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Learning objectives

1. Understand the role of proper indoor humidification in improving health, learning and productivity
2. Understand that proper indoor humidification is an effective intervention to decrease seasonal influenza illness
3. Understand the design of an energy-saving humidification system for health-care applications
4. Understand how to estimate the ROI break-even point of the most common steam and adiabatic humidification systems

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Acknowledgements

Co-author on research project:

Michael Colin Tasi, MD, MBA
Harvard Affiliated Emergency Residency Program, Boston, MA

Generous donor:

Thank you to Condaire for the *pro bono* humidification equipment for the Phase II study, in progress

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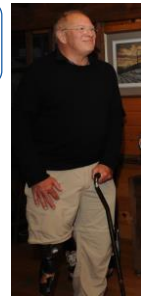
Summary outline

- Background**
 - Hospital study in 2014
- Multiple studies create a knowledge base**
 - New data on IAQ and elderly patients
 - New data on IAQ and pathogens
- Conclusions and next steps**
 - Pathogen infectivity
 - Human health

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Hospitalization is the third leading cause of death in the US!

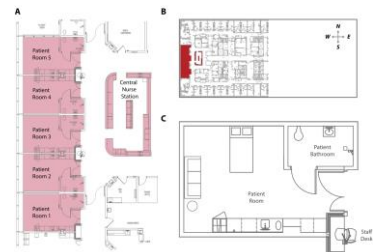
- Healthcare Associated Infections (HAIs) are the main cause.
- How is the hospital building involved in this sad statistic?



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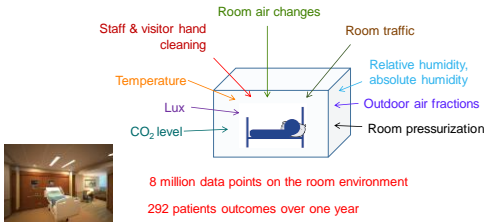
2014 Hospital Study: Do Building Design And Operation Support Human Health?

10 patient rooms were monitored over 12 months



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Patient room environment and clinical outcomes analyzed

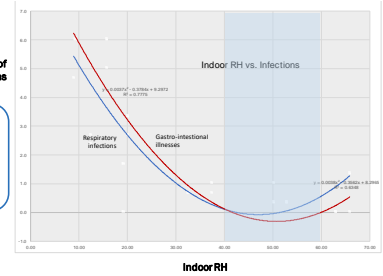


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Respiratory and gastro-intestinal infection rates were lowest at indoor RH 40–60%

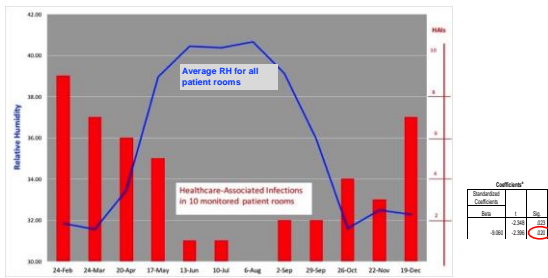


- Incidence of Infections**
- Respiratory and GI Infections were lowest when RH was 40–60%
 - Trending was found with eye and skin infections
 - No correlation was found with urinary tract infections



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Dry Indoor Air Correlated With New Patient Infections!

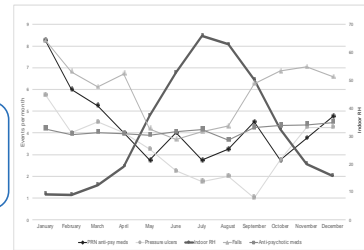


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Non-infectious adverse patient events trended lower when RH 40–60%



- Adverse events trended down when RH 40–60% vs. scheduled antipsychotic medication usage
- Cognitive functioning was best at 40%–60% (trend)



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2018: Four year study in residential care facility for elderly patients with dementia



- Patient events:**
- Infections
- respiratory (viral & bacterial)
 - GI (Noro & Notovirus, C. diff)
 - urinary tract
 - conjunctivitis
 - cellulitis
- Cognitive and behavioral
- scheduled antipsychotic meds
 - PRN antipsychotic medication
 - falls, pressure ulcers

- External measurements:**
- Outdoor climate
- temperature
 - relative humidity
 - flu outbreaks
- Indoor conditions
- temperature
 - relative humidity
 - visitors
 - staff absenteeism

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Independent group t-test - all patient events and RH

Events	Monthly incidence rate			T-test comparisons	
	RH <40% Mean (SD)	RH 40%-60% Mean (SD)	RH >60% Mean (SD)	<40% to 40%-60% RH T-test (p-value)	>60% to 40%-60% RH T-test (p-value)
Falls	49.63 (13.72)	41.57 (16.26)	29.20 (19.20)	1.31 (0.20)	1.21 (0.25)
Antipsychotic medications	33.08 (4.00)	34.14 (4.45)	29.60 (9.02)	-0.60 (0.55)	1.16 (0.27)
PRN antipsychotic medications	4.04 (2.76)	4.29 (1.80)	2.80 (2.05)	-0.22 (0.83)	1.33 (0.21)
Pressure ulcers	4.67 (4.19)	1.71 (1.38)	2.40 (0.89)	1.82 (0.08)	-0.97 (0.36)
Infections					
Urinary tract infections	2.29 (1.57)	3.14 (2.34)	2.60 (1.67)	-1.13 (0.27)	0.44 (0.67)
Upper respiratory infections	3.13 (2.86)	0.57 (0.79)	0.80 (1.30)	2.31 (0.03)	-0.38 (0.71)
Gastrointestinal infections	3.67 (2.84)	0.29 (0.49)	0.00 (0.00)	3.10 (<0.01)	1.29 (0.25)
Cellulitis	2.17 (1.49)	1.00 (0.82)	0.60 (0.55)	1.97 (0.06)	0.95 (0.37)

SD—Standard Deviation
RH—Relative Humidity

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2018: Humidity As A Non-pharmaceutical Intervention For Influenza A

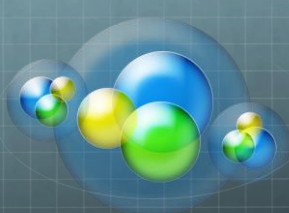
Next presentation

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Conclusions

- Temperature: 22 – 26°C depending on the season
- Relative humidity: 40 – 60% RH
- CO₂ level: < 800 ppm

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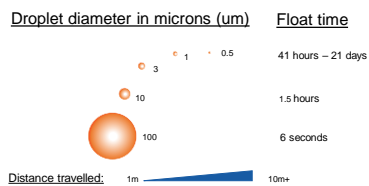


Indoor Climate – Conquerer of the students?

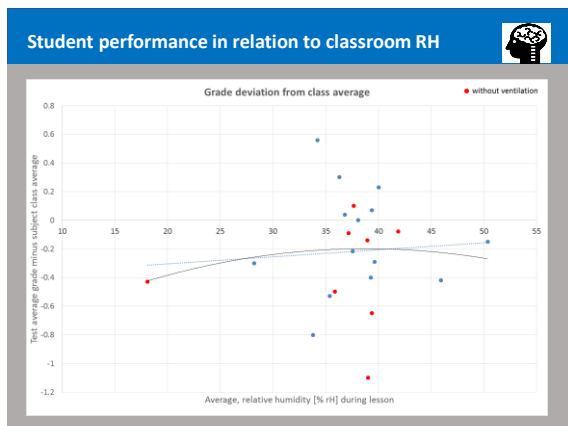
Matura presentation
Eric Zimmermann, G4f
Supervision: Markus Boner, Martin Speck

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Infectious Droplets Shrink And Travel Far In Dry Air

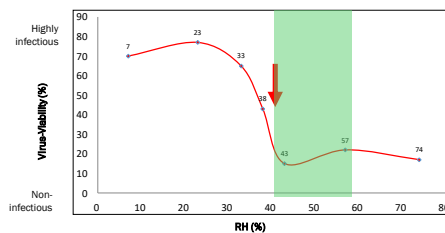


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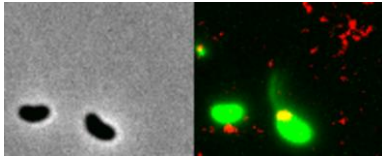
Rh Of 40% Inactivates 80% Airborne Influenza A



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This Is New and Startling Data...

"Antibiotic Resistance Can Spread Through The Air, Scientists Warn, And Yes You Should Be Terrified"
July 26, 2018



Dry conditions increase horizontal transfer of antibiotic resistance genes

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There Is Hope For Humidification



September 5, 2018

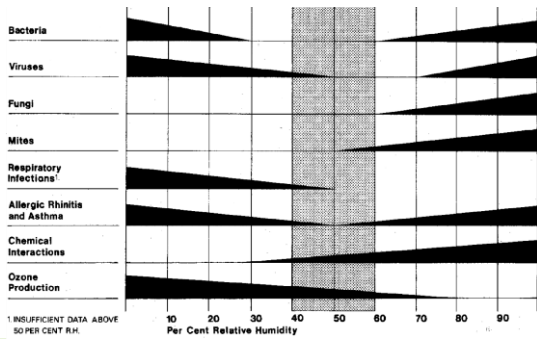
Emirates Flight from Dubai with 100 passengers and crew members with flu-like symptoms.

October 15, 2018



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1985 ASHRAE Sterling *et al*, Optimum relative humidity ranges for health = 40%–60%



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Conclusions

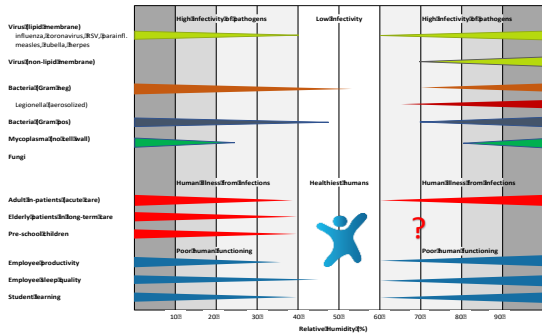
This four-year study shows that indoor relative humidity between 40–60% is correlated with decreased viral and bacterial infections and trended with improved cognitive functioning in elderly patients in residential care

Maintaining adequate indoor air humidification is an under-utilized tool which effectively decreases the transmission of infectious organisms both known to be airborne, and those thought to travel primarily through contact transmission

With proper building design, balanced indoor humidification is a very cost-effective strategy to improve the health and cognitive functioning of all building occupants

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35 years later..... 2019



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Questions?

Stephanie Taylor, MD, M Arch
MD@taylorcx.com

Michael C Tasi, MD, MBA
Mtasi@mgh.harvard.edu

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