Irish Medical Journal
Established 1867

Issue: Ir Med J; Vol 113; No. 7; P126

Airborne Transmission of Covid-19: Implications for Irish Hospitals

H. Humphreys[1,2], F. Fitzpatrick[1,2]

1. Department of Clinical Microbiology, the Royal College of Surgeons in Ireland, Dublin, Ireland.
2. Department of Microbiology, Beaumont Hospital, Dublin, Ireland.

The pandemic spread of COVID-19 raises many questions about its transmissibility. The initial consensus was that spread was primarily by contact with a contaminated surface and by inhalation of droplets. However, airborne transmission is increasingly considered probable. Clarifying COVID-19 transmission is crucial for effective infection prevention and control (IPC) and healthcare worker (HCW) protection.[1] SARS-C0V-2 is more transmissible than influenza, with a mean reproductive number of 2.65, even if not as high as other viruses such as measles.[2] Personal protective equipment (PPE) shortages, IPC lapses, workload intensity and other factors not yet known, may explain significant hospital transmission during the early stages of the pandemic in Ireland and elsewhere.

It is increasingly clear that SARS-CoV-2 can persist in the environment. Under experimental conditions, SARS-CoV-2 remained viable in aerosols for three hours.[3] While these data must be interpreted cautiously in a healthcare context, it is possible that this virus is more persistent than we think and can spread further than by droplets.

In Hong Kong, a number of measures, including isolation in airborne infection isolation rooms (AIIR) were used in caring for confirmed cases of COVID-19, and transmission to patients or to HCW, including following unprotected exposure, was not observed.[4] In Wuhan, SARS-CoV-2 was detected in 14/40 (35%) air samples, and they estimated that the maximum transmission distance might be up to 4m.[5] Liu and colleagues found SARS-Cov-2 containing aerosols of 0.25-1.0u in patient, physician and public areas, and suggest that these are capable of re-suspension from surfaces.[6]

To implement IPC measures, it is easier to classify transmission in the air as either droplet (short range) or airborne (long-range) transmission, even if it may not be as simple as this. Conventional opinion suggest that droplets spread influenza. However, after an investigation of a hospital outbreak, it was concluded that aerosol transmission was possible arising from air flowing from the clinical area of the index patient to areas where other patients acquired influenza.[7] Teller and colleagues suggest that influenza may be transmitted by the airborne route and this may lead to more severe illness.[8]

Many factors are likely to be involved in the transmissibility of SARS-CoV-2, including the stage of illness and the likely viral load, possible differing susceptibilities to infection amongst contacts of cases, airflows, and surfaces, which vary in their capacity to support viral persistence. However, it seems likely that transmission may include both droplets and aerosols. Full PPE (including respirators or equivalent masks) is required during aerosol generating procedures (AGP). However, it seems biologically plausible that a symptomatic patient may disseminate via both means during coughing, sneezing and even talking. If so, that has implications for IPC practises and for hospital infrastructure.

Some now argue strongly that the transmission of SARS-CoV-2 includes aerosols that may travel 2m or more.[9-12] This is based on experimental and observational data as well as mathematical modelling. Droplets (>5ųm) may spread further than many believe, with the distance being influenced by relative humidity, temperature and particulate matter.[10,11]

The inference is that AIIR facilities and full PPE may be required for more patients with COVID-19 than just those during AGP. We also need to consider more the direction of airflows where there are multi-patient facilities, e.g. ward bays, to minimise spread.

After the epidemic of severe acute respiratory syndrome (SARS) due to SARS-CoV-1 in 2003, many countries reviewed their capacity to control epidemics and potential pandemics. In Hong Kong, the government insisted on a minimum distance between beds and the provision of more than 1,400 isolation rooms with negative pressure ventilation in public hospitals.[13] This may partly explain why some Asian countries with prior experience of managing SARS, such as Hong Kong and Singapore, appear to have coped better with this pandemic than countries largely unaffected by SARS.

In Ireland, the Health Information and Quality Authority have published standards for IPC in acute hospitals.[14] However, implementation of best practice IPC is challenging because of sub-optimal infrastructure in many hospitals. In 2009 an expert group recommended that newly built hospital in-patient accommodation should comprise 100% single-patient rooms, existing multiple bedded rooms contain no more than three beds, and that there be at least one AIIR per 150 acute inpatient beds with double that for regional or tertiary referral hospitals.[15] However, little progress was made in implementing these recommendations since then. In a 2011-2012 European hospital study, the country median proportion of single-bed rooms was 24.2%, with Irish hospitals reporting between 10-20%.[16] Of 60 Irish acute hospitals surveyed in May 2017, the average proportion of single patient rooms in public hospitals ranged from 15% to 29% with 52% in private hospitals. The majority (76%) of single rooms were reported to have en suite facilities, however, there were only 1.8 AIIR per 100 beds.[17]

The recent pandemic underscores the need for more single rooms with AIIR capacity in acute hospitals to facilitate appropriate patient placement and to prevent cross-infection. While natural ventilation probably suffices for most patients in hospitals, we need to learn from recent evidence, plan for the future, and improve the environmental conditions for all in acute hospitals. This will help control the next pandemic, reduce nosocomial and HCW acquisition, and better prevent more common infections such as seasonal influenza.

Key words:
SARS-CoV-2, COVID-19, transmission, airborne, droplet

Funding:
External funding to the authors or to their affiliated institutions did not support the drafting of this manuscript.

Declaration of Conflicts of interest:
H.H. has recently been in receipt of research funding from Astellas and Pfizer and has received a consultancy fee from Pfizer in the last three years. F.F. has no conflict of interest to declare.

Corresponding Author:
Prof Hilary Humphreys
Department of Clinical Microbiology,
RCSI Education and Research Centre,
Smurfit Building,
Beaumont Hospital,
Dublin D09 YD60,
Ireland.
Email: hhumphreys@rcsi.ie

References:

1. Public Health England. Reducing the risk of transmission of COVID-19 in the hospital setting. COVID-19: infection prevention and control (IPC) (https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control) (accessed 17th June 2020))
2. Aronson JK, Brassey J, Mahtani KR on behalf of the Oxford COVID-19 Evidence Service Team. "When will it be over?": An introduction to viral reproduction numbers, R_0 and R_e. www.cebm.net/oxford-covid-19/) accessed 17th June 2020).
3. Holbrook MG, Gamble A, Williamson BN, Tamin A, Harcourt JL, Thornburg NT, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. New Eng J Med 2020; 382: 1564-1567.
4. Cheng VCC, Wong S-C, Chen JHK, Yip CCY, Chuang VWM, Owen TY, et al (2020) Escalating infection control response to the rapidly evolving epidemiology of the Coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong. Infect Control Hosp Epidemiol; 2019; 41: 493-498.
5. Guo Z-D, Wang Z-Y, Zhang S-F, Li X, Li L, Li C, et al. Aerosol and surface distribution of severe acute respiratory syndrome coronavirus 2 in hospital wards, Wuhan, China, 2020. Emerg Infect Dis 2020; 26(7) doi:10.3201/eid2607.200885.
6. Liu Y, Ning Z, Chen Y, Guo M, Liu Y, Gali NK, et al. Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals. Nature 2020; https://doi:org/10.1038/s41586-020-2271-3.
7. Wong BCK, Lee N, Li Y, Chan PKS, Quiu H, Luo Z, et al. Possible role of aerosol transmission in a hospital outbreak of influenza. Clin Infect Dis 2010;51: 1176-1183.
8. Tellier R, Li Y, Cowling BJ, Tang JW. Recognition of aerosol transmission of infectious agents: a commentary. BMC Infect Dis 2019; 19.101. doi: org/10.1186/s12879-019-3707-y.
9. Bourouiba L. Turbulent gas clouds and respiratory pathogen emissions potential implications for reducing transmission of COVID-19. JAMA 2020; 323: 1837-1838.
10. Setti L, Passarini F, De Gennaro G, Barbieri P, Perrone MG, Borelli M et al. Airborne transmission route of COVID-19: Why 2 meters/6 feet of inter-personal distance could not be enough. Int J Environ Res Pub Health 2020, 17, 2932; doi:10.3390/ijerph17082932.
11. Bahl P, Doolan C, se Silva C, Chughtai AA, Bourouiba L, MacIntyre CR. Airborne or droplet precautions for healthcare workers treating COVID-19. J Infect Dis 2020 Apr 16:jiaa189. doi:10.1093/infdis/jiaa189.
12. Zhang R, Li Y, Zhang AL, Wang Y, Molina MJ. Identifying airborne transmission as the dominant route for the spread of COVID-19. PNAS 2020 pnas.org/cgi/doi/10.1073/pnas.2009637117.
13. Hui DS. Severe acute respiratory syndrome (SARS): lessons learnt in Hong Kong. J Thorac Dis; 2013;5(S2): S122-S126.
14. Health Information and Quality Authority. National Standards for the Prevention and Control of Healthcare-Associated Infections in Acute Healthcare Services. 2017. https://www.hiqa.ie/reports-and-publications/standard/2017-national-standards-prevention-and-control-healthcare (accessed 23rd June 2020).
15. Strategy for the Control of Antimicrobial Resistance in Ireland (SARI). Infection Prevention and Control Building Guidelines for Acute Hospitals in Ireland. 2009. https://www.hpsc.ie/a-z/microbiologyantimicrobialresistance/infectioncontrolandhai/guidelines/File,3439,en.pdf (accessed 23rd June 2020).
16. European Centre for Disease Prevention and Control. Point prevalence survey of healthcare associated infections and antimicrobial use in European acute care hospitals. Stockholm: ECDC; 2013. https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/healthcare-associated-infections-antimicrobial-use-PPS.pdf (accessed 24th June 2020)
17. Health Protection Surveillance Centre, Point Prevalence Survey of Hospital Acquired Infections & Antimicrobial Use in European Acute Care Hospitals, May 2017: National Report Ireland. https://www.hpsc.ie/az/microbiologyantimicrobialresistance/infectioncontrolandhai/surveillance/hospitalpointprevalencesurveys/2017/nationalppsreports/PPS%202017%20National%20Report_FINAL_191218.pdf (accessed 24th June 2020)