Putting People First: The Healing Power of Indoor Air

Seminar 21: Sunday, February 2, 2020, 1:30 PM

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Learning Objectives

1. Provide a data-driven description of indoor environmental factors that are associated with occupant health.
2. Learn the application of energy-saving and hygienic approaches to active humidification when supplementation is necessary as an intervention for dry air.
3. Provide building owners a cost-benefit analysis of occupant health as a building performance metric.
4. Understand the relationship between water in the liquid and vapor state and the human body.

Presentation Summary

We have much to celebrate!
- My path to you
- Buildings, medicine, analytics

What the world is calling for now
- Topics in the news
- Re-searching health and buildings

Co-constructing our future
- Driving large-scale change
- The value of healthy humans

My journey to you, starting in Papua New Guinea, 1983

Non-hygienic hospital conditions, yet few infections

Wewack General Hospital, Papua New Guinea 1983
Yet, in USA 1,700,000 patients/year get a Healthcare-Associated Infection

“Never underestimate the power of the environment!”

Harvard Medical School Chief of Surgery, M. Judah Folkman, M.D. working with medical student, S. Taylor, 1986

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Topics in the news
- US on track for one of the worst flu seasons in decades
- This year’s flu season is taking deadly aim at kids

Topics in the news – Wuhan Coronavirus

Advances in the built environment

<table>
<thead>
<tr>
<th>timeline</th>
<th>10,000 BC</th>
<th>800 BC - 300 AC</th>
<th>1000 AC</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>housing</td>
<td>primitive housing, no sanitation systems</td>
<td>simple sanitation, in rural villages</td>
<td>industrial revolution, central sewage &amp; water systems, heating, electricity</td>
<td>post-industrial cities, tighter buildings, dryer and warmer indoor air</td>
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Environmental factors contribute to genetic mutation

Genetic analysis tools reveal a vast microbial world

What indoor factors correlate with infections?

Co-evolution of buildings and infectious diseases

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<td>infectious diseases</td>
<td>parasites, zoonosis</td>
<td>1st epidemics: smallpox, measles, influenza, plague</td>
<td>1st pandemic: &quot;Spanish flu&quot; introduction of antibiotics &amp; vaccines</td>
<td>Increasing infections, zoonotic transmiss., ABX-resistant bacteria</td>
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Infectious diseases:
- Parasites
- Zoonosis

Timeline:
- 10,000 BC
- 800 BC - 500 AC
- 1500 AC
- 2020
As patient room RH went down, infections went up!

Infection rates were lowest when RH = 40-60%

2018: Humidity decreased Influenza A illness in a pre-school

When RH < 40%, pathogen infectivity is high

The elephant *is* the room
The majority of bacteria causing HAIs survive very well in the air

- Acinetobacter supp. 3 d up to 5 months 6 references
- Clostridium difficile (spores) 7 d up to 5 months 3 references
- Escherichia coli 1.5 h up to 16 months 10 references
- Enterococcus supp. incl. VRE und VSE 5 d up to 4 months 4 references
- Klebsiella supp. 2 h up to >30 months 5 references
- Pseudomonas aeruginosa 6 h up to 16 months 7 references
- Staphylococcus aureus, incl. MRSA 7 d up to 7 months 6 references

Hospital surfaces are dry

reaction to hospital’s dry environment → increased infectivity

Fitness mapping of survival changes in low RH

- Pathogens thrive
  - increased disease transmission
  - greater resistance to medications

- Humans suffer

Taylor Chart 2019

Indoor moisture influences health in ways contrary to our intuition

**WE THOUGHT**

midrange RH best for health!

**WE KNOW**

• low RH
• intermediate RH
• high RH

Keeping buildings dry decreases disease transmission in patients

Dampness creates conditions favorable to mold

Now how would you think about the low infection rate?

Factors:
1. good RH indoors
2. no selection for pathogen virulence
3. people have robust immunity

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Leading change at scale

Vision – The Why

Trust – The Who

Alignment – The What’s In It for Me

Data – The What

Capacity – The How

Value analysis of humidification in 250-bed hospital

$899,880

$999,880

$7,225,018

1st Quarter 500.97%

Financial losses from employee sickness are huge

2010 Building operational costs

Costly respiratory illness costs the workforce U.S. $225B
per year (2016)

Building design and operation criteria

The six most common healthcare-associated infections:

- Urinary Tract Infections: 1,296, Total Excess Costs: $1,435,050, Total Excess Hospital Days: 2,032
- Surgical Wound Infections: 365, Total Excess Costs: $7,042,644, Total Excess Hospital Days: 4,278
- C.diff: 148, Total Excess Costs: $4,800,000, Total Excess Hospital Days: 2,939
- VAP: 15, Total Excess Costs: $491,300, Total Excess Hospital Days: 170
- MRSA: 120, Total Excess Costs: $927,102, Total Excess Hospital Days: 669
- CDIFF: 122, Total Excess Costs: $500,200, Total Excess Hospital Days: 739

Total: 2,866, Total Excess Costs: $11,937,765, Total Excess Hospital Days: 1,556
Einstellung effect — our past constrains us

"The difficulty lies not so much in developing new ideas as in escaping from old ones..."

John Maynard Keynes
1883-1946

Sub-four magic — The power of thinking

1. Attempted since 1886
2. Became a psychological and physical ‘barrier’
3. Within 46 days (1), a year (3), 50yrs (1,000) more

Roger Bannister (25), May 6, 1954
3:59.4

Together, we can do this!

Indoor-air hydration is powerful medicine that is essential in buildings that truly protect our health!

Building factors:
1. Rethink building design and use of spaces (bee-hive)
2. New materials for building shells to avoid condensation
3. Use of materials which have adsorptive properties

Changes in disease prevention and management
1. Clinical practices (prescribe humidifiers)
2. Use of materials which have adsorptive properties

Changes in education
1. Engineers will learn more medicine
2. Physicians will learn more engineering

Bibliography

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- Tropical Medicine & International Health, 2009., Volume 13, Issue 12, pages 1543-1552, 6 Oct.

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