Humidity Control Events in Perioperative Care Areas

Developed by

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Introduction

This white paper provides a protocol for perioperative care areas when mechanical systems are unable to maintain relative humidity (RH) within the desired range that has been established by the facility for their specific operations. For the purpose of this paper, a humidity control event occurs when the RH is above or below the established facility RH range.

At certain conditions, the RH in an operating room will drift outside the established facility RH range. This paper suggests protocols to follow in those situations, which are best agreed upon in advance to avoid the need for decision making during stressful situations. Primary consideration must be for the safety of patients.

Development of Established Facility RH Range

The facility should designate a Perioperative Decision Team (PD Team) to periodically review the specifics of their perioperative case types, mechanical system capabilities, existing codes and standards, infection control statistics, and recent research and trends in indoor RH levels. A PD Team typically includes the facility's management, operations management, and infection control personnel. As a suggested minimum, the PD Team should include a facility engineer, an infection control professional, and a perioperative professional. Once the PD Team is assembled, consideration should be given to the conditions and protocols when the space is occupied and when the space is unoccupied. This information is then used to determine both an upper and a lower RH limit for the space. These upper and lower RH limits—the established facility RH range—should be documented, and the actual RH values should be monitored and recorded. A facility may have a clinical reason to occasionally adjust the temperature in the space, resulting in the RH being outside of the established facility RH range; this is not considered a humidity control event for the purpose of this paper.

ANSI/ASHRAE/ASHE Standard 170-2017, *Ventilation of Health Care Facilities* (ASHRAE 2017), which is a minimum design standard, defines the minimum RH level for an operating room as 20% and the maximum RH level for an operating room as 60%. The ranges for low, medium, and high RH and temperature as referred to in the literature vary and do not have scientifically determined demarcations (Memarzadeh 2011). Thus, neither the 60% upper RH limit nor the 20% lower RH limit are strictly defined boundaries. The optimal RH range in healthcare settings is an area of active research. A facility may decide to narrow this range for health, safety, or operational benefits and document their rationale for future reference. See the References and Bibliography section for sources with additional information regarding the impact of RH on health.

Operating Protocols during Humidity Control Events

The designated PD Team should be available to respond to humidity control events and assesses the following:

- Severity and consistency of the RH deviation
- Infection risk to patients of the scheduled procedures
- Level of clinical staff, patient, and support family members' comfort
- Confidence of the facility engineer in a timely resolution
- Occupied or unoccupied status of the perioperative space

The facility engineer should report the RH values of the rooms in question and the status of sensor calibration (e.g., "RH has been lower than 35% in 80% of our readings in the last 2 hours. RH sensor has been calibrated to x accuracy in last 1 year."). Hourly, minute-by-minute, temperature, and pressure data are not required.

Infection Risks Associated with Humidity Control Events

Infection risks associated with low and high RH are covered in the literature and are an area of active research. In recent years, more research has been published regarding the risks of having the RH

below 40% which creates a tighter RH range than the minimum level of 20% currently required by ASHRAE/ASHE Standard 170. The facility is encouraged to evaluate these infection risks in determining the established facility RH range.

Areas of infection risk that are associated with low or high RH for the PD Team to consider include the following:

- Development of mold and mildew in high-RH air (water in gas form cannot be utilized by fungi unless the RH is over 85%)
- Loss of healthy immune system functioning (respiratory epithelium, skin, etc.) in vulnerable patients and in on-site hospital staff
- Shelf life and integrity of sterile supplies and equipment calibration
- Transmission of airborne and droplet diseases
- Survival rate of pathogens
- Decreased effectiveness of hand hygiene and surface cleaning because of surface recontamination
- Discomfort of the surgical team

Possible Responses to Humidity Control Events

When the upper RH limit is exceeded, there are two responses for the PD Team to take:

1. If the RH is up to 5% above the upper RH limit for over 6 hours, the facility engineer should take corrective action and adjust the mechanical system to bring the RH down. The PD Team should convene if the RH is out of range for more than 12 hours. If the RH is up to 5% above the upper RH limit for more than 24 hours, the PD Team should consider halting operations for repairs. Traffic limiting, enhanced cleaning between cases, and perspiration controls may be added at the discretion of the PD Team.
2. If the RH is more than 5% above the upper RH limit for over 2 hours, the facility engineer should take corrective action and convene the PD Team. If the RH is more than 10% above the upper RH limit for more than 8 hours, it is very likely that the mechanical system needs repair. The PD Team should consider halting operations until the issue is resolved. Traffic limiting, enhanced cleaning between cases, and perspiration controls should be added where appropriate.

When the lower RH limit is exceeded, there are two responses for the PD Team to take:

1. If the RH is up to 5% below the lower RH limit for over 6 hours, the facility engineer should take corrective action and adjust the mechanical system to bring the RH up. The PD Team should convene if the RH is out of range for more than 12 hours. If the RH is up to 5% below the lower RH limit for more than 24 hours, the PD Team should consider halting operations for repairs.
2. If the RH is more than 5% below the lower RH limit for more than 2 hours, the facility engineer should take corrective action and convene the PD Team. If the RH is more than 5% below the lower RH limit for more than 8 hours, it is very likely that the mechanical system needs repair. The PD Team should consider halting operations until the issue is resolved.

References and Bibliography

AORN. 2019. *Guidelines for perioperative practice*. AORN Guideline 73-104. Denver, CO: AORN, Inc.

ASHE. 2010. *Briefing for CMS on reduction of low-level humidity in short-term patient care areas*. Chicago: American Society of Healthcare Engineering. www.ashe.org/advocacy/research/pdfs/briefing_cms_humidity-04-19-2011.pdf.

ASHRAE. 2010. Addendum d to Standard 170-2008. Atlanta: ASHRAE.

ASHRAE. 2017. ANSI/ASHRAE/ASHE Standard 170-2017, *Ventilation of health care facilities*. Atlanta: ASHRAE.

AST. 2017. *Guidelines for best practices for humidity in the operating room*. Littleton, CO: Association of Surgical Technologists. www.ast.org/uploadedFiles/Main_Site/Content/About_Us/AST GuidelinesHumidityintheOR.pdf.

CMS. 2013. *Relative humidity (RH): Waiver of Life Safety Code (LSC) anesthetizing location*. Baltimore, MD: Centers for Medicare and Medicaid Services.

Derby, M.M., M. Hamehkasi, S. Eckels, G.M. Hwang, B. Jones, R. Maghirang, and D. Shulan. 2017. Update of the scientific evidence for specifying lower limit relative humidity levels for comfort, health, and indoor environmental quality in occupied spaces. ASHRAE RP-1630. http://dx.doi.org/10.1080/23744731.2016.1206430.

Martinez, M. 2018. The calendar of epidemics: Seasonal cycles of infectious diseases. *PLOS Pathogens*. https://doi.org/10.1371/journal.ppat.1007327.

Memarzadeh, F. 2012. Literature review of the effect of temperature and humidity on viruses. *ASHRAE Transactions* 118(1):1049–60.

Metz, J., and A. Finn. 2015. Influenza and humidity, why a bit more damp may be good for you! *J Infection* 71:554–58.

Nakamura, K., R. Brown, D. Araujo, S. Narayanan, and D. Arnold. 2014. Correlation between brain volume change and T2 relaxation time induced by dehydration and rehydration, Implications for monitoring atrophy in clinical studies. *Neuroimage*, Clinical 6, pp. 166–70.

Reiman, J.M., B. Das, G.M. Sindberg, M.D. Urban, M.E.M. Hammerlund, H.B. Lee, K.M. Spring, J. Lyman-Gingerich, A.R. Generous, T.H. Koep, K. Ewing, P. Lilja, F.T. Enders, S.C. Ekker, W.C. Huskins, H.J. Fadel, and C. Pierret. 2018. Humidity as a non-pharmaceutical intervention for Influenza A. *PLoS ONE* 13(9):e0204337. https://doi.org/10.1371/journal.pone.0204337.

Richet, H. 2012. Seasonality in gram-negative and healthcare-associated infections. *Clinical Microbiology and Infection*. 18:934–40.

Sfera, A., M. Cummings, and C. Osorio. 2016. Dehydration and cognition in geriatrics: A hydromolecular hypothesis. *Frontiers in Molecular Bioscience* 3:18.

Tang, J. 2009. The effect of environmental parameters on the survival of airborne infectious agents. *J.R. Soc. Interface* 6:S737–S746.

Taylor, S., and W. Hugentobler. 2016. Is low indoor humidity a driver for healthcare-associated infections? *Indoor Air*, Paper 340: Session 98. www.isiaq.org/docs/Papers/Paper340.pdf.

Thiele, R.H., J.L. Huffmyer, and E.C. Nemergut. 2008. The "six sigma approach" to the operating room environment and infection. *Best Practice & Research Clinical Anesthesiology* 22(3):537–52.

Wan, G.-H., F.-F. Chung, and C.-S. Tang. 2011. Long-term surveillance of air quality in medical center operating rooms. *Am J Infect Control* 39:302–308.

Wilkoff, L.J., L. Westbrook, and G.L. Dixon. 1969. Factors affecting the persistence of Staphylococcus aureus on fabrics. *Appl Microbiol.* 17(2):268–74.

Wolkoff, P. 2018. Indoor air humidity, air quality, and health—An overview. *International Journal of Hygiene and Environmental Health* 221(3):376–90.