

# Waste Audit of Robotic Gynecologic Surgery

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## INTRODUCTION

Climate change is a critical modern global issue that will require engagement from all major industrial sectors to address. The healthcare sector is a significant contributor to climate change worldwide, and is responsible for 4.4% of global net emissions.<sup>1</sup>

Almost three-quarters of healthcare emissions come from the production, transport, and disposal of supplies and services.<sup>1</sup> Hospitals generate 3.4 billion pounds of waste annually, with operating rooms responsible for around one-third of this waste.<sup>2</sup>

There is increasing use of robotic gynecologic surgical techniques, which have been demonstrated to produce more waste than other techniques (open, vaginal, or laparoscopic).<sup>3</sup> There is a need for improved quantification and awareness of the environmental impact of robotic operative waste as well as strategies to reduce the impact

TABLE 1: SUMMARY OF AUDITS AND EMISSIONS

	Hysterectomy	Fallopian Tube, Ovarian, or Endometriosis Surgery	Myomectomy	All Cases
<b>Number of Cases Audited</b>	10	4	6	20
<b>Total waste (kg); kg CO<sub>2</sub>E<sup>†</sup></b>	200.32; 93.97	66.20; 80.52	110.18; 87.72	376.69; 89.40
<b>Average MSW<sup>*</sup> waste (kg); kg CO<sub>2</sub>E from MSW processing</b>	19.36; 13.70	16.24; 11.68	18.09; 13.08	18.35; 13.11
<b>Average RMW<sup>^</sup> waste (kg); kg CO<sub>2</sub>E from RMW processing</b>	0.68; 2.60	0.31; 0.81	0.28; 1.27	0.48; 1.84
<b>SMS polypropylene waste (kg); kg CO<sub>2</sub>E</b>	5.05; 25.01	4.10; 20.35	4.68; 23.25	4.75; 23.55
<b>Average Hard Plastic waste (kg); kg CO<sub>2</sub>E</b>	1.59; 5.46	1.28; 4.39	1.44; 4.94	1.48; 5.09
<b>Average Recyclables waste (kg)</b>	0.66	0.53	0.60	0.61
<b>Average Soft Plastic waste (kg); kg CO<sub>2</sub>E</b>	3.28; 8.46	2.36; 8.95	2.65; 7.76	2.91; 8.35
<b>Average Cotton waste (kg); kg CO<sub>2</sub>E</b>	0.99; 17.39	0.68; 15.75	1.01; 17.67	0.93; 17.14
<b>Average Gloves waste (kg); kg CO<sub>2</sub>E</b>	0.83; 5.04	0.39; 2.99	0.76; 4.42	0.72; 4.44
<b>Average Unused Items waste (kg)</b>	1.18	1.32	0.82	1.10
<b>Average No. Reprocessable Items</b>	2.80	1.25	4.33	2.95
<b>Average No. AA Batteries</b>	11.90	13.00	11.00	11.85

\*MSW=municipal solid waste; ^RMW=regulated medical waste, †CO<sub>2</sub>E= CO<sub>2</sub> emissions

## METHODS

**Case Location:** an urban tertiary care center that performs ~6341 procedures per year, of which 3135 are robotic hysterectomies

**Waste Audits:** detailed waste audits were conducted in February 2022 to quantify and characterize the materials disposed via municipal solid waste (MSW) and regulated medical waste (RMW)

**Included cases:**

- 10 Hysterectomies
- 6 Myomectomies
- 4 Tubal, Ovarian, or Endometriosis Surgeries

**Life Cycle Assessments (LCIs):** waste data were used to quantify the environmental impact of production and disposal of materials and products used during each case. This was conducted using OpenLCA (v. 1.11.0) and Ecoinvent (v. 3.7.1).

FIGURE 1: AVERAGE WASTE COMPOSITION BY PROCEDURE

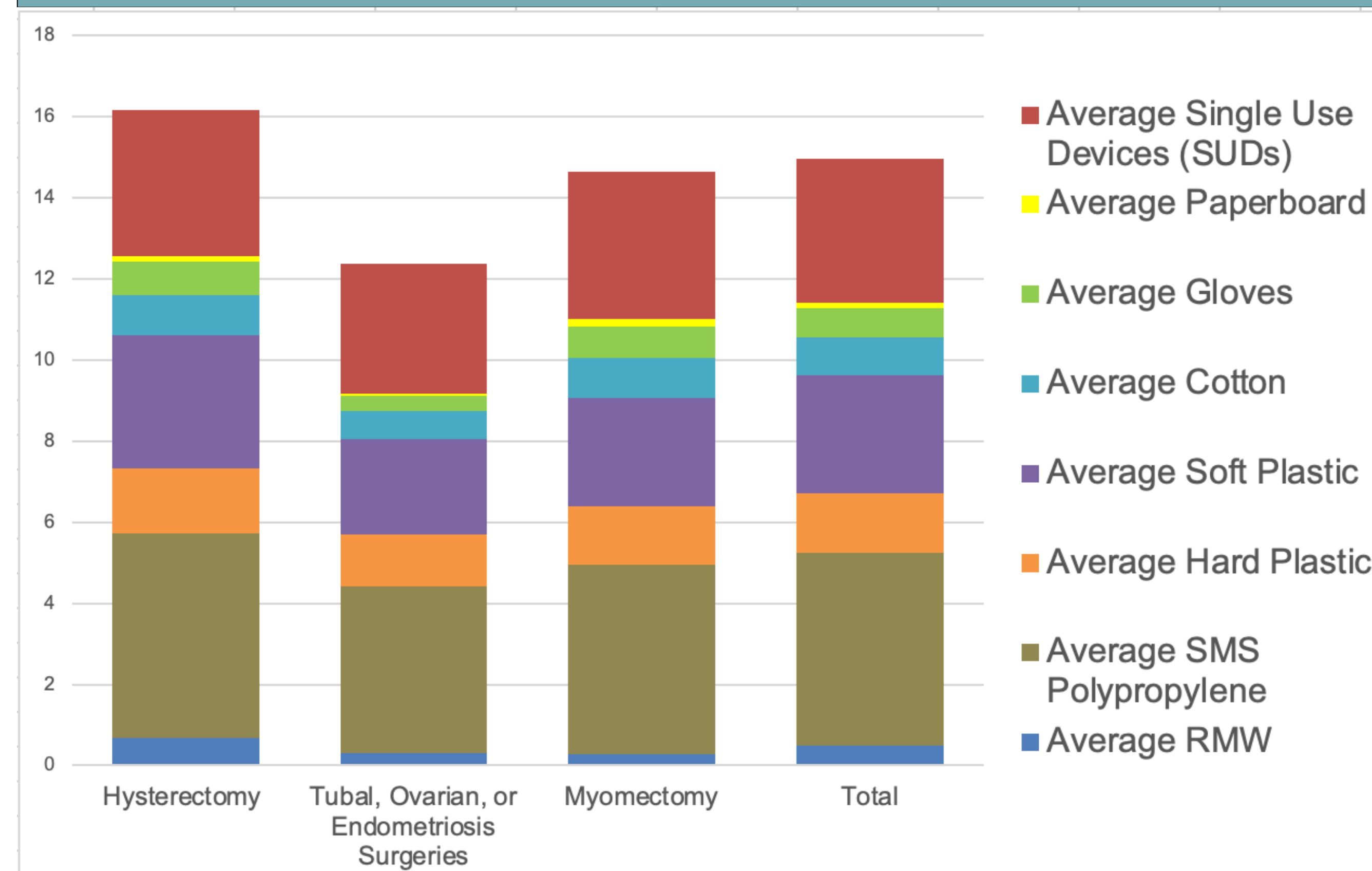
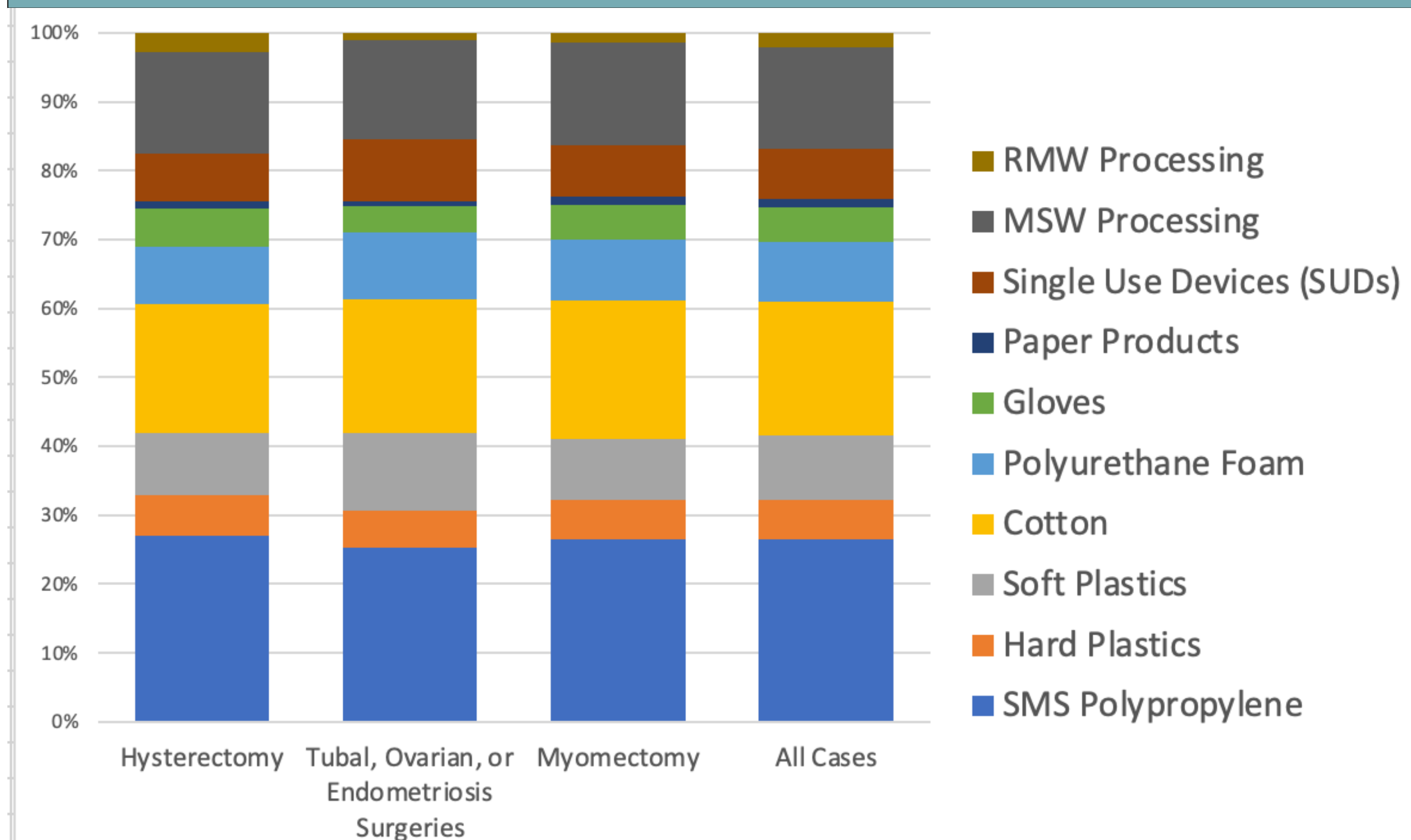


FIGURE 2: PERCENT CONTRIBUTION to CO<sub>2</sub> EMISSIONS



## RESULTS

### Audit Results

- Total waste during audit period: 367.02 kg MSW and 9.68 kg RMW
  - Per case waste: 18.35 kg MSW and 0.48 kg RMW
  - Projected 60.69 metric tons of MSW produced annually from robotic hysterectomies alone
- The largest contributor of waste by category was SMS propylene products, the primary material found in surgical gowns and drapes
- An average of 7 single-use surgical devices (SUDs) was used per case that are not currently eligible for reprocessing
- An average of 0.61 kg of recyclable plastics and 11.85 batteries per case were thrown away as MSW
- An average of 1.10 kg of waste per case were unused items
  - Most common: surgical gowns, towels, gauze, gloves, suction tubing, specimen cups
- No waste found in the RMW met criteria for biohazard waste

### LCIA Results

- An average of 89.04 kg of CO<sub>2</sub> emissions (CO<sub>2</sub>e) were produced per case
  - 0.64 kg CO<sub>2</sub>e per minute of operative time
- Hysterectomies produced the most emissions by case type
- Tubal, Ovarian, or Endometriosis Surgeries produced the most emissions per minute of operative time
- The largest contributor of CO<sub>2</sub>e by category was SMS propylene product (average 23.55 kg CO<sub>2</sub>e per case)
- The largest contributor of CO<sub>2</sub>e per kg of material was cotton (17.56 kg CO<sub>2</sub>e per kg cotton textile)
- The misuse of RMW waste streams results in an additional 1.67 kg CO<sub>2</sub>e per kg of waste produced

## CONCLUSIONS

Reduce Greenhouse Gas Emissions in robotic surgeries by:

- Reorganization of pre-prepared surgical kits to avoid unnecessarily opening items that are commonly unused
- Expanding the catalog of SUDs that are eligible for reprocessing
- Increasing recycling of recyclable plastic and paper product
- Improved waste sorting into regulated medical waste streams

Further research is needed to:

- Quantify the emissions reduction of replacing SMS propylene products with reusable gowns and drapes
- Identify more environmentally friendly alternatives to cotton surgical supplies

## REFERENCES

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