

Pre- / non- ICU respiratory support options in COVID-19

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Objectives

- Highlight need for options for respiratory failure management prior to/in the absence of intensive care with mechanical ventilator and skilled operator
- Summarise the options available, in terms of:
 - Guideline recommendations / Examples of use by hospitals
 - Skill/training required
 - Cost
 - Oxygen requirement
 - Risk of aerosolization
 - Other considerations

Background

Background

Presentations & Pathophysiology

- Severe and critical COVID-19 usually characterised by pneumonia -> hypoxaemia & acute respiratory distress syndrome (ARDS)¹
- Increasing reports of pulmonary embolism and possibly pulmonary microthrombi²
- Most patients have hypoxaemic, normocapnic (type 1) respiratory failure
 - Some - especially if underlying chronic respiratory disease- may develop hypercapnic (type 2) failure
- Increasingly recognition of a distinct group with severe hypoxaemia but no breathlessness or signs of respiratory distress – “happy hypoxaemic”

Sources

1. WHO May 2020; Guan NEJM Feb 2020
2. Ackermann NEJM May 2020; Thachil SeminThrombHemost May 2020

When/whether to intubate

- Several guidelines/hospitals advocate early intubation if simple oxygen therapy fails, where possible¹
- Supported by drive to minimize aerosolization of virus particles
- Some concerns this may lead to high mortality – possibly due to ventilator-induced lung injury²
- Some settings using trial of alternatives prior to intubation
- Capacity to intubate, invasively ventilate, monitor blood gases is not always available – especially in SEAR countries
- Some core reasons to intubate remain:
 - Rising PaCO₂ - especially if BiPAP failed or not appropriate
 - Reduced conscious level
 - Increased work of breathing despite correction of hypoxia
 - Raised serum lactate

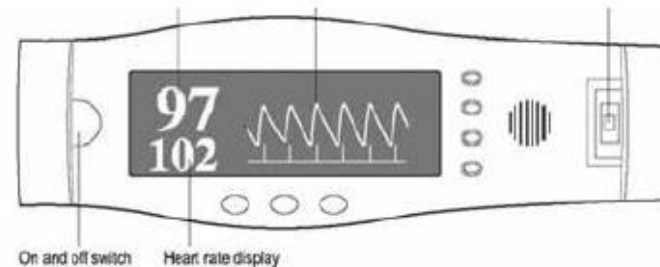
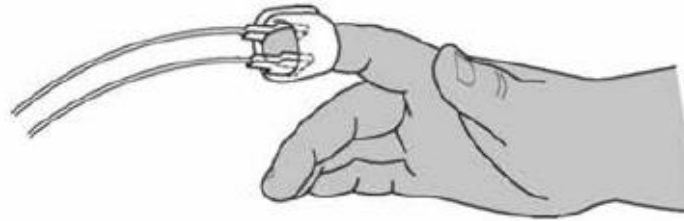
Sources

1. WHO May 2020; OTHERS
2. Richardson JAMA April 2020; Marini JAMA April 2020

Airway and
Breathing :
First: Use pulse
oximeter to assess
hypoxaemia and
give oxygen

USING A PULSE OXIMETER TO MONITOR SpO₂

- Turn on the pulse oximeter.
- Attach the oximeter probe to the finger or toe.
- Wait until there is a consistent pulse signal (this may take 20–30 seconds).
- Record the SpO₂ on a monitoring chart.
- If titrating oxygen down, recheck SpO₂ within 15 minutes and record on the monitoring chart.
- If problems with the reading or inconsistent with clinical state, remove nail polish.



HOW TO DELIVER INCREASING OXYGEN



Place prongs inside the nostril.
Hook tubing behind ears.
Flow rates higher than 5 litres
will dry mucous membranes.

- Start oxygen at 5 litres/minute (10-15 litres if critically ill [see below])
- Use nasal prongs
- Assess response

■ If increasing respiratory distress or $SpO_2 < 90$;
<94 if ABCD emergency sign or pregnant



Secure mask firmly on face over
nose and mouth.
Pull strap over head.

- Use face mask with reservoir
- Increase oxygen to 10-15 litres/minute
- Make sure bag inflates
- Call for help from district clinician
- Assess response

■ If ABCD emergency sign or pregnant



Make sure bag is full to deliver
highest oxygen concentration.
An empty bag is dangerous.

- Use face mask with reservoir
- Increase oxygen to 10-15 litres/minute
- Make sure bag inflates
- Call for help from district clinician
- Assess response

Proning in the awake, non-intubated patient

HOW TO SUPPORT PRONING IN AWAKE COVID PATIENT (NOT INTUBATED)



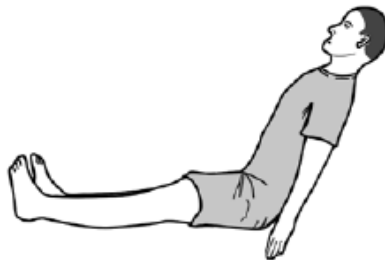
Prone
30 minutes –
2 hours: laying on belly



Right Lateral Recumbent
30 minutes – 2 hours:
lying on your left side

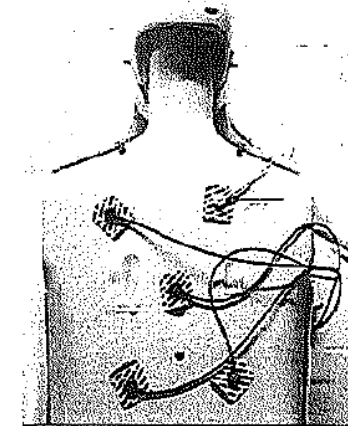


Left Lateral Recumbent
30 minutes – 2 hours:
lying on your right side



Reclining 45 degrees
30 minutes – 2 hours:
sitting up

Placement of ECG Leads *if on telemetry*



Englewood Health protocol

Sources for proning: Caputo N, Strayer R, and Levitan R. Early self-proning in awake, non-intubated patients in the emergency department: A single ED's experience during the COVID-19 pandemic. Academic Emergency Medicine 2020; 27:375-378; Protocol adapted from NHS- Royal Free London., UK. Englewood Health, NJ, USA. Also recommended in WHO 2018 May 2020 Interim clinical guidance for COVID-19 for clinical trials.. Illustration from draft SEARO IMAI District Clinician Manual.

High-flow nasal oxygen (HFNO)

Administration of high-flow oxygen via nasal cannula – up to 60L/min. Generates small amount of PEEP. Actively heats and humidification as part of circuit.

Guideline recommendations / Examples of use by hospitals:

- WHO suggest trial in some patients
- Varying endorsement from organisations/hospitals: biggest concern is aerosol generation

Skill/training required:

- Usually requires specialist nursing care, but videos available online

Oxygen requirement:

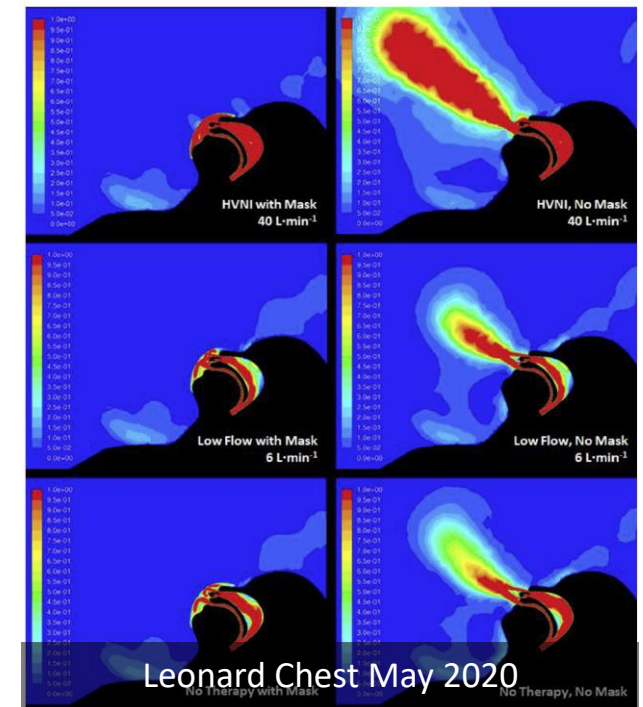
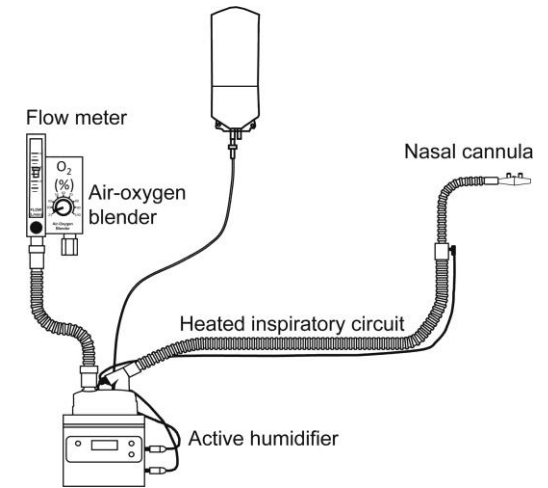
- High: 20-60 L/minute -> 30,000-90,000 L/day

Risk of aerosolization/aerosol dispersion:

- Variable dispersion: 17cm [similar to low-flow O₂; Hui 2019] to 2m [similar to cough; Loh 2020]
- Wearing surgical mask on top may almost eliminate dispersion [Leonard 2020] – opposite.
- Iwashyna [2020] found similar small (<0.5µm) particles in a room after HFNO vs low-flow O₂

Other considerations:

- Requires uninterrupted power supply.
- Possibly more comfortable than NIV. Enables eating, drinking, talking without interruption of therapy.



Continuous positive airway pressure (CPAP)



Helmet

Applies positive pressure throughout respiratory cycle.

Leads to splinting of smaller airways in expiration (positive end-expiratory pressure = PEEP) & recruitment of additional parts of lung.

Guideline recommendations / Examples of use by hospitals:

- WHO suggest trial in some patients. Varying endorsement from organisations/hospitals: biggest concern is aerosol generation .
- Commonly used in Italy – especially with helmets. Increasingly used in UK and USA

Skill/training required:

- Usually administered by specialist staff, but patients use simple versions at home independently.

Oxygen requirements:

- Could start with low flow (5-10 L/minute) but may need 15-20 L/minute -> 7,000-30,000 L/day.

Risk of aerosolization/aerosol dispersion:

- Depends on delivery interface:
 - Reduced with helmet with cushion (almost nil dispersion) or non-vented full face/oronasal mask with filter
 - Nasal/oral masks and those with vents have higher dispersion.
 - Any mask disperses more when the seal is not ideal and air leak is high.

Other considerations:

- Requires uninterrupted power supply.
- Can be manufactured at low-cost: <https://www.ucl.ac.uk/news/2020/apr/designs-life-saving-breathing-aid-are-made-freely-available>.
- Bubble CPAP can be improvised at low cost – for infants (not adults).
- Simple/home versions can be used, but may need additional attachments for oxygen, and may not adjust flow rates well.



CPAP:
simple/
home



Full
face
mask



Viral
filter



Hose

Bi-level positive airways pressure (BiPAP) non-invasive ventilation (NIV)

Similar to CPAP, but with higher inspiratory pressure than expiratory, leading to more active ventilation of patients' lungs.

BiPAP machines can be used for CPAP: inspiratory pressure (IPAP) = expiratory (EPAP).

Can be delivered using non-invasive settings on invasive ventilators.

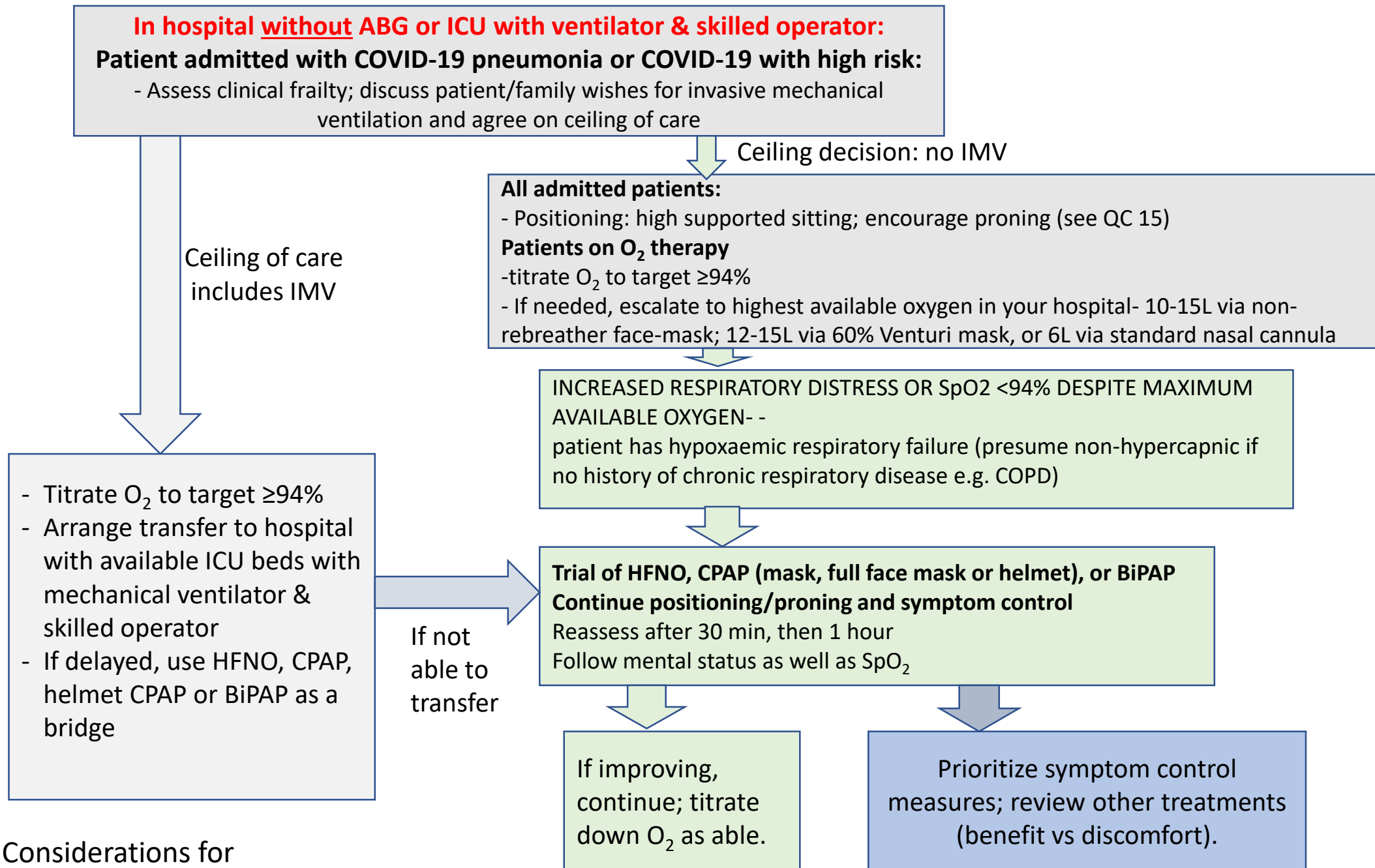
More evidence for its use in acute respiratory failure in systematic reviews than CPAP/HFNO – especially type 2/hypercapnic failure.

Similar to CPAP in terms of:

- WHO guidelines – consider trial
- Concerns/mitigations of aerosol generation & dispersion
- Delivery interfaces: masks and helmets
- Oxygen & power requirements

May require more training than for CPAP/HFNO.

Fewer guidelines recommend this in place of or in preference to CPAP/HFNO.



Remember IPC! Considerations for aerosolization.

In hospital with ICU with ventilator & skilled operator:

Patient admitted with COVID-19 pneumonia or COVID-19 with high risk:

- Assess clinical frailty; discuss patient/family wishes for invasive mechanical ventilation and agree on ceiling of care



All admitted patients with severe respiratory distress:

- Positioning: high supported sitting; encourage proning (see QC 15)

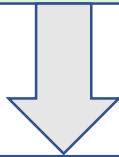
Patients on O₂ therapy

- titrate O₂ to target $\geq 94\%$
- If needed, escalate to highest available oxygen in your hospital- 10-15L via non-rebreather face-mask; 12-15L via 60% Venturi mask



INCREASED RESPIRATORY DISTRESS OR SpO₂ <94% DESPITE MAXIMUM AVAILABLE OXYGEN- - patient has hypoxaemic respiratory failure (presume non-hypercapnic if no history of chronic respiratory disease e.g. COPD and no ABG); Assess for ARDS.
-Consider indications for advance airway management now and patient/family wishes for IMV

IMV indicated
now and ceiling of
care includes IMV



Intubate and Ventilate

Trial in select patients OR Ceiling
decision: no IMV



**Trial of HFNO, CPAP (mask, full face mask or helmet), or BiPAP
(in select patients OR Ceiling decision: No IMV)**
Continue positioning/proning and symptom control
Reassess after 30 min, then 1 hour
Follow mental status as well as SpO₂



If improving, continue;
titrate down O₂ and
pressure support as able.

If not improving



Remember IPC!

Experience from Englewood Health, New Jersey, USA



Project PreVent: Circuit Configuration Options Overview

[Standard 22m Respiratory
Tubing & Proximal Pressure
Sense Tubing, ~72"]



[Exhalation
Port]



[Inline
Filter]



[Non-Vented
Elbow & Mask]



[Secondary Leak
Containment Hood]

*Many Options:
target ~3.5mm
diameter orifice*

*Standard B/V
(Bacterial/Viral),
or HEPA*

*Various combinations,
prefer Anti-Asphyxia
Valve*

*Balance
imperviousness
against patient
comfort*



Med-Tech Resources
Part No MTR-755R



*Distal, toward
Philips V60 (or equiv)
BiPAP Machine*



*Proximal,
toward
Patient*

SEE TABS BELOW FOR SPECIFIC COMPONENT MANUFACTURER, DISTRIBUTOR, & PART NUMBER INFO

Project PreVent: Circuit Option 4

Philips Respironics V60
BiPAP
Machine
with O₂
Mixing &
Alarms



Proximal Pressure
Sense Line

Standard 7'
22mm Tubing/
Respiratory Circuit

Cuff
Adapter
(optional)

Secondary Leak Containment
Hood, Cover, Bouffant,
Balaclava, Bag, etc (optional)

**Philips Respironics Performax or
FitLife Total Face Mask**
(Alternatively can use
Philips AF531 Oro-nasal mask)

ReddyPort Elbow
with Reddy Port, Low-Leak (~1-2LPM)
"Anti-Asphyxiation" Valve, &
Proximal Pressure Port (also
optional Microphone & Accessories)

Viral/Bacterial Filter
(Primarily for expiration, but placed
inline due to using Adapter
w/O₂ stem as exhalation port)

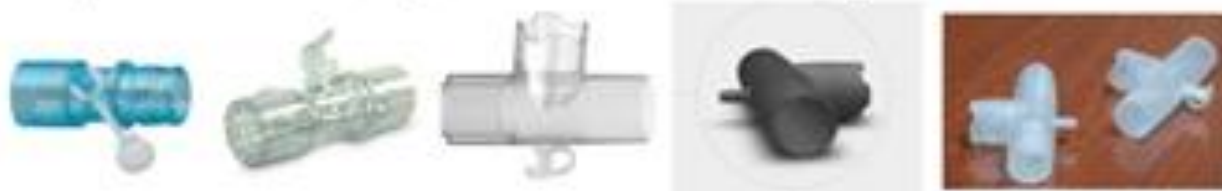
**22mm Adapter with O₂ Stem
to serve as Alt Exhalation Port**
(~4mm diameter orifice)
***IMPORTANT: ENSURE STEM
DOES NOT GET PLUGGED***

Secondary Leak Containment Options



Exhalation Port Options

Adapter w/O₂ Stem, Philips 1065775 DEP, Fisher Paykel RT017, 3D Print



Experience from
Royal Free
Hospital, London,
United Kingdom

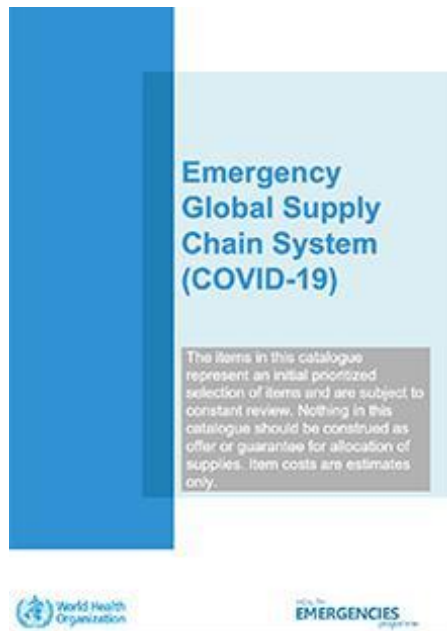
Overview of estimates for equipments and consumables

Considerations between options

- What's available: equipment, consumables
- Staff training/comfort
- Aerosolization & risk mitigation strategies available for transmission
- Cost
- Availability of oxygen
- Power supply
- Benefit vs risk/comfort assessment by clinician/patient/relative

Cost

Some estimated costs in WHO Emergency Global Supply Chain System (COVID-19) catalogue [6 May 2020]: [https://www.who.int/who-documents-detail/emergency-global-supply-chain-system-\(covid-19\)-catalogue](https://www.who.int/who-documents-detail/emergency-global-supply-chain-system-(covid-19)-catalogue)



Low-cost invasive & non-invasive ventilators being built in India & Sri Lanka – what about other SEAR countries eg Myanmar?

[https://www.bbc.com/news/world-asia-india-52106565#:~:text=The%20invasive%20ventilator%20being%20developed,cost%20%2C000%20rupees%20\(%24662\).](https://www.bbc.com/news/world-asia-india-52106565#:~:text=The%20invasive%20ventilator%20being%20developed,cost%20%2C000%20rupees%20(%24662).)

Coronavirus: India's race to build a low-cost ventilator to save Covid-19 patients



Soutik Biswas
India correspondent

1 April 2020

f t e Share

Coronavirus pandemic



India has an estimated 48,000 ventilators and most of them are already in use

Cost

Approximate costs obtained from suppliers in India (thanks to CMC Vellore ID & Purchase Depts). All are:

- Inclusive of local Indian taxes only (no import tax)
- In USD as of today's exchange rate
- Exclusive of delivery

Treatment modality	Machine	Consumables
HFNO	\$4,000	Nasal cannula with hose/tubing: \$60
CPAP, with O2 connection & flow meter	\$1,500-3,000	Hose/tubing: \$15-20 Oronasal mask: \$30-60
BIPAP, with O2 connection & flow meter	\$2,500-5,000	Full face mask: \$120 Helmet: \$200 Filter: \$5
Invasive ventilator	\$15,000-30,000	Hose/tubing: \$30-40 Endotracheal tube: \$1-5

THANK YOU!

Questions/Discussion