COVID Information Commons (CIC) Research Lightning Talk

Transcript of a Presentation by Michael Kinzel (University of Central Florida), February 10, 2021

Title: *RAPID: Fluid Dynamic Driving Mechanisms of Airborne Pathogen Transmission and Control*

Michael Kinzel CIC Database Profile

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Youtube Recording with Slides

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Transcript

Michael Kinzel:

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Well yeah, this talk is on essentially studying fluid dynamic drivers associated with pathogen transmission. It's done by myself focusing on the computation and Co-PI Kareem Ahmed focusing on experiments, we have a pretty nice team of Postdocs and Ph.D. students that have been helping us out on this effort.

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Okay, here we are. So ultimately, we're asking if we can control transmissibility by controlling, basically, the underlying fluid dynamics in your saliva. It basically comes down to what we see here is called the Wells Curve. What you can see here is droplet size. These are droplets emitted through speech, coughing, sneezing, these sorts of things, and this is time. And what happens is for very large droplets they tend to fall to the ground, so this is the time takes a droplet to fall two meters to the ground, but at some point, it evaporates faster than it falls to the ground and it becomes this airborne type path or an aerosol. So how does this relate to the different transmission paths? Very large droplets, they tend to just fall down to the ground, and they actually don't -- they're very hard to basically breathe in, they don't really survive social distancing as much as the mid-range ones. These mid-range particles are the ones that get trapped into the air that you emit as you speak, cough, and sneeze, and those are the ones that travel far. And then we have the airborne path. So, this is the ones that evaporate and they just circulate throughout the room as very tiny particles. What generally happens is the droplet evaporates, leaving essentially a viral particle with a small amount that's still survivable and can transmit the illness, but it is not necessarily -- it is very small and just floats around in the air essentially. So, the goal that we're trying to focus on is: Can we control the underlying fluid dynamics associated with the generation of these droplets to generate on average larger heavier droplets that have a tendency to reduce the transmissibility? So, we want to make these droplets fall rather than spread out around the room.

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So, the basic concepts we're studying are viscosity (so how thick it is). You can see here the honey (it's a very thick fluid) you can think about variations in viscosity in your mouth, and specifically in saliva and mucus, and as well as content - how much saliva you have in your mouth or mucus in the various films in your body and how that may relate to transmissibility. We're looking specifically at direct transmission using numerical simulations and experiments, as well as airborne transmission specifically in rooms - we're looking at things like restaurants, classrooms, these sorts of things. And ultimately what we're trying to ask is: How do saliva properties (viscosity and content) relate to social distancing and capacity of rooms? Can we study this to better understand what's driving super spreaders? And can we develop products that can actually reduce transmission based on things other than a mask?

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So, this is some of some results from our numerical simulations. This is a thin saliva - a way you could conceptually see that is just a spray bottle with water right - it atomizes or it breaks up into a lot of droplets and it basically spreads throughout a room. And this is what we're seeing in our simulations. These small droplets tend to float, loft, and aerosolize. On the other hand, you can think of a very thick fluid - a very easy way to think of this is this “I can't believe it's not butter” spray - it just falls, right. It leads to very large droplets, and when we study this we are seeing and observing that, yeah, these things drop, don't fall. So, these are all human sneezes and you can see that the majority of the droplets, the majority of the content of something that is emitted, or all the fluids are emitted during the sneeze, have a tendency to fall to the ground. This- so from a probability standpoint this is, you know, the more ideal scenario, because it's going to be less likely to transmit the virus.

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If we kind of summarize this, this is kind of a cop [unclear] after about five seconds. You can see these red droplets - they're all the thin saliva they're lofted up in the air - they're not really falling too much; the thicker droplets are tending to fall. If we look at essentially droplet counts, so number of droplets as a function of droplet diameter (this is all within kind of like a region around here where things can are more susceptible to transmission), you see you have a lot of the thin saliva leads to a lot of droplets that are lofted and very prone to transmitting coronavirus, versus when you have droplets you have very few of them they're very heavy and they tend to be much larger, they're going to end up falling. This is kind of the - one of the, you know, some of the findings from the study but we're finding a lot of other things too. When you dig into the dental literature you see that there's a lot of tendencies for humans to actually have thicker saliva. So, somebody who is older, stressed, or ill, or even women as compared to men, they all have thicker and less saliva and they're going to be less likely to be transmitting disease. So, kind of our ideal super spreader is probably a younger male 18-year-old kind of man - it's probably the super spreader profile. So, but we also wonder, you know, this does pose a question: Do humans actually naturally respond to reduce these airborne transmission routes? It may be, it's an interesting question that, you know, at least it seems our initial studies are pointing to maybe they do. We also had found that if you're congested, your sneezes will travel about 65 percent further - basically blocks up the nasal flow path leading to a stronger jet that comes out of your mouth. If you're interested we have a physics of fluids paper that kind of highlights some of our results.

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The other thing we're studying is airborne transmission. We just have a paper out on studying classroom safety. Basically, a few key results here are -- we're finding that using advanced modeling we do see a pretty consistent comparison with kind of like the estimators that say how safe it is for you to stay in a room with a certain number of infected people and the worst case scenario we found was those numbers are twice as bad as the worst case scenario of all the different transmission routes so you can think of this classroom where you have nine students one teacher there are a whole bunch of different transmission routes and we were trying to identify the worst case transmission route, and that case was only twice as bad as the estimators, which is I think a good thing to find. Another thing we're studying is the effective ventilation system - this is a room with ventilation, so this is kind of a distribution of all the transmission routes. And when we have this distribution we see about a two to three percent transmission rate - under a lot of assumptions - under the same assumptions, an unventilated room is about twice as bad. Last kind of result we see is infection probability in the context of airborne route is very weakly correlated to distance, so social distancing is not that effective when you actually are focusing on the airborne route. So, where we're moving with this next is to study -- most of these studies have been under the assumptions of masks, we want to look into the assumptions of our fluidic control type effect. We actually, you know, we think we will get about 80% reduction in aerosol using fluidic control.

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So, if we move just quickly into broader impact we've been able to get some, you know, to help actually *Good Morning America* a few times studying, or you know using our visualizations, to help them show you know how safe are certain things. So, this is one study where we were showing, hey, you have these barriers, they help but they aren't fail-safe - don't not use masks.

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And then we're moving into another *Good Morning America* piece with Martin Bazant at MIT. There's actually a simulation of an entire church and essentially, we're able to visualize how aerosols kind of move around in very big room environments.

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Okay, kind of the last thing we're looking at is how do we actually take this and implement this in reality? So, we actually have developed a chocolate that does exactly what we're saying - makes thicker and less saliva - and we think that it'd be a nice way to -- you know CDC is actually recommending now double masks, really tightly fitted. We think this might be another route - a single mask with a chocolate that is, you know, much more desirable, much more acceptable to the public. So, if you have any interest you could check out our, we did a National Academies I-corps and pitch with them, and we have a website - we're trying to get this stuff [unclear]. So hopefully this is another, we think we can take it to a solution.

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That's pretty much it if you have any questions feel free else stay around.