ILSI 2021 Annual Symposium Session 4: Advances in Enhancing the Microbiology Safety of Foods

Transcript of the presentation, Impacts and Risk of COVID-19 in the Essential Workforce of the Food Supply Chain, **Lee-Ann Jaykus**, PhD, North Carolina State University, United States

I'm delighted to be here to talk about impacts and risks associated with COVID-19 in the food supply. I will just sort of start with my obligatory Conflicts of Interest statement, which tells you what I have been involved in relative to potential conflict of interest, which really is not much.

Potential conflicts of interest, which really Is not much. Before I launch into this, I really need to acknowledge Dr. Juan Leon, who is a faculty member at Emory university school of public health. He and I have together been working on putting the risk model together that I'm going to talk about at the end of this presentation. And particularly, Julia his PhD student has done most of the boots on the groundwork relative to this. So, this is definitely a joint effort. But with that, I am going to start with the official statement about foodborne transmission. And Mike actually already gave this at the beginning of the symposium. I'll probably use the WHO statement, which is, "There is currently no evidence that people can catch COVID-19 from food or food packaging." And we stand by that statement, and that is very uniform throughout all of the agencies in the world.

So, this is not a foodborne pathogen. With that said, it has had significant impact on the food industry and that's been largely in the essential workforce. And so that's pretty much food workers on. We'll talk a little bit more about that in a few slides. The first we saw this in the U.S. Probably really was in the restaurant industry, but we also began seeing clusters of illness in meat processing facilities. And that actually expanded by probably, the summer of 2020 we begun seeing first visible ness in other food manufacturing facilities, such as frozen fruits, such as seafood, even some prepared food manufacturing facilities. So clearly, COVID-19 was spreading amongst workers in these facilities. And there's a great study that was done in California that was able to kind of get a handle on how much this particular sector was impacted by the pandemic.

And in the United States, we have this classification of essential workforce or essential workers. Those are kind of individuals that are necessary for health purposes, but also secondarily for keeping our world and economy going. And the food and agriculture sector is part of this essential workforce. And you can see here from this slide that they experienced excess mortality, that certainly it's experienced excess morbidity as well. And relative to some of the other members of the essential workforce, the food and exit sector was actually even more highly effective.

Now, there are lots and lots and lots of things we can say about SARS-CoV-2, which make it this unique pathogen. I am not going to go into a lot of detail on many of those, but I do want to make the point that, and it's a really important point that there is a high level of virus shedding, both pre-symptomatically. So, before people develop symptoms and also in asymptomatic individuals, and that presents a huge issue because people are getting exposed to the virus from individuals that have no idea that they're infected. And that is an important, it's certainly not the only driver of the pandemic, but that's been an important driver of the pandemic. So, let's talk a little bit about transmission of SARS-CoV-2. This is a respiratory or largely a respiratory transmitted virus. There's some fascinating aerosol physics engineering information that's come out of working with SARS-CoV-2.

But basically, what happens is certainly in the phase of disease where people are sharing a lot, most of the virus tends to be in the upper respiratory tract and any activities that involve that from as simple as breathing to talking, coughing, sneezing, yelling, etc. You produce this multi-phase turbulent get as cloud, okay. Which you can see on the right side. And in that cloud is a combination of air and droplets of various sizes. And those droplets are from very tiny to very large, and the virus tends to associate with those droplets. So, if you are exposed to the turbulent gas cloud immediately, you can directly infect the virus from exposure to the cloud. And then there are also indirect transmission routes.

And this slide is a great illustration of what those indirect or kind of the cadre of exposure routes to source maybe to. So here is the infected individual, they let's say sneeze and they produce droplets of all sorts. And if a susceptible person is in contact, close contact with that gas cloud, they'll directly get infected by inhalation. The very little, large particles tend to settle quite rapidly onto surfaces. They just drop. And that is the source of virus contamination for what we call fomite contamination or surface contamination. And that results in infection, if somebody contacts the surface and then manages to contact their nose or their mouth that they basically self [inaudible 01:45:41].

The smaller particles in that [inaudible 01:45:48] will stay in the air for long periods of time. And that could be hours sometimes even days. And of course, they're going to get alluded out in the process, but the bottom line is that if you have spent a significant amount of time in an enclosed area where you have these small particles floating around with virus association, it's also possible to become inoculated or become infected in that. And certainly, straight person to person transmission is possible, although that is not what we've done in our model... progressed in our model.

What has the food industry done in order to address this issue? Well, they've pretty much done most of the controls that we have as a community at large put into place. And they've instituted these controls extraordinarily quickly. Testing was really done mostly in instances of clusters. Some companies are also doing a little bit of screen testing. Vaccination approaches are just being started. And you can see on the right-hand side of this slide, that there have been just a cadre of physical distancing and posts that have been put into place. Now, I mentioned that these were put into place and in an ideal world, we would have had data to inform what are the best mitigation is to put into place where, when, why, how.

We didn't. We had to act very quickly. And so, you can see here on the left-hand side of this slide, these are just some basic practices, but there's a ton of uncertainty about what really is the most effective mitigation strategy to address those. And so, of course, as a risk assessment person, it makes sense to inform this kind of decision-making with quantitative microbial risk assessment. And I suspect almost everyone in the audience is pretty familiar with risk assessment. So, I don't really need to explain this slide. What's sufficient to say is that we haven't really been able to use risk models because we didn't have sufficient data to make the initial decisions that we needed to make to manage COVID-19.

Now, we have more data and we're starting to see risk models be reduced, and I'm going to spend the rest of the presentation talking about this. So, this is actually a very early one. And I love this study. It's illustrative of the complexity of managing COVID-19. And it's also illustrated of a really simple but effective approach. So, what these investigators were interested in was a cadre of potential controls. So low occupancy and high occupancy. They were also interested in ventilation, face coverings or the effectiveness of face coverings and also time period, contact time period. And they looked at how those all interfaced together to effectively express risks. And this is what's called a qualitative risk assessment. So, there's high, medium, low risk. Red is high. Yellow is medium. Green is lower risk.

And a great illustration of this would be for low occupancy conditions with good indoor ventilation, if people wear face coverings they fall into the low-risk category, but if they wear no face coverings, they fall into a moderate risk category. And that would be associated with speaking action for example. And you can make these comparisons across the board using this particular risk model. This is a very recent publication that was very interested in the relative importance of actions like breathing, speaking, singing, coughing, and sneezing. Remember the size of the plume and how far it travels is all dependent upon the type of physical activity. And these particular investigators were interested in looking at the impact of ventilation or air exchange.

And I'll just show you, for example, in the case of the sneeze event, they found that at inoculum dose of about 10 to the 9th viruses in a two-hour period with no ventilation, the risk of infection was quite high, almost a hundred percent. And when they were able to Institute six air exchanges per hour, which is pretty moderate degree of air exchange, that risk falls down to about 50%. So relatively speaking, that shows how we were able to modify risk based on an intervention.

So, that leads me to the work that Juan and Julia and I and the Emory team have done. And we were interested specifically in an enclosed food manufacturing facility and how to manage COVID transmission within such a facility with respect to the essential workforce. We used as a model, a frozen food facility with approximately a hundred workers in the production line. And we asked two major questions, which transmission pathway was most important. Was it aerosols? In other words, the tiny droplets of tiny particles that lasted for long periods of time, droplets, which are the larger droplets or surfaces, and are the current worker protection strategies enough. And these were the worker protection strategies that we focused on in this risk modeling to be precise. So, to show you a very quick overview of the model, we began with an infected SARS-CoV-2 worker. We were looking at exposure of that worker, and then finally infection risk to that worker.

We looked at aerosols, both large and small particle aerosols, as well as environmental or fomite sources of infection. And there were a number of factors that we investigated that were really important for inclusion in the model, one is droplet size because that impacts both distance traveled as well as how quickly something falls to another surface. We were very interested in distance between the infected worker and the susceptible worker. We modeled this within a one-to-eight-hour exposure that was indicative of a working shift. And as I said before, we looked at masking, we looked at their exchange rates. We looked at gloving and handwashing and we looked at surface disinfection.

Now, this slide just shows you an overview of some, not all of the parameters that were included in the model, a large number of the parameters we were able to get from published literature or good literature that was in view. There were instances where we had to consult experts, particularly in the aerosolization area. And American Frozen Foods Institute was gracious and helped us get processing of and facility dementias, things like that from their stakeholders.

So, I'm going to go back to our first risk modeling question was which of these three transmission routes or pathways is the most important? And this is some of the early simulations that we did. And we were basically looking at total infectious SARS-CoV-2 on the y-axis as a function of droplet transmission, fomite transmission or aerosol transmission, and distance. And overwhelmingly, we had the highest potential dose exposure at a three-foot distance with droplets. And in point of fact, any of the other combinations gave exposure to a much lower dose of virus. So based on that, we were able to say that droplet transmission appears to be driving the outbreak in this particular venue. And that distance was a very important consideration.

So, with that, we went on and did some more simulations and looked at what the relative difference in distance had based on, in this case worker risk rather than number of viruses. And this is in association with coughing events. And if you know, at a three-foot distance between worker and susceptible infected worker and susceptible individual, you can see here that risk, oops, sorry. That the increases pretty substantially with time, but it is relatively low when you're at these longer greater distances. And that is more indicative of course, of aerosol exposure. And interestingly risk hits almost unity. It's almost a hundred percent if this distance of three-foot over an eight-hour period of time is kept.

We then looked at the impact of masking. We first investigated cloth masks versus surgical masks and found them to be pretty at a distance of three-foot between infected and susceptible individual. They provided risk reduction between 50 and 60%. If you double masked, you got about a 90% risk reduction. And if you used an N95, which is not used by this particular population, you could get it down to 99.9%. Okay, so that's at your three-foot distance. As you increase distance, you get much better control such that even masking with cloth or surgical reduces your risk to less than 1%. So masking is extraordinarily helpful.

We also were interested in air exchanges per hour and its impact on risk with an eight-hour exposure. The industry standard is two to six air exchanges per hour in most of these facilities, we found again in at the three-foot or distance, air changes, as you increase the air exchange rate up to a high of potentially eight, you reduced risk in that short distance by about 50%. And if you were looking at further distances, pretty much air exchange helped even pretty dramatically by certainly four to six air exchanges. And in point of fact, the contribution to risk reduction at the greater distance was not as overwhelming as compared to the distance.

Okay. So, once you've controlled or sought to control droplet transmission, then we wanted to also look at surface transmission, both associated with more hygiene and disinfection. You can couple of take-home messages here relative to risk, the contribution of hand hygiene and surfaces is much lower than the contribution of respiratory, maximum of a little bit over 20%. Although, there is substantial reduction in that 20% risk by instituting hand washing and loving policies, and also certain reduction in the potential of surfaces to serve as a source of infection, particularly if you went down to every other hour of surface disinfection.

So, in point of fact, and how do we actually do this? Well in real life, we use multiple strategies. So, the final simulation that we did looked at handwashing twice per shift, plus sanitizing once per shift. And we combined that with distance as well as with masking. And again, at the three-foot distance, this kind of bundled strategy gave us about a 75 to 85% risk reduction. Double masking brought that up to 95% and increasing distance of course brings through risk down to literally less than 1%. So bundled strategies work.

So, what's our Summary here. Well, the focus needs to be at least according to this particular risk modeling exercise on droplet transmission at a distance of less than three feet. Once droplet transmission is addressed, surface transmission strategies to reduce service transmission are effective combinations work. And based on our model, we really felt that the food industry practices do protect workers from SARS-CoV-2 infection. And I think the epidemiology is very clear that once these strategies were put in place, the clusters of diseases in these particular facilities fell pretty dramatically.

So, what are we going to do with this model going forward? Well, it's designed such that it can be used for a variety of other venues. We could use it in a restaurant setting. We can use it in other types of food plants with modification. Right now, there's a lot of interest in industry about the potential for transmission of SARS-CoV-2 in frozen food packaging. This is actually a big issue on the international scale. And so, we are in the process of adapting the model to understand, or to get a better feel of what exactly is the risk of transmission of this virus through frozen food packaging.

And Just sort of wet your whistle for where we in COVID management phase two, as vaccination strategies are introduced in the population. We certainly want to look at the impact of vaccination and vaccination compliance on worker health and this particular workforce. And this model can definitely do that. We are also really interested in understanding and once vaccination becomes more widespread, what, if any strategies can be relaxed. Because what's being done now is really at great cost to the food industry as well as its workers. As we approach herd immunity, which is probably 85 ish percent, how are we going to approach disease surveillance? A little lower than herd immunity, we're going to still be seeing clusters, but we're going to have to be able to figure out how to detect those clusters and that's going to be tricky. And that there may be a place for testing strategies relative to that.

Certainly, we know very little about the variants and what their impact is going to be. And it's pretty clear that we're going to have to boost after initial vaccination. And so, managing that is also a big black box. And with that, I will finish my presentation and be happy to take any questions.