Evidence check

11 May 2020

Rapid evidence checks are based on a simplified review method and may not be entirely exhaustive, but aim to provide a balanced assessment of what is already known about a specific problem or issue. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

NIPPV and requirements

Rapid review question

Has the increasing use of NIPPV to manage suspected or confirmed COVID-19 patients led to any additional guidance regarding the physical requirements and engineering services (e.g. negative pressure rooms or where positive pressure rooms vent to)?

Background

Non-invasive ventilation (NIV) is a mode of delivering mechanical ventilation and oxygenation support to patients with respiratory distress which does not require tracheotomy or intubation. There are two main types of NIV: negative-pressure ventilation and non-invasive positive-pressure ventilation (NIPPV). The latter is most commonly used in intensive care units and includes two sub-types:

- CPAP (continuous positive airway pressure) which has a single pressure setting for both inhalation and exhalation
- BiPAP (bi-level positive airway pressure) which has two pressure settings: one pressure for inhalation and a lower pressure for exhalation.(1)

There have been some reports that NIV therapy, such as CPAP or BiPAP, can be used for patients with COVID-19 to prevent the need for endotracheal intubation and reduce days on a ventilator.(2) However, there is evidence that the use of NIV and other aerosol-generating procedures (AGPs) are associated with higher risk of transmission of coronaviruses, such as SARS-CoV.(3) Thus, the application of NIV in patients with COVID-19 in intensive care units (ICUs) is controversial, particularly for patients with more severe disease pathology and other complications.(4). For some patients, however, NIV therapy may be able to assist, provided that appropriate mitigations are in place to minimise aerosolation of the virus.

Guidelines from the National COVID Clinical Evidence Taskforce (30 April 2020) (5)

- In negative pressure rooms, consider using NIV therapy for patients with hypoxaemia associated with COVID-19, ensuring it is used with caution and strict attention is paid to staff safety.
- In single rooms or shared ward spaces with a cohort of confirmed COVID-19 patients only, consider using NIV therapy for patients with hypoxaemia associated with COVID-19, ensuring it is used with caution and strict attention is paid to staff safety.
- In shared wards or emergency department cubicles, do not use NIV therapy for patients with hypoxaemia associated with COVID-19.

- During inter-hospital patient transfer and/or retrieval, do not use NIV therapy for patients with hypoxaemia associated with COVID-19.
- In patients with COVID-19 who are deteriorating, consider endotracheal intubation and invasive mechanical ventilation. In patients with COVID-19 for whom NIV is appropriate for an alternate clinical presentation (e.g. concomitant chronic obstructive pulmonary disease with type 2 respiratory failure and hypercapnoea), ensure airborne and other infection control precautions are optimised.
- In adults with COVID-19 on high-level respiratory support, monitor for worsening respiratory status. If worsening occurs, undertake early in the disease course endotracheal intubation in a controlled setting. Patients can deteriorate rapidly 5-10 days after symptom onset.

Guidance on engineering

Current guidance for COVID-19 patients recommend AGPs, including non-invasive ventilation, are undertaken in *a negative pressure single room.*(6-9). Negative pressure rooms use an engineering control intended to prevent the spread of contagious airborne pathogens from room to room. Negative air pressure is created and maintained by a ventilation system that allows extra air to enter the isolated room by differential pressure, and is exhausted directly to the outside or filtered through a high-efficiency particulate air (HEPA) filter directly before recirculation.(8) Appropriate personal protective equipment (PPE) precautions should still be observed.

It is recommended that negative pressure rooms:

- undergo at least 12 air changes per hour and controlled direction of air flow or at least 160l/second/patient in facilities with natural ventilation (7)
- have discharge points that are located as far as possible from air intakes and from where people congregate or work. Air should not be recirculated (10)
- are equipped with a functional anteroom for donning and doffing PPE for staff (6) and an en suite that is not shared (10)
- has separate entry doors to allow for movement of the patient in and out of the room (10)
- have the absolute minimum number of staff required for patient care and support (7).

Where negative pressure rooms are not available, patients with COVID-19 may be managed in a single room with door closed, given appropriate engineering controls (such as ventilation) and with clear areas demarcated for donning and doffing of PPE. If AGPs are being performed, air conditioning should still exhaust to an external point and air should not be recycled. An alternative is the use of a hood. (9)

Without negative pressure capability, airborne droplets can remain in the air for up to three hours post procedure. Thus, temporary negative pressure air rooms can also be set up with the use of portable negative air units fitted with a HEPA filter. Filter pressure drops should be monitored across filters at weekly intervals to ensure that filters are functioning. It is recommended that filters be replaced when the pressure drop reaches 80% of maximum allowable limit.

Health Protection NSW advises that the majority of patients with COVID-19 can be managed in standard clinical environments without any change needed to air handling systems. However, it is recommended that health services should check existing air handling systems to:

- assess the existing configuration, air flows, air changes and pressures
- ensure the air conditioning and ventilation system is functioning properly
- replace existing filters with new for this purpose (9).

Other guidance on NIV in COVID-19 has been summarised in Table 1.

Limitations

Evidence on this topic is emerging rapidly; and guidelines in various jurisdictions differ in their recommendations.(1)

Methods (appendix 1)

Search was updated from the 17 April CIU evidence check on CPAP.

Results

Table 1: Non-invasive ventilation in COVID-19

Source title and author	Country	Findings	Source link
Peer reviewed journals			
Use of non-invasive ventilation for patients with COVID-19: a cause for concern? Arulkumaran, et al. 2020 (11)	US	A good interface fitting for CPAP or NIV systems minimises widespread dispersion of exhaled air and, consequently, should be associated with low risk of airborne transmission from patients. With the use of PPE on the ICU, use of NIV during the severe acute respiratory syndrome epidemic was not associated with an increased risk of transmission of the virus to health-care workers.	Click here
Exhaled air dispersion during high-flow nasal cannula therapy versus CPAP via different masks Hui, et al. 2019 (12)	Hong Kong	Exhaled air dispersion during CPAP via different interfaces is limited provided there is good mask interface fitting. [Note from Cheung et al. 2020: Cheung and colleagues note that specific NIV models and modes tested in the Hui study are not universally used across all hospitals. Therefore, the authors do not recommend using NIV until the patient is cleared of COVID-19.]	Click here
Staff safety during emergency airway management for COVID-19 in Hong Kong Cheung, et al. 2020 (13)	Hong Kong	All AGPs (e.g. such as NIV) should be done in an airborne infection isolation room. Double-gloving, as a standard practice at our unit, might provide extra protection and minimise spreading via fomite contamination to the surrounding equipment after intubation.	Click here
Grey literature			
Clinical management of severe acute respiratory infection when novel coronavirus (2019-nCoV) infection is suspected: Interim guidance	International	NIV should only be used in selected patients with hypoxemic respiratory failure. Patients with hemodynamic instability, multiorgan failure, or abnormal mental status should generally not receive NIV. Generally, NIV guidelines make no recommendation on use in hypoxemic respiratory failure (apart from cardiogenic pulmonary oedema and post-operative respiratory failure) or pandemic viral illness (referring to studies of SARS and pandemic influenza).	Click here

Source title and author	Country	Findings	Source link
World Health Organization 2020 (4)		Patients treated with NIV should be closely monitored for clinical deterioration. They should be in a monitored setting and cared for by experienced personnel capable of endotracheal intubation in case the patient acutely deteriorates or does not improve after a short trial (about 1hr). Recent publications suggest that newer NIV systems with good interface fitting do not create widespread dispersion of exhaled air and therefore should be associated with low risk of airborne transmission.	
Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected: Interim guidance World Health Organization 2020 (7)	International	Ensure that health care workers performing AGPs: • perform procedures in an adequately ventilated room, that is natural ventilation with air flow of at least 160l/s per patient or in a negative-pressure room with at least 12 air changes per hour and controlled direction of air flow when using mechanical ventilation • use a particulate respirator at least as protective as a US National Institute for Occupational Safety and Health certified N95, European Union standard FFP2, or equivalent. When healthcare workers put on a disposable particulate respirator, they must always perform the seal check. Note that facial hair (e.g. a beard) may prevent a proper respirator fit • use eye protection (i.e. goggles or a face shield) • wear a clean, non-sterile, long-sleeved gown and gloves. If gowns are not fluid-resistant, healthcare workers should use a waterproof apron for procedures expected to create high volumes of fluid that might penetrate the gown • limit the number of people present in the room to the absolute minimum required for the patient's care and support.	Click here
Surviving sepsis campaign: guidelines on the management of critically ill adults with coronavirus disease 2019 (COVID-19) Alhazzani et al. 2020 (8) (Un-edited accepted proof)	International collaboration	1. For healthcare workers performing AGPs on patients with COVID-19 in the ICU, we recommend using fitted respirator masks (N95 respirators, FFP2, or equivalent), as opposed to surgical or medical masks, in addition to other PPE (i.e. gloves, gown, and eye protection, such as a face shield or safety goggles) (best practice statement). 2. We recommend performing AGPs on ICU patients with COVID-19 in a negative pressure room (best practice statement). Negative pressure rooms are an engineering control intended to prevent the spread of contagious airborne pathogens from room to room (e.g. measles, and tuberculosis). The main goal is to avoid the accidental release of pathogens into a larger space and open facility, thereby protecting healthcare workers and patients in a hospital setting. Negative air pressure is created in the patient's room to keep the pathogen inside and avoid its diffusion. By adopting this precaution when AGPs like tracheal intubation, bronchoscopies, or NIPPV are performed	Click here

Source title and author	Country	Findings	Source link
		within the room, there is a lower risk of cross-contamination among rooms and infection for staff and patients outside the room. Negative pressure is created and maintained by a ventilation system that allows extra air to enter the isolated room by differential pressure, and be exhausted directly to the outside or be filtered through a HEPA filter directly before recirculation. Moreover, the presence of unnecessary staff in the room should be avoided. Negative pressure rooms have proven to be an effective measure that helped to avoid cross-contamination during the SARS epidemic. Bronchoscopies are among the procedures at highest risk of aerosolization, and their use should be minimised. Non-invasive ventilation is also at high risk of aerosolization, and strategies have been described to contain the risk of virus spread, also according to a previous report on SARS infection. Where this is not feasible, a portable HEPA filter should be used in the room wherever possible. A HEPA filter is a mechanical air filter, used for isolation where maximum reduction or removal of submicron particulate matter from air is required. HEPA filters have been demonstrated to reduce virus transmission in simulated settings.	
COVID-19 guidelines: version 2. 15 April 2020 Australian and New Zealand Intensive Care Society (ANZICS) 2020 (6)	Australia and New Zealand	If AGPs are required, these should ideally be performed in a negative pressure room, however, this needs to be balanced with the safety of transporting the patient. **The authors recommend COVID-19 patients ideally be treated in a Class N* negative pressure single room.** If Class N rooms are not available then the preference should be Class S single rooms (with appropriate engineering considerations) with clear areas demarcated for donning and doffing of PPE. It is recommended that if AGPs are performed in Class S rooms, air conditioning should exhaust to an external point and air should not be recycled. Temporary negative pressure air rooms can be set up with the use of portable negative air units fitted with a high efficiency particulate air (HEPA) filter. We recommend engineering support can help advise hospitals on whether this is logistically possible. * Class N rooms are negative pressure isolation rooms used to isolate patients capable of transmitting airborne infection. A negative pressure room can have a functional anteroom for donning and doffing PPE. Airborne PPE precautions are still required. Doffing is performed in	Click here

Source title and author	Country	Findings	Source link
		the anteroom. There are a limited number of negative pressure bays and pods and/or rooms across Australia and New Zealand. ** Class S rooms are standard rooms which can be used for isolating patients capable of transmitting infection by droplet or contact routes. Class S rooms have no negative pressure capability and therefore no engineering controls. Airborne droplets can remain in the air for up to three hours post procedure.	
Australasian Health Facility Guidelines: Part D - Infection Prevention and Control (Revision 7.0) Australasian Health Infrastructure Alliance 2016	Australia and New Zealand	Class N - Negative Pressure Isolation Room A Class N isolation room is a single room with an ensuite that is not shared. It is used for patients who require isolation to reduce airborne transmission of disease (e.g. varicella, measles, pulmonary or laryngeal tuberculosis). A Type B hand basin within the room and a self-closing door are required, with sufficient and appropriate storage for clinical waste. The design of the room must provide separate entry doors to allow for movement of the patient in and out of the room. The anteroom is only for use by staff and visitors. The air handling system in Class N isolation rooms operates at a lower pressure with respect to adjacent areas such as the anteroom and corridor. Air in negative pressure rooms will be exhausted to the outside in accordance with AS 1668.2 to prevent air recirculation. Ideally, supply air into the room should be located on the ceiling above the foot of the bed. The exhaust air to be located at the head of the bed. The discharge points should be located as far as possible from air intakes and from where people congregate or work. If external exhaust is not possible, air should be recirculated through HEPA filters. Provision of a dedicated exhaust system to each room, separate to the common exhaust air system, will reduce the risk of contamination.	Click here
COVID-19 surge capacity management: Adapting	Australia	Based on current advice from the Clinical Excellence Commission, special environmental controls, such as negative pressure isolation rooms or negative pressure air flows within an entire clinical unit, are not necessary to prevent the transmission of COVID-19 as the pathogen	Click here

Source title and author	Country	Findings	Source link
and commissioning clinical spaces Health Protection NSW 2020		is spread via contact and droplet. **The need for negative pressure controls are recommended for AGPs but where not available alternative of single room with door closed is sufficient.** It is important to note the aerosolisation of droplets does not create airborne spread. This advice is consistent with National and International recommendations. The overwhelming majority of patients with COVID-19 can be managed in standard clinical environments without any change needed to air handling systems. Health services should check existing air handling systems to: assess the existing configuration, air flows, air changes and pressures ensure the air conditioning and ventilation system is functioning properly replace existing filters with new for this purpose. Monitor filter pressure drops across filters at weekly intervals to ensure that filters are functioning and replace filters when the pressure drop reaches 80% of maximum allowable limit. Negative pressure rooms can be used to accommodate patient care requiring AGP. An alternative is the use of a hood.	

References

1. Pardojr M. Noninvasive Ventilation. ScienceDirect. 2007;Available at: https://www.sciencedirect.com/topics/medicine-and-dentistry/noninvasive-ventilation.
2. McEnery T, Gough C, Costello RW. COVID-19: Respiratory support outside the intensive care unit. Lancet Respir Med. 2020.
3. 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.
4. World Health Organization. Clinical management of severe acute respiratory infection when novel coronavirus (2019-nCoV) infection is suspected: Interim guidance 2020 28 January 2020.
5. National COVID-19 Clinical Evidence Taskforce. Non-invasive ventilation. Available from: https://appmagicapporg/#/guideline/L4Q5An/section/j9akBj 2020.

6. The Australian and New Zealand Intensive Care Society. The Australian and New Zealand Intensive Care Society (ANZICS) COVID-19 Guidelines. . 2020 16 March 2020.
7. World Health Organisation. Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected: Interim guidance. . 2020 19 March 2020.

8. Alhazzani W, Møller MH, Arabi YM, Loeb M, Gong MN, Fan E, et al. Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19). Intensive Care Med. 2020;46(5):854-87.
9. NSW Health. COVID-19 surge capacity management: Adapting and commissioning clinical spaces. Webpage, accessed on 11 May 2020 Available from: https://wwwhealthnswgovau/Infectious/covid-19/communities-of-practice/Pages/surge-managementaspx. 2020.
10. Australian Health Infrastructure Alliance. Australasian Health Facility Guidelines. Part D - Infection Prevention and Control. Available from: https://aushfg-prod-com-aus3amazonawscom/Part%20D%20Whole_7_2pdf. 2016.
11. Arulkumaran N, Brealey D, Howell D, Singer M. Use of non-invasive ventilation for patients with COVID-19: a cause for concern? The Lancet Respiratory Medicine. 2020.
12. Hui DS, Chow BK, Lo T, Tsang OTY, Ko FW, Ng SS, et al. Exhaled air dispersion during high-flow nasal cannula therapy versus CPAP via different masks. Eur Respir J. 2019;53(4).
13. Cheung JC-H, Ho LT, Cheng JV, Cham EYK, Lam KN. Staff safety during emergency airway management for COVID-19 in Hong Kong. The Lancet Respiratory Medicine. 2020;8(4):e19.

Appendix 1

PubMed: (CPAP OR “continuous positive airway pressure”) AND restrict to year 2020.
PubMed: (CPAP OR “continuous positive airway pressure”) AND (aerosol* OR exhale*)
PubMed: ((aerosol* OR exhale* OR transmission)) AND ((BIPAP) OR (Bilevel Positive Airway Pressure))

Google: (CPAP OR “continuous positive airway pressure”) AND (covid19 OR covid 19 OR 2019-nCoV OR nCoV OR covid-19 OR coronavirus

Cochrane Library: (CPAP OR “continuous positive airway pressure”) AND restrict to year 2020.

Australian Guidelines for the Prevention and Control of Infection in Healthcare