Anesthetic Waste and Emissions

Karin Zuegge, MD
Department of Anesthesiology, University of Wisconsin - Madison
Duration of Ice on Lake Mendota (1852/53 - 2015/16 Winter Seasons)

Wisconsin State Climatology Office

Median Duration: 104 days (161 seasons)
Shortest Duration: 21 days 2001/02
Longest Duration: 161 days 1880/81

Wisconsin State Climatology Office: http://www.aos.wisc.edu/%7Esco/lakes/mendota-dur.gif
Is waste a big deal?

- United States hospitals produce more than 7000 tons of waste per day (= 14 mil lbs)
- The cost of waste disposal accounts for approximately 20 % of a hospital’s environmental budget
- 20-30 % of all hospital waste arises from the operating rooms


What we waste
Is this valuable?

ET tube: $1.62 \times 129 = $209

Bair: $6.10 \times 16 = $98

SpO₂: $8.58 \times 17 = $146

Stylette: $2.26 \times 73 = $165

ET tube: $1.62 \times 129 = $209
Does Waste Matter?

- UWHC 356,940 lbs trash per month (= 178 tons)
Does Waste Matter?

FROM GARBAGE TO DIRT: The Decomposing Time line

- Paper towel: 2 years
- Wool socks: 5 to 7 years
- Plastic bag: 40 years
- Tin can: 250 years
- Aluminum can: 1 Million years
- Orange peel: 1 year
- Newspaper: 4 years
- Nylon fabric: 20 years
- Plastic cup lid: 500 years
- Glass bottle: 1 Million years

Operating Room Waste

- > 30,000 cases per year...
- **9,179 cu yd** diverted from landfill
- **226,520 lbs**
How much is that anyway?

Olympic swimming pool = 3250 cu yd

2.25 X the volume of Shorewood Hills Pool
Recycling in the OR
Global Plastics Market Changes

How the global river of plastic waste changed course in just 12 months

Exports of plastic waste, parings and scrap from G7 countries ('000 tonnes)

How the global river of plastic waste changed course in just 12 months

Exports of plastic waste, parings and scrap from G7 countries ('000 tonnes)

China and Hong Kong received nearly 60 per cent of plastic waste exports from G7 countries in the first half of 2017.

Following a Chinese crackdown on imports of plastic waste, which came into effect at the beginning of 2018, exports from the G7 fell by more than 20 per cent overall. The share of the remaining exports that went to China and Hong Kong fell below 10 per cent, with other Asian countries – particularly Malaysia – making up much of the shortfall.
Consider Entire Life Cycle

Point of Use

Upstream Impacts

Fossil fuel consumption

Petrochemical processing

Downstream Impacts

Landfill Space
Pollution and Toxins
Recycling is Important

Valuable resources are saved
- Paper (trees, water)
- Plastic (fossil fuels)
- Aluminum (water, fuel, costly mining)

Less goes to a landfill
- Costly (in $$)
- Toxins seep into groundwater
- Toxic gasses expelled (e.g. dioxin)
Refuse
what you do not need

Reduce
what you do need

Reuse
what you consume

Recycle
what you cannot refuse, reduce, or reuse

Rot
(compost)
the rest
“Just in time” opening of disposable supplies
Pharmaceutical Waste

PHARMACEUTICAL WASTE MANAGEMENT

Hazardous
Average Cost Per Pound: $1.80
- Drug Product
- Sharps
- Empty Containers & Wrappers
  - Black Bin
  - Yellow Sharps
  - Yellow Trash

Biohazardous
Average Cost Per Pound: $0.45
- Drug Product
- Sharps
- Empty Containers & Wrappers
  - Red Bin
  - Red Sharps
  - Red Trash

Non-Hazardous Pharmaceuticals
Average Cost Per Pound: $0.35
- Drug Product
- Empty Containers
- Empty Containers & Wrappers
  - White Bin
  - Recycle Bin
  - Garbage Bin

Flammable drugs such as pressurized inhalers and gaseous should be thrown away in a black bin marked as flammable gas “aerosols” or returned to a pharmacy for proper disposal.

Biohazardous waste is any waste containing infectious materials or potentially infectious substances such as blood, tissue, live vaccines or genetic material.

UW Health non-hazardous waste is defined as all pharmaceutical waste that would not fall into the hazardous, biohazardous or controlled substance drug categories.

When using recycling or regular garbage bins, patient identifiers must be removed.

CONTAiner LOCATIONS CAN VARY BY SITE BASED UPON COMMONLY UTILIZED PHARMACEUTICAL GROUPS—LEARN MORE ABOUT ALTERNATIVES UNDER EACH DESCRIPTION ON U-CONNECT

Controlled Substances
Average Cost Per Pound: $1.20

Drug Only
- No Containers
- No Wrappers
- No Sharps

Sink/Sewer Waste
Average Cost Per Pound: EPA Restricted

Drug may be wasted in the sink/sewer if they meet one of these categories:
- Susceptible Serum
  1. Calcium Salts
  2. Dextrose
  3. Lactated Ringers
  4. Magnesium Salts
  5. Potassium Salts
  6. Sulfate
  7. Sterile Water
- Controlled substance where Cactus not available

February 20, 2018

Waste matrix is for UW Hospital and Clinics only. Please reference information on MedDrop Boxes for patient’s own unused medicine.

Black Bins: Hazardous drugs

- Less than 1% of our drugs are hazardous
- Bins will be replaced with white bins soon
- Empty vials, syringes and containers do NOT need to go in here. (unless rare special case of hazardous drug)
Hazardous Drugs in the OR

AFCH OR: New Monthly Dispenses
- Non-Hazardous (NEW): 99%
- Hazardous (NEW): 1%

UWH OR: New Monthly Dispenses
- Non-Hazardous (NEW): 100%
- Hazardous (NEW): 0%

TAC OR: New Monthly Dispenses
- Non-Hazardous (NEW): 100%
- Hazardous (NEW): 0%

UWH Carbone: New Monthly Dispenses
- Non-Hazardous (NEW): 70%
- Hazardous (NEW): 30%
### One month’s administrations IP and OSC

<table>
<thead>
<tr>
<th>Row Labels</th>
<th>Sum of Total Hazardous (NEW)</th>
<th>Sum of High (NEW)</th>
<th>Sum of Low (NEW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cidofovir</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>UWH SURG SERV - OP OR</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Fluconazole in Sodium Chloride</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>UWH SURG SERV - IP OR</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Levonorgestrel</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>UWH SURG SERV - IP OR</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>UWH SURG SERV - OP OR</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mitomycin</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>UWH SURG SERV - IP OR</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>UWH SURG SERV - OP OR</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mycophenolate Mofetil HCl</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>UWH SURG SERV - IP OR</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Mycophenolate Sodium</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>UWH SURG SERV - IP OR</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Tacrolimus</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>UWH SURG SERV - IP OR</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>33</strong></td>
<td><strong>16</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

- Very infrequent administration
- EMPTY CONTAINERS of ONLY THESE FEW go into black bins
- Will be labelled with orange sticker by pharmacy
Pharmaceutical Incineration = more emissions
White Bins: nonhazardous drugs (MSC, TSC and TAC)

- *Empty* bottles and tubing go into the trash
- Residual of 1% is considered empty
- Safety first
Red Bins: Sharps and biohazard

- Needles
- Blood
- Drippable/pourable material
- Shards of glass
Where do these EMPTY containers go?

LANDFILL
Where do these EMPTY containers go?
Where do these EMPTY items go?

SHARPS BIN

LANDFILL
Where do these go?
Vial cap collection

- 352 lbs
- 20 cubic feet
- Recycled into stacking bins, tools, toys...
Vial cap collection
Anesthesia Gas Emissions

• Halogenated compounds
  Comparative GWP* to CO₂ (by definition = 1)
  130 (sevoflurane)
  510 (isoflurane)
  2540 (desflurane)

• Nitrous oxide
  300 times the GWP of CO₂
  Atmospheric life time of 114 years

• Consider flow reduction, gas choice

Sulbaek Andersen et al., Aneth Analg 2012 May;114(5): 1081-5.
ORGANIC CHEMISTRY
fluoromethyl hexafluoroisopropyl ether

Sevoflurane
Halogenated hydrocarbon
Related compounds include

DDT
Chlorinated hydrocarbons

Freon 113a
Chlorofluorocarbons

2,4-D
No worker should be exposed to concentrations of WAGs > 2 parts per million (ppm) of any halogenated anesthetic agent, based on the weight of the agent collected for a 45-liter air sample by charcoal adsorption over a sampling period not to exceed one hour.
How much gas are you breathing?
Gas choice and Flow reduction
QRC smart link

anesthesia.wisc.edu
CO₂ Emissions Reduction

2011
- Isoflurane: 1%
- Sevoflurane: 2%
- Desflurane: 78%
- N₂O: 19%
- 91.67 kg CO₂/case

2015
- Isoflurane: 2%
- Sevoflurane: 5%
- Desflurane: 63%
- N₂O: 30%
- 56.32 kg CO₂/case

38% reduction

4,140,291.28 kg less CO₂ annually

875 cars off the road for 1 year

According to the EPA Greenhouse Gas Equivalencies Calculator

One hour of anesthetic like driving a car...miles

(EPA 2012 USA fuel efficiency average, 23.9 mpg)

<table>
<thead>
<tr>
<th>Flow Rate</th>
<th>Sevoflurane 2.2%</th>
<th>Isoflurane 1.2%</th>
<th>Desflurane 6.7%</th>
<th>N₂O* 0.6-MAC-hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 L/min</td>
<td>XXXX</td>
<td>4</td>
<td>93</td>
<td>29</td>
</tr>
<tr>
<td>1.0 L/min</td>
<td>4</td>
<td>7</td>
<td>189</td>
<td>57</td>
</tr>
<tr>
<td>2.0 L/min</td>
<td>8</td>
<td>15</td>
<td>378</td>
<td>112</td>
</tr>
<tr>
<td>5.0 L/min</td>
<td>19</td>
<td>38</td>
<td>939</td>
<td>282</td>
</tr>
<tr>
<td>10.0 L/min</td>
<td>38</td>
<td>74</td>
<td>1,876</td>
<td>564</td>
</tr>
</tbody>
</table>

Courtesy J. Sherman
### Emissions Calculators

#### Inputs

- **Sevoflurane % (Scroll to the Bottom for Live Results):**
  - 0%
- **Isoflurane %:**
  - 1.6%
- **Desflurane %:**
  - 0%
- **Halothane %:**
  - 0%
- **Nitrous Oxide Flow (L/min):**
  - 0 L/min
- **Oxygen Flow (L/min):**
  - 0.6 L/min
- **Air Flow (L/min):**
  - 0.6 L/min

#### Outputs

- **Carbon Dioxide Equivalent (Kg of CO2 Prod):**
  - 4.506278
- **Driving Equivalent (Miles Driven per Hour - relative order of magnitude and not degree):**
  - 10.964181
- **Driving Equivalent (Kilometers Driven per Hour - relative order of magnitude and not degree):**
  - 17.671680
- **Approximate Cost of All Anesthetics (from Nitrous Oxide and Oxygen (from e-cylinders purchased):**
  - U.S. $1.63

Enter Your Own Drug Prices in Our Cost Calculator below):

https://jcalc.io/calc/do4SOJVRzXM
Simple Steps

▪ Don't open supplies unnecessarily
▪ Favor reusable items if possible
▪ Don't open a pulse ox sticker
▪ Pause gas flows, use lower flows
▪ Drive less
▪ Bring your own spoon and cup

it adds up and matters
Small Steps Over Time
Long Term Results