

COVID-19 Scientific Advisory Group Rapid Response Report

Key Research Question:

1. **What is the risk for COVID-19 transmission associated with oxygen therapy (conventional and humidified high flow (HHFO)) and when is oxygen therapy considered an AGMP?**
2. **When is it appropriate to use conventional oxygen delivery vs humidified high flow oxygen therapy in the healthcare setting?**

28 February 2022

Since this review was written, the evidence on this topic has advanced but the recommendations made in this report remain unchanged. A relevant evidence synthesis commissioned by the Respiratory Section of the Medicine Strategic Clinical Network™ and the following two peer-reviewed references can be used to support clinical practice.

[Non-invasive ventilation and heated humidified high-flow oxygen therapies for severe COVID-19 \(albertahealthservices.ca\)](https://albertahealthservices.ca)

Cammarota, G., et al. (2021). [Noninvasive respiratory support outside the intensive care unit for acute respiratory failure related to coronavirus-19 disease: a systematic review and meta-analysis](#). Critical care (London, England), 25(1), 268.

Ospina-Tascón, G. A., et al. (2021). [Effect of high-flow oxygen therapy vs conventional oxygen therapy on invasive mechanical ventilation and clinical recovery in patients with severe COVID-19: a randomized clinical trial](#). JAMA, 326(21), 2161-2171.

Context

- Questions have arisen from the respiratory and emergency department health care professional community regarding the use of conventional oxygen therapy, high flow nasal oxygen therapy (HFNO), and humidified high flow oxygen therapy (HHFO) in patients with COVID-19 and the potential risk to health care workers (HCWs). HHFO can refer to heated humidified oxygen delivery systems (such as Optiflow™/AIRVO™) or cold nebulization via facemask.
- Media reports suggest that NIV and HHFO are being used extensively in the COVID-19 patient group⁶
- The rapid review excludes mask oxygen delivery including non-rebreather and Venturi mask.
- The rapid review was based upon limited literature and existing published guideline documents
- This review does not address the use of oxygen therapy in the home setting
- The information in this rapid review is meant to be used in addition to clinical judgment and to inform clinical decision making

Glossary of Terms:

AGMP: Aerosol generating medical procedure

Conventional oxygen therapy: nasal prongs, high flow nasal prongs

HHHFO: Heated, humidified, high flow oxygen (any system that adds humidity to the delivered oxygen, such as the heated high flow oxygen delivery systems- AIRVO™ and Optiflow™)

HFNO: High flow nasal oxygen

HCW: Health care worker

Key Messages from the Evidence Summary

- Oxygen delivery by nasal prongs (from 1-5LPM) is not associated with an increased risk of COVID-19 transmission beyond droplet and contact risk. HHHFO is generally considered to be an AGMP and thus PPE with the use of N95 and a contained environment (ie private room) is required.
- Oxygen therapy is considered to be an AGMP when it is humidified
- The use of HHHFO during the COVID-19 pandemic is controversial. There is some indication that it may offer value to individuals' with early hypoxemia using appropriate PPE with inclusion of N95 mask, but is a very limited resource and creates the need for AGMP precautions where they would not otherwise be required.
- HHHFO may also be used in the event that ventilator care is not available, or delayed, so guidelines may need to be adjusted for future resource limitations.

Recommendations regarding question 1:

- Oxygen delivery by nasal prongs (from 1-5LPM) is not associated with an increased risk of COVID-19 transmission beyond droplet and contact risk
- There is no strong evidence to support that high flow oxygen by nasal prongs (ie 6 LPM to 15 LPM) is an AGMP
- HHHFO (via Optiflow™ or Airvo™) is AGMP and requires PPE plus N95 and private room.

Recommendations regarding question 2:

- When oxygen requirements exceed oxygen delivery by simple nasal prongs (ie >5 LPM), clinical judgement must be used, but first line therapy should continue to be conventional oxygen with high flow nasal prongs up to 15 LPM rather than heated, humidified oxygen delivery.
- HHHFO is an AGMP and thus requires increased resources (N95 and isolation rooms) compared to non-humidified oxygen delivery, and both Optiflow and Airvo are extremely limited resources in the current AHS environment. In a patient whose goals of care include possible intubation, involvement of critical care in decision making when oxygen requirements exceed 6 LPM or if there is rapid clinical deterioration is advised.

Committee discussion:

There was consensus among the committee about these recommendations. One reviewer noted that there is controversy about whether oxygen delivery at 6-15 LPM could pose a risk of aerosolization.

Summary of Evidence

Credible information sources were identified through a rapid online search. One reference is original research (RCT), four papers were published correspondence, and there were four review articles. Thirteen published guidelines or consensus documents were included, which use a range of research sources and likely expertise consensus within these organizations. One paper provided the clinical experience of those working China during the pandemic, and one Health Technology Assessment.

Key limitations of this review:

- Rapid turnaround time resulted in a limited time to conduct a thorough search of the research and grey literature.
- Given the rapidly changing information and literature related to COVID-19, the literature available is limited primarily to reviews, guideline documents, published letters, and descriptive papers.

Description of the Therapy

Heated and humidified oxygen may have a number of benefits compared to conventional oxygen therapy, however this needs to be weighed against the fact that heated HHHFO is a very limited resource and its use is an AGMP thus increasing use of other limited resources (N95 and private rooms). Standard oxygen therapy delivered through a nasal cannula or another device, delivers cold and dry gas. This cold, dry gas may lead to airway inflammation, increase airway resistance, and impair mucociliary function, possibly impairing secretion clearance.¹⁴ Also, a significant amount of energy is expended by individuals to both warm and humidify gas during normal breathing.¹⁰ Thus, heated and humidified oxygen may improve secretion clearance, decrease airway inflammation, and also decrease energy expenditure, particularly in the setting of acute respiratory failure.^{10,14} A 2019 meta-analysis by Huang et al.¹⁰ assessed the use of high-flow nasal cannula therapy compared to conventional oxygen therapy or non-invasive ventilation for treatment of acute respiratory failure in emergency department.¹⁰ They found that compared to conventional oxygen therapy, those that received HFNO therapy had a reduced need for treatment escalation, reduced dyspnea scores, and improved comfort. However, the interventions across the studies varied, making studies difficult to compare. In addition, there was an increasing trend in intubation rate associated with the use of HFNO therapy, although this result was not significant.¹⁰

A previous meta-analysis of RCTs from Ou et al. in 2017, found HFNO had lower intubation rates than conventional oxygen therapy and similar rate to non-invasive ventilation in critical care patients with acute hypoxemic respiratory failure.²⁰ It is congruent with the results from a 2019 systematic review that found HFNO may decrease tracheal intubation without impacting mortality when used to treat patient with acute hypoxemic respiratory failure.⁷ The applicability of these studies is limited, as the primary outcome was the need for intubation.

*Research Question 1***What is the risk for COVID-19 transmission associated with oxygen therapy (conventional and HHHFO)?**

SARS-CoV-2, the causative agent of COVID-19, can be transmitted by large respiratory droplets or aerosol via inhalation or mucosal surfaces; feces; and contaminated objects (fomites). The World Health organization (WHO) suggests that all respiratory care poses a potential risk to health care workers (HCW) during the COVID-19 pandemic.²⁷ HCW should strictly adhere to hand hygiene protocol and ensure they use optimal donning and doffing technique of all PPE to reduce risk.

Conventional Oxygen Therapy**Conventional Oxygen Therapy is not considered an AGMP**

A systematic review in 2012 by Tran et al. evaluated the transmission of acute respiratory infections to HCWs, and determined conventional oxygen therapy is not significantly associated with a risk of transmission to HCWs.²⁴

Only 10 studies were identified and all evaluated transmission of SARS virus to HCWs (2002-2003). All studies were graded very low quality. Manipulation of the oxygen mask was based on 2 cohort studies with a pooled estimate of OR 4.6 (95% CI 0.6 to 32.5), and was not a significant risk of transmission. Simonds and colleagues (2010) evaluated characteristics of droplets and aerosol generating in an observational study of 44 patients (normal controls, those with symptomatic viral infection and those with chronic lung disease). They determined that providing O₂ via mask at 24% and 60% was neither aerosol nor droplet generating.

As per the previously described review by Tran et al. one cohort study evaluated the risk of SARS transmission with the use of high-flow oxygen (non-humidified). This study found no statistically significant risk of viral transmission (OR 0.4, 95%CI 0.1-1.7). Leung and colleagues (2018) found HHNO use in patients with Gram negative bacteria pneumonia did not increase airborne and surface contamination when compared with an oxygen mask.

Heated humidified high flow oxygen (HHHFO)**HHHFO is considered a risk for AGMP and thus requires the use of PPE for contact and droplet plus the use of N95 and private room.**

HHHFO studies suggest that aerosol generation with HHHFO at 60L/min is minimal, and less than that caused by typical coughing and sneezing when the equipment is used appropriately and fits well.⁶ Additionally, the risk of exposure to aerosolization to a HCW from HHHFO depends upon the duration of use, flow rate, patient coughing and cooperation, fit of the patient apparatus, and the quality and fit of HCW's personal protective equipment (PPE).^{6,17}

However, in contrast, Cheung et al. did not recommend HHHFO for COVID-19 patients, as current published research demonstrating minimal dispersion of exhaled air was conducted in simulation with optimally fitting equipment, which would imply reduced exposure. They also

elaborated that variability of models and modes of delivery differ across jurisdictions and also the potential/theoretical risk of transmission is uncertain. In addition, a consensus statement from the Safe Airway Society of Australia and New Zealand published March 16th, 2020 cautions that there is little evidence for HFNC's utility in viral pandemics, although anecdotal information indicates it being used internationally during COVID-19 pandemic.⁶

When is oxygen therapy considered an aerosol generating medical procedure (AGMP)?

Generally, oxygen is delivered dry, at a low flow rate, however, high gas flows (up to 60 L/min) may cause aerosolization of infectious particles and spread of infection¹³, creating concern for the HCW during the COVID-19 pandemic.

HHHFO is considered an AGMP

Recent guidelines indicate that HHHFO is considered an AGMP.^{2,4-6,12,15,16, 21,25,27,28} However, there is no evidence that conventional oxygen delivery by nasal prongs, even using high flow nasal prongs up to 15 LPM are a AGMP²⁴ In a clinical practice guideline by Restrepo et al. they describe some of the hazards associated with the use of humidification devices and describe that when it is disconnected from the patient, some ventilators generate a high flow through the patient circuit that may aerosolize contaminated condensate, putting the patient and HCW at risk.²²

As the clinical benefit of HHHFO is controversial and not standard of care as a first line treatment for severe hypoxemia, consideration should be given to use of conventional oxygen delivery via nasal prongs as initial therapy. If a patient is deteriorating and oxygen demands increasing, clinical judgement needs to be used with consideration of involvement of critical care if intubation is within the goals of care of the patient. HHHFO is a limited resource within the hospital that requires the use of PPE plus N95 in a closed environment, thus the use of this modality during a COVID pandemic needs to be balanced with the increased system demands.

Therefore, as HHHFO is considered an AGMP, **any patient** treated with HHHFO require PPE with N95 respirator, and a single room with 4 walls and a closed door

Research Question 2

When is it appropriate to use high flow vs humidified high flow oxygen therapy in the healthcare setting?

Conventional Oxygen Therapy

The WHO recommends preparing to provide advanced respiratory support to all COVID-19 patients. The guidelines endorse giving supplemental oxygen therapy (oxygen by nasal prongs) immediately to patients with severe acute respiratory illness and respiratory distress, hypoxaemia or shock with the target of SpO₂ > 94%.

HHHFO

According to the World Health Organization, there are no evidence-based guidelines on HHHFO and literature specific to coronavirus-infected patients is limited. The American Association of Respiratory Care in their guideline document suggest HHHFO may be useful in patients with early hypoxemia. Experience from China has suggested HHHFO may be used for mild-to-moderate hypoxemia ($100 \text{ mmHg} \leq \text{PaO}_2/\text{FiO}_2 < 300 \text{ mmHg}$); no indications for intubation; and generally stable vital signs.²⁶ Their response should be closely monitored over one to two hours. Similarly, Matthay suggest HHHFO may delay or prevent intubation for patients with moderately severe hypoxaemia.¹⁸ Corley and colleagues (2017) conducted a review of HHHFO use in ICU compared to other oxygen delivery. A total of 11 studies and 1972 patients were included and they found no evidence that HHHFO reduced the rate of treatment failure or risk of death compared with low-flow oxygen devices, no advantage in adverse event rates, ICU length of stay, or duration of respiratory support. They observed no differences in participants' lab values, and small differences in breathing rates (not considered clinically meaningful). There were no differences in patient-rated measures of comfort. Only one study found evidence of less dry mouth when HHHFO was used.

Given that HHHFO is a very limited resource and is an AGMP which will contribute to the demand for private rooms and N95 masks with little evidence of clinical benefit, the use of HHHFO over conventional oxygen delivery is not recommended in routine practice. Application of clinical judgement in the context of resource availability and patient goals of care will remain essential.

HHHFO should be avoided in patients with severe respiratory failure hemodynamic instability, multiple organ failure, disorders of consciousness, or when intubation is likely.^{6,26}

HHHFO

The CADTH review in 2019 summarized the literature on the clinical effectiveness of heated humidified high flow oxygen in hospital and during transfers as well as the cost-effectiveness of heated humidified high flow oxygen compared with other respiratory support. Eight systematic reviews, 8 RCTs, and 1 cost-effectiveness analysis were included. Their key findings indicate that the evidence supports that HHHFO may help to avoid intubation compared to conventional oxygen therapy or non-invasive ventilation, though the findings were not consistent. The evidence does not suggest that the length of stay or oxygenation outcomes are improved with HHHFO compared to conventional oxygen therapy or non-invasive ventilation.

One possible additional indication of HHHFO is in the event that mechanical ventilators are unavailable, HHHFO may be required.⁶ However, further details regarding its use under these circumstances would need to be explored more fully.

Evolving Evidence

We acknowledge that the evidence regarding the care and management of individuals that are suspect or confirmed COVID-19 is rapidly evolving. Therefore significant changes in clinical guidelines may occur and impact this rapid review.

Date question received by advisory group: March 30, 2020

Date report submitted to committee: March 31, 2020

Date of first assessment: April 3, 2020

(If applicable) Date of re-assessment:

Authorship & Committee Members

This report was written by Heather Sharpe, Ania Kania-Richmond, and Jenine Leal and scientifically reviewed by Brandie Walker and Giovanni Ferrara (external reviewer). The full Scientific Advisory Group was involved in discussion and revision of the document: Braden Manns (co-chair), Lynora Saxinger (co-chair), John Conly, Alexander Doroshenko, Shelley Duggan, Nelson Lee, Andrew McRae, Jeremy Slobodan, James Talbot, and Nathan Zelyas.



This copyright work is licensed under the [Creative Commons Attribution-NonCommercial-NoDerivative 4.0 International license](https://creativecommons.org/licenses/by-nc-nd/4.0/). You are free to copy and distribute the work including in other media and formats for non-commercial purposes, as long as you attribute the work to Alberta Health Services, do not adapt the work, and abide by the other licence terms. To view a copy of this licence, see <https://creativecommons.org/licenses/by-nc-nd/4.0/>. The licence does not apply to AHS trademarks, logos or content for which Alberta Health Services is not the copyright owner.

Disclaimer: This material is intended for general information only and is provided on an "as is", "where is" basis. Although reasonable efforts were made to confirm the accuracy of the information, Alberta Health Services does not make any representation or warranty, express, implied or statutory, as to the accuracy, reliability, completeness, applicability or fitness for a particular purpose of such information. This material is not a substitute for the advice of a qualified health professional. Alberta Health Services expressly disclaims all liability for the use of these materials, and for any claims, actions, demands or suits arising from such use.

Reference List

1. Alberta Health Services. (2018). Contact & Droplet Precautions (sign for patient rooms). Retrieved from: <https://www.albertahealthservices.ca/assets/healthinfo/ipc/hi-ipc-contact-and-droplet-sign.pdf>. Accessed 1 April 2020.
2. Alberta Health Services. (2020). Respiratory Illness: Assessing the Need for Additional Precautions (Isolation). Retrieved from: <https://www.albertahealthservices.ca/assets/healthinfo/ipc/hi-ipc-contact-and-droplet-sign.pdf>. Accessed 1 April 2020.
3. American Association of Respiratory Care. (2020). SARS CoV-2 Guidance Document. Retrieved from: <https://www.aarc.org/wp-content/uploads/2020/03/guidance-document-SARS-COVID19.pdf>. Accessed 1 April 2020.
4. Arabi, Y. M., Fowler, R., & Hayden, F. G. (2020). Critical care management of adults with community-acquired severe respiratory viral infection. *Intensive Care Medicine*, 46(2), 315-328. Retrieved from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7079862/>. Accessed 1 April 2020.
5. The Australian and New Zealand Intensive Care Society. (2020). COVID-19 The Australian and New Zealand Intensive Care Society (ANZICS) COVID-19 Guidelines Version 1. Retrieved from: <https://www.anzics.com.au/wpcontent/uploads/2020/03/ANZICS-COVID-19-Guidelines-Version-1.pdf>. Accessed 1 April 2020.
6. Brewster, D. J., Chrimes, N. C., Do, T. B., Fraser, K., Groombridge, C. J., Higgs, A., ... & Nickson, C. P. (2020). Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group. *The Medical Journal of Australia*, 212(10), 1. Preprint. Retrieved from: <https://www.mja.com.au/system/files/2020-03/Updated%20PREPRINT%20SAS%20COVID19%20consensus%20statement%2017%20March%202020.pdf>. Accessed 1 April 2020.
7. CADTH. Heated humidified high flow oxygen for respiratory support: a review of clinical effectiveness, cost-effectiveness, and guidelines. Ottawa: CADTH, 2019 Feb. (CADTH rapid response report: summary with critical appraisal)
8. Cheung, J. C. H., Ho, L. T., Cheng, J. V., Cham, E. Y. K., & Lam, K. N. (2020). Staff safety during emergency airway management for COVID-19 in Hong Kong. *The Lancet Respiratory Medicine*. Retrieved from: [https://www.thelancet.com/journals/lanres/article/PIIS2213-2600\(20\)30084-9/fulltext](https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30084-9/fulltext). Accessed 1 April 2020.
9. Corley, A., Rickard, C. M., Aitken, L. M., Johnston, A., Barnett, A., Fraser, J. F., Lewis, S. R., & Smith, A. F. (2017). High-flow nasal cannulae for respiratory support in adult intensive care

- patients. The Cochrane database of systematic reviews, 5(5), CD010172.
<https://doi.org/10.1002/14651858.CD010172.pub2>
10. Huang CC, Lan HM, Li CJ, Lee TH, Chen WL, Lei WY, Hsieh PY, Yang MC, Chou CC, Wu HP, Syue YJ. Use high-flow nasal cannula for acute respiratory failure patients in the emergency department: a meta-analysis study. *Emergency Medicine International*. 2019, Article ID 2130935: 1-10. <https://doi.org/10.1155/2019/2130935>.
 11. Jahagirdar D, Picheca L. (2019). Heated Humidified high flow oxygen for respiratory support: A review of clinical effectiveness, cost-effectiveness, and guidelines. CADTH Rapid Response Report: Summary with Critical Appraisal. Ottawa (ON): Canadian Agency for Drugs and Technologies in Health. Retrieved from:
<https://www.cadth.ca/sites/default/files/pdf/htris/2019/RC1066%20Optiflow%20Final.pdf>. Accessed 1 April 2020.
 12. UK – Intensive Care Medicine – Anaesthesia. (2020). Critical care preparation and management in the COVID-19 pandemic. Retrieved from: <https://icmanaesthesiacovid-19.org/critical-care-preparation-and-management-in-the-covid-19-pandemic>. Accessed 1 April 2020.
 13. Leung, C. C. H., Joynt, G. M., Gomersall, C. D., Wong, W. T., Lee, A., Ling, L., ... & Hui, M. (2019). Comparison of high-flow nasal cannula versus oxygen face mask for environmental bacterial contamination in critically ill pneumonia patients: a randomized controlled crossover trial. *Journal of Hospital Infection*, 101(1), 84-87. Retrieved from:
[https://www.journalofhospitalinfection.com/article/S0195-6701\(18\)30542-5/fulltext](https://www.journalofhospitalinfection.com/article/S0195-6701(18)30542-5/fulltext). Accessed 1 April 2020.
 14. Lodeserto FJ, Lettich TM, Rezaie SR. High-flow nasal cannula: mechanisms of action and adult and pediatric indications. 26 November 2018. *Cureus* 10(11): e3639. DOI 10.7759/cureus.3639.
 15. Loh N-HW, Tan Y, Taculod J, et al. (2020). The impact of high-flow nasal cannula (HFNC) on coughing distance: implications on its use during the novel coronavirus disease outbreak. *Can J Anaesth*. Retrieved from: <https://link.springer.com/article/10.1007/s12630-020-01634-3>. Accessed 1 April 2020.
 16. London Health Sciences Centre. (2020). Guidelines for Aerosol Generating Medical Procedures (AGMP) For Failed ARI Screen or Unable to Assess or Confirmed COVID-19. Retrieved from: <https://www.lhsc.on.ca/media/8476/download>. Accessed 1 April 2020.
 17. Murthy S., Gomersall CD., Fowler RA. (2020). Care for critically ill patients with COVID-19. *JAMA Insights*. Retrieved from: <https://jamanetwork.com/journals/jama/fullarticle/2762996>. Accessed 1 April 2020.
 18. Matthay, M. A., Aldrich, J. M., & Gotts, J. E. (2020). Treatment for severe acute respiratory distress syndrome from COVID-19. *The Lancet Respiratory Medicine*. Retrieved from:
[https://www.thelancet.com/journals/lanres/article/PIIS2213-2600\(20\)30127-2/fulltext](https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30127-2/fulltext). Accessed 1 April 2020.
 19. Ng, K., Poon, B. H., Kiat Puar, T. H., Shan Quah, J. L., Loh, W. J., Wong, Y. J., Tan, T. Y., & Raghuram, J. (2020). COVID-19 and the Risk to Health Care Workers: A Case Report. *Annals of internal medicine*, L20-0175. Advance online publication. <https://doi.org/10.7326/L20-0175>.
 20. Ou X, Hua Y, Liu J, Gong C, Zhao W. Effect of high-flow nasal cannula oxygen therapy in adults with acute hypoxemic respiratory failure: a meta-analysis of randomized controlled trials. *CMAJ* 2017 February 21; 189:E260-7. doi: 10.1503/cmaj.160570
 21. Public Health Ontario. (2020). Evidence Brief – Infection prevention and control for first responders providing direct care for suspected or confirmed COVID-19 patients. Retrieved from:
<https://www.publichealthontario.ca/-/media/documents/ncov/evidence-brief/eb-covid-19-first-responders.pdf?la=en>. Accessed 2020.
 22. Restrepo, R. D., & Walsh, B. K. (2012). Humidification during invasive and noninvasive mechanical ventilation: 2012. *Respiratory care*, 57(5), 782-788. Retrieved from:
<https://www.ncbi.nlm.nih.gov/pubmed/22546299>. Accessed 1 April 2020.

23. Simonds, A., Hanak, A., Chatwin, M., Morrell, M., Hall, A., Parker, K., Siggers, J., Dickinson, R. (2010). Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections. *Health Technology Assessment*. 14(46) 131-172. Retrieved from: <https://www.journalslibrary.nihr.ac.uk/hta/hta14460-02/#/abstract>. Accessed 1 April 2020.
24. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. (2012). Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One*. 7: e35797. Retrieved from: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0035797>. Accessed 1 April 2020.
25. Vancouver Coastal Health. (2020). IPAC BEST PRACTICES GUIDELINE: Aerosol Generating Medical Procedures. Retrieved from: <http://ipac.vch.ca/Documents/Acute%20Resource%20manual/Aerosol%20Generating%20Medical%20Procedures.pdf>. Accessed 1 April 2020.
26. Xia, J., Zhao, J., Cheng, Z., Hu, Y., Duan, J., Zhan, Q. (2020). Non-invasive respiratory support for patients with novel coronavirus pneumonia: clinical efficacy and reduction in risk of infection transmission. *Chinese Medical Journal*. Epub. Retrieved from: https://journals.lww.com/cmj/Citation/publishahead/Non_invasive_respiratory_support_for_patients_with.99377.aspx. Accessed 1 April 2020.
27. World Health Organization. (2020). Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: interim guidance. Retrieved from: [https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected). Accessed 1 April 2020.
28. Respiratory care committee of Chinese Thoracic S. [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.
29. Zhonghua, J., He, H., Hu, X., Zhi, Z. (2020) 19. Expert consensus on preventing nosocomial transmission during respiratory care for critically ill patients infected by 2019 novel coronavirus pneumonia (Abstract). *Chinese Journal of Tuberculosis and Respiratory Medicine*. 17(0):E020. Retrieved from: <https://www.ncbi.nlm.nih.gov/pubmed/32077661>. Accessed 1 April 2020.