuses on the materials for drug delivery systems only, the GHG emissions related to manufacturing drugs are out of scope.



Carbon footprint

IV: a. Drug delivery



b. Compounding/Dispensing



c. IV set-up



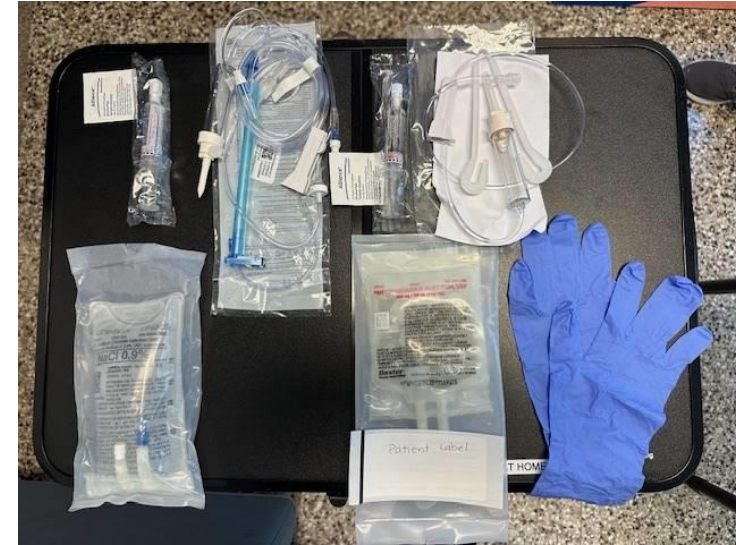
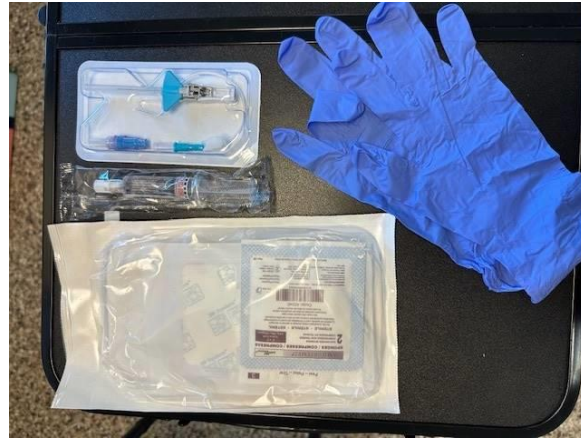
- Disassemble and weigh different materials
- Collect CIs of different materials from LCA database

Carbon footprint

PO



IV



Carbon footprint

**IV vs PO=
~60-170x**

Unpublished data

Carbon footprint

Potential GHG savings

82,000 g CO₂-eq

over 5 days

Equivalent to driving **400 Km**

or

~6 million g CO₂-eq

per year

Equivalent to driving **73%** of the
circumference of Earth per year

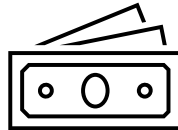


Antimicrobial cost


\$835 potential antimicrobial cost savings over 5 days

or

\$61,000 per year



Discussion

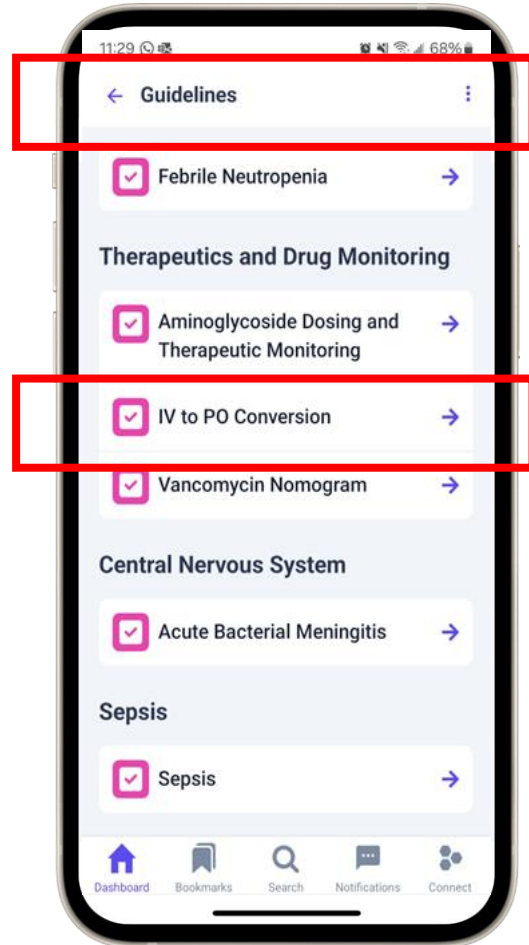
- Opportunity to educate prescribers on **IV to PO switch** and the benefits to **patients, healthcare system, and the planet**
- Add **daily** IV to PO assessment at team rounds
- Local IV to PO conversion guideline on  Firstline
- Promote pharmacist IV to PO conversion policy
- Optimize the EMR

Education

- General Surgery
- Internal Medicine
- Hospitalist
- Pharmacy

IV to PO Switch Guideline

Check out our guideline in



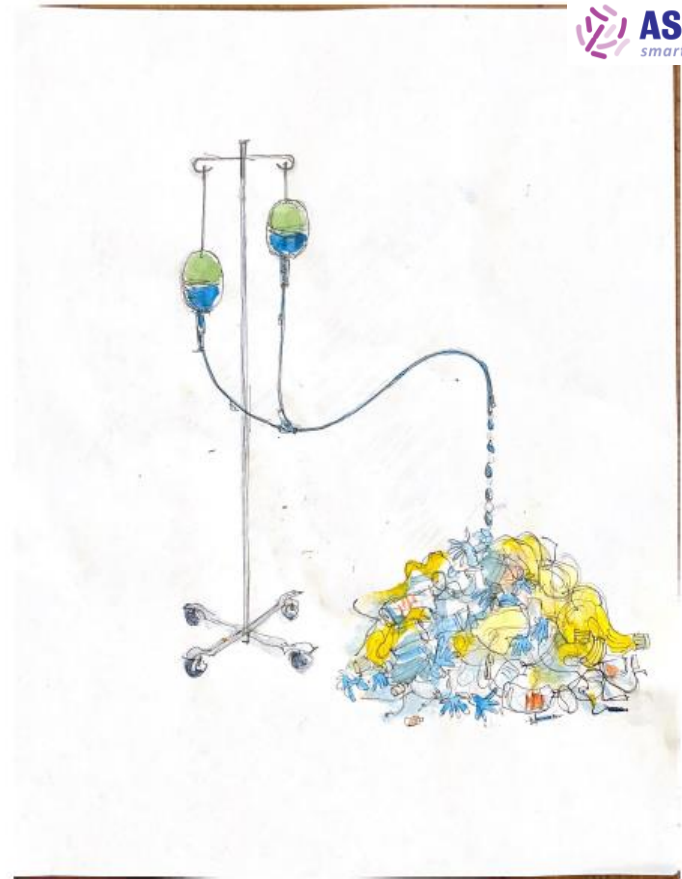
More than a Drip

Artist: Peter Clarkson, Tofino, BC

This installation represents a small portion of the waste generated from IV administration of antimicrobials at VGH.

The installation complements an Antimicrobial Stewardship and Planetary Health effort to raise awareness about the significant medical waste and associated carbon footprint generated from the utilization of IV antimicrobials compared to their oral counterparts.

The goal of this campaign is to reduce the unnecessary use of IV when PO administration is feasible.



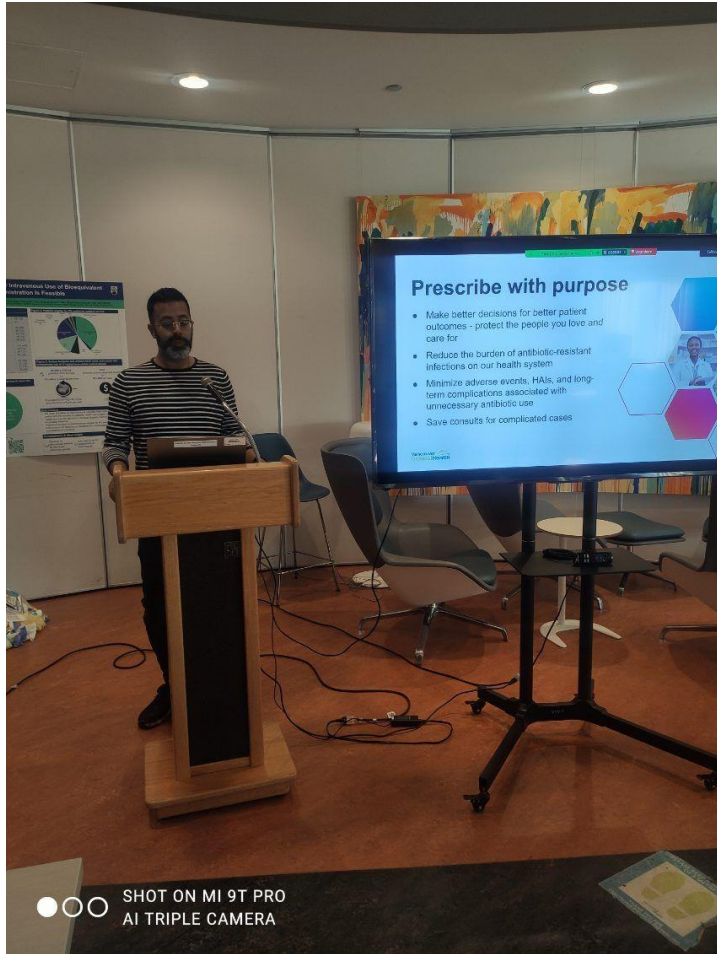
We gratefully acknowledge the support of the Canadian Society of Healthcare-Systems Pharmacy (CSHP) and Vancouver General Hospital.

More than a Drip

Artist: Peter Clarkson, Tofino, BC



"Creating this installation was very revealing to me regarding the **tremendous quantity of medical waste** produced every day. The proliferation of single-use disposable materials in health care is particularly difficult to address given their **many positive benefits**. However, the consumption and disposal of these products **comes with a real cost to the environment** - our collective life support system. Ultimately we must ensure **both patients and the planet are cared for.**"



World Antimicrobial Resistance Awareness Week



October 19, 2024

Let's GO, PO!

The problem:

IV antimicrobials have a significantly higher carbon footprint versus PO

- ☛ The Canadian healthcare system contributes directly to climate change
- ☛ IV antimicrobials produce a significant amount of waste versus oral (PO)
- ☛ Patients are often ordered IV antimicrobials when PO options can be safely used



The solution:

Use oral antimicrobials preferentially whenever clinically appropriate for the patient*

Benefits for healthcare:

- ✓ Easier for patients to take
- ✓ Avoids patient adverse effects from IV catheter (i.e., clots, line infections)
- ✓ Reduces healthcare staff workload
- ✓ Reduces length of stay and hospital costs

Benefits for the planet:

- ✓ PO has a significantly lower carbon footprint compared to IV
- ✓ The average greenhouse gas emissions savings per patient per day from switching IV to PO is 1044 g CO₂-eq

That's like driving your gas-powered car from Stanley Park to Capilano Suspension Bridge (about 5km)!



Say this: Let's GO, PO!

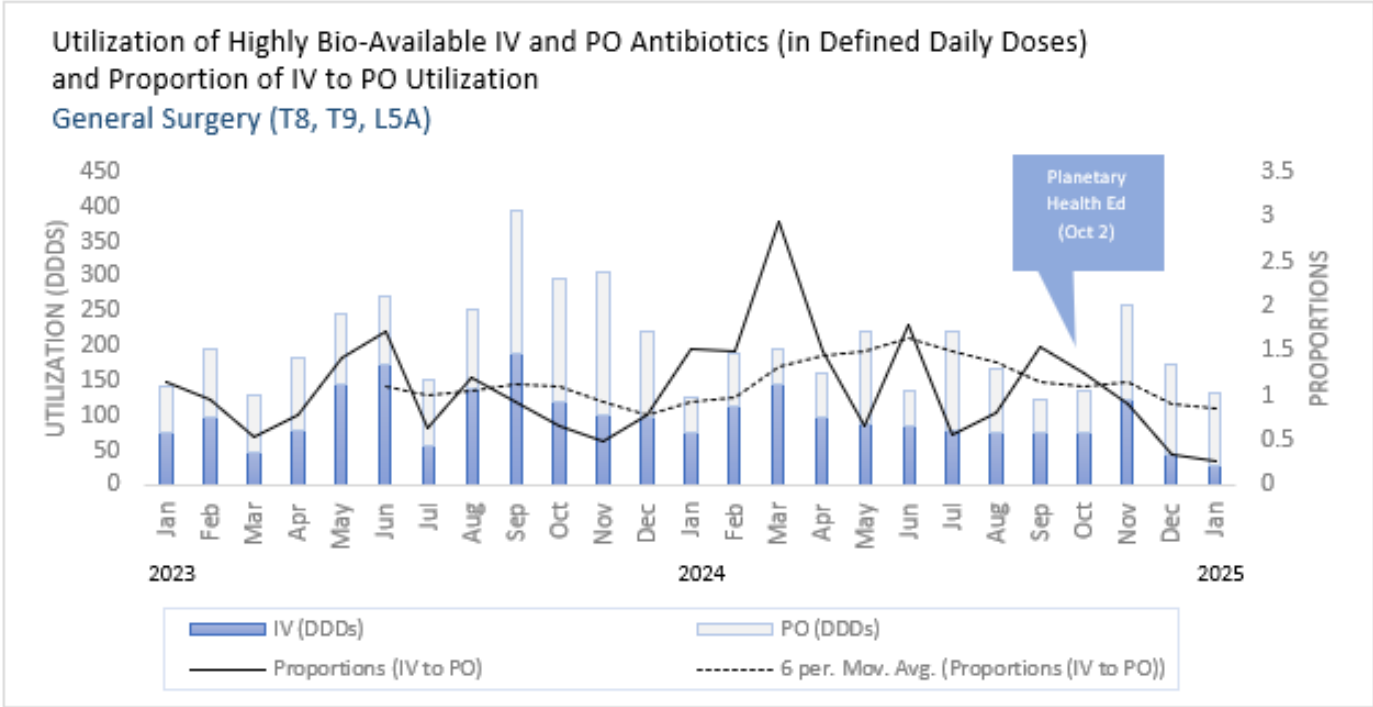
*PO is only contraindicated when the patient is unable to take oral, has a poorly functioning gastrointestinal tract, is at risk of septic shock, has significant drug-drug or drug-disease interactions that may alter absorption, or has an infection that requires IV route only.

Highly bioavailable antimicrobials: Amphotericin^B, daptomycin, dexamethasone, fusidic acid, linezolid, levofloxacin, meropenem, moxifloxacin, sulfamethoxazole-trimethoprim, vancomycin. Mupirocin has reduced bioavailability which is compensated by high tissue penetration and a long half-life.

References:

- Reinise JA, Gordon J. Early switch from intravenous to oral antibiotics in hospitalized patients. *Arch Intern Med* 2005; 165:848-50.
 Raja D, Pinedo A, Claeys E, Garcia-Rodriguez A, Garcia V. Analysis of risk factors associated with nosocomial bacteremia. *J Hosp Infect* 1999; 42:126-41.
 Swartz F, Price JM, Koopmans RP, et al. Early switch from intravenous to oral antibiotics: guidelines and implementation. *J Antimicrob Chemother* 1996; 42:501-6.
 Meier D, Keller M, Haller P, et al. Outcome of early switching from intravenous to oral antibiotics on medical wards. *J Antimicrob Chemother* 2006; 54:888-9.

Proportion of IV versus PO (Gen Surg)



Conclusion:



Opportunity to promote IV to PO switch in select patients



Requires collaboration between all healthcare professionals



Patient and healthcare system benefits



Reduced carbon footprint and hospital costs

Acknowledgments

- VGH Pharmacy leadership:
 - Drs. Nilu Partovi, Trana Hussaini, Cesilia Nishi
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 - CASCADES
 - Sylvia Nobrega (Clinical Nurse Educator)
 - VGH Pharmacy dispensary
- VGH Pharmacy purchasing



Thank you!

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