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Indoor Air Quality: What Can We Learn from Hospitals

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This week IAQ Radio+ welcomed Ehsan Mousavi, PhD for a look and discussion of his work on Indoor Air Quality in Hospitals. We focused on what we can learn and use from the hospital setting in other indoor environments. Dr. Ehsan Mousavi is an Assistant Professor in the Department of Construction Science and Management (CSM) at Clemson University. He received his Ph.D. from the University of Nebraska in 2015 and has served in various capacities in the construction industry including dam, road, and building construction projects. Collaborating on projects funded by the National Science Foundation (NSF), and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Dr. Mousavi has developed an extensive research background in the indoor air quality of hospitals. Specifically, he has studied the effect of environmental parameters (ventilation rate, ventilation arrangement, temperature, door motion, etc.) on the transmission and spread of pathogenic agents.

Nuggets mined from today's episode:

Dr. Mousavi's father came to the US, studied and graduated from Oklahoma State University. Ehsan decided to follow a similar path. At the University of Nebraska, he faced both culture shock and winter temperature shock.

Working as a construction manager and studying construction project management, prompted Ehsan to accumulate a list of questions. He wanted more information and decided to earn a PhD. Through his advisor he became interested in hospital work.

Somewhat overwhelmed by the new vocabulary and acronyms he asked his professor for a 2 week break during which through reading he did a deep dive into hospital construction and developed a several page list of questions.

The average U.S. health-care facility uses three to five times more energy than a comparable size office building. More than two-thirds of total energy consumption is dedicated to maintaining environmental control and indoor air quality.

The main goal of Dr. Mousavi's research is to appraise the effect of environmental parameters on the design, construction, operation, and maintenance (DCOM) of healthcare premises. In particular, questions are addressed as to how patient safety and the quality of care can be improved through attention to DCOM. The research results will be further implemented in the development of regulatory codes and standards.

According to Dr. Mousavi, existing healthcare premises need to transition into newer and more effective facilities in response to growing demands. Due to the large expense of building a new facility and the increasing use of modular elements, renovation has shown to be an effective solution to providing reliable health care facilities. Hospitals cannot afford a complete shut-down to proceed with renovation; that is, the "construction" zone and the "functioning" zone coexist in a renovation project to minimize the down-time of the hospital. Under such conditions the two zones, hosting two vastly different types of contaminants, are adjacent and cross-contamination is highly plausible. Research is needed to systematically measure the current efforts to minimize the impact of construction on patient safety and comfort. Thus, Dr. Mousavi's group of collaborators actively seeks to document the best practices performed by industry professionals, and to address questions as these measures' effectiveness.

When preparing for and doing renovations in hospitals its tough if not impossible to shut down operations. You did some research on the use of Control Cubes to assist with this. What did you find?

Control Cubes are small, portable, work spaces, fitted with fan and HEPA filtration which are used to lower cross contamination risks during the inspection or repair of overhead spaces. 10X the ambient dust level is released when worker leaves the control cube. HEPA vacuuming of clothing and skin or misting before exiting would reduce dust generation and release.

Renovation in hospitals: Tips for training construction crews to work in health care facilities?

Go to the source, we approached the largest 15 hospital renovation contractors and asked them to share their best practices and provide access to their project managers.

Frontline workers don't think about the life and death importance of dust control during hospital renovation and construction. They get bored easily with conventional training technology (lecture and PowerPoints). The best way to engage them is through practical hands-on demonstrations e.g. giving them goggles and having them cut drywall while measuring the particulate generated.

Anterooms are specific to hospitals but the concepts can help with other types of environmental remediation. What is an anteroom?

An anteroom is a temporary structure containment structure attached to a hospital isolation room. Plastic air barriers are effective. (Note: plastic film may be retain static charges and attract particulate, so it should be cleaned before being dismantled or discarded). During experiments two HEPA air filtration devices were used. The filtration device I the isolation room was run on high setting (12 pascals negative pressure). The filtration device in the anteroom was run on low setting (4 pascals negative pressure).

For more info see: Performance analysis of portable HEPA filters and temporary plastic anterooms on the spread of surrogate coronavirus
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7424318/

Are pressurization and filtration the same phenomena?

Pressurization and filtration while interconnected are different. For example if an air filtration device (AFD) is installed in a space, exhausted outside to create negative pressure, simply drilling a hole in a ceiling will create a noticeable difference in pressurization. Leakage is noticeable! You don't need to get carried away with over pressurization, after a certain point adding more pressurization has little benefit.

How much does expect that door opening and closing affect pressurization and particulate control?

Human traffic and door opening and closing can create negative pressures up to 8 pascals and can reverse pressurization up to 3 pascals. This depends on opening direction of doors. This is a big concern, AND anterooms can come to the rescue!

How much does the movement of humans affect airflow and particulate distribution? Can the effect of human movement on indoor airflow patterns be measured in 3 dimensions?

Anemometers measure air speed not air velocity. Cal Berkeley invented a 3 D air velocity measurement device which measures the velocity of air. Human walking is horizontal X-Y pattern. The Z component of airspeed is pressurization. The X component is motion. Walking at 1 meter per second can create .5 meters per second of upward velocity.

Roundup with Global Restoration Watchdog Pete Consigli:

- Sports trivia: The Big 8 has included the top 3 college football teams, Nebraska, Oklahoma and Colorado.
- In 2008 a multi-industry delegation in partnership with industry met in Charleston, SC to discuss improving flood resilience of buildings. Attendees included: Charleston 10 term Mayor Riley who made a presentation on Charleston's flood response, a team from Savannah River National Laboratory, cleaning and restoration industry notables, etc. A highlight was a visit to the H.L. Hunley Museum (civil war submarine).
- Pete suggested that Ehsan be invited to a future Healthy Building Summit to collaborate on practice to research.
- The world is a small place, Clemson is involved in building resilience as are Purdue and other universities.

Final thoughts: Dr Mousavi

- Is an optimistic person.

Floated the suggestion that COVID (and possible future airborne pandemics) be deemed a US disaster and be studied as such. Clemson has assembled a team including: Dr Mousavi, psychologists, optimization specialists, building scientists, computer scientists, etc. who are working on this concept.

Pete's final comments:

- Congratulations to Dr. Randy Rapp, PhD is now the named professor for Reconstruction & Demolition at Purdue.

- In 2014, Purdue hosted an international disaster preparedness and response seminar. A panel discussion was peer reviewed and published as part of the proceedings. IAQ Radio+ covered the event with a live onsite broadcast.
- Dr. Sam Baroudi, PhD is an internationally known visiting professor in construction and project management https://researchers.adelaide.edu.au/profile/sam.baroudi

Additional references

COVID-19 Outbreak and Hospital Air Quality: A Systematic Review of Evidence on Air Filtration and Recirculation

https://pubs.acs.org/doi/pdf/10.1021/acs.est.0c03247

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https://scholar.google.com/citations?hl=en&user=XFrwMsEAAAAJ&view_op=list_works&sortby=pubdate

Testimonials from today's broadcast

From Terry Sopher Sr to Everyone
I appreciate the 'practical', non-hospital implications of Ehsan's research to residential remediation situations. And Cliff/Joe: excellent point/reminder that plastic barriers attract particles—emphasizes importance of decontamination of barriers. TERRIFIC session.

Z-Man signing off

Trivia question:

In 1996, the CDC established a term: broadening the focus on prevention, applying the principles to all patients regardless of diagnosis or presumed infection status, considering the risk of transmission of illness from both recognized and unrecognized sources. Name the term?

Answer: Standard Precautions

Answered by Dr. Pat Cafaro, Virginia