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EVIDENCE SEARCH REPORT

RESEARCH QUESTION:	UNIQUE IDENTIFIER:
What is the clinical evidence used to support aerosol generating medical procedures recommendations and guidelines regarding line flow volume or pressure?	PPE041702-01 ESR
REQUESTED RESOURCES: • Primary research (clinical studies)	
LIMITS/EXCLUSIONS/INCLUSIONS:	
DATE: APRIL 11, 2020	
LIBRARIAN: Lukas Miller, Michelle Dalidowicz	REQUESTOR: Mark Fenton --Michelle McCarron
TEAM: PPE	
CITE AS: Miller, L; Dalidowicz, M. **What is the clinical evidence used to support aerosol generating medical procedures recommendations and guidelines regarding line flow volume or pressure?** 2020 Apr 11; Document no.: PPE041702-01 ESR. In: COVID-19 Rapid Evidence Reviews [Internet]. SK: SK COVID Evidence Support Team, c2020. 12 p. (CEST evidence search report)	

LIBRARIAN NOTES/COMMENT

Michelle & Mark,

This was a less traditional search approach given the specificity of the request. My approach was more to connect the dots of citations and references in various AGMP (old & new) recommendations back to their source data. The systematic review by Tran et al (2012) was a frequently cited work in the post-SARS era, but there are also some studies measuring aerosolization and exhaustion in/around oxygen therapy in controlled environments

The first reference (Ferioli M et al), though recent, is well referenced and descriptive of the methods used to validate the recommendations.

Please let me know if I can be of any further assistance in this at all,

Lukas

SEARCH RESULTS

To obtain full-text articles email library@saskhealthauthority.ca.

SUMMARIES, GUIDELINES & OTHER RESOURCES

Background Info & Clinical Evidence

Public Health Canada –Part B, Section IV, subsection iii, 1b: strategies to reduce aerosol generation. In *Routine Practices & Additional Precautions for the transmission of infection in healthcare settings* (p. 97).
https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/diseases-conditions/routine-practices-precautions-healthcare-associated-infections/routine-practices-precautions-healthcare-associated-infections-2016-FINAL-eng.pdf

- *Included given their relevance/importance to established practices. PHAC and IPAC have released some documents/guidance specific to COVID-19 but they refer back to the routine guidance as best practice.*

Doyle, G.R., McCutcheon, J.A. (2015). Clinical Procedures for Safer Patient Care. Victoria, BC: BCcampus. Retrieved from https://opentextbc.ca/clinicalskills/
Chapter 5: Oxygen Therapy Systems https://opentextbc.ca/clinicalskills/chapter/5-5-oxygen-therapy-systems/

- *Textbook-level background information. The table data/info is sourced from a nursing textbook. Can pursue this further if you think it's necessary*

Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. PLoS One. 2012;7(4):e35797. doi:10.1371/journal.pone.0035797
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3338532/

- *Highly cited document for many recent recommendations. Primary data based on SARS transmissions to HCW data. Also listed below.*

ARTICLES FROM LIBRARY DATABASES

Note: References are sorted by year (newest to oldest)

0. Ferioli M, Cisternino C, Leo V, et al. Protecting healthcare workers from SARS-CoV-2 infection: practical indications. European respiratory review : an official journal of the European Respiratory Society. 2020;29(155):200068. DOI: 10.1183/16000617.0068-2020

ABSTRACT: The World Health Organization has recently defined the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection a pandemic. The infection, that may cause a potentially very severe respiratory disease, now called coronavirus disease 2019 (COVID-19), has airborne transmission via droplets. The rate of transmission is quite high, higher than common influenza. Healthcare workers are at high risk of contracting the infection particularly when applying respiratory devices such as oxygen cannulas or noninvasive ventilation. The aim of this article is to provide evidence-based recommendations for the correct use of "respiratory devices" in the COVID-19 emergency and protect healthcare workers from contracting the SARS-CoV-2 infection.This article provides evidence-based recommendations for the correct use of "respiratory

devices" in the COVID-19 emergency to protect healthcare workers from contracting the SARS-CoV-2 infection https://bit.ly/2wEcyHW
URL: http://err.ersjournals.com/content/29/155/200068.abstract
DOI: https://dx.doi.org/10.1183/16000617.0068-2020

1. Hui DS, Ip M, Tang JW, et al. Airflows around oxygen masks: A potential source of infection? Chest. 2006;130(3):822-6. DOI: 10.1378/chest.130.3.822

ABSTRACT: Patients with respiratory infections often require the use of supplemental oxygen via oxygen masks, which, in the hospital, may become sources of aerosolized infectious pathogens. To assess this risk, a human lung model (respiration rate, 12 breaths/min) was designed to test the potential for a simple oxygen mask at a common setting (4 L/min) to disperse potentially infectious exhaled air into the surrounding area. A laser sheet was used to illuminate the exhaled air from the mask, which contained fine tracer smoke particles. An analysis of captured digital images showed that the exhaled air at the peak of simulated exhalation reached a distance of approximately 0.40 m.
URL: https://www.ncbi.nlm.nih.gov/pubmed/16963681
DOI: https://dx.doi.org/10.1378/chest.130.3.822

2. Roberge RJ. Evaluation of the rationale for concurrent use of N95 filtering facepiece respirators with loose-fitting powered air-purifying respirators during aerosol-generating medical procedures. Am J Infect Control. 2008;36(2):135-41. DOI: 10.1016/j.ajic.2007.04.284

ABSTRACT: The concurrent use of N95 filtering facepiece respirators with powered air-purifying respirators during aerosol-generating medical procedures in patients with severe respiratory pathogens has been promoted as offering additional protection against infectious agents. The purpose of this article is to examine the impact of this additional respiratory equipment upon protection and personal performance. The presumed additive protective effect of an N95 filtering facepiece respirator used concurrently with a powered air-purifying respirator has not been subjected to rigorous scientific investigation. The burden imposed by additional respiratory protective equipment should not be discounted, and the potentially minor contribution to protection may be offset by the negative impact on personal performance. Novel uses of protective equipment occasionally are spawned during crisis situations, but their generalized applicability to healthcare workers should ultimately be evidence-based.
DOI: https://dx.doi.org/10.1016/j.ajic.2007.04.284

3. Hui DS, Chow BK, Chu L, et al. Exhaled air dispersion and removal is influenced by isolation room size and ventilation settings during oxygen delivery via nasal cannula. Respirology. 2011;16(6):1005-13. DOI: 10.1111/j.1440-1843.2011.01995.x

ABSTRACT: BACKGROUND AND OBJECTIVE: We compared the exhaled air dispersion distances during oxygen delivery via nasal cannula to a human-patient simulator (HPS) in two different isolation rooms. METHODS: Airflow was marked with intrapulmonary smoke for visualization. Oxygen flow was gradually increased from 1 to 5 L/min, with the HPS sitting at 45 degrees. The leakage jet plume was revealed by laser light-sheet and images captured by high-definition video. Smoke concentration in the plume was estimated from the light scattered by smoke particles. The experiments were conducted at a double-door, negative pressure isolation room with a dimension of 4.1 x 5.1 x 2.6 m, pressure of -7.4 Pa and 16 air exchanges/h (ACH) (room A). Results were compared with experiments repeated in a smaller isolation room with a dimension of 2.7 x 4.2 x 2.4 m, pressure of -5 Pa and 12 ACH (room B). RESULTS: Room A: an exhalation jet spread almost horizontally outward from the nostrils of the HPS to 0.66 m and 1 m towards the end of bed when oxygen flow was increased from 1 to 5 L/min respectively. Room B: there was interaction between the downward ceiling ventilation current and the exhaled air from the HPS, leading to deflection of exhaled smoke towards the head of the HPS at an oxygen flow rate of 1 L/min. As oxygen flow was increased gradually to 5 L/min, more room contamination with smoke was noted. CONCLUSIONS: Substantial exposure to exhaled air occurs within 1 m towards the end of the bed from patients

receiving oxygen via nasal cannula. Room dimension and air exchange rate are important factors in preventing contamination in isolation rooms.
URL: https://www.ncbi.nlm.nih.gov/pubmed/21605275
DOI: https://dx.doi.org/10.1111/j.1440-1843.2011.01995.x

4. Tang JW, Noakes CJ, Nielsen PV, et al. Observing and quantifying airflows in the infection control of aerosol- and airborne-transmitted diseases: an overview of approaches. J Hosp Infect. 2011;77(3):213-22. DOI: 10.1016/j.jhin.2010.09.037
ABSTRACT: With concerns about the potential for the aerosol and airborne transmission of infectious agents, particularly influenza, more attention is being focused on the effectiveness of infection control procedures to prevent hospital-acquired infections by this route. More recently a number of different techniques have been applied to examine the temporal-spatial information about the airflow patterns and the movement of related, suspended material within this air in a hospital setting. Closer collaboration with engineers has allowed clinical microbiologists, virologists and infection control teams to assess the effectiveness of hospital isolation and ventilation facilities. The characteristics of human respiratory activities have also been investigated using some familiar engineering techniques. Such studies aim to enhance the effectiveness of such preventive measures and have included experiments with human-like mannequins using various tracer gas/particle techniques, real human volunteers with real-time non-invasive Schlieren imaging, numerical modelling using computational fluid dynamics, and small scale physical analogues with water. This article outlines each of these techniques in a non-technical manner, suitable for a clinical readership without specialist airflow or engineering knowledge.
DOI: 10.1016/j.jhin.2010.09.037

5. Hui D, Chan M, Chow B. Aerosol dispersion during various respiratory therapies: a risk assessment model of nosocomial infection to health care workers. Hong Kong Med J. 2014;20(4 Supplement 4).
URL: https://pdfs.semanticscholar.org/79b4/3b8b452f9f9e498d8cc9f13693c5ad5b4634.pdf

6. Hui DS, Chow BK, Lo T, et al. Exhaled air dispersion during noninvasive ventilation via helmets and a total facemask. Chest. 2015;147(5):1336-43. DOI: 10.1378/chest.14-1934
ABSTRACT: BACKGROUND: Noninvasive ventilation (NIV) via helmet or total facemask is an option for managing patients with respiratory infections in respiratory failure. However, the risk of nosocomial infection is unknown. METHODS: We examined exhaled air dispersion during NIV using a human patient simulator reclined at 45 degrees in a negative pressure room with 12 air changes/h by two different helmets via a ventilator and a total facemask via a bilevel positive airway pressure device. Exhaled air was marked by intrapulmonary smoke particles, illuminated by laser light sheet, and captured by a video camera for data analysis. Significant exposure was defined as where there was >/= 20% of normalized smoke concentration. RESULTS: During NIV via a helmet with the simulator programmed in mild lung injury, exhaled air leaked through the neck-helmet interface with a radial distance of 150 to 230 mm when inspiratory positive airway pressure was increased from 12 to 20 cm H2O, respectively, while keeping the expiratory pressure at 10 cm H2O. During NIV via a helmet with air cushion around the neck, there was negligible air leakage. During NIV via a total facemask for mild lung injury, air leaked through the exhalation port to 618 and 812 mm when inspiratory pressure was increased from 10 to 18 cm H2O, respectively, with the expiratory pressure at 5 cm H2O. CONCLUSIONS: A helmet with a good seal around the neck is needed to prevent nosocomial infection during NIV for patients with respiratory infections.
URL: https://www.ncbi.nlm.nih.gov/pubmed/25392954
DOI: https://dx.doi.org/10.1378/chest.14-1934

7. Seto WH. Airborne transmission and precautions: facts and myths. J Hosp Infect. 2015;89(4):225-8. DOI: 10.1016/j.jhin.2014.11.005
ABSTRACT: Airborne transmission occurs only when infectious particles of <5 mum, known as aerosols, are propelled into the air. The prevention of such transmission is expensive, requiring N95 respirators and negative

pressure isolation rooms. This lecture first discussed whether respiratory viral infections are airborne with reference to published reviews of studies before 2008, comparative trials of surgical masks and N95 respirators, and relevant new experimental studies. However, the most recent experimental study, using naturally infected influenza volunteers as the source, showed negative results from all the manikins that were exposed. Modelling studies by ventilation engineers were then summarized to explain why these results were not unexpected. Second, the systematic review commissioned by the World Health Organization on what constituted aerosol-generating procedures was summarized. From the available evidence, endotracheal intubation either by itself or combined with other procedures (e.g. cardiopulmonary resuscitation or bronchoscopy) was consistently associated with increased risk of transmission by the generation of aerosols.
DOI: https://dx.doi.org/10.1016/j.jhin.2014.11.005

8. Wei J, Li Y. Airborne spread of infectious agents in the indoor environment. Am J Infect Control. 2016;44(9 Suppl):S102-8. DOI: 10.1016/j.ajic.2016.06.003

ABSTRACT: BACKGROUND: Since the 2003 severe acute respiratory syndrome epidemic, scientific exploration of infection control is no longer restricted to microbiologists or medical scientists. Many studies have reported on the release, transport, and exposure of expiratory droplets because of respiratory activities. This review focuses on the airborne spread of infectious agents from mucus to mucus in the indoor environment and their spread as governed by airflows in the respiratory system, around people, and in buildings at different transport stages. METHODS: We critically review the literature on the release of respiratory droplets, their transport and dispersion in the indoor environment, and the ultimate exposure of a susceptible host, as influenced by airflows. RESULTS: These droplets or droplet nuclei are transported by expired airflows, which are sometimes affected by the human body plume and use of a face mask, as well as room airflow. Room airflow is affected by human activities such as walking and door opening, and some droplets are eventually captured by a susceptible individual because of his or her inspired flows; such exposure can eventually lead to long-range spread of airborne pathogens. Direct exposure to the expired fine droplets or droplet nuclei results in short-range airborne transmission. Deposition of droplets and direct personal exposure to expired large droplets can lead to the fomite route and the droplet-borne route, respectively. CONCLUSIONS: We have shown the opportunities for infection control at different stages of the spread. We propose that the short-range airborne route may be important in close contact, and its control may be achieved by face masks for the source patients and use of personalized ventilation. Our discussion of the effect of thermal stratification and expiratory delivery of droplets leads to the suggestion that displacement ventilation may not be applicable to hospital rooms where respiratory infection is a concern.
DOI: https://dx.doi.org/10.1016/j.ajic.2016.06.003

9. Haddrell AE, Thomas RJ. Aerobiology: Experimental Considerations, Observations, and Future Tools. Applied and environmental microbiology. 2017;83(17). DOI: 10.1128/aem.00809-17

ABSTRACT: Understanding airborne survival and decay of microorganisms is important for a range of public health and biodefense applications, including epidemiological and risk analysis modeling. Techniques for experimental aerosol generation, retention in the aerosol phase, and sampling require careful consideration and understanding so that they are representative of the conditions the bioaerosol would experience in the environment. This review explores the current understanding of atmospheric transport in relation to advances and limitations of aerosol generation, maintenance in the aerosol phase, and sampling techniques. Potential tools for the future are examined at the interface between atmospheric chemistry, aerosol physics, and molecular microbiology where the heterogeneity and variability of aerosols can be explored at the single-droplet and single-microorganism levels within a bioaerosol. The review highlights the importance of method comparison and validation in bioaerosol research and the benefits that the application of novel techniques could bring to increasing the understanding of aerobiological phenomena in diverse research fields, particularly during the progression of atmospheric transport, where complex interdependent physicochemical and biological processes occur within bioaerosol particles.

DOI: https://dx.doi.org/10.1128/aem.00809-17

10. O'Neil CA, Li J, Leavey A, et al. Characterization of Aerosols Generated During Patient Care Activities. Clin Infect Dis. 2017;65(8):1335-41. DOI: 10.1093/cid/cix535

ABSTRACT: Background: Questions remain about the degree to which aerosols are generated during routine patient care activities and whether such aerosols could transmit viable pathogens to healthcare personnel (HCP). The objective of this study was to measure aerosol production during multiple patient care activities and to examine the samples for bacterial pathogens. Methods: Five aerosol characterization instruments were used to measure aerosols during 7 patient care activities: patient bathing, changing bed linens, pouring and flushing liquid waste, bronchoscopy, noninvasive ventilation, and nebulized medication administration (NMA). Each procedure was sampled 5 times. An SKC BioSampler was used for pathogen recovery. Bacterial cultures were performed on the sampling solution. Patients on contact precautions for drug-resistant organisms were selected for most activity sampling. Any patient undergoing bronchoscopy was eligible. Results: Of 35 sampling episodes, only 2 procedures showed a significant increase in particle concentrations over baseline: NMA and bronchoscopy with NMA. Bronchoscopy without NMA and noninvasive ventilation did not generate significant aerosols. Of 78 cultures from the impinger samples, 6 of 28 baseline samples (21.4%) and 14 of 50 procedure samples (28.0%) were positive. Conclusions: In this study, significant aerosol generation was only observed during NMA, both alone and during bronchoscopy. Minimal viable bacteria were recovered, mostly common environmental organisms. Although more research is needed, these data suggest that some of the procedures considered to be aerosol-generating may pose little infection risk to HCP.
DOI: https://dx.doi.org/10.1093/cid/cix535

11. Zemouri C, de Soet H, Crielaard W, et al. A scoping review on bio-aerosols in healthcare and the dental environment. PLoS ONE. 2017;12(5):e0178007. DOI: 10.1371/journal.pone.0178007

ABSTRACT: BACKGROUND: Bio-aerosols originate from different sources and their potentially pathogenic nature may form a hazard to healthcare workers and patients. So far no extensive review on existing evidence regarding bio-aerosols is available. OBJECTIVES: This study aimed to review evidence on bio-aerosols in healthcare and the dental setting. The objectives were 1) What are the sources that generate bio-aerosols?; 2) What is the microbial load and composition of bio-aerosols and how were they measured?; and 3) What is the hazard posed by pathogenic micro-organisms transported via the aerosol route of transmission? METHODS: Systematic scoping review design. Searched in PubMed and EMBASE from inception to 09-03-2016. References were screened and selected based on abstract and full text according to eligibility criteria. Full text articles were assessed for inclusion and summarized. The results are presented in three separate objectives and summarized for an overview of evidence. RESULTS: The search yielded 5,823 studies, of which 62 were included. Dental hand pieces were found to generate aerosols in the dental settings. Another 30 sources from human activities, interventions and daily cleaning performances in the hospital also generate aerosols. Fifty-five bacterial species, 45 fungi genera and ten viruses were identified in a hospital setting and 16 bacterial and 23 fungal species in the dental environment. Patients with certain risk factors had a higher chance to acquire Legionella in hospitals. Such infections can lead to irreversible septic shock and death. Only a few studies found that bio-aerosol generating procedures resulted in transmission of infectious diseases or allergic reactions. CONCLUSION: Bio-aerosols are generated via multiple sources such as different interventions, instruments and human activity. Bio-aerosols compositions reported are heterogeneous in their microbiological composition dependent on the setting and methodology. Legionella species were found to be a bio-aerosol dependent hazard to elderly and patients with respiratory complaints. But all aerosols can be can be hazardous to both patients and healthcare workers.
DOI: https://dx.doi.org/10.1371/journal.pone.0178007

12. Lizal F, Jedelsky J, Morgan K, et al. Experimental methods for flow and aerosol measurements in human airways and their replicas. European journal of pharmaceutical sciences : official journal of the European Federation for Pharmaceutical Sciences. 2018;113:95-131. DOI: 10.1016/j.ejps.2017.08.021

ABSTRACT: Recent developments in the prediction of local aerosol deposition in human lungs are driven by the fast development of computational simulations. Although such simulations provide results in unbeatable resolution, significant differences among distinct methods of calculation emphasize the need for highly precise experimental data in order to specify boundary conditions and for validation purposes. This paper reviews and critically evaluates available methods for the measurement of single and disperse two-phase flows for the study of respiratory airflow and deposition of inhaled particles, performed both in vivo and in replicas of airways. Limitations and possibilities associated with the experimental methods are discussed and aspects of the computational calculations that can be validated are indicated. The review classifies the methods into following categories: 1) point-wise and planar methods for velocimetry in the airways, 2) classic methods for the measurement of the regional distribution of inhaled particles, 3) standard medical imaging methods applicable to the measurement of the regional aerosol distribution and 4) emerging and nonconventional methods. All methods are described, applications in human airways studies are illustrated, and recommendations for the most useful applications of each method are given.

DOI: https://dx.doi.org/10.1016/j.ejps.2017.08.021

13. Mirskaya E, Agranovski IE. Sources and mechanisms of bioaerosol generation in occupational environments. Crit Rev Microbiol. 2018;44(6):739-58. DOI: 10.1080/1040841x.2018.1508125

ABSTRACT: The primary purpose of this study was to critically review published data related to the sources and mechanisms of aerosolization of microorganisms, their fragments and metabolites in a variety of occupational environments. The processes and mechanisms considered in the review include bursting bubbles; liquid dispersion as the result of irrigation, separation, high pressure cleaning and technological water recycling; manual and automated handling of contaminated material in agriculture, waste processing and industrial processes; as well as high temperature industrial processes. The review identifies the gaps in the existing knowledge regarding the sources of bioaerosol, aerosolization mechanisms, bioaerosol distribution and potential risks for the workers and residents. The study also reviews the existing laboratory methods of bioaerosol generation with particular focus on the advantages and shortcomings of each method.

DOI: https://dx.doi.org/10.1080/1040841x.2018.1508125

14. Hui DS, Chow BK, Lo T, et al. Exhaled air dispersion during high-flow nasal cannula therapy versus CPAP via different masks. Eur Respir J. 2019;53(4). DOI: 10.1183/13993003.02339-2018

ABSTRACT: BACKGROUND: High-flow nasal cannula (HFNC) is an emerging therapy for respiratory failure but the extent of exhaled air dispersion during treatment is unknown. We examined exhaled air dispersion during HFNC therapy versus continuous positive airway pressure (CPAP) on a human patient simulator (HPS) in an isolation room with 16 air changes.h(-1). METHODS: The HPS was programmed to represent different severity of lung injury. CPAP was delivered at 5-20 cmH2O via nasal pillows (Respironics Nuance Pro Gel or ResMed Swift FX) or an oronasal mask (ResMed Quattro Air). HFNC, humidified to 37 degrees C, was delivered at 10-60 L.min(-1) to the HPS. Exhaled airflow was marked with intrapulmonary smoke for visualisation and revealed by laser light-sheet. Normalised exhaled air concentration was estimated from the light scattered by the smoke particles. Significant exposure was defined when there was >/=20% normalised smoke concentration. RESULTS: In the normal lung condition, mean+/-sd exhaled air dispersion, along the sagittal plane, increased from 186+/-34 to 264+/-27 mm and from 207+/-11 to 332+/-34 mm when CPAP was increased from 5 to 20 cmH2O via Respironics and ResMed nasal pillows, respectively. Leakage from the oronasal mask was negligible. Mean+/-sd exhaled air distances increased from 65+/-15 to 172+/-33 mm when HFNC was increased from 10 to 60 L.min(-1). Air leakage to 620 mm occurred laterally when HFNC and the interface tube became loose. CONCLUSION: Exhaled air dispersion during HFNC and CPAP via different interfaces is limited provided there is good mask interface fitting.

URL: https://www.ncbi.nlm.nih.gov/pubmed/30705129
DOI: https://dx.doi.org/10.1183/13993003.02339-2018

15. Tang JW, Li Y. Editorial: the airborne microbiome - implications for aerosol transmission and infection control - special issue. BMC Infect Dis. 2019;19(1):755. DOI: 10.1186/s12879-019-4399-z
ABSTRACT: Although the title of the Special Issue is 'Airborne Microbiome' the manuscripts received have highlighted a variety of peripheral, yet related aspects of this. The contributions are a mixture of primary research, reviews and commentaries, including: new methods to explore environmental niches where such microbes may grow, their detection and characterisation in the human host, which pathogens are present in the respiratory tract and can be exhaled in human breath to potentially spread via the airborne route, and some strategies for their control. Finally, a historical-to-current overview explores human-microbial interactions, including problems with sampling and detection methods, drug resistance, the role of super-spreaders and issues around research funding.
DOI: https://dx.doi.org/10.1186/s12879-019-4399-z

16. Amirav IMD, Newhouse MTMDM. Transmission of coronavirus by nebulizer: a serious, underappreciated risk: CMAJ CMAJ. Canadian Medical Association Journal. 2020;192(13):346. https://doi.org/10.1503/cmaj.75066
ABSTRACT: Amirav and Newhouse discuss the risk of transmission coronavirus disease 2019 (COVID-19) by nebulizer. The current pandemic of COVID-19 cases demands greater infection control precautions. Nebulizers generate aerosol particles in the size of 1-5 µm, which can carry bacteria and viruses into the deep lung. The risk of infection transmission via droplet nuclei and aerosols may increase during nebulizer treatments because of the potential to generate a high volume of respiratory aerosols that may be propelled over a longer distance than is involved in a natural dispersion pattern. Furthermore, the larger particles may stimulate both patients' and bystanders' cough and thus increase the risk of spreading the disease. There is a possibility that nebulizer therapy in patients with COVID-19 infection can transmit potentially viable coronavirus to susceptible bystander hosts.
URL: https://doi.org/10.1503/cmaj.75066

17. Balachandar V, Mahalaxmi I, Kaavya J, et al. COVID-19: emerging protective measures. Eur Rev Med Pharmacol Sci. 2020;24(6):3422-5. DOI: https://dx.doi.org/10.26355/eurrev_202003_20713
ABSTRACT: The COVID-19 (Coronavirus disease 2019) spreads primarily through droplets of saliva or discharge from the nose. COVID-19 is predominantly considered as an unavoidable pandemic, and scientists are very curious about how to provide the best protection to the public before a vaccine can be made available. There is an urge to manufacture a greater number of masks to prevent any aerosol with microbes. Hence, we aim to develop an efficient viral inactivation system by exploiting active compounds from naturally occurring medicinal plants and infusing them into nanofiber-based respiratory masks. Our strategy is to develop fibrous filtration with three-layered masks using the compounds from medicinal plants for viral deactivation. These masks will be beneficial not just to healthcare workers but common citizens as well. In the absence of vaccination, productive masks can be worn to prevent transmission of airborne pathogenic aerosols and control diseases.
DOI: https://dx.doi.org/10.26355/eurrev_202003_20713

18. Chica-Meza C, Peña-López LA, Villamarín-Guerrero HF, et al. Respiratory Care In Covid-19. Acta Colombiana de Cuidado Intensivo. 2020. DOI: 10.1016/j.acci.2020.04.001
ABSTRACT: Background: COVID-19 is part of the family of viruses known as Coronaviridae. The new pathogen β-coronavirus of the subgenus Sarbecovirus was initially named as a novel coronavirus (2019-nCoV), identified in a pneumonia outbreak in Wuhan. Patients developed alterations in the respiratory system leading to severe pneumonia, pulmonary oedema, and acute respiratory distress syndrome (ARDS). Objective: To review the available scientific evidence related to the care of the respiratory system in order to establish general treatment guidelines. Methods: Narrative review of the literature was carried out that included a search, selection, and

review of original and secondary articles written in English or Spanish in the different databases: NCBI, CENTRAL, MEDLINE and EMBASE published up to March 2020. Results: No specific treatment for the new disease has been defined, with symptomatic control as the main therapeutic measure. The use of biosecurity elements, such as goggles, hats, gloves, long waterproof aprons, high efficiency masks for healthcare personnel (FFP2 or N95) is recommended. In symptomatic patients use surgical masks, hospital soap, paper towels, and 70% alcohol or isopropyl alcohol. Use oxygen through low flow systems. A mechanical ventilation program in VCP or VCV modes, Vt: 4-6 ml/Kg, Fr: ≤ 35, FiO2: for PaO2 = 60 mmHg or SpO2: 92-96%, PEEP: 12-17 cmH(2)O, Prone ventilation if PAFI ≤ 150 with ratio16/8 or 18/6, nitric oxide: 5-20 ppm. Conclusions: Use biosecurity equipment in order to prevent transmission. In hypoxaemia use low flow oxygen therapy systems. Use lung protection strategies, decrease in tidal volumes, plateau pressures and respiratory rates, plus implementation of high PEEP values, low conduction pressure values and prone ventilation. These have been shown to improve hypoxaemia and survival in patients with ARDS.
URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7144845/
DOI: https://dx.doi.org/10.1016/j.acci.2020.04.001

19. Fathizadeh H, Maroufi P, Momen-Heravi M, et al. Protection and disinfection policies against SARS-CoV-2 (COVID-19). Infez Med. 2020;28(2):185-91.
ABSTRACT: In late December 2019, reports from China of the incidence of pneumonia with unknown etiology were sent to the World Health Organization (WHO). Shortly afterwards, the cause of this disease was identified as the novel beta-coronavirus, SARS-CoV-2, and its genetic sequence was published on January 12, 2020. Human-to-human transmission via respiratory droplets and contact with aerosol infected surfaces are the major ways of transmitting this virus. Here we attempted to collect information on virus stability in the air and on surfaces and ways of preventing of SARS-CoV-2 spreading.
URL: https://www.ncbi.nlm.nih.gov/pubmed/32275260

20. Guo ZD, Wang ZY, Zhang SF, 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):10. DOI: https://dx.doi.org/10.3201/eid2607.200885
ABSTRACT: To determine distribution of severe acute respiratory syndrome coronavirus 2 in hospital wards in Wuhan, China, we tested air and surface samples. Contamination was greater in intensive care units than general wards. Virus was widely distributed on floors, computer mice, trash cans, and sickbed handrails and was detected in air =4 m from patients.
DOI: https://dx.doi.org/10.3201/eid2607.200885

21. Institute LHR. Non Invasive Positive Pressure Ventilation to Minimize Aerosolization for COVID 19. ClinicalTrials2020.
URL: https://ClinicalTrials.gov/show/NCT04344925

22. Matava CT, Yu J, Denning S. Clear plastic drapes may be effective at limiting aerosolization and droplet spray during extubation: implications for COVID-19. Canadian Journal of Anesthesia/Journal canadien d'anesthésie. 2020:1-3. DOI: 10.1007/s12630-020-01649-w
URL: http://link.springer.com/10.1007/s12630-020-01649-w
DOI: https://dx.doi.org/10.1007/s12630-020-01649-w

23. Meng L, Qiu H, Wan L, et al. Intubation and Ventilation amid the COVID-19 Outbreak: Wuhan's Experience. Anesthesiology. 2020. DOI: 10.1097/ALN.0000000000003296 [doi]
ABSTRACT: The COVID-19 outbreak has led to 80,409 diagnosed cases and 3,012 deaths in mainland China based on the data released on March 4, 2020. Approximately 3.2% of patients with COVID-19 required intubation and invasive ventilation at some point in the disease course. Providing best practices regarding intubation and

ventilation for an overwhelming number of patients with COVID-19 amid an enhanced risk of cross-infection is a daunting undertaking. The authors presented the experience of caring for the critically ill patients with COVID-19 in Wuhan. It is extremely important to follow strict self-protection precautions. Timely, but not premature, intubation is crucial to counter a progressively enlarging oxygen debt despite high-flow oxygen therapy and bilevel positive airway pressure ventilation. Thorough preparation, satisfactory preoxygenation, modified rapid sequence induction, and rapid intubation using a video laryngoscope are widely used intubation strategies in Wuhan. Lung-protective ventilation, prone position ventilation, and adequate sedation and analgesia are essential components of ventilation management.
DOI: https://dx.doi.org/10.1097/ALN.0000000000003296 [doi]

24. Respiratory care committee of Chinese TS. Expert consensus on preventing nosocomial transmission during respiratory care for critically ill patients infected by 2019 novel coronavirus pneumonia. Zhonghua jie he he hu xi za zhi = Zhonghua jiehe he huxi zazhi = Chinese journal of tuberculosis and respiratory diseases. 2020;17(0):E020-E. DOI: 10.3760/cma.j.issn.1001-0939.2020.0020
ABSTRACT: Definite evidence has shown that the novel coronavirus (COVID-19) could be transmitted from person to person, so far more than 1,700 bedside clinicians have been infected. A lot of respiratory treatments for critically ill patients are deemed as high-risk factors for nosocomial transmission, such as intubation, manual ventilation by resuscitator, noninvasive ventilation, high-flow nasal cannula, bronchoscopy examination, suction and patient transportation, etc, due to its high possibility to cause or worsen the spread of the virus. As such, we developed this consensus recommendations on all those high-risk treatments, based on the current evidence as well as the resource limitation in some areas, with the aim to reduce the nosocomial transmission and optimize the treatment for the COVID-19 pneumonia patients. Those recommendations include: (1) Standard prevention and protection, and patient isolation; (2) Patient wearing mask during HFNC treatment; (3) Using dual limb ventilator with filters placed at the ventilator outlets, or using heat-moisture exchanger (HME) instead of heated humidification in single limb ventilator with HME placed between exhalation port and mask; avoid using mask with exhalation port on the mask; (4) Placing filter between resuscitator and mask or artificial airway; (5) For spontaneous breathing patients, placing mask for patients during bronchoscopy examination; for patients receiving noninvasive ventilation, using the special mask with bronchoscopy port to perform bronchoscopy; (6) Using sedation and paralytics during intubation, cuff pressure should be maintained between 25-30 cmH(2)O; (7) In-line suction catheter is recommended and it can be used for one week; (8) Dual-limb heated wire circuits are recommended and only changed with visible soiled; (9. For patients who need breathing support during transportation, placing an HME between ventilator and patient; (10) PSV is recommended for implementing spontaneous breathing trial (SBT), avoid using T-piece to do SBT. When tracheotomy patients are weaned from ventilator, HME should be used, avoid using T-piece or tracheostomy mask. (11) Avoid unnecessary bronchial hygiene therapy; (12) For patients who need aerosol therapy, dry powder inhaler metered dose inhaler with spacer is recommended for spontaneous breathing patients; while vibrating mesh nebulizer is recommended for ventilated patients and additional filter is recommended to be placed at the expiratory port of ventilation during nebulization.
URL: https://pubmed.ncbi.nlm.nih.gov/32077661
DOI: https://dx.doi.org/10.3760/cma.j.issn.1001-0939.2020.0020

25. Satheesan MK, Mui KW, Wong LT. A numerical study of ventilation strategies for infection risk mitigation in general inpatient wards. Build Simul. 2020. DOI: 10.1007/s12273-020-0623-4
ABSTRACT: Aerial dispersion of human exhaled microbial contaminants and subsequent contamination of surfaces is a potential route for infection transmission in hospitals. Most general hospital wards have ventilation systems that drive air and thus contaminants from the patient areas towards the corridors. This study investigates the transport mechanism and deposition patterns of Middle East Respiratory Syndrome Coronavirus (MERS-CoV) within a typical six bedded general inpatient ward cubicle through numerical simulation. It demonstrates that both air change and exhaust airflow rates have significant effects on not only the airflow but

also the particle distribution within a mechanically ventilated space. Moreover, the location of an infected patient within the ward cubicle is crucial in determining the extent of infection risk to other ward occupants. Hence, it is recommended to provide exhaust grilles in close proximity to a patient, preferably above each patient's bed. To achieve infection prevention and control, high exhaust airflow rate is also suggested. Regardless of the ventilation design, all patients and any surfaces within a ward cubicle should be regularly and thoroughly cleaned and disinfected to remove microbial contamination. The outcome of this study can serve as a source of reference for hospital management to better ventilation design strategies for mitigating the risk of infection.
URL: https://doi.org/10.1007/s12273-020-0623-4
DOI: https://dx.doi.org/10.1007/s12273-020-0623-4

26. World Health O. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. 2020.
ABSTRACT: Modes of transmission of the COVID-19 virus Respiratory infections can be transmitted through droplets of different sizes: when the droplet particles are 5-10 µm in diameter they are referred to as respiratory droplets, and when then are 5µm in diameter, they are referred to as droplet nuclei.1 According to current evidence, COVID-19 virus is primarily transmitted between people through respiratory droplets and contact routes.2-7 In an analysis of 75,465 COVID-19 cases in China, airborne transmission was not reported.8 Droplet transmission occurs when a person is in in close contact (within 1 m) with someone who has respiratory symptoms (e.g., coughing or sneezing) and is therefore at risk of having his/her mucosae (mouth and nose) or conjunctiva (eyes) exposed to potentially infective respiratory droplets. Transmission may also occur through fomites in the immediate environment around the infected person.8 Therefore, transmission of the COVID-19 virus can occur by direct contact with infected people and indirect contact with surfaces in the immediate environment or with objects used on the infected person (e.g., stethoscope or thermometer). Airborne transmission is different from droplet transmission as it refers to the presence of microbes within droplet nuclei, which are generally considered to be particles 5µm in diameter, can remain in the air for long periods of time and be transmitted to others over distances greater than 1 m. In the context of COVID-19, airborne transmission may be possible in specific circumstances and settings in which procedures or support treatments that generate aerosols are performed; i.e., endotracheal intubation, bronchoscopy, open suctioning, administration of nebulized treatment, manual ventilation before intubation, turning the patient to the prone position, disconnecting the patient from the ventilator, non-invasive positive-pressure ventilation, tracheostomy, and cardiopulmonary resuscitation. There is some evidence that COVID-19 infection may lead to intestinal infection and be present in faeces. However, to date only one study has cultured the COVID-19 virus from a single stool specimen.9 There have been no reports of faecal−oral transmission of the COVID-19 virus to date.
URL: https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations

27. Zuo MZ, Huang YG, Ma WH, et al. Expert Recommendations for Tracheal Intubation in Critically ill Patients with Noval Coronavirus Disease 2019. Chin Med Sci J. 2020;27:27. DOI: https://dx.doi.org/10.24920/003724
ABSTRACT: Coronavirus Disease 2019 (COVID-19), caused by a novel coronavirus (SARS-CoV-2), is a highly contagious disease. It firstly appeared in Wuhan, Hubei province of China in December 2019. During the next two months, it moved rapidly throughout China and spread to multiple countries through infected persons travelling by air. Most of the infected patients have mild symptoms including fever, fatigue and cough. But in severe cases, patients can progress rapidly and develop to the acute respiratory distress syndrome, septic shock, metabolic acidosis and coagulopathy. The new coronavirus was reported to spread via droplets, contact and natural aerosols from human-to-human. Therefore, high-risk aerosol-producing procedures such as endotracheal intubation may put the anesthesiologists at high risk of nosocomial infections. In fact, SARS-CoV-2 infection of anesthesiologists after endotracheal intubation for confirmed COVID-19 patients have been reported in hospitals in Wuhan. The expert panel of airway management in Chinese Society of Anaesthesiology

has deliberated and drafted this recommendation, by which we hope to guide the performance of endotracheal intubation by frontline anesthesiologists and critical care physicians. During the airway management, enhanced droplet/airborne PPE should be applied to the health care providers. A good airway assessment before airway intervention is of vital importance. For patients with normal airway, awake intubation should be avoided and modified rapid sequence induction is strongly recommended. Sufficient muscle relaxant should be assured before intubation. For patients with difficult airway, good preparation of airway devices and detailed intubation plans should be made.
DOI: https://dx.doi.org/10.24920/003724

SEARCH STRATEGIES

Search Terms Used (in various combinations / rootwords)

- Aerosols
- Oxygen (O2)
- Volume
- Pressure
- Line flow
- Intubate
- Extubate
- Ventilate
- Cannula
- Airways
- Oxygen therapy
- Respiratory therapy
- Nosocomial
- Infection prevention