NIPH
Norwegian Institute of Public Health

memo

COVID-19-EPIDEMIC :

Aerosol generating procedures in health care, and COVID-19

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Key messages

The findings in this memo are based on rapid searches in the PubMed and Embase databases. One researcher went through all search records, selected and summarised the findings. In the current situation, there is an urgent need for identifying the most important evidence quickly. Hence, we opted for this rapid approach despite an inherent risk of overlooking key evidence or making misguided judgements.

We identified one scoping review, two unsystematic reviews and ten primary studies from the literature search and by manual searching of reference lists.

We did not identify direct evidence on the risk of aerosol related transmission of SARS-CoV-2, but data from similar viruses substantiates that SARS-CoV-2 can be transmitted by aerosol generating procedures in hospitals.

Some studies consistently show that aerosols can be produced during tracheal intubation, tracheotomy, cardiopulmonary resuscitation and manual ventilation. Bronchoscopy, non-invasive ventilation and nebuliser may also produce aerosols, but this evidence is weaker and less consistent. The evidence was uncertain and inconclusive regarding the aerosol generating potential of other procedures.

Hovedfunn (Norwegian)

Funnene i denne hurtigoversikten baserer seg på raske søk i PubMed og Embase. Én forsker har gått gjennom søketreff, valgt ut og oppsummert resultatene. Ettersom det har vært viktig å få fram forskningsresultatene raskt, har vi valgt denne framgangsmåten, selv om det innebærer risiko for at vi kan ha oversett viktig dokumentasjon og kan ha gjort feilvurderinger underveis.

En kartleggingsoversikt, to usystematiske oversikter og ti primærstudier ble identifisert fra litteratursøket og gjennom manuelle søk i referanselister.

Vi identifiserte ikke studier av SARS-CoV-2, men data fra lignende virus underbygger at SARS-CoV-2 kan smitte i forbindelse med gjennomføring av aerosolgenererende prosedyrer på sykehus.

Noen konsistente funn tyder på at det kan produseres aerosoler i forbindelse med intubering, trakeotomi, hjerte-lungeredning og manuell ventilering. Noen studier tyder også på at bronkoskopi, ikke-invasiv ventilering og bruk av forstøver kan bidra til produksjon av aerosoler, men denne dokumentasjonen er svakere og mindre konsistent. For andre prosedyrer enn de overnevne var dokumentasjonen svært begrenset og/eller tvetydig.

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Introduction

In relation to the Norwegian Institute of Public Health's role in handling the COVID-19 epidemic, we have been asked to prepare a rapid summary of the available research on aerosol generating procedures in health care, and the associated risk of COVID-19 infection for health care workers.

Methods

We carried out searches in the PubMed and Embase databases (see Attachment). Searches were limited to the period from 2016 to 27. March 2020, as we considered the years before 2016 to be sufficiently covered by a mapping review published in 2017 (1).

We selected studies where the concentration of aerosols was directly linked to the execution of a specific medical procedures or patient related activities. We excluded modelling studies and studies measuring levels of aerosols in general environment.

One researcher (Kjetil Brurberg) assessed the relevance of each reference and summarized the findings. Another researcher (Atle Fretheim) contributed in defining the research questions, assessing some of the included reports and reading the manuscript.

Elisabet Hafstad (Information Specialist) prepared the literature searches. Kirsten Midttun Gravningen (Senior Consultant, Norwegian Institute of Health) read swiftly through a draft of this document before publication.

Results

The search resulted in 569 unique records, and we ended up including one systematic scoping review, two narrative reviews and ten primary studies.

Summary of scoping review

We identified one systematic scoping review aiming to review evidence on aerosols in healthcare and dental setting. The objectives of the scoping review were threefold: 1) to identify sources generating bio-aerosols, 2) to assess microbial load and composition of bio-aerosols, and 3) to investigate the risk of transmission following aerosol-generating procedures.

The scoping review was based on systematic searches for both primary studies and systematic reviews in PubMed and Embase. The authors included in total 62 studies.

Some dental procedures were found to produce bio-aerosols, including ultrasonic scalers, high-speed hand pieces, air turbines and syringes (1). A wide range of hospital procedures were found to be aerosol generating, e.g. colonoscopy, intubation, suction before and after intubation, non-invasive ventilation, nebulisers and bed making. It is challenging, however, that an increased particle count does not necessarily mirror an increased risk of transmission.

To explore the risk of transmission, the scoping review authors summarized studies where a hazard was observed, i.e. case reports and case-control studies. From the included case-control studies, it seems that intubation and non-invasive ventilation is associated with increased risk of transmission of legionnaire's disease (*L. pneumophila*). The authors included a systematic review on the risk of transmission of acute respiratory infections to health care workers, who had been exposed to bio-aerosol generating procedures in patients with SARS-CoV (2). Procedures reported to represent an increased risk of transmission included tracheal intubation (OR 6.6; 95% CI 2.3 to 18.9), non-invasive ventilation (OR 3.1; 95% CI 1.4 to 6.8), tracheotomy (OR 4.2; 95% CI 1.5 to 11.5) and manual ventilation before intubation (OR 2.8; 95% CI 1.3 to 6.4). A long list of other procedures did not reach statistical significance as risk factors, e.g. chest compressions, nebuliser treatment and bronchoscopy (2). The author of the systematic review assessed the quality of the evidence as being very low, implying that the conclusions are very uncertain (2).

Recent primary studies

Our updated search identified seven primary studies where the authors had measured the concentration of aerosols in the proximity of medical procedures (Table 1). The most important study seems to be the one by O'Neil and co-workers, with results indicating that only two of seven procedures and activities they examined, were associated with increase in aerosol concentrations – nebulised medication administration (NMA) and bronchoscopy with NMA. The authors report that patient bathing, changing bed linens, pouring and flushing liquid waste, bronchoscopy, non-invasive ventilation, and nebulized medication administration (NMA) did not generate significant aerosols (3).

Table 1 Detection of aerosols in proximity of medical procedures or activities

First author Country	Particle detection	Procedure or activity	Conclusion
Alsved (4) Sweden Patients (n=26) Samples (n=86)	Norovirus (NoV)	Vomiting	Airborne virus correlated with vomiting episodes.
Kwak (5) Korea Patients (n=11)	Hepatitis B (HBV)	Robotic or laparoscopic resections	HBV detectable in surgical smoke.
O'Neil (3) US Samples (n=35)	Aerosols	Patient bathing Changing bed linens Pouring liquids into hopper Flushing liquid waste Noninvasive ventilation Nebulized medication administration (NMA) Bronchoscopy	Two procedures showed a significant increase in particle concentrations over baseline: NMA and bronchoscopy with NMA. No viruses and minimal viable bacteria were detected. More research is needed, but these data suggest that some of the procedures considered to be aerosol-generating may pose little infection risk to health care workers.
Marchand[a] (6) Canada Full day sampling from two rooms	Streptococcus spp, Neisseria spp, Corynebacterium spp, Streptococcus pneumoniae, Mycobacterium spp, influenza A and B virus	Bronchoscopy	Culturable bacteria from oral, nasal, and pulmonary flora were aerosolized during bronchoscopy. Mycobacterium spp and influenza virus was not detected.

Michailidis[a] (7) Australia Patients (n=24)	NA	Ultrasonic debridement (dental procedure)	There was higher microbial count during treatment ($P < .001$) with a higher microbial count associated with lower ultrasound amplitude ($P = .028$), lower saline flow rate ($P = .010$), no suction attachment ($P = < .001$), and a larger wound area ($P = .002$).
Singh (8) India Patients (n=20)	Staphylococcus aureus, Staphylococcus epidermidis, streptococcus	Ultrasonic scaling (dental procedure)	The results of this study confirm the findings by others of unusually high levels of microorganisms in aerosols after using the ultrasonic handpieces.
Vilarinho Oliveira[a] (9) Brazil	Curvularia clavata, Aspergillus niger, Phialemonium obovatum, Curvularia geniculate, Scopulariopsis koningii and more	High rotation pens (dental procedure)	High rotation pens contribute dispersion of contaminated aerosols in dental clinics.

a. Summary based on information from abstract – full text not available

Three case reports documented a) transmission of tuberculosis to a surgeon during intra-operative irrigation of a tuberculosis septic elbow (10), b) transmission of severe fever with thrombocytopenia syndrome virus during resuscitation (11) and c) transmission of MERS during cardiopulmonary resuscitation (12). In the latter two cases, other routes of infection than aerosols are possible.

Other reviews

We included two relevant unsystematic reviews (14,15). Kutter and co-workers summarise evidence for coronavirus transmission routes and state that SARS outbreaks in hospitals are most probably related to aerosol-generating procedures on severely ill patients (15). Judson and co-workers summarise evidence on aerosol-generating procedures and list bronchoscopy, cardiopulmonary resuscitation, non-invasive ventilation, tracheal intubation and manual ventilation as having possible association with SARS-CoV transmission (14).

Discussion and conclusion

We did not identify research on transmission routes for SARS-CoV-2, but based on data from similar viruses it seems likely that SARS-CoV-2 can be transmitted following the use of aerosol generating procedures in hospitals.

Consistent findings suggest that aerosols may be produced following intubation, tracheotomy, cardiopulmonary resuscitation and manual ventilation. According to some studies, bronchoscopy, non-invasive ventilation and use of nebulisers can also contribute to aerosol production, but this documentation is weaker and less consistent. For procedures others than those mentioned above, the documentation was very limited and / or ambiguous.

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Attachment

Search strategies

Databaser: Embase 1974 to 2020 March 26, Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) 1946 to March 26, 2020

Interface: Advanced search

1	exp Aerosols/ or (aerosol* or bioaerosol* or bio-aerosol*).tw,kw,kf.	134301
2	(Gastroscopy/ or Gastroscopes/) use ppezv or Gastroscope/ use oemezd or ((gastrointestinal adj3 endoscop*) or gastroscop*).tw,kw,kf.	60035
3	1 and 2	87
12	((exp Hospitals/ or (hospital* or healthcare or cross infection* or health facilit*).tw,kw.) and (exp Infection/ or exp Microorganism/ or exp Fungi/ or exp Virus/ or exp Sepsis/ or exp Bacteria/) and (exp aerosols/ or (aerosol* or bioaerosol* or bio-aerosol*).mp.)) use oemezd	1877
13	exp Hospitals/ or exp "health facilities"/ or exp "Cross infection"/ or (hospital or hospitals or "health care" or "cross infection" or cross-infection or nosocomial or "health facility" or "health facilities").tw,kw,kf.	4755986
14	Aerosols/ or (aerosol or aerosols or bioaerosol or bio-aerosol or "bio aerosol" or bio-aerosols or "bio aerosols").tw,kw,kf.	122553
15	exp Bacteria/ or exp Viruses/ or Amoebozoa/ or exp Fungi/ or exp Parasites/ or (bacteria or bacterial or bacteremia or bacteraemia or sepsis or septicaemia or septicemia or virus or viruses or viral or viridae or viral or amoebozoa or amoebe or amoebas or amoebic or fungus or fungal or fungi or fungating or parasitic or parasite or parasites or parasitemia or parasitemias or "micro organism" or "micro organisms" or microorganism or microorganisms or micro-organism or micro-organisms or "health care associated infections" or infections or infection or infectious).tw,kf,kw.	8357067
16	13 and 14 and 15	2584
17	16 use ppezv	1035
18	12 or 17	2912
19	limit 18 to yr="2016 -Current"	684

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