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COVID-19 Design & Construction:

Droplet & Airborne Viruses

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In early March, MKM architecture + design was engaged by Medxcel to help Ascension St. Vincent Indiana with potential high volumes of COVID-19 patients within the hospital(s) and the increased demand placed on the facility's minimal required airborne infection Isolation Rooms (AIIR). During that time MKM wrote two white papers based on our collaboration with Medxcel and Indiana State Department of Health (ISDH) resulting in Indiana's first COVID blanket waiver being issued by ISDH for designing temporary negative pressure rooms. The following day after the waiver was issued, Ascension St. Vincent Indianapolis had ISDH scheduled for their on-site review of their temporary COVID units, and on-site were impressed with Medxcel as knowledge leaders in the healthcare industry.

Within one week after our initial collaboration with Medxcel and ISDH, the facts on COVID-19 evolved in other ways. COVID-19 could potentially be droplet based and not solely airborne based as previously anticipated. With this new development, Medxcel was evaluating the virus's capability of going back and forth between

aerosol and droplet as it pertained to the type of patient care treatment. How could this new development change our COVID-19 designs from the week before, if at all? What is the difference between the two virus forms? It most likely will change our design thoughts from the beginning of this process, but to know for sure we need to establish the differences between airborne and droplet. Let's dive into the impact this new development has on designs and/or the hospitals' process and treatments during the COVID-19 pandemic.

TRANSMISSION-BASED PRECAUTIONS

Based on what we know today, it is still questionable on whether COVID-19 is droplet in lieu of airborne and this could change the way we design COVID-19 patient care areas. We will be utilizing the WHO's definition of airborne and droplet transmission and the CDC Precautions as it relates the built environment for airborne and droplet viruses.

WHO's Definition: Airborne transmission is different from droplet transmission as it refers to the presence of

microbes within droplet nuclei, which are generally considered to be particles <5µm in diameter, can remain in the air for long periods of time and be transmitted to others over distances greater than 1 m. Droplet transmission occurs within 1 m (close contact) with someone with respiratory systems (e.g., coughing, sneezing) and having a non-infectious persons mouth, nose, and eyes exposed to the infective respiratory droplets (direct contact with infective person or indirect contact with infective surface).

CDC Droplet Precautions - Use Droplet Precautions for patients known or suspected to be infected with pathogens transmitted by respiratory droplets that are generated by a patient who is coughing, sneezing, or talking.

- Ensure appropriate patient placement in a single room if possible. In acute care hospitals, if single rooms are not available, utilize the recommendations for alternative patient placement considerations in the Guideline for Isolation Precautions. CDC also gives recommendations for long-term care and ambulatory facilities for Droplet Precautions.
- Use personal protective equipment (PPE) appropriately. Don mask upon entry into the patient room or patient space.

CDC Airborne Precautions - Use Airborne Precautions for patients known or suspected to be infected with pathogens transmitted by the airborne route (e.g., tuberculosis, measles, chickenpox, disseminated herpes zoster).

- Ensure appropriate patient placement in an airborne infection isolation room (AIIR) constructed according to the Guideline for Isolation Precautions. In settings where Airborne Precautions cannot be implemented due to limited engineering resources, masking the patient and placing the patient in a private room with the door closed will reduce the likelihood of airborne transmission until the patient is either transferred to a facility with an AIIR or returned home.
- Restrict susceptible healthcare personnel from entering the room of patients known or suspected to have measles, chickenpox, disseminated zoster, or smallpox if other immune healthcare personnel are available.
- Use personal protective equipment (PPE) appropriately, including a fit-tested NIOSH-approved N95 or higher-level respirator for healthcare personnel.

In reviewing WHO's definition and the CDC's precautions when caring for an infectious patient, it raises many questions:

- If social distancing correctly, droplets are heavier than the air so they should quickly fall to the ground, but do we know enough yet on COVID to rely on gravity and how long it takes to land on a surface?
- If a negative pressure room is not required for a droplet-based virus, then should we increase air changes per hour through a HEPA filter to lower our risk and improve patient care room turnover?
- Are there certain treatments that can cause a droplet-based virus to return to aerosol form?

If you feel there are still too many COVID uncertainties then negative pressure rooms still provide the best protection for staff and those in close proximity, but this is not a realistic option for all hospitals. How should this uncertainty be applied as a pandemic risk assessment for a hospital as they provide patient care?

DESIGN ALTERATIONS TO PATIENT CARE TREATMENT

Based upon this new information and as we move forward with the COVID-19 potentially being a droplet-based virus, Ascension and Medxcel were aware of what treatments that could cause a droplet-based virus to revert to aerosol-base. The three most common treatment types discussed with Medxcel were intubation, ventilators, and nebulizers. The next question is how and where these treatments fit into a hospital's COVID-19 surge plan.

- Infectious patients on ventilators cause the virus to revert to aerosol, these patients are placed in a COVID temporary negative pressure unit (TNPU). This COVID TNPU was designed to contain only temporary negative pressure rooms (TNPR).
- Infectious patients not on ventilators but require intensive care are placed in a COVID intensive care unit. This COVID ICU was designed for patients being cared for as a droplet-based virus. Since intubation is one of the treatments that causes the virus to revert to aerosol, they transport the infectious patient to a dedicated TNPR within the same COVID ICU. Once the intubation is complete, they move them back to their intensive care room. If the infectious patient later requires mechanical ventilation, they will move them to the COVID TNPU designed for aerosol intensive care.
- The older hospitals often have underutilized bed counts from the decrease in inpatient care over

the years. This allowed Ascension St. Vincent to shift patient beds around to different non-intensive care floors within the hospital and vacate an entire floor, wing, and/or section of a patient tower. These vacated floors are being utilized for triage of patients under investigation (PUI) and allowing them to better separate the PUI's from non-infectious patients. Once the PUI is transported to the vacated non-intensive care floor, the hospital can hold them in the PUI patient room(s) until the hospital completes their on-site test screening. If screening detects a presumptive positive, they immediately move them to a room on the opposite wing of the same floor for observation. The hospital will then review COVID bed capacity make the determination if the positive-patient is low-risk and can be sent home to quarantine, or if they are moderate-risk and need to remain in a non-intensive observation room, or if they are high-risk and need to be moved to the COVID ICU or the COVID TNPU. On the non-intensive care floor(s) there are two existing and five converted negative pressure patient rooms where they can place a patient they feel may be higher risk of emergency intubation before they can get them to a COVID Intensive Care Unit.

- To responsibly distance potential infectious patients from non-infectious patients, the Emergency Department (ED) has a process and procedure to immediately transport patients under investigation (PUI) from the ED to the separate and designated COVID non-intensive care floor. The ED is still taking every precaution to protect the staff and public. A few ED exam rooms are dedicated to the use of nebulizers in case a patient is infectious but not showing symptoms. The use of nebulizers causes the virus to revert to aerosol and the hospital had concerns with room turnover. Based on COVID and the air changes needed the room wouldn't be able to be turnover to another patient for an hour. Based on CDC recommendations HEPA filters were used and these rooms contain HEPA filtered air scrubbers that have been set to improve the 6 air changes per hour to just ten minutes.

FUTURE DESIGN CHALLENGES

We are constantly in collaboration with Medxcel on potential options to handle the COVID surge at Ascension St. Vincent Indianapolis. Anywhere from patient displacement, to a feasibility study on a COVID operating

room, and converting a six room CVOR into 18 temporary negative pressure rooms. I am very appreciative of Medxcel's leadership during this pandemic and MKM appreciates the partnership we've established with them. Medxcel...the silent heroes of the pandemic. Special thank you to all the resources used to present all the viable options to Ascension St. Vincent in order to provide effective pandemic care include:

- Ascension St Vincent Indianapolis
- Medxcel
- MKM architecture + design, inc.
- IMEG Corporation
- Hagerman Construction
- Indiana State Department of Health

About the Author:



Matthew Sparling, AIA, LEED AP

As a Principal, Matt Sparling provides valuable leadership within the firm's healthcare studio. With over fifteen years managing complex healthcare projects for large institutional clients, he has a reputation for successfully planning, designing, and executing right-sized solutions that benefits our client's goals. His ability to skillfully facilitate interdisciplinary design teams and engage diverse user groups has provided invaluable service to our clients. As the youngest managing Principal, Matt offers a unique perspective to the leadership team at MKM. While managing the firm's quality control initiatives, he has taken the skills he honed as an effective project manager and translated them become an effective corporate leader. His obsession with work efficiency and value-added activities have substantially contributed to the firm's continued growth.