

Environmental Impact of Medical Ultrasound Use

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Introduction

We aim to investigate scope 2 and 3 emissions related to ultrasound use in our department and identify ways to reduce our environmental impact

Scope 1 (Direct)

- Fuel used on-site
- Volatile anesthetics

Scope 2 (Purchased electricity)

- Emissions at power plant

Scope 3 (Everything else)

- Manufacturing
- Use
- Disposal

Methods

- Measured electrical output, battery characteristics, and screen power settings for our ultrasound machines
- Computed theoretical electricity use and carbon emissions¹.**
- Battery degradation, and its downstream environmental impact, was also evaluated in theoretical use scenarios.
- IRB/IND approval not required for quality improvement project.

Abbreviations: CO2e, carbon emissions

References

1: United States, Energy Information Administration. State Electricity Profiles. U.S. Energy Information Administration, 2022, https://www.eia.gov/electricity/state/unitedstates/state_tables.php. Accessed December 7th, 2023.

2: Barcellona, S., and L. Piegari. "Effect of current on cycle aging of lithium-ion batteries." Journal of Energy Storage 29 (2020): 101310.

3: Winslow, Kevin M., Steven J. Laux, and Timothy G. Townsend. "A review on the growing concern and potential management strategies of waste lithium-ion batteries." Resources, Conservation and Recycling.129 (2018): 263-277

Results: Scope 2

- 10.8V & 5200-5800 mAh Li-ion batteries
 - Maximum power use: **75 watts**
 - Use AC power when connected to a wall source
- Use pattern
 - Brief active periods & prolonged standby time
- Sleep mode (decreased power use) & auto-off engage automatically after adjustable periods
 - Default set to maximum intervals
- Two hours of downtime per day** calculate to lead to:
 - 54 kWh** wasted
 - >21kg CO2e¹** per year

Results: Scope 3

- Battery lifespan: 300-700 cycles** depending on use pattern & Li-ion composition
- Li-ion degradation** is due to increased **cycle counts**, abnormal **state of charge**, and abnormal **temperature**³⁻²
- Non-productive ultrasound battery time contributes significantly to cycle counts
 - 2h non-productive time = one wasted battery cycle**
- Battery degradation is compounded by draining to near-minimal state of charge
- Wasted battery cycles → premature battery replacement
 - Financial impact:** several hundred dollars per battery

Discussion

- Waste can be limited by:
 - Limiting non-productive “on” time: turn on right before use, turn off at end of use
 - Adjusting sleep & auto-off intervals to minimum settings
- Early battery replacement leads to **unnecessary scope 3 emissions.**
 - Beyond carbon emissions:** landfill waste, heavy metals leeching into groundwater²⁻³
- Calculated electricity emissions are a minor contributor

Figure 1: Fishbone Diagram

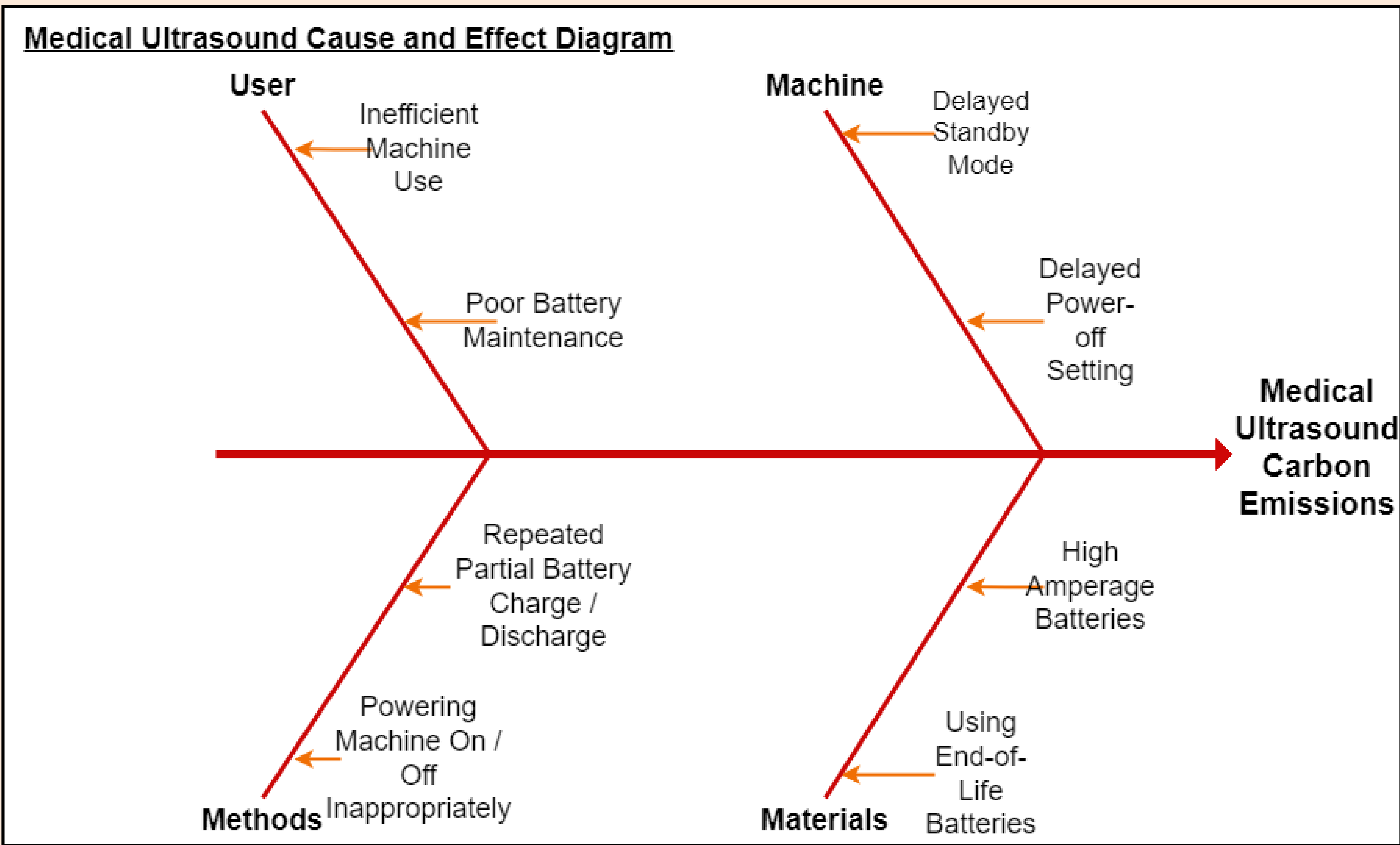


Figure 2: Hypothetical Battery Cycle Waste

Greatest impact: extending battery life to prevent premature disposal & replacement of Li-ion batteries.

