Operating Room HVAC Waste Reduction

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Introduction

The American healthcare sector is responsible for an estimated 8-10% of U.S. CO_2 production. Per square foot, hospitals consume twice the energy as office buildings; furthermore, North American hospitals use twice as much energy as those in Europe.

There is continuous wasteful energy use in the perioperative setting of the Moffitt-Long (ML) ORs – UCSF's largest surgical facility with 28 ORs (26 functioning ORs, 2 under construction) – as lighting, machines, and heating, ventilation, & air conditioning (HVAC) are left on during periods of non-use, namely during nights, weekends, and holidays.

During a typical week from Monday through Friday most, if not all, ML ORs are in use between 7am and 7pm; OR usage decreases throughout the day particularly after 7pm. Most of the time there are at most two occupied ML ORs by 11pm (only emergency cases are performed after 11pm), yet no changes are made in perioperative energy use, including HVAC.

Few ORs are used throughout the night, and similarly on weekends and holidays. Assuming 6 ORs are used on a given weekend day, more than 75% (20/26) of perioperative energy is not used meaningfully (i.e., wasteful energy consumption) – this means there is large potential for energy and cost savings.

Project Goals

Focusing on the 26 ML ORs at UCSF, the goal for this project was to identify opportunities to eliminate energy waste reduction, focusing on HVAC, while keeping OR maintenance within national guidelines. The project was divided into three phases:

- **Identify the scope of problem:** quantify unused OR time, and define opportunities to improve energy efficiency in terms of HVAC.
- **Work with clinical engineering and facilities management** to understand OR HVAC infrastructure and determine which ORs on which to focus for data collection
- **Analyze data for energy and cost savings:** Energy consumption can be determined in terms of kilowatt-hours (kWh) and cubic feet per minute (CFM) of refrigerated air. Reductions in kWh and CFM can be tracked and translated into cost savings.

Materials & Methods

Identify the scope of problem: Collected data from the UCSF OR case manager to identify what percentage of ORs were used between different time intervals (e.g., 7am-11pm, 7am-7pm, 7pm-11pm, 11pm-7am)

Work with clinical engineering and facilities management: Met with facility directors to understand HVAC layout for the ML ORs, and subsequently identified five pilot ORs from which to collect baseline temperature data, two temperature loggers per OR

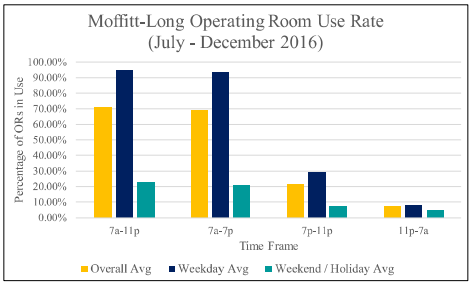
Analyze data for energy and cost savings: Projected energy and cost savings based on similar OR HVAC "setback" projects

Results and Outcomes

Scope of the Problem:

	% ML ORs in use			
	7a-11p	7a-7p	7p-11p	11p-7a
Overall Avg	70.76%	69.40%	21.71%	7.17%
Weekday Avg	94.44%	93.53%	28.95%	8.19%
Weekend / Holiday Avg	23.01%	20.74%	7.12%	5.11%

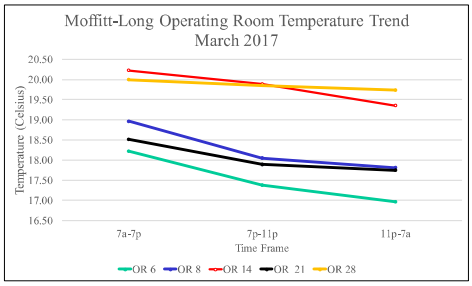
Table 1. Six month aggregate ML OR usage, July-Dec 2016



- A decreasing number of ORs are used throughout a given 24 hours span beginning at 7am (i.e., fewer ORs are used during the evening and night)
- An even smaller percentage of ORs is used on weekends and holidays

	Average OR Temp (Celsius)				
	All Times	7a-11p	7a-7p	7p-11p	11p-7a
OR 6	17.67	18.01	18.22	17.38	16.96
OR 8	18.43	18.74	18.96	18.05	17.81
OR 14	19.88	20.14	20.23	19.88	19.35
OR 21	18.16	18.36	18.51	17.89	17.74
OR 28	19.89	19.96	19.99	19.85	19.74

Table 2. ML OR temperature trends, March 2017



- OR temperatures trend downward throughout a given 24 hours span beginning at 7am
- Down-trending OR temperatures most certainly reflects decreased heat production from lights, machines, and body heat as ORs become unoccupied, but also represents wasteful air cooling during periods of non-use

Energy & Cost Savings Projections

Based on similar case reports, assume "unoccupied setback" for ML ORs yields reduction of 6,500 CFM per hour of refrigerated air flow

Assume "setback" of 8 hours per day (e.g., 11pm-7am)

- 6,500 CFM per hour * 56 hours = 364,000 CFM

Assume 300 CFM = 1 ton of refrigerated air

- 364,000 CFM = 1,213.33 ton

Given 1 ton = 3.52 kWh

- 364,000 CFM = 4,270.93 kWh

Electricity cost = $0.11/kWh

→ $469.80 weekly savings

→ $24,429 annual savings

Conclusions

- As any given work day progresses, fewer ORs are occupied: 69% occupied from 7am to 7pm, 21% from 7pm to 11pm, 7% from 11pm to 7am
- A large percentage of ORs are unoccupied on weekends and holidays, especially compared to normal weekdays: 93% occupied from 7am to 7pm vs 20% from 7am to 7pm
- Unoccupied ORs are continuously cooled, without necessity, thereby wasting energy
- There exists potential of energy and cost savings with OR HVAC "setbacks"

Future Goals

- Trend CFM and quantify anticipated reduction with HVAC "setback" (feasible at newer Mission Bay facilities) as an ongoing project with the next CNI fellow
- Determine optimal temperature for ORs when not in use
- Establish work flow to ensure HVAC "setback"
- Expand to other UCSF Medical Center sites including Mount Zion, Mission Bay, and the Orthopaedic Institute
- Expand energy reduction beyond HVAC (e.g., to electricity)

References

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- Guenther R, Vittori G. Sustainable Healthcare Architecture. 2013.
- Operating Room HVAC Unoccupied Setback Year 2 Outcomes; Quality and Energy Success (Memorial Hermann case report)

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