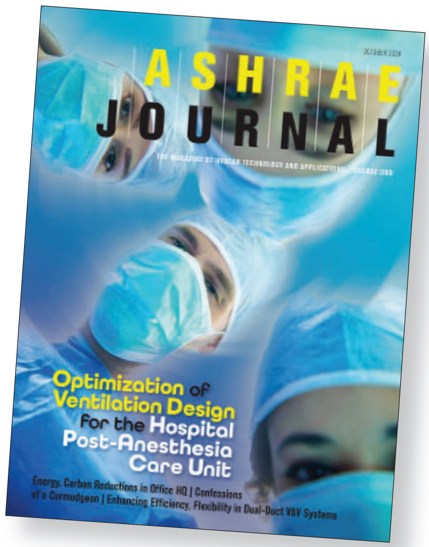
Ventilation Design in Hospital PACUs

This letter is submitted in response to the October 2024 *ASHRAE Journal* article, "Optimization of Ventilation Design for the Hospital Post-Anesthesia Care Unit," by Kishor Khankari, Ph.D., Fellow ASHRAE. The information provided was very detailed and well-presented with respect to how airflow variations can affect the distribution of airborne contaminants. However, therein lies the problem.



Rearranging doorways, furniture and air supply/return vent locations; attempting to manage indoor airflow patterns and volumes; or depending on typical filtration systems is an inefficient means of reducing hospital staff and patient exposure to hazardous airborne contaminants (i.e., germs and toxins).

Germ-laden air ducts, synthetic material off-gassing, decomposition of natural resources and industry-generated chemical emissions are all potential instigators of serious health, safety and environmental issues.

Unfortunately, most germicidal and toxic contaminants remain unaffected when speeding through filters and past UV-C lamps inside existing ventilation ducts. To effectively achieve improved indoor air quality within any building, it is necessary to destroy airborne contaminants at the source—either upon entry into or within the ventilation system.

A March 2024 *ASHRAE Journal* article, "CFD Analysis of Hydroxyl Technology to Reduce Risk of Indoor Pathogen Transmission," also written by Khankari, validated the same thought process of eliminating, rather than continually redistributing, airborne contaminants since "hydroxyl radicals" are considered nature's second most powerful cleaning agent!

Aside from achieving a healthier indoor environment, recirculating cleaner air could potentially also reduce energy costs via fewer outdoor air exchanges.

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KHANKARI RESPONDS

Dear Reinhard,

Thank you for reading my article in *ASHRAE Journal*. I am pleased to hear that you enjoyed it.

I appreciate your insights regarding the inactivation of airborne contaminants using appropriate technologies. However, it's important to note that not all airborne contaminants can be destroyed or inactivated with the current proven methods. Specifically, there are no existing technologies available for the inactivation or cleaning of waste anesthetic gases. In these cases, dilution and effective removal of the contaminants remain the only viable solutions.

Additionally, indoor airflow patterns play a crucial role in controlling the spread and effective removal of contaminants, whether or not air cleaning or inactivation devices are used. Therefore, the optimal placement of supply diffusers, return vents and air cleaners is essential for achieving effective ventilation.

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Optimizing Ventilation Design In PACUs

Thank you, Dr. Khankari, for publishing the excellent work, "Optimization of Ventilation Design for the Hospital Post-Anesthesia Care Unit" in the the October 2024 *ASHRAE Journal*. I was involved with ventilation to control nurses' exposure to waste anesthetic gases (WAGs) in the 1980s. The issue was brought to my attention by a nurse attending a short course on industrial ventilation that I taught in a suburb of Vancouver. Applying what I had learned from *Industrial Ventilation, A Manual of Recommended Practice for Design*, a publication of the ACGIH, I recommended installing an exhaust grille in the wall, just above the patient's head. The principle set out in ACGIH's *Manual* is that exhaust inlets should be placed as close as practically possible to the source of an air contaminant. Another core lesson is that ventilation should be specified as cfm per emission source. Kishor, could you translate the 4 ach in the simulation to cfm per bed (or patient)?

This same principle should be applied in labor/delivery rooms where nitrous oxide is offered to ease labor pains.

I learned that anesthetic gases pass through the lungs to the blood and are likely stored in other body tissues. The longer a patient inhales gas, the more gas is stored in the body, and the longer it takes to be cleared.

Some years later I became aware of a local exhaust system for anesthetic gases that brings the exhaust inlet within 2 in. of the patient's nose and mouth, for very efficient control.

I suggest that all ventilation engineers designing systems for hospitals, trades training facilities and similar buildings where a work process generates harmful air contaminants refer to *Industrial Ventilation: A Manual of Recommended Practice for Design* from ACGIH.

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KHANKARI RESPONDS

Thank you for your kind words. I am pleased to see that the recommendation from the ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Design* is supported by the computational fluid dynamics (CFD) analysis. The supply airflow rate of 2,723 cfm (6 ach) translates to 272 cfm per bed or 209 cfm per person. In addition to the 10 patients, there are three nurses in the post-anesthesia care unit (PACU) CFD model.

As the article explains, the optimized ventilation layout is also effective at a reduced airflow rate of 1,800 cfm (4 ach), which corresponds to 180 cfm per bed or 138 cfm per person. The airflow patterns play an important role in controlling the spread of contaminants rather than the flow rate of supply air.

There are devices designed to extract WAGs from near the patient's mouth. However, these devices can be uncomfortable when inserted into the patient's throat and may interfere with care. Nonetheless, the capturing efficiency of these devices when positioned close to the patient's face is an important consideration.

I agree that such optimized HVAC layouts should be evaluated for all health-care facilities, including patient rooms and isolation rooms.

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