

# Lights, Airflow, Action: Unmasking Turbulence in the OR

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**PICO:** To what degree with the implementation of a surgical light designed with a laminar air cut out along with a conductive warming system, compare to a surgical light designed without a laminar air cut out along with forced air warming optimize environmental airflow in the operating room

## Background

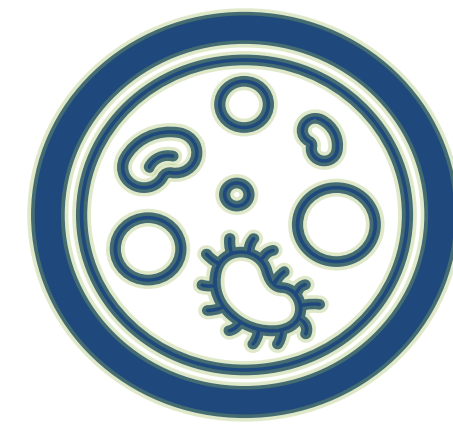
- Laminar airflow systems reduce contamination risk by directing clean, filtered air downward over the sterile field.
- Equipment design and heat sources can disrupt this intended airflow pattern.
- Surgical lights without laminar-flow cut-outs may interfere with vertical air movement.
- Forced-air warming systems can produce thermal plumes that create recirculation zones near the wound site.
- These disruptions may compromise air cleanliness and increase the potential for airborne contamination.
- Understanding how device design and warming modality influence airflow is vital for optimizing infection-prevention strategies in the perioperative environment.

## Purpose

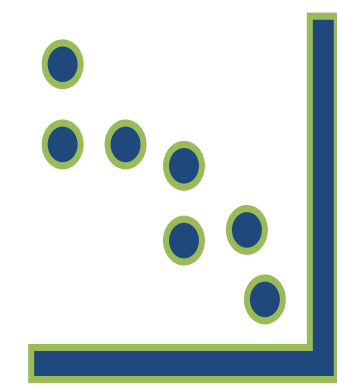
- Visualize and compare airflow behavior in a simulated operating room environment.
- Evaluate the effect of surgical light design — with versus without a laminar-airflow cut-out.
- Assess how warming methods (conductive versus forced-air) influence air movement around the sterile field.
- Provide qualitative insight into how these factors interact to support or disrupt laminar airflow integrity.

## Ventilation blockages in the OR can lead to:

Increased Contamination



Disrupted Air Patterns



Compromised Sterility



## Methods

- Design: Prospective, observational simulation study in a full-scale mock operating room.
- Model: Fully thawed human cadaver positioned supine to replicate realistic surgical conditions.
- Tracer: Surgical smoke generated by monopolar electrocautery used to visualize airflow patterns.
- Visualization: Continuous laser sheet projected across the sterile field in a darkened room illuminated smoke movement.
- Configurations Tested:
  1. Laminar-cutout light + conductive warming
  2. No - Laminar-cutout light + forced-air warming
- Data Collection: High-definition video recordings captured airflow behavior in each configuration.
- Analysis: Two independent reviewers qualitatively assessed airflow entrainment, recirculation, and clearance.
- Statistics: Descriptive only; no inferential testing performed.

Laminar Cut-Out and Conductive Warming



No Laminar Cut-Out and Forced Air Warming



## Results

**Airflow Stability:** Surgical lights with laminar-flow cut-outs maintained more coherent downward airflow patterns.  
**Smoke Clearance:** Faster plume dissipation observed with conductive warming and laminar-cutout light combinations.  
**Thermal Disruption:** Forced-air warming created visible turbulence and upward thermal plumes near the surgical site.  
**Interaction Effect:** Airflow disruption was most pronounced when forced-air warming was paired with a non-cutout light.  
**Overall Finding:** Equipment design and warming modality significantly influenced visual airflow behavior and plume dispersion.



Did You Know? The average daily surgical smoke exposure for perioperative teams had the passive effects of smoking **27 to 30** unfiltered cigarettes per day?

## Implications for Perioperative Nursing

- Equipment selection directly affects the stability of sterile-field airflow and environmental cleanliness.
- Forced-air warming systems may introduce turbulence that increases the risk of particle entrainment near the wound site.
- Conductive warming and laminar-cutout surgical lights may better preserve downward airflow.
- Perioperative leaders and engineers should include airflow performance as a criterion when specifying OR lights and warming devices.
- Further research using quantitative airflow or particle-count methods is recommended to measure the degree of impact observed qualitatively

## References

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## Keywords

Laminar airflow; surgical lighting; forced-air warming; conductive warming; operating room environment; airflow visualization; infection prevention