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RESEARCH ARTICLE

The Vulnerability of Meat Processing and Other Food Processing Facilities to Airborne Viral Threats

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ABSTRACT
The SARS-COVID-19 pandemic has resulted in over 6 million deaths worldwide (>967,000 deaths in the U.S. alone). Importantly, this pandemic has had a disproportionate impact on the food industry, including the meat processing industry. As a result, the health of food processing workers has been negatively impacted, leading to high numbers of SARS-COVID-19 cases at food processing facilities and surrounding communities. Resulting shutdowns have also led to product shortages for consumers and economic losses to the industry. In response, the food processing industry and public health agencies have prioritized continued food access over identifying evidence-based best practices for controlling airborne viral threats (AVTs). Consequently, the lack of high -quality evidence has made it more difficult to identify appropriate control measures that could prevent current and future airborne viral threats (AVT) in food processing facilities. Without evidence-based best practices, the food processing industry will remain vulnerable to future AVT events. Therefore, there is a pressing need for timely research on the spread of AVT in food processor settings. The aim of this article is to summarize the epidemiological knowledge regarding the impact COVID-19 has had on the food industry and the meat industry in particular and to emphasize the need for empirical research into the factors that contribute to the spread of airborne viruses in these settings in order to secure these facilities from future AVTs.

Introduction

The impact of the COVID-19 pandemic on the food industry has prompted the need to be proactive rather than reactive with regard to the prevention of future outbreaks. A proactive approach means generating high-quality evidence that can inform best practices for controlling Airborne Viral Threats (AVTs). Evidence-based best practices will be required to address current and future pandemics and mitigate the impact of AVTs on worker health, economic losses, and food security. The current COVID-19 pandemic has conclusively demonstrated the need for AVT research within a food processing setting.

COVID-19 and Food Processing Plants

From March 1-May 31, 2020, 8,978 food and agricultural workers tested positive for COVID-19 in 30 states [1]. By November 2020, the per capita death among food and agricultural workers in California alone was more than ***double*** that of healthcare workers [2]. Meat and poultry processing (MPP) plants were among those facilities subject to high rates of infection among the workforce. For example, as of July 21, 2020 MPP plants were associated with 236,000 to 310,000 COVID-19 cases (6% to 8% of total cases in the United States) and 4,300 to 5,200 deaths, equivalent to 3% to 4% of total U.S. deaths [3]. These numbers also included the communities where MPP plants were located [3]. Notably, the mere presence of an MPP plant was associated with transmission in the surrounding community, suggesting that MPP plants might have been a transmission vector [3]. The vulnerability of MPP workers to COVID-19 is well documented, ranking second only to healthcare workers in priority to receive COVID-19 vaccines [2,4]. To exacerbate this problem, almost half (45%) of MPP workers are low income, 44% are Hispanic 23% are African American and 52% are immigrants [5]. These statistics are even higher for assembly line workers. In addition, 14% of workers are undocumented and thus less likely to have access to healthcare and worker protections [5]. In fact, 80% of all COVID-19 cases in the MPP plants occurred among racial and ethnic minorities [6]. As a result, there is a social justice aspect to ensuring MPP worker safety in anticipation of future AVTs.

The COVID-19 pandemic clearly exposed vulnerabilities in the food supply chain, demonstrating that controlling AVT is synonymous with food security. Outbreaks in MPPs led to plant closures [7], which led to meat shortages in the early months of the COVID-19 epidemic [8] resulting in US$13.6 billion in economic losses by April 2020 alone. Shortages are a natural consequence of the just-in-time production strategy that eschews stockpiling alongside the highly centralized nature of the meat processing industry [7]. Such centralization is particularly severe in the pork industry, where the four largest companies control between 55% and 85% of their respective markets. Moreover, only 12 plants in the U.S. are responsible for 50% of pork production and 12 for beef production [9]. Absenteeism due to illness can also be disruptive in the meat industry, as a 25% increase in absenteeism can result in a decrease of 45% in the food supply [10]. Therefore, ensuring the safety of meat industry workers is critically linked to maintaining an uninterrupted meat supply.

During the COVID-19 pandemic, presidential executive orders declared meat processing plants as essential facilities, which led to plants reopening after having been closed as a means to slow the spread of SARS-CoV-2. This decision could be viewed as a reactive measure that balanced risks to workers and surrounding communities with the need to keep the population fed. As a result, even today, the reaction to an outbreak is to temporarily close a facility in order to clean and disinfect operations [11]. Therefore, it is incumbent upon food safety experts to establish evidence-based best practices to control AVT in a food processing setting. Such evidence-based control measures should be incorporated into an overall AVT mitigation strategy that includes screening, medical leave rules, and personal hygiene recommendations.

Future Viral Threats to the Meat Industry

As several COVID-19 vaccines are now available, it is our expectation that the current pandemic will eventually end. However, this assertion is in itself questionable, given the emergence of new variants and the increasing incidence of breakthrough infections. The recent experience with COVID-19 has thus demonstrated the need to proactively prepare for future AVTs. Moreover, the World Health Organization (WHO) has predicted future infectious disease pandemics [12], which have been increasing in frequency over recent years, largely due to deforestation, species extinction [13], population growth, pollution and climate change [14]. Between 2011 and 2018, the WHO documented 1,483 epidemics in 172 countries, and six international health emergencies have been announced since 2009 [15]. Well-known viral outbreaks include SARS-COV (2003), MERS-COV (2012 and 2020), H1N1 (2009) and Ebola (2014). In addition, another novel coronavirus, CCoV-HuPn-2018, recently made a leap from canines to humans [16].

Regulations and Control Measures

Regarding COVID-19 control measures, early in the pandemic, the U.S. Centers for Disease Control and Prevention (CDC) recommended increased hand hygiene, improving medical leave practices [17], social distancing, sanitizing surfaces, wearing cloth masks, using plexiglass partitions, minimizing fans, and adding handwashing or hand sanitizer stations [18]. When these recommendations were made, it was not known if they were sufficient to stem the tide of infections because of the lack of empirically-derived evidence to inform practices. In hindsight, these measures were clearly inadequate as the number of COVID-19 cases continued to increase [11]. Importantly, regulators were also unprepared to address AVT as the focus of USDA regulations had been on the control enteric pathogens NOT respiratory viruses.

An additional problem that emerged was that CDC recommendations were viewed as optional and were not necessarily universally applied across MPPs and other food processing plants [5]. The recommendations appear to have been derived from general knowledge of what was understood about other airborne viruses such as influenza rather than SARS-CoV-2 [19]. For example, proper handwashing hygiene is an effective way to mitigate the spread of infectious diseases but has limited application to viruses spread by respiratory droplets [20]. Physical barriers have also been used in health care to help to prevent the movement of virus-laden respiratory droplets [21]. However, more research is needed in order to confirm the impact of such barriers in a food processing setting and to determine the most effective barrier materials. Meanwhile, air scrubbing technologies can also be effective against COVID-19 [22] and other technologies such as bipolar ionization should be explored [23]. A key point is that SARS-CoV-2 is spread primarily from person-to-person rather than via contaminated surfaces [24]. Therefore, research focus on the dynamics of AV transmission should be prioritized over surface contamination studies.

Factors associated with COVID transmission in Food Processing Facilities

Meanwhile, facility size [25] and higher assembly line speeds [3] have been associated with increased virus transmission at MPP facilities. Other factors associated with increased transmission include: 1) longer work shifts (8-12 hours), 2) close and prolonged proximity to other workers (<6 feet; >15 minutes) [6], 3) difficulties in maintaining proper face coverings due to physical demands, 4) shared work spaces [6], 5) shared transportation [17], 6) temperatures of 0°C -12°C degrees associated with a higher risk of contracting COVID-19 [26], 7) fast work pace that may prevent the appropriate donning and doffing of masks [27], and 8) high relative humidity (90-95%) that has been associated with longer distance movement of virus respiratory particles[28]. Moreover, the MPP cooling systems appear to spread COVID-19 by carrying bioaerosols over long distances, as can air flow generally[29]. Another factor generally known to play a role in AV transmission is air exchange rates [30].

While there is some epidemiological evidence that gives hints about the factors that may lead to increased transmission, there is a critical lack of *empirical* evidence about how these risk factors contribute to AVT in a food processing plant. Therefore, the task at hand is to carry out the empirical research necessary to understand what environmental factors contribute the most to the spread of airborne viruses in food processing facilities. This research is necessary for making evidence-based recommendations about practices which can help mitigate future AVTs in the food industry.

Conclusion

To address this gap in our understanding, our primary objective should be to develop an AVT laboratory model that simulates the physical conditions of MPPs. This laboratory can be used to conduct AVT research and corresponding control measures. To execute such studies, it would make sense to apply an approach used in healthcare settings [31] in which pathogens, including viruses, are quantitatively measured in the air and on surfaces in order to determine levels of exposure over defined distances (i.e., AV dynamics) [32, 33]. These findings can then be used to inform evidence-based best practices for use in MPPs as well as other food processing plants. A proactive approach like this is necessary to prevent future viral threats in food industry, particularly the meat industry.

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Conflicts of Interest

The authors declare no conflict of interest.

References

1. Crews J. Tyson confirms hundreds of COVID-19 cases at Missouri chicken plant. *Meat + Poultry*. 2020. 12/28/2020, https://www.meatpoultry.com/articles/23379-tyson-confirms-hundreds-of-covid-19-cases-at-missouri-chicken-plant
2. Devleesschauwer B, Chen Y-H, Glymour M, et al. Excess mortality associated with the COVID-19 pandemic among Californians 18–65 years of age, by occupational sector and occupation: March through November 2020. *Plos One*. 2021;16(6)doi:10.1371/journal.pone.0252454
3. Taylor CA, Boulos C, Almond D. Livestock plants and COVID-19 transmission. *Proceedings of the National Academy of Sciences*. 2020;117(50):31706-31715. doi:10.1073/pnas.2010115117
4. Shoup M. Frontline food industry workers prioritized for next phase of COVID-19 vaccination. 2020. 12/30/2020, HTTPS://WWW.FOODNAVIGATOR-USA.COM/ARTICLE/2020/12/21/FRONTLINE-FOOD-INDUSTRY-WORKERS-PRIORITIZED-FOR-NEXT-PHASE-OF-COVID-19-VACCINATION
5. Fremstad SR, H.J.; Brown, H. Meatpacking Workers are a Diverse Group Who Need Better Protections. *Center for Economic and Policy Research*. 2020. 12/32/2020, 2020. https://cepr.net/meatpacking-workers-are-a-diverse-group-who-need-better-protections
6. Waltenburg M, et al. Coronavirus Disease among Workers in Food Processing, Food Manufacturing, and Agriculture Workplaces. *CEnter for Disease Control-Dispatch*. 2020. Accessed 12/31/2020. https://wwwnc.cdc.gov/eid/article/27/1/20-3821_article
7. McCarthy RD, S. COVID-19 meat plant closures. *Meat + Poultry*. 2020. 12/31/2020, https://www.meatpoultry.com/articles/22993-covid-19-meat-plant-map
8. Repko M. The meat supply chain is broken. Here's why shortages are likely to last during the coronavirus pandemic. *CNBC*. 2020. 12/31/2020, Accessed 12/31/2020. https://www.cnbc.com/2020/05/07/heres-why-meat-shortages-are-likely-to-last-during-the-pandemic.html
9. Skerrit JSD, and Hirtzer; M. Meat Shortages Reopen Costly Path to Smaller U.S. Plants. *Bloomberg Business*. 2020;
10. Huff AG, Beyeler WE, Kelley NS, McNitt JA. How resilient is the United States' food system to pandemics? *Journal of Environmental Studies and Sciences*. 2015;5(3):337-347. doi:10.1007/s13412-015-0275-3
11. Abott C. CORONAVIRUS OUTBREAKS AT TWO CALIFORNIA CHICKEN PLANTS. *Successful Farming*. 2020. https://www.agriculture.com/news/business/coronavirus-outbreaks-at-two-california-chicken-plants
12. WHO. The best time to prevent the next pandemic is now: countries join voices for better emergency preparedness. *World Health Organization*. 2020. https://www.who.int/news/item/01-10-2020-the-best-time-to-prevent-the-next-pandemic-is-now-countries-join-voices-for-better-emergency-preparedness
13. Gibb R, Redding DW, Chin KQ, et al. Zoonotic host diversity increases in human-dominated ecosystems. *Nature*. 2020;584(7821):398-402. doi:10.1038/s41586-020-2562-8
14. Pimentel D, Whitecraft M, Scott ZR, et al. Will Limited Land, Water, and Energy Control Human Population Numbers in the Future? *Human Ecology*. 2010;38(5):599-611. doi:10.1007/s10745-010-9346-y
15. GPMB. The world at risk: annual report on global preparedness for health emergencies. *Global Preparedness Monitoring Board*. 2019;
16. McLernan L. Another new coronavirus has jumped to people. *CIDRAP news*. University of Minnesota; 2021. https://www.cidrap.umn.edu/news-perspective/2021/05/another-new-coronavirus-has-jumped-people
17. Dyal Jea. COVID-19 Among Workers in Meat and Poultry Processing Facilities — 19 States, April 2020. *Morbidity and Mortality Weekly Report (MMWR)*. 2020. 12/31/2020, 2020.
18. CDC. Meat and Poultry Processing Workers and Employers. *Center for Disease Control*. 2020. 12/31/2020, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/meat-poultry-processing-workers-employers.html
19. Prevention CfDCa. Interim Guidance from CDC and the Occupational Safety and Health Administration (OSHA): Meat and Poultry Processing Workers and Employers. Accessed 5/18/2020, 2020.
20. WHO. Recommendation to Member States to improve hand hygiene practices widely to help prevent

the transmission of the COVID-19. *World Health Organization*. 2020. Accessed 12/31/2020. https://www.who.int/docs/default-source/inaugural-who-partners-forum/who-interim-recommendation-on-obligatory-hand-hygiene-against-transmission-of-covid-19.pdf
21. Eykelbosh A. Physical Barriers for COVID-19 Infection Prevention and Control in Commercial Settings. *National Collaborating Center for Environmental Health*. 12/31/2020 2020;
22. Barnewall RE, Bischoff WE. Removal of SARS-CoV-2 bioaerosols using ultraviolet air filtration. *Infection Control & Hospital Epidemiology*. 2021;42(8):1014-1015. doi:10.1017/ice.2021.103
23. Hagbom M, Nordgren J, Nybom R, Hedlund K-O, Wigzell H, Svensson L. Ionizing air affects influenza virus infectivity and prevents airborne-transmission. *Scientific Reports*. 2015;5(1)doi:10.1038/srep11431
24. Han J, Zhang X, He S, Jia P. Can the coronavirus disease be transmitted from food? A review of evidence, risks, policies and knowledge gaps. *Environmental Chemistry Letters*. 2020;doi:10.1007/s10311-020-01101-x
25. Nelson CC, Baker MG, Peckham TK, Seixas NS. Estimating the burden of United States workers exposed to infection or disease: A key factor in containing risk of COVID-19 infection. *Plos One*. 2020;15(4)doi:10.1371/journal.pone.0232452
26. Zuber S, Brüssow H. COVID 19: challenges for virologists in the food industry. *Microbial Biotechnology*. 2020;13(6):1689-1701. doi:10.1111/1751-7915.13638
27. Durand-Moreau QA, A; Mackenzie, G; Bowley, J.; Straube, S; Chan, XH; Zelyas, N.; Greenhalgh, T. COVID-19 in meat and poultry facilities: a rapid review and lay media analysis. 2020. https://www.cebm.net/covid-19/what-explains-the-high-rate-of-sars-cov-2-transmission-in-meat-and-poultry-facilities-2/
28. Zhao L, Qi Y, Luzzatto-Fegiz P, Cui Y, Zhu Y. COVID-19: Effects of Environmental Conditions on the Propagation of Respiratory Droplets. *Nano Letters*. 2020;20(10):7744-7750. doi:10.1021/acs.nanolett.0c03331
29. Günther T, Czech-Sioli M, Indenbirken D, et al. SARS-CoV-2 outbreak investigation in a German meat processing plant. *EMBO Molecular Medicine*. 2020;12(12)doi:10.15252/emmm.202013296
30. WHO. In: Atkinson J, Chartier Y, Pessoa-Silva CL, Jensen P, Li Y, Seto WH, eds. *Natural Ventilation for Infection Control in Health-Care Settings*. 2009. *WHO Guidelines Approved by the Guidelines Review Committee*.
31. Bischoff W, Russell G, Willard E, Stehle J. Impact of a novel mobile high-efficiency particulate air–ultraviolet air recirculation system on the bacterial air burden during routine care. *American Journal of Infection Control*. 2019;47(8):1025-1027. doi:10.1016/j.ajic.2018.12.019
32. Bischoff WE, Swett K, Leng I, Peters TR. Exposure to Influenza Virus Aerosols During Routine Patient Care. *The Journal of Infectious Diseases*. 2013;207(7):1037-1046. doi:10.1093/infdis/jis773
33. Inagaki H, Saito A, Sugiyama H, Okabayashi T, Fujimoto S. Rapid inactivation of SARS-CoV-2 with deep-UV LED irradiation. *Emerging Microbes & Infections*. 2020;9(1):1744-1747. doi:10.1080/22221751.2020.1796529