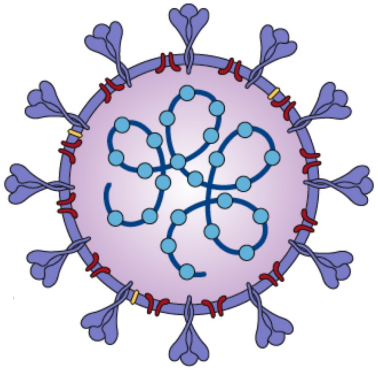
Managing respiratory failure outside the ICU



3rd June 2021

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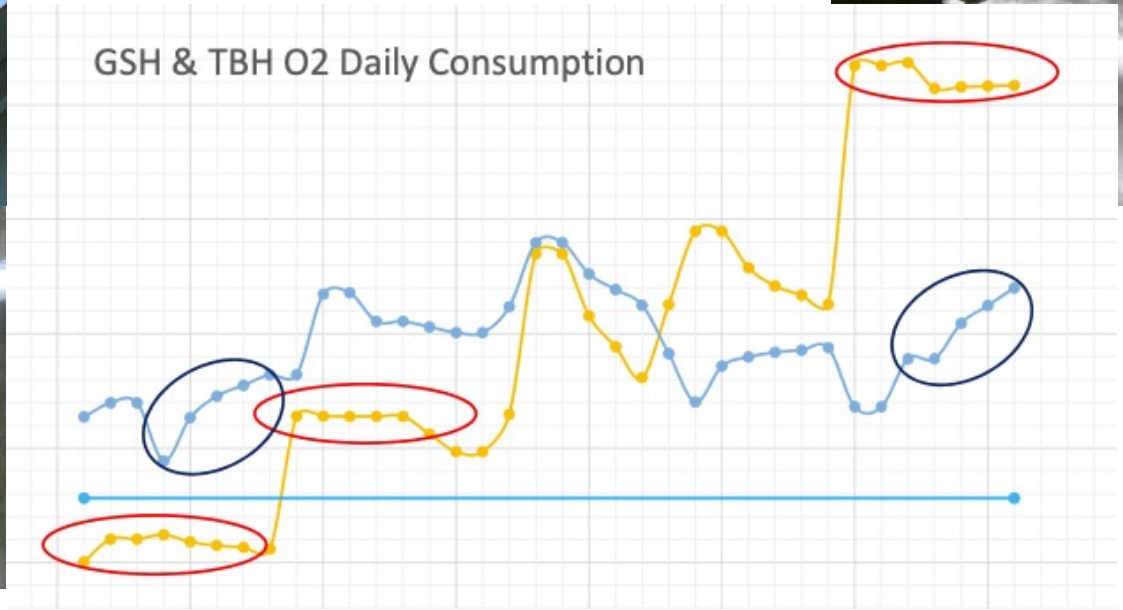
Respiratory support outside of the ICU

Requirements:

- Cohorting in high-care area of designated wards
- Preferably two oxygen points and three plugs
- No specific nursing needs but N95 masks
- Support from clinical technologists
- Monitored with co-oximetry at least
- Intubation teams/service available

Oxygen supply

- Total supply
- Reticulation (flow rate at each bed head)



Indications for stepwise escalation of oxygen therapy

Category	Clinical status	Suggested action
Red	RR ≥ 30bpm with SpO_2 ≤92% on 15L/min or HFNC and/or patient confused/ obtunded, rising FiO2 needs, significant clinical decline	Urgent review by ICU with preparation for intubation
Yellow	RR ≥ 30bpm with SpO_2 ≤92% on FiO_2 ≥ 40%	Start O_2 15L/min via non-rebreather face mask Consider awake self-proning* Senior clinical review to consider HFNO**
Green	RR ≥ 30bpm with SpO_2 ≤92%	Administer O_2 via either nasal cannula (2-4L/min) or by 40% face mask. If SpO_2 rises to >93%, observe and monitor.

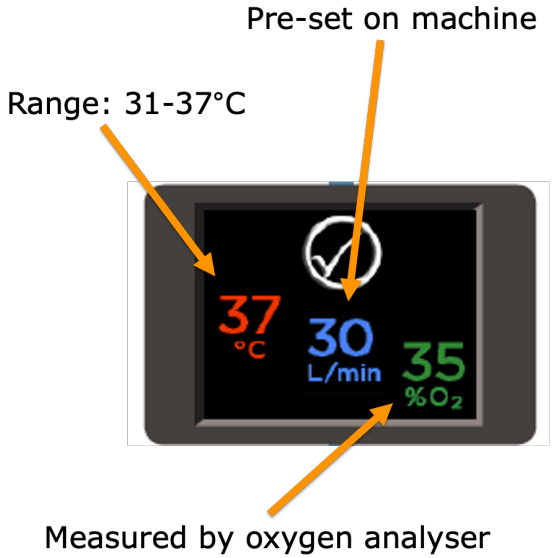
HFNO as maximal level of respiratory support (outside of ICU)

Comfortable interface	No need for tight seal, able to eat and drink, can wear mask
Heat and humidification	Avoids airway injury, well-tolerated by patient
Washout of dead space	Improved oxygen delivery
PEEP	Decrease work of breathing
High flow rate	Reliable FiO_2

HFNO outside of the ICU

Practically:

- Start flow at 40-50L/min and titrate FiO2 upwards to maintain saturations ~92%
- Increase flow at 10L/min increments if RR fails to improve
- Patients can also wear a face mask (and allows eating and drinking)
- Composite clinical assessment of the need for intubation

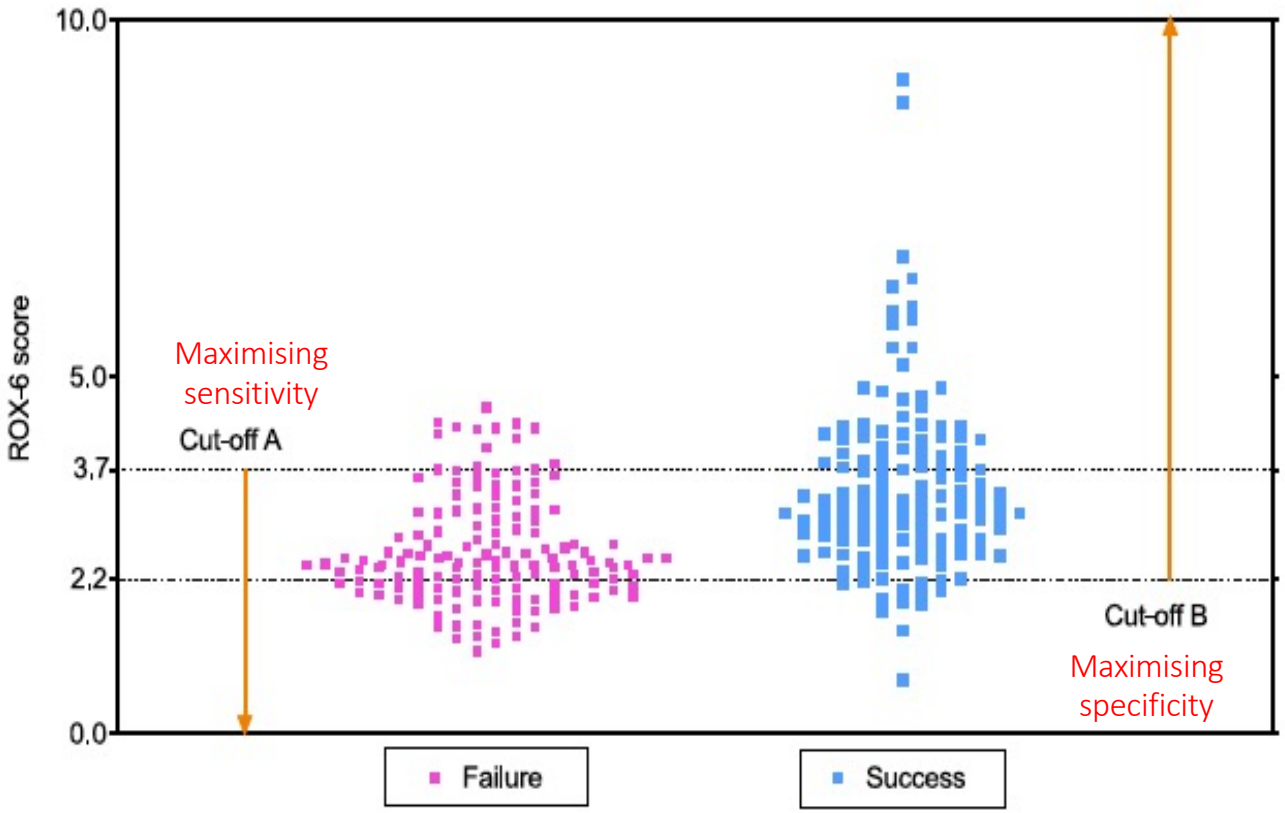


$$ROX = \frac{(SpO_2/FiO_2)}{RR}$$

ROX-6 = ROX 6 hours after HFNO initiation

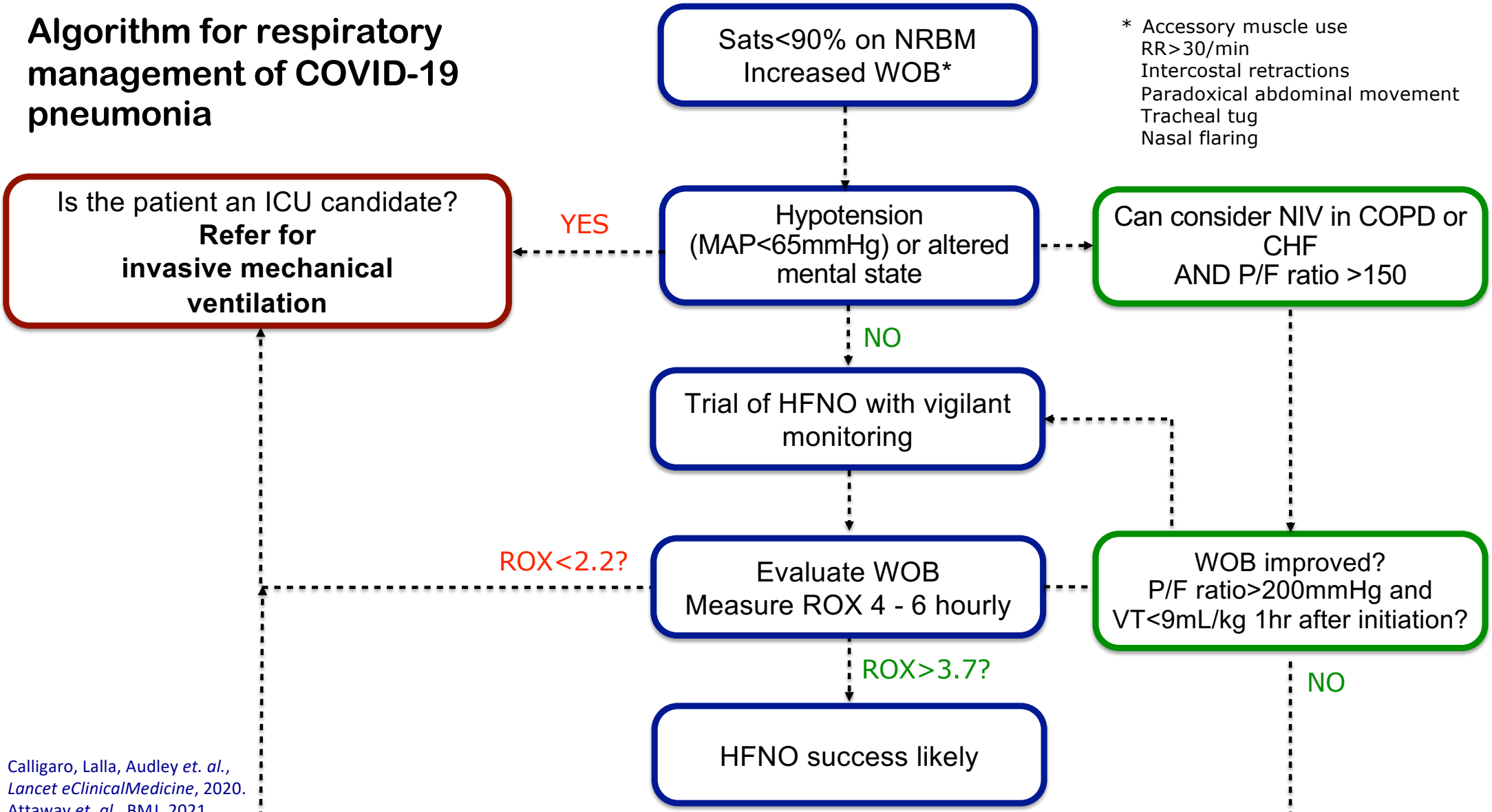
ROX-6 above 3.7 – 90% probability of HFNO success

ROX-6 below 2.2 – 90% probability of HFNO failure



Calligaro, Lalla, Audley *et. al.*, *eClinicalMedicine*, 2020.

Algorithm for respiratory management of COVID-19 pneumonia



Calligaro, Lalla, Audley *et. al.*, *Lancet eClinicalMedicine*, 2020.
Attaway *et. al.*, BMJ, 2021.

Study	N (HFNC)	Age median (interquartile range)	Gender (% F)	Oxygenation at baseline PaO_2/Fi_02	Duration of use	Outcome	Comment
Selected studies on high flow nasal cannula							
Calligaro et al	293	52 (44-58)	44	68 (54-92)	6 (3-9) days-success 2 (1-5) days failure	47% success on HFNC alone. Overall survival to discharge 52%	ROX-6 h ≥3.7, 80% success ROX-6 h ≤2.2, 74% failure
Ferrando et al	199	HFNC only: 63 (55-71) HFNC+ Prone: 60 (54-70)	26	HFNC only 111 (83-144) HFNC+prone 125 (99-187)	Treatment duration not available ICU length of stay 7.5-8 days	HFNC success 58.3% +prone 60% ICU mortality 13.9% and 16.3% respectively	No difference in outcomes when proning HFNC patients. Potential delay in intubation when proning
Demoule A et al	146	60 (53-67)	21	126 (86-189)	4 (2-6)	28 day mortality 21 %	HFNC reduced intubation rate without affecting case fatality (propensity score matched analysis versus those who did not receive HFNC)
Zucman et al	62	55 (48-63)	Not reported	F_IO_2 0.8 (0.6-1) SpO_2 96 (94-98) %	10 hours (7-57) for failure	34% success on HFNC alone. Overall ICU mortality 17%	ROX-4 h ≥5.37, lower risk of intubation HR 0.59 (95% confidence interval 0.41 to 0.84)
Xia et al	43	64 SD 9.7	42	122.3 ±51.3 mm Hg	4 (2-7) days 5 (3-7) days success 3.5 (1.5-6.5) days failure	53.5% success on HFNC alone. Hospital mortality 32.5% for entire cohort (65% if HFNC failure)	Male sex and lower oxygenation on admission risk factors for failure. Overall mortality 32.5%. Mortality 65% for invasive mechanical ventilation
Panadero et al	40	58.9 SD 11.8	30%	S_pO_2/F_IO_2 113.4 ±6.6 (success) 93.7 ±6.7 (failure)	6 (5-8) days success 2 (1-4) days failure	Not intubated at 30 days 47.5% Mortality 22.5%	ROX 2-6 <4.94 associated with high risk of intubation HR 4.03 (1.18-13.7)
Vianello et al	28	69 (42-87)	33.3	108 (52-296)	Not available	67.8% discharged alive. 17.8% required IMV 15 day mortality 11% (3 patients on IMV)	Patients with P_3O_2/F_IO_2 ≤100 had failure rate of 77.8%. Among the 73 healthcare workers who took care of the patients for an average of 48 hours per person, no infections were reported
Guy et al	27	77 (77-79)	19	124 (120-158)	6 (2-10) days	70% HFNC success. 26% required invasive mechanical ventilation. Overall mortality 15%	Consecutive patients treated in a non-ICU setting
Duan et al	23	65 SD14	48%	196 ±46	3.6 days (1.6-8.4)	57% HFNC success. 43% transitioned to NIV 17% eventually intubated mortality 4%	Elevated C reactive protein predicted intubation
Wang et al	17	65 (56-75)	59	209 (179-376)	76 hours	59% HFNC success	If P_3O_2/F_IO_2 >200, 0% failure. Reduction in respiratory rate after 1-2 h on HFNC predicted success

- Mean PaO_2/FiO_2 68 - 209 mmHg
- Average duration of HFNO was 3-6 days; patients who require escalation do so earlier in the course of treatment
- HFNO was associated with success without need for intubation in 34 to 70% of cases
- ROX index at 4-6 hours predicts need for escalation of care

Attaway *et. al.*, BMJ, 2021.

Timing of HFNO vs IMV?

- No RCTs possible!
- HFNO failures have poor outcomes (survival to discharge in patients failing HFNO 14% at GSH/TBH)
- Propensity-score matching studies:
  - less intubation
  - higher number of ventilator-free days
  - reduced LOS

Demoule A *et. al.*, *AJRCCM*, 2020.
Mellado-Artigas R *et. al.*, Crit Care, 2021.

Summary

- Respiratory support outside of the ICU has important O_2 supply and equipment considerations
- In limited resource settings, using HFNO (in severe disease, and even outside the ICU) has the potential to avoid intubation in half of patients
- Threshold for intubation is needs clarification, especially in settings with limited access to ventilation BUT ROX-6 is an important discriminator of HFNO success
- Scaling up use requires ongoing monitoring of local capacity and oxygen supply chain