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Personalized indoor environment solutions for alleviating surgeon heat stress in operating rooms

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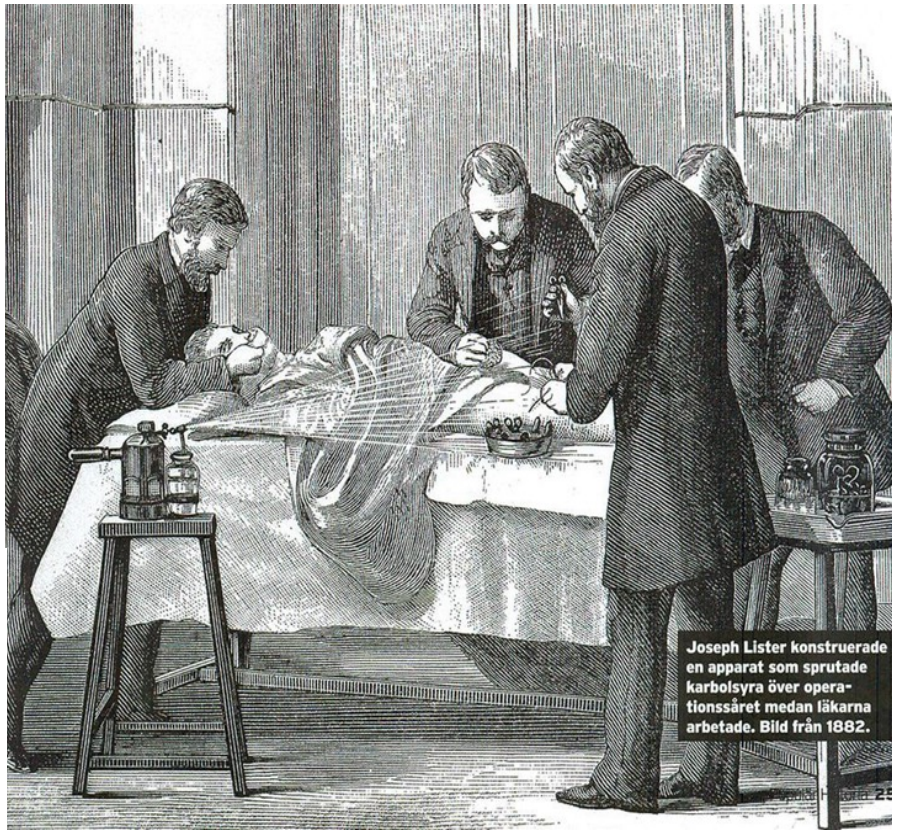
CBE, UC Berkely

Background

Why operating rooms (ORs) are important

- Over 300 million surgical procedures each year globally
  - Surgical site infection (SSI) from 2-10%
- Very high indoor air quality requirements

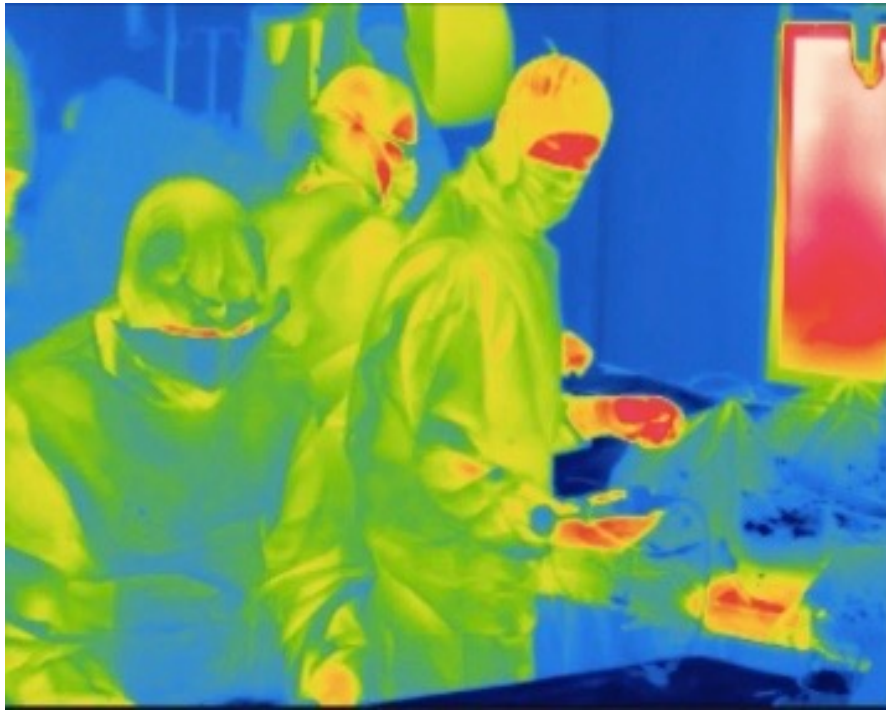


1882, Joseph Lister invented a disinfection method by spraying Phenol

Background

Why operating rooms are important

- Over 300 million surgical procedures each year globally
  - Surgical site infection (SSI) from 2-10%
- Very high indoor air quality requirements
- Many complaints from surgical staff
  - Thermal conditions are too warm for surgeons
  - About 80% of surgeons are dissatisfied with OR mixing ventilation systems



Thermal image of surgical staff in operating room

Project overview

Objective

- Develop and test new personalized indoor environment solutions which provide thermal environment for both surgical staff and patients in ORs

Method

- Simulation
- Experimental measurements

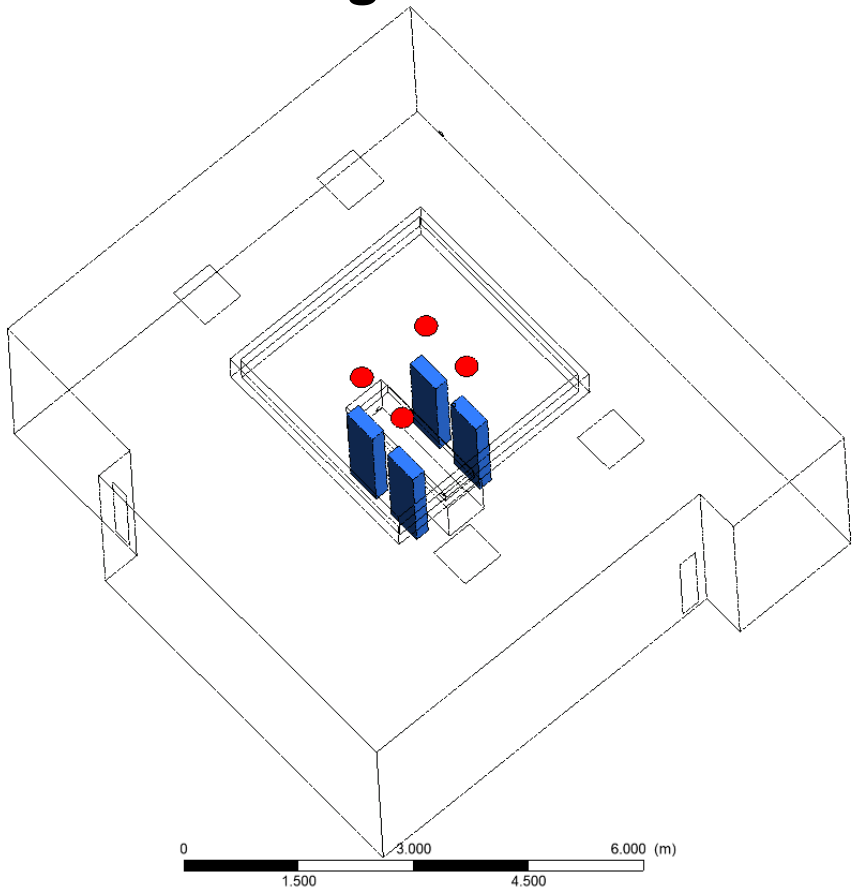
Funding

- Peder Sather Grant (2023-2025)

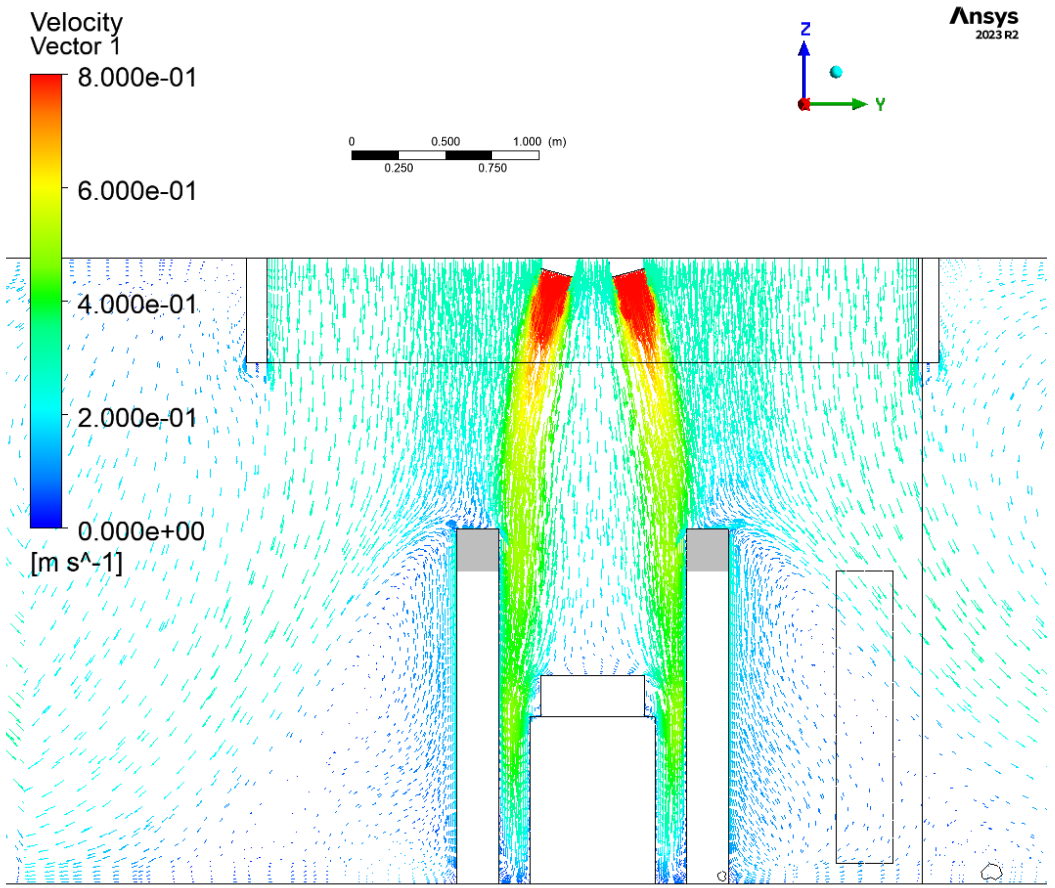
A photo of a mockup surgery at St. Olavs hospital, Norway

Preliminary simulation setups and results

Round jet integrated laminar airflow ceiling



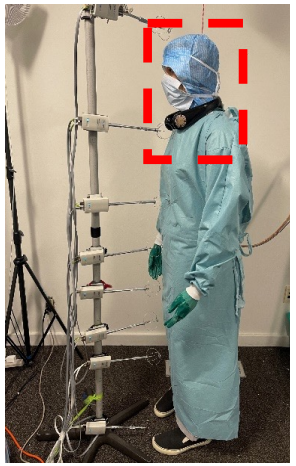
Airflow from the ceiling round jet



CFD simulation showed great potential benefits of using localized nozzle air jets to cool surgeons

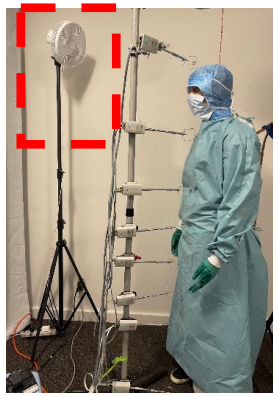
Laboratory test setup: personalized cooling solutions

Solution 1: External nozzle air jet

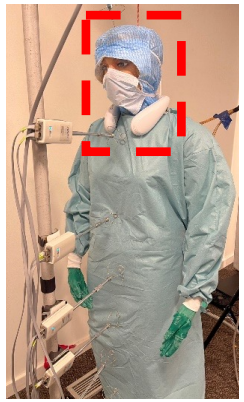


Solution 2: Neck fan with heating

Solution 3: Through back fan



Solution 4: Mixing wall fan



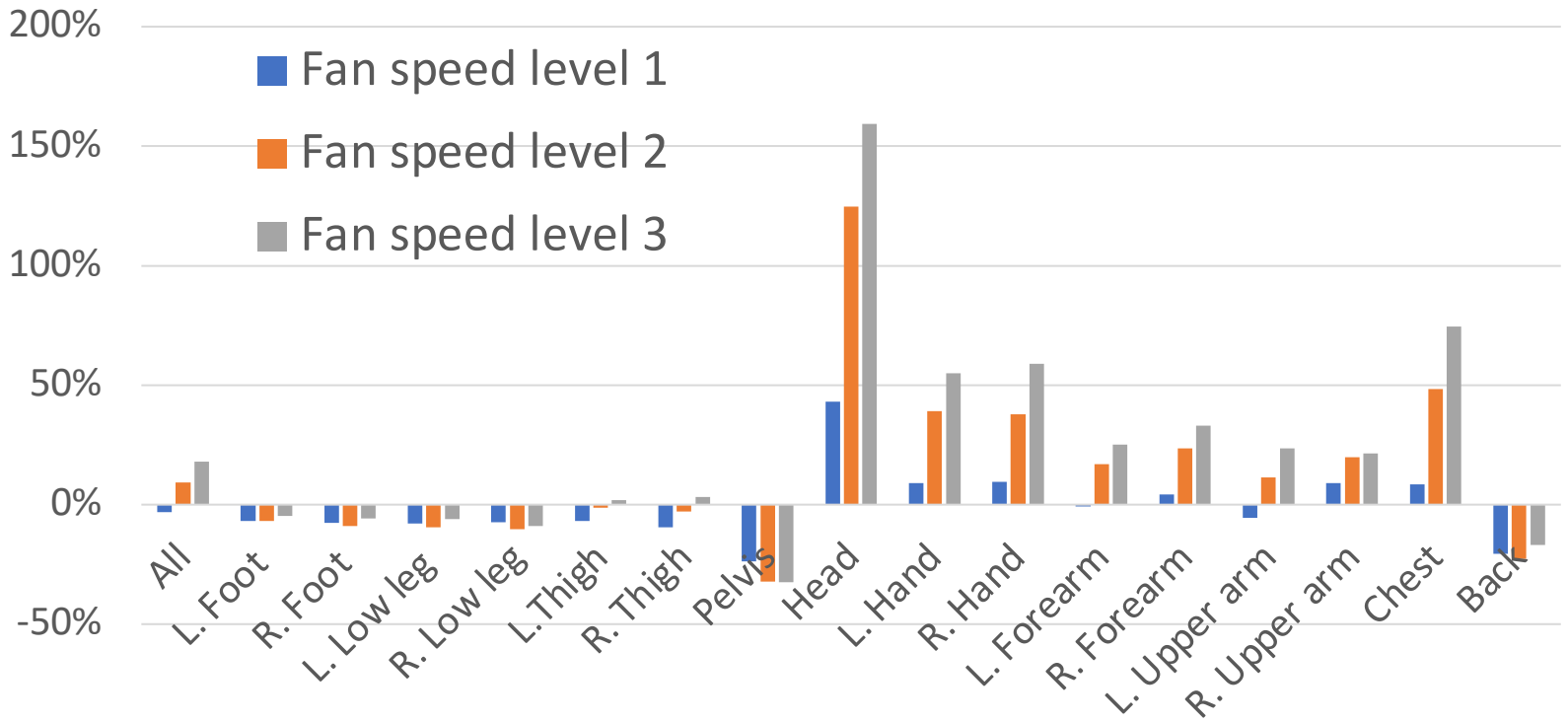
Solution 5: Neck fan

Solution 6: Within the gown wearable

Solution 1: External nozzle air jet

Relative heat losses were increased approximately:

- 160% for the head
- 75% for the chest



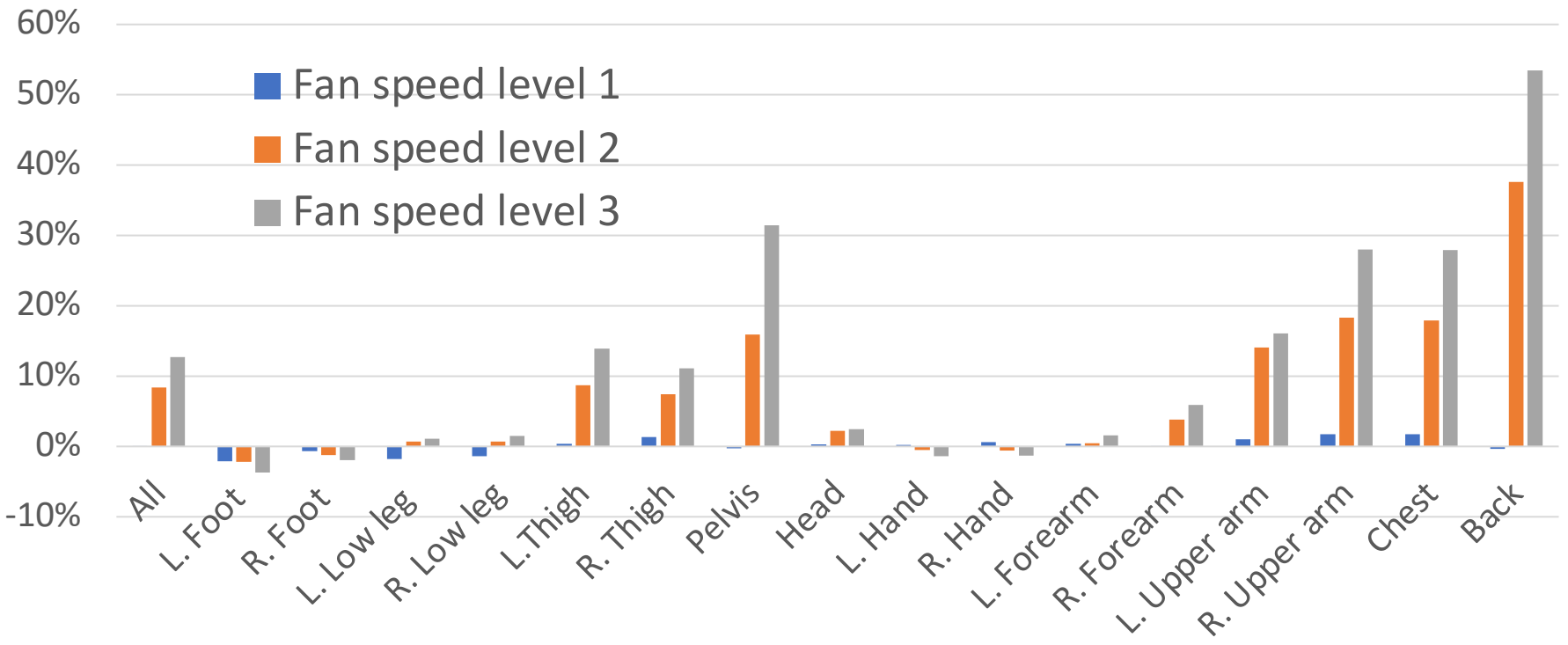
Relative heat loss of different body parts

Solution 1: External nozzle air jet

Solution 6: within the gown wearable

Relative heat losses were increased approximately:

- 55% on the back
- 30% for pelvis



Relative heat loss of different body parts

Solution 6: Within the gown wearable

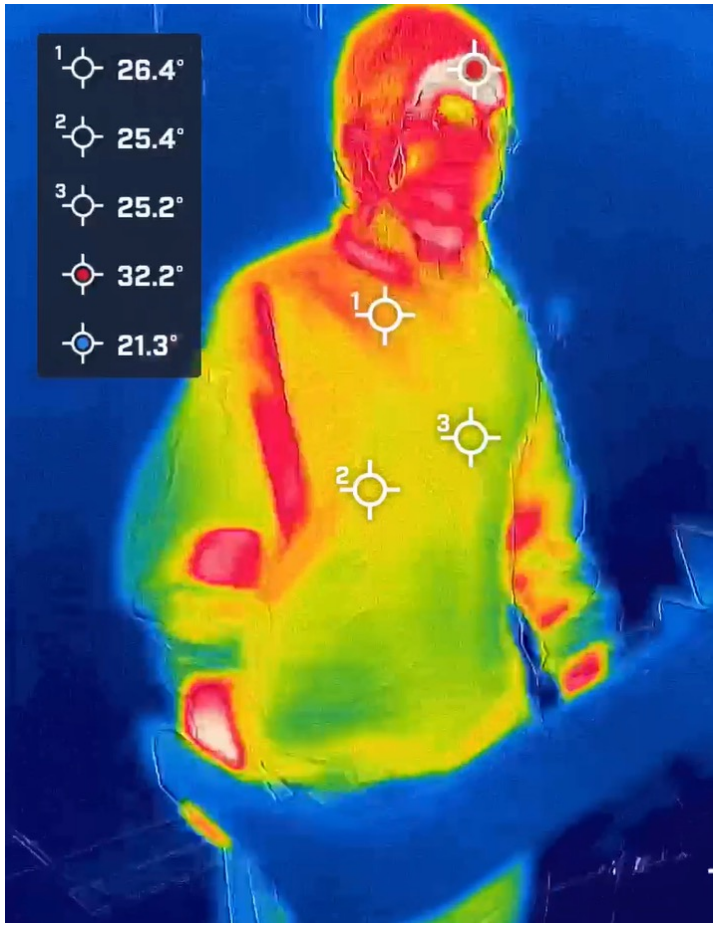
Solution 1: External nozzle air jet may increase heat losses on head and chest by 160% and 75% respectively

Solution 6: Within the gown wearable may increase heat losses on the back and the pelvis by 55% and 30% respectively

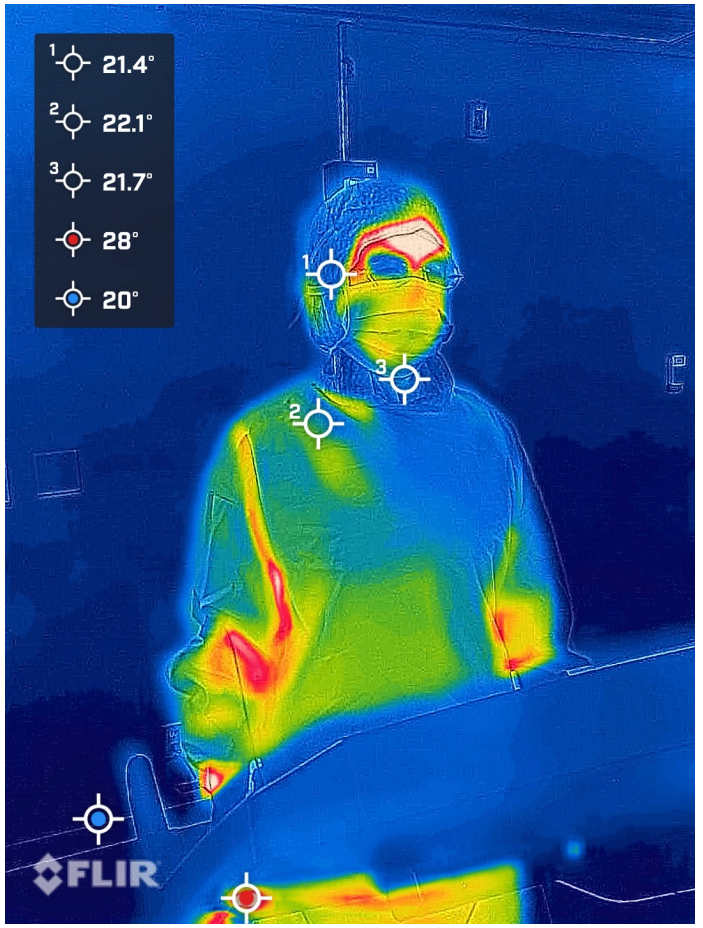
Pilot human subject tests – surface temperature (using Solution 1)

Walking 10 min, 3 km/h, 2.4 met

Thermal image during walking without air jet



Thermal image walking with an air jet



Conclusions

Local cooling solutions can increase heat loss from surgeons

- External nozzle air jet can effectively cool the upper body
- The within gown wearable on the back can cool upper body and thighs

The effect of local cooling solutions on local air quality needs further study

Future study

Air quality related issues will be studied at an OR lab at NTNU

Q&A

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Join the breakout session on 'Indoor Environmental Quality in Less-Studied Building Types'

Papers here

- ASHRAE Summer conference: Experimental evaluation of targeted cooling devices to alleviate surgeon heat stress in operating rooms