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

June 4, 2020

Moderators for presentation: Drs. Hillary Cohen (Englewood Health/IMAI Alliance)/Bhagteshwar Singh (SEARO/University of Liverpool), Mona Shah (IMAI Alliance)

Presenters:
Dr. Srikant Kondapaneni and Dr Judy Wong- Englewood Health, New Jersey, USA
Dr. Swapna Mandal- Royal Free Hospital, London, United Kingdom

Moderators for discussion: Drs. Fabio Caldas de Mesquita (WHO Myanmar), Pushpa Ranjan Wijesinghe (SEARO), Moe Khaing (MoH Myanmar), Sandy Gove (IMAI Alliance)
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
• Severe and critical COVID-19 usually characterised by pneumonia -> hypoxaemia & acute respiratory distress syndrome (ARDS)\(^1\)

• Increasing reports of pulmonary embolism and possibly pulmonary microthrombi\(^2\)

• 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 possible\(^1\)
• Supported by drive to minimize aerosolization of virus particles
• Some concerns this may lead to high mortality – possibly due to ventilator-induced lung injury\(^2\)
• 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 PaCO\(_2\) - 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**

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

  - **If increasing respiratory distress or SpO₂ < 90; < 94 if ABCD emergency sign or pregnant**

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

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

- **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

- **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

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]
- Iwashyna [2020] found similar small (<0.5um) 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)

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.
• 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.
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.
In hospital without ABG or 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

Ceiling of care includes IMV

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

Patients on O\textsubscript{2} therapy
- titrate O\textsubscript{2} to target ≥94%
- If needed, escalate to highest available oxygen in your hospital - 10-15L via non-rebreather face-mask; 12-15L via 60% Venturi mask, or 6L via standard nasal cannula

INCREASED RESPIRATORY DISTRESS OR SpO\textsubscript{2} <94% DESPITE MAXIMUM AVAILABLE OXYGEN:
- patient has hypoxaemic respiratory failure (presume non-hypercapnic if no history of chronic respiratory disease e.g. COPD)

Trial of HFNO, CPAP (mask, full face mask or helmet), or BiPAP
Continue positioning/proning and symptom control
Reassess after 30 min, then 1 hour
Follow mental status as well as SpO\textsubscript{2}

If not able to transfer

If improving, continue; titrate down O\textsubscript{2} as able.
Prioritize symptom control measures; review other treatments (benefit vs discomfort).

Remember IPC! Considerations for aerosolization.
All admitted patients with severe respiratory distress:
- Positioning: high supported sitting; encourage proning (see QC 15)

Patients on O₂ therapy
- titrate O₂ to target ≥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

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

IMV indicated now and ceiling of care includes 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 not improving
- IMV indicated now and ceiling of care includes IMV

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

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 ]
Many Options: target ~3.5mm diameter orifice

[ Inline Filter ]
Standard B/V (Bacterial/Viral), or HEPA

[ Non-Vented Elbow & Mask ]
Various combinations, prefer Anti-Asphyxia Valve

[ Secondary Leak Containment Hood ]
Balance imperviousness against patient comfort

Distal, toward Philips V60 (or equiv) BiPAP Machine

Proximal, toward Patient

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

Med-Tech Resources Part No MTR-755R
Project PreVent: Circuit Option 4

Secondary Leak Containment Options

- 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**

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


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

<table>
<thead>
<tr>
<th>Treatment modality</th>
<th>Machine</th>
<th>Consumables</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFNO</td>
<td>$4,000</td>
<td>Nasal cannula with hose/tubing: $60</td>
</tr>
<tr>
<td>CPAP, with O2 connection &amp; flow meter</td>
<td>$1,500-3,000</td>
<td>Hose/tubing: $15-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oronasal mask: $30-60</td>
</tr>
<tr>
<td>BIPAP, with O2 connection &amp; flow meter</td>
<td>$2,500-5,000</td>
<td>Full face mask: $120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Helmet: $200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Filter: $5</td>
</tr>
<tr>
<td>Invasive ventilator</td>
<td>$15,000-30,000</td>
<td>Hose/tubing: $30-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Endotracheal tube: $1-5</td>
</tr>
</tbody>
</table>
THANK YOU! Questions/Discussion