Journal of Hospital Infection 106 (2020) 637–638

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Commentary

Airborne or droplet — is it possible to say?

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ARTICLE INFO

Article history:
Received 18 August 2020
Accepted 21 August 2020
Available online 29 August 2020

It had been assumed that we could, through the identification of a pathogen and/or procedure, accurately categorize airborne pathogens from those transmitted via droplets. For severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), the main routes of transmission are via droplets and contact [1]. There is an increased risk of airborne transmission under certain conditions. Airborne transmission necessitates airborne precautions; for example, healthcare workers (HCWs) are required to use FFP3 masks for airborne transmission, whereas, for droplet transmission, a fluid-repellent surgical face mask will suffice to protect the mouth and nose (additional eye protection is required) [1]. The terminology in national guidance was familiar to infection prevention and control teams but was unfamiliar to clinicians and created confusion. Investigations reveal that the basis for classifying respiratory transmission is perhaps over-interpreted.

The term 'aerosol-generating procedures' (AGPs), used to differentiate when airborne transmission could arise, provoked uncertainty. Firstly, the term 'aerosol' has multiple definitions (e.g. a perfume spray creates aerosols). Guidance defines aerosols as small, neutrally buoyant, and thus able to remain suspended in the air for long periods and distances [2]. Evaporated larger droplets, termed 'droplet nuclei', also result in airborne transmission. Another review states that: 'aerosolised disease transmission can be classified as either droplet or airborne' [3]. Ergo, as droplets are also aerosols, it is understandable that using the term 'AGPs' caused confusion — the term lacks specificity. The listed AGPs were devised from literature reviews which evaluated evidence largely from outbreak reports [4]. However, unlike other coronaviruses, SARS-CoV-2 is reported to replicate throughout the respiratory tract [5], which may explain some of the high transmissibility. It also raises questions about the validity of extrapolating data from reports of pathogens with lower transmissibility and applying it to SARS-CoV-2.

The US Centers for Disease Control and Prevention (CDC) argue that the defining characteristic of airborne vs droplet transmission is the size of the expelled aerosols [6]. The UK guidance followed the CDC aerosol size ($\leq$5 μm vs $>$5 μm) definition for both airborne and droplet precautions [1]. CDC [6] referenced the aerosol size delineation to work published by Duguid (1946) [7]. However Duguid referred such a finding to Hatch (1942) [8]. Hatch, without producing data, stated that 'particles larger than 5 μ are primarily removed in the upper tract while fine particles are deposited by settlement in the alveoli' [8]. The implication of Hatch's work was considered of 'aetiological significance in the cause of lung infection' [7]. There is no mention in either paper of the size of the particles being relevant to disease transmission. Duguid showed that '… nuclei larger than 8 μ in diameter usually disappeared within 20 minutes, the nuclei larger than 4 μ within 90 minutes and the smaller nuclei [presumably $\leq$3 μm and not $\leq$5 μm] remained airborne for much longer periods' [7]. Others argue that the cut-off at $>$5 μm fails to acknowledge that the size and behaviour of particles follows a continuum which overlaps either side of this cut-off [3]. Ergo, there is an absence of absolute aerosol size delineation to determine airborne or droplet transmission. Also, for any individual patient, critical factors such as respiratory activity (and its frequency), the number of particles generated and the pathogen load are unknown [3].

Droplets evaporate rapidly and fall to the ground quickly; however, horizontally expelled large droplets travel long distances [9]. These large droplets were carried more than 6 m by exhaled air at a velocity of 50 m/s for sneezing, 2 m/s for

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https://doi.org/10.1016/j.jhin.2020.08.022

coughing and 1 m/s for breathing [9]. Another recent report demonstrated that coughs and sneezes are made up of a 'multiphase turbulent gas cloud that entrains ambient air and traps and carries within it droplets with a continuum of droplet sizes' [10]. Could it be that it is the closeness of HCWs to this 'gas cloud' during AGPs that is the issue, rather than the size of the particles created?

The theory that aerosol size delineation can determine the respiratory precautions required appears to be unsupported by evidence cited in UK and US guidelines. However, despite the theory muddle, there are yet-to-be-published nosocomial outbreak reports which demonstrate cross-transmission resulting from a failure of fully applied droplet precautions. It may be that a full face shield and fluid-resistant surgical face mask are sufficient to negate the risk of transmission from virus-laden aerosols (regardless of size) in many circumstances. That said, the need for critical reconsideration of respiratory transmission is needed urgently.

The author is not seeking to present herself as an expert in respiratory disease transmission. However, in trying to understand the rationale for current recommendations, she has found anomalies that appear to question the prevalent paradigm.

Conflict of interest statement

None declared.

Funding sources

None.

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