The 18th Scientific Respiratory Medicine Meeting

PIPKRA 2021

Petemuan Ilmiah Pulmonologi & Kedokteran Respirasi

Conventional and High-flow Oxygen Therapy in COVID-19

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RUMAH SAKIT UNIVERSITAS INDONESIA

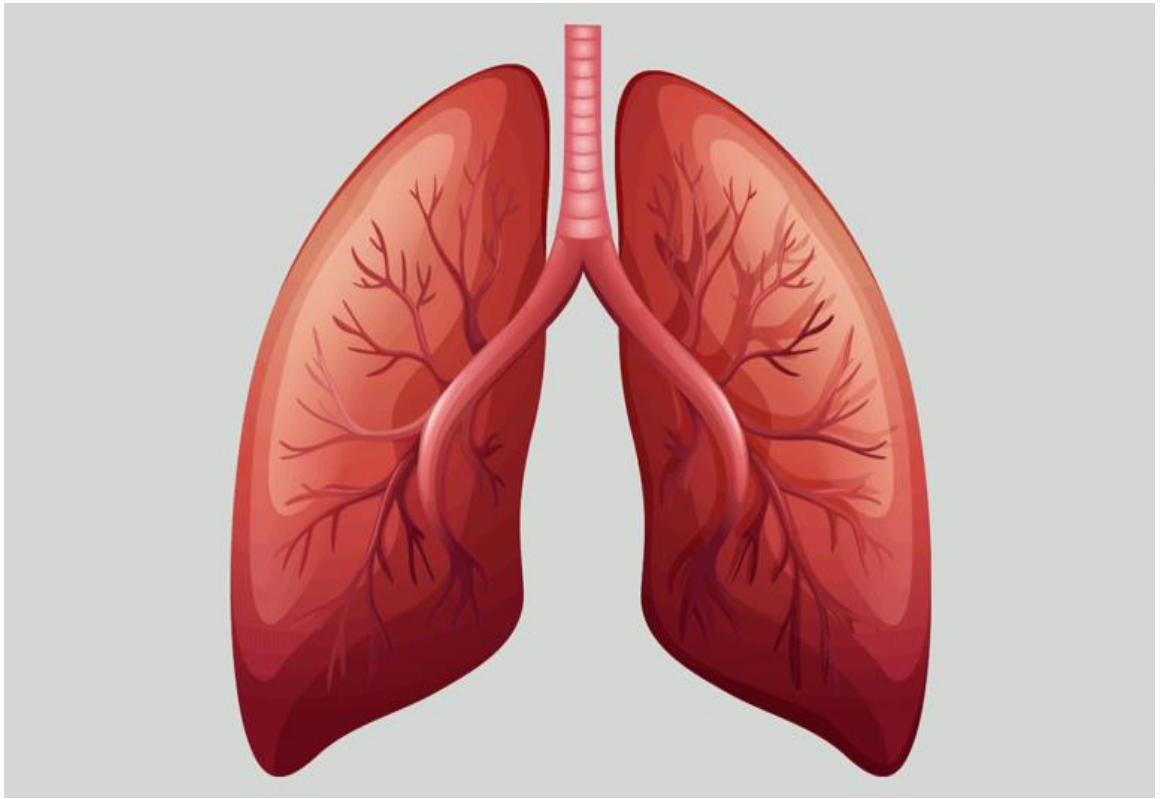
Holistic Management of COVID-19 and Other Emerging Diseases

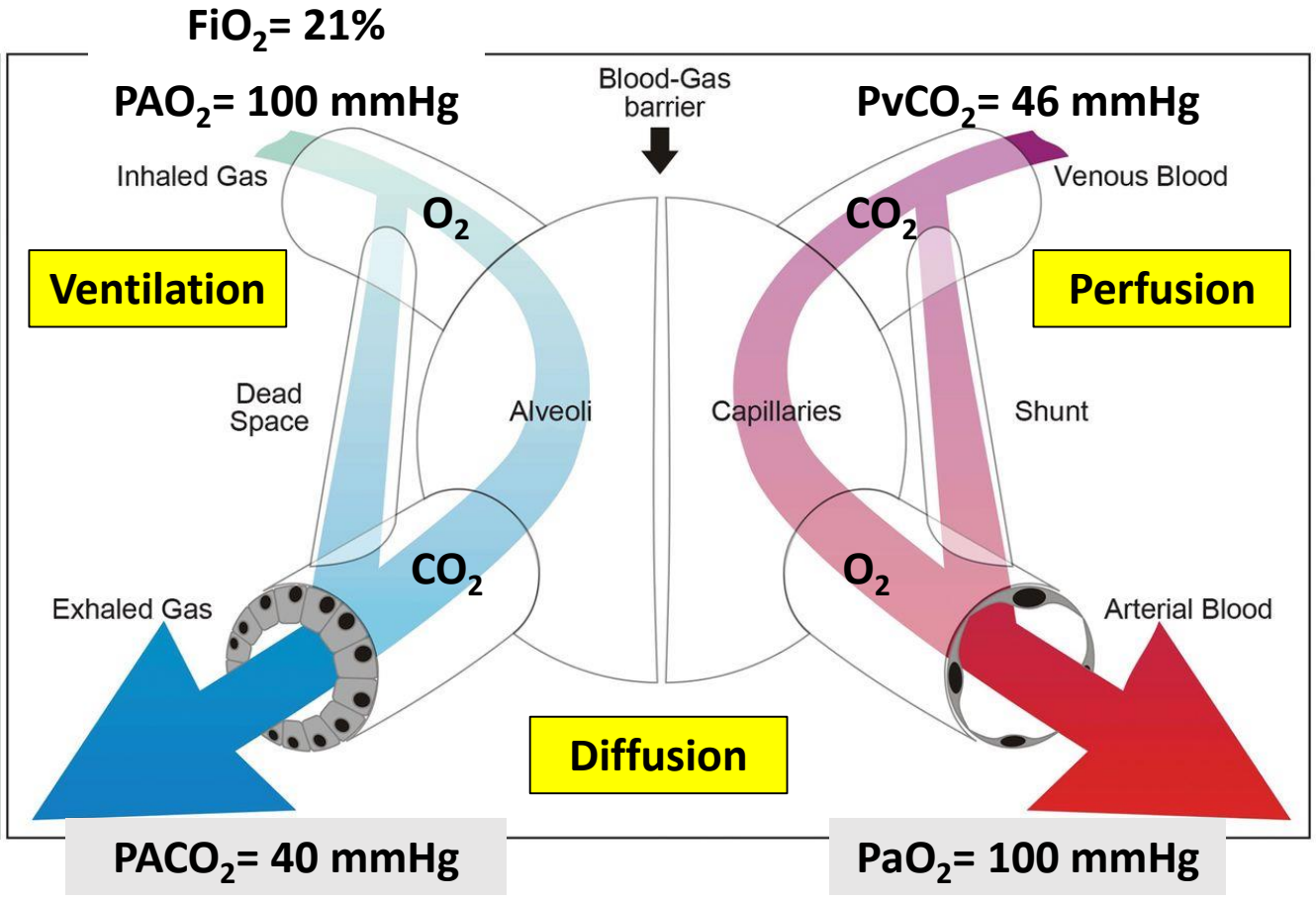
PIPKRA Workshop, 26 February, 2021

Presentation Outline

- Pulmonary Physiology at-A-Glimpse
- Oxygen Impairments in COVID-19
- Oxygen Therapy in COVID-19
- High-flow Oxygen Therapy in COVID-19
- Preparation & Unfavored Events of High-flow Oxygen Therapy
- Conclusion

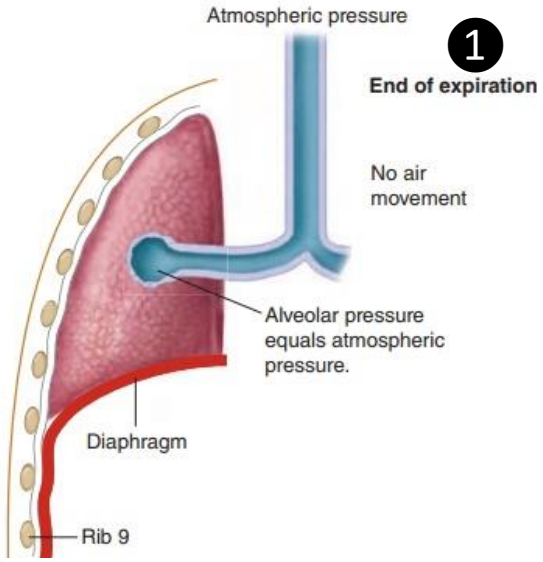
Pulmonary Physiology at-A-Glimpse

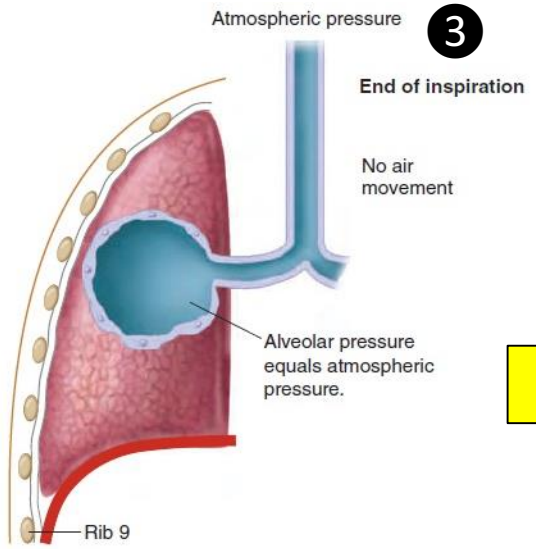


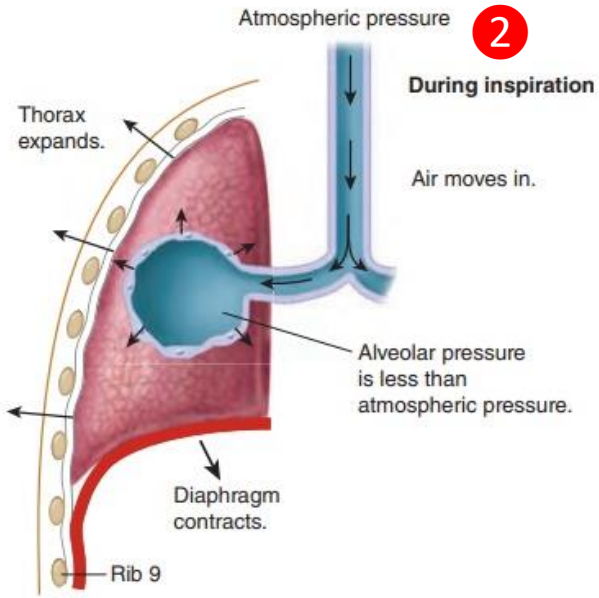


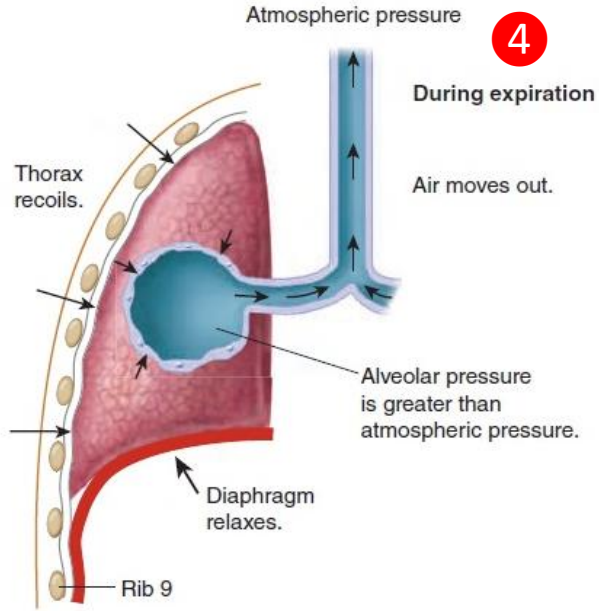
https://doi.org/10.4187/respcare.03377

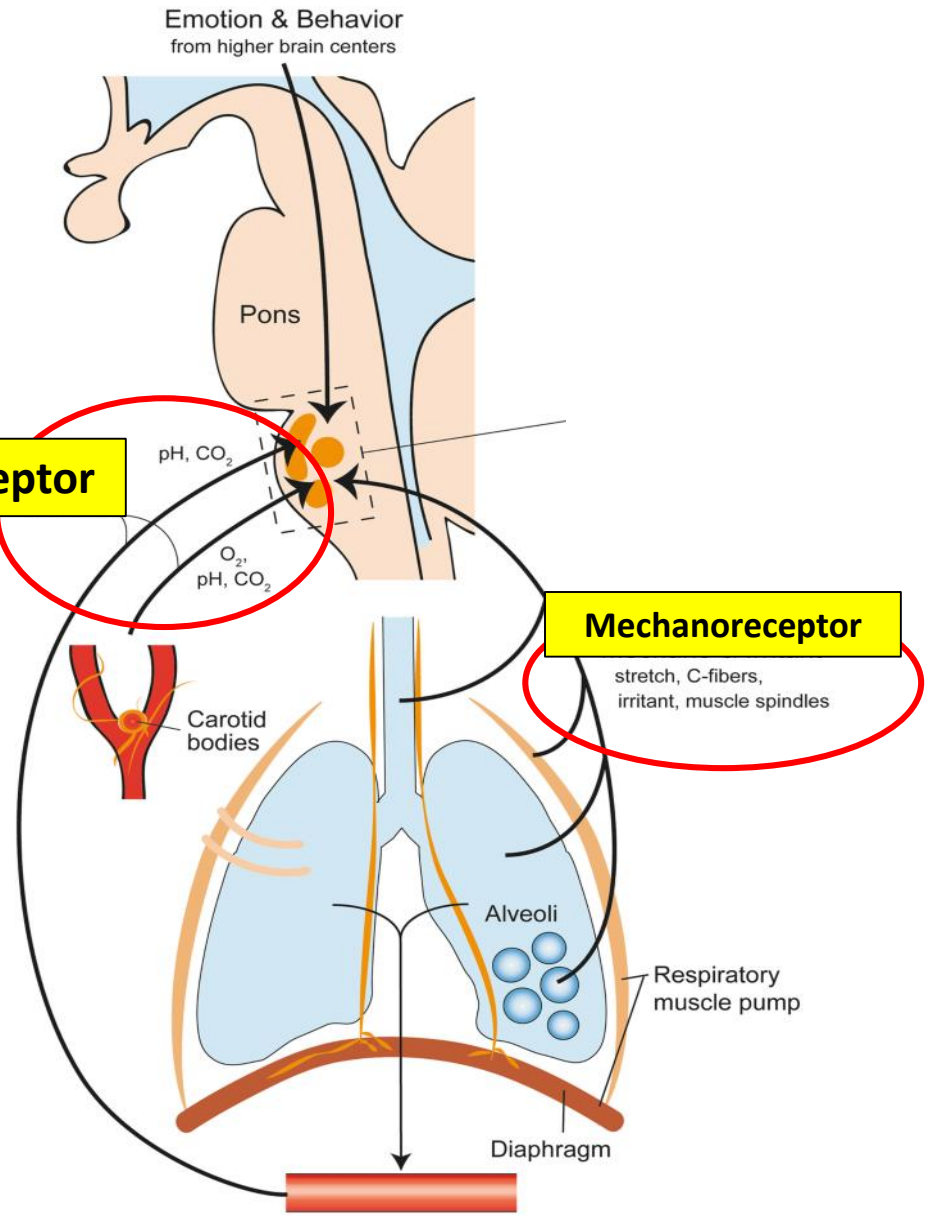
Respiratory Drive





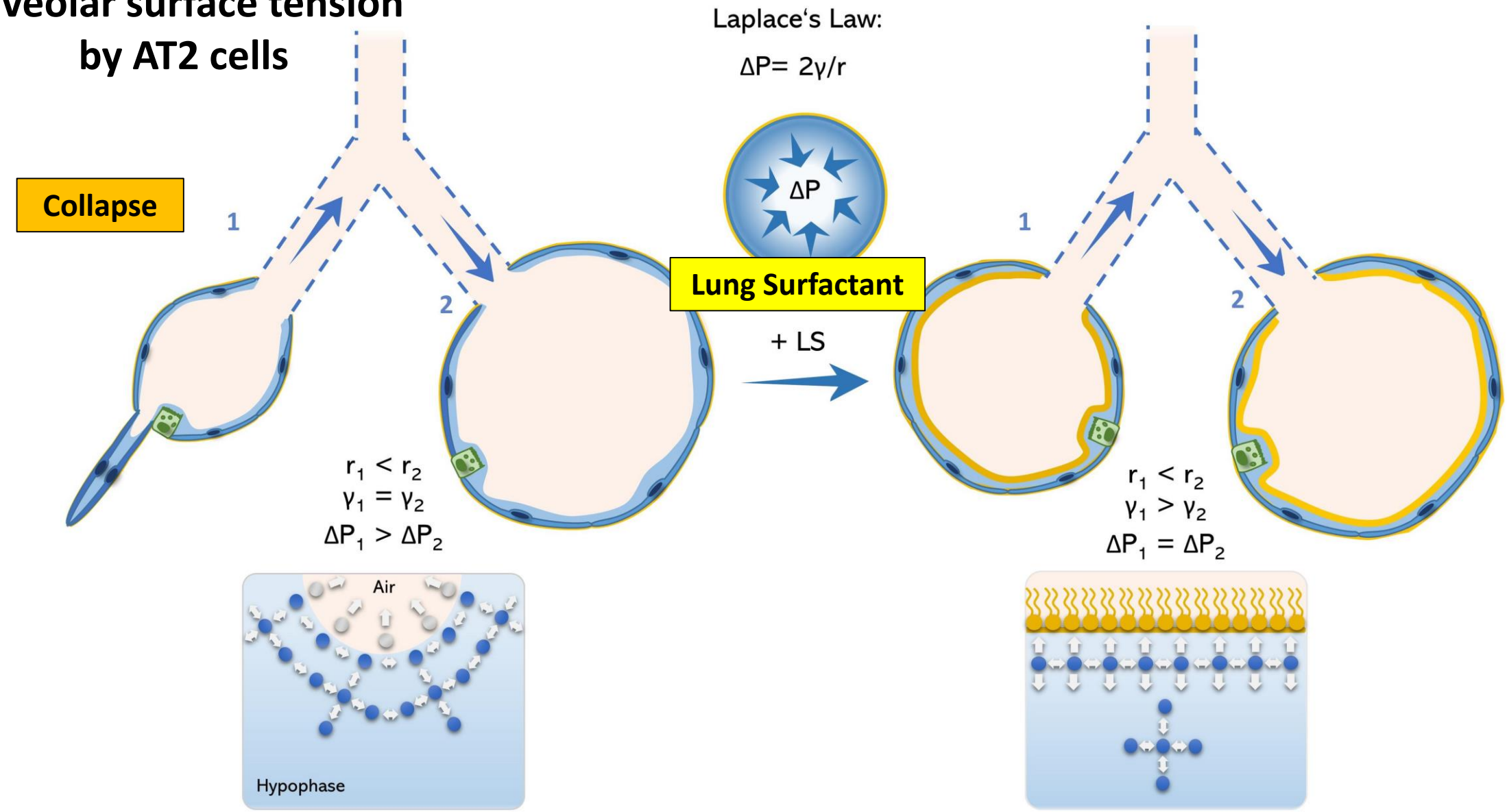






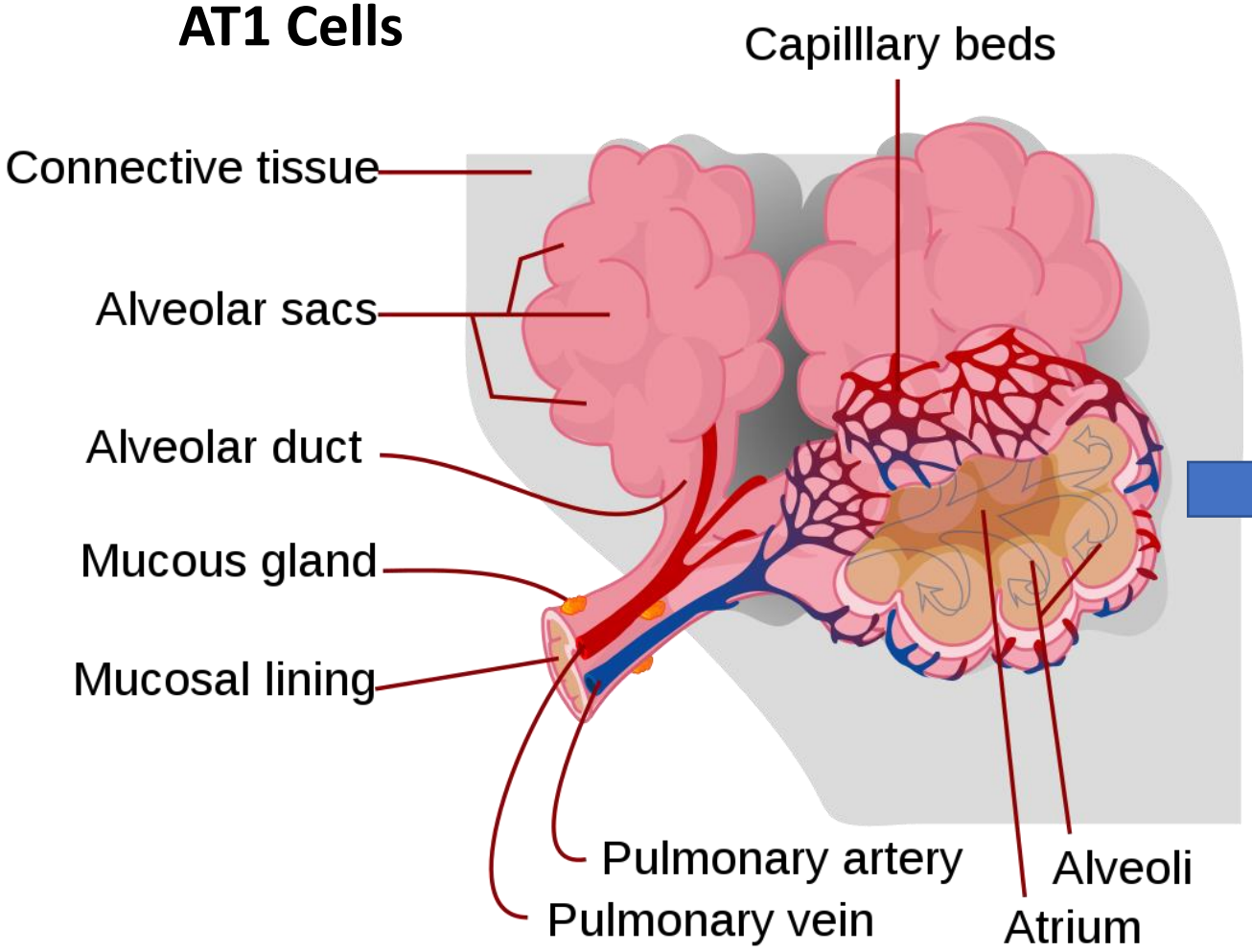
https://doi.org/10.1186/s13054-020-2776-z
http://www.brainkart.com/article/Changing-Alveolar-Volume_21921/

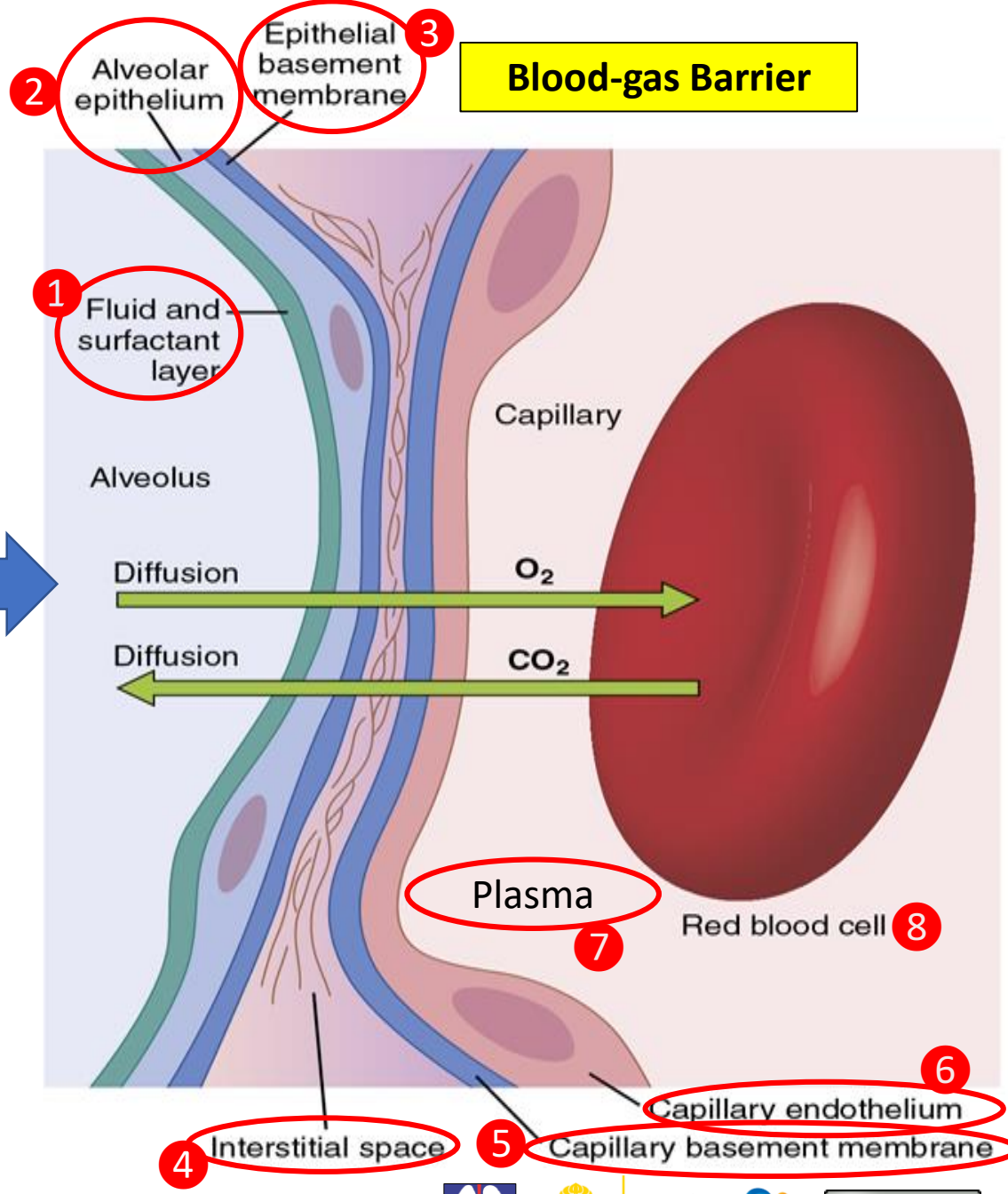
Alveolar surface tension by AT2 cells



https://doi.org/10.3389/fphys.2020.00386

Gas Diffusion by AT1 Cells

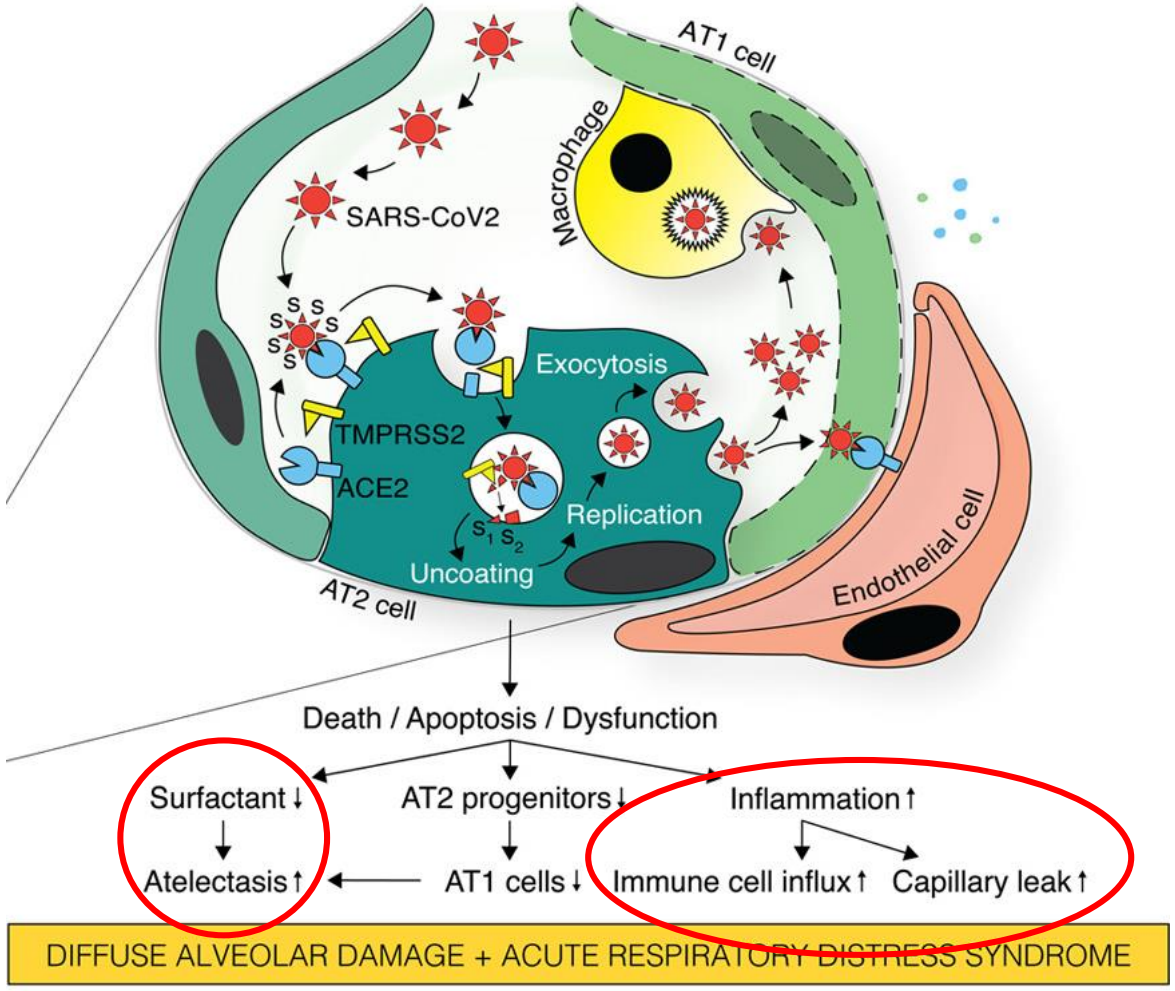


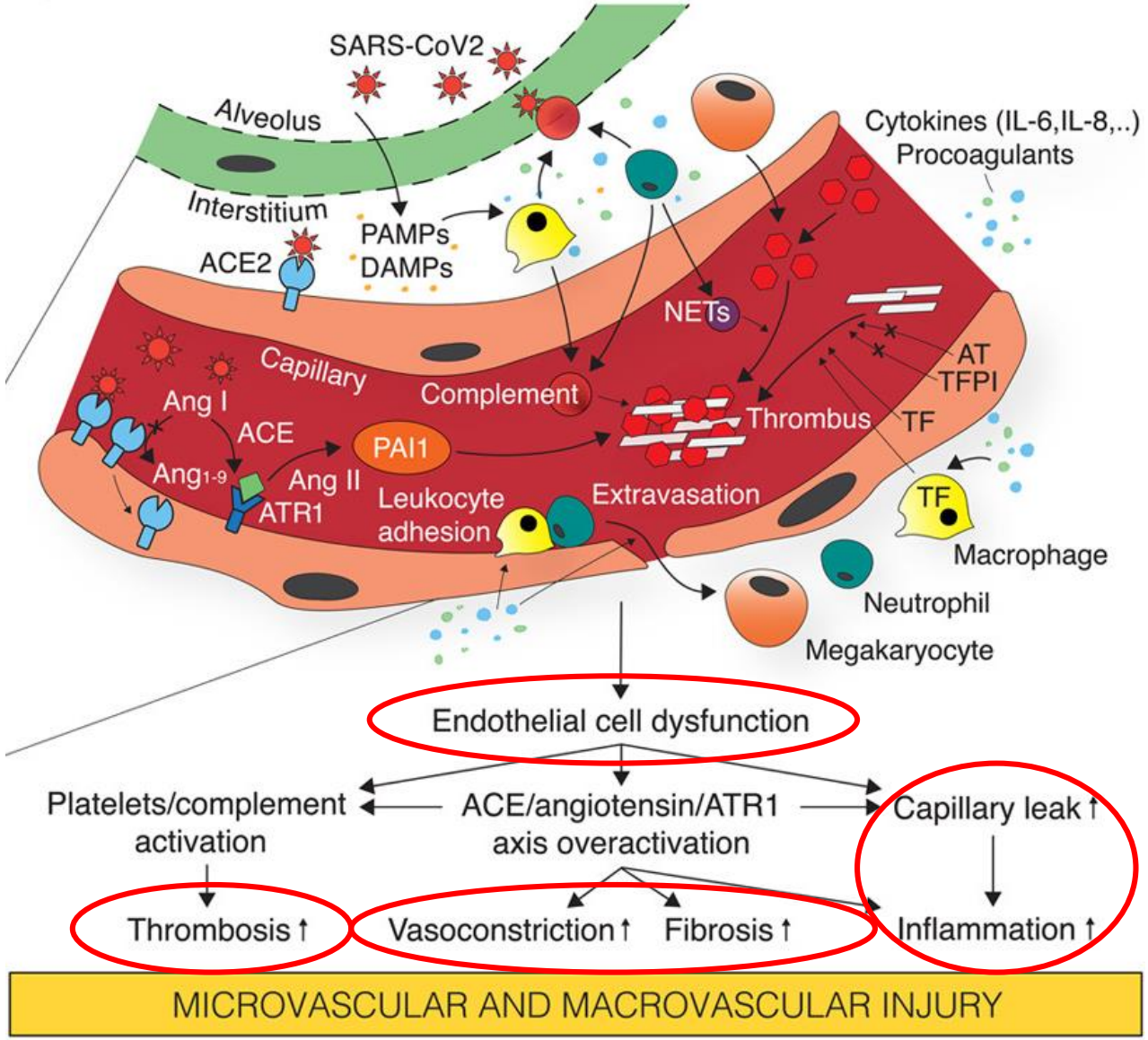


Conventional and High-flow Oxygen Therapy in COVID-19

Irandi Putra Pratomo, M.D., Ph.D., FAPSR

Oxygen Impairments in COVID-19





https://doi.org/10.1161/ATVBAHA.120.314515

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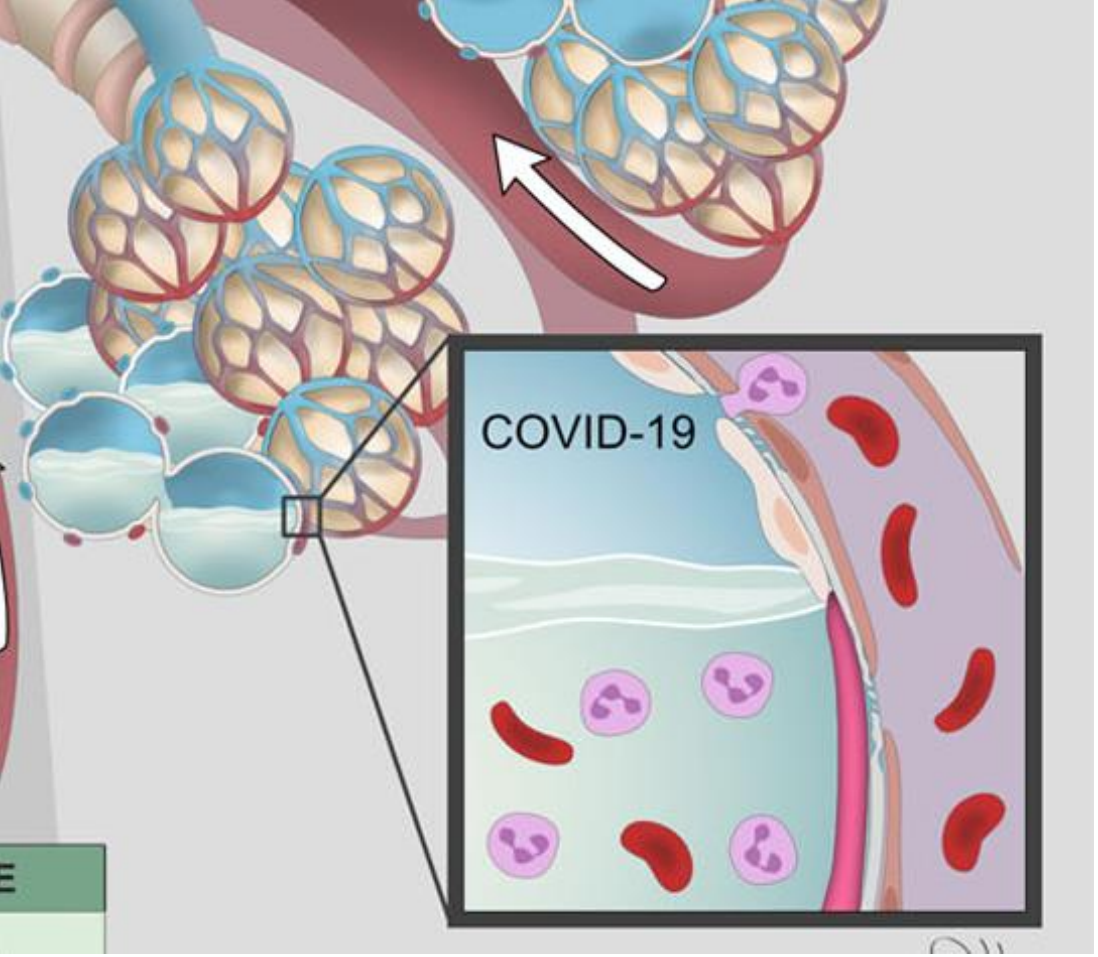

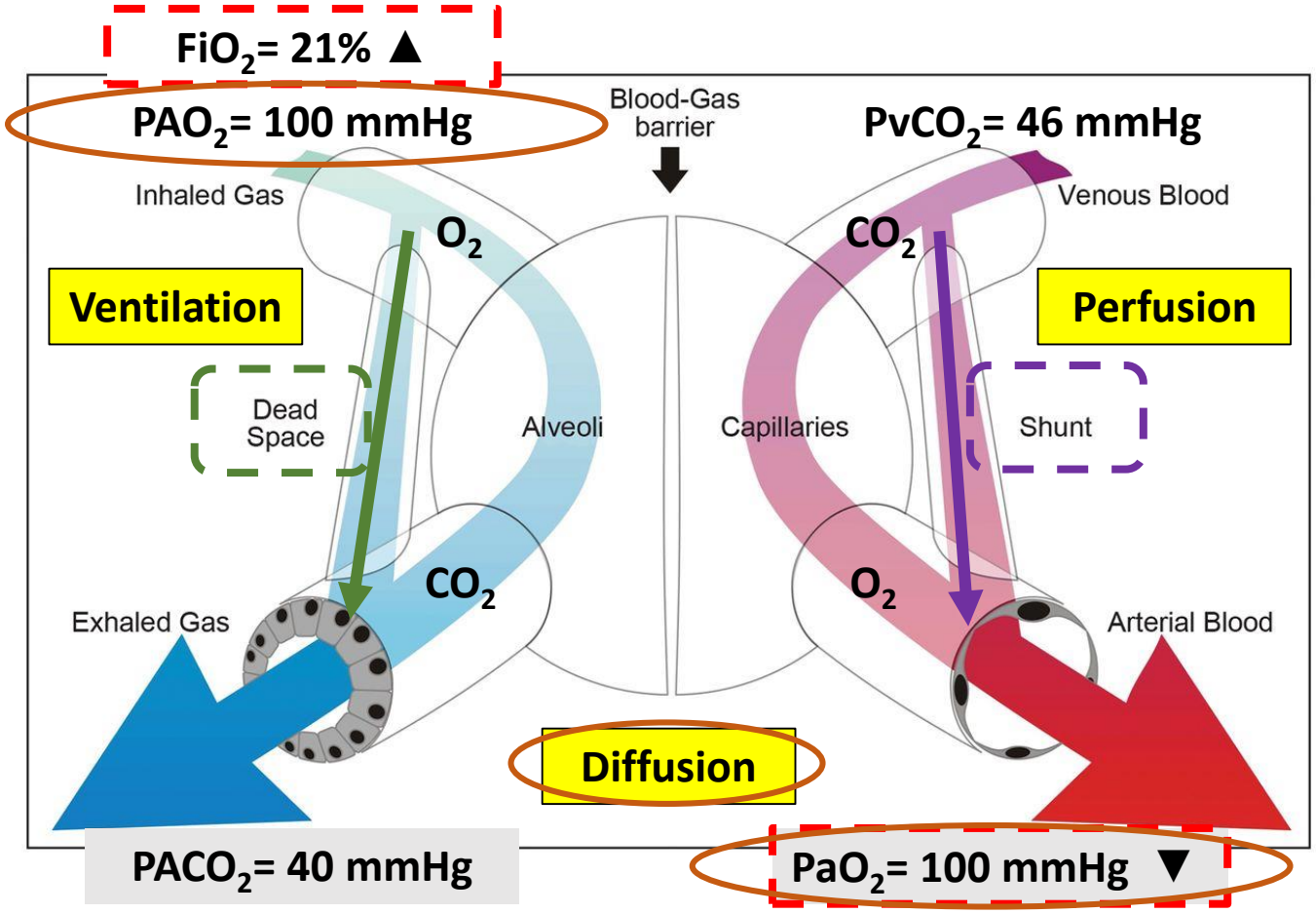

Alveolar-arterial oxygen gradient (A-a DO_2)

Ventilation – Perfusion (V/Q) Mismatch

PaO_2:FiO_2 decreased/ARDS (<300)

https://dx.doi.org/10.4103%2F0970-2113.197116
https://doi.org/10.4187/respcare.03377
https://doi.org/10.1161/CIRCULATIONAHA.120.047915

Conventional and High-flow Oxygen Therapy in COVID-19

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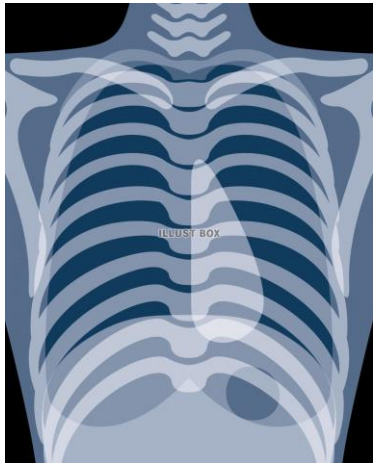
Oxygen Therapy in COVID-19

- Determine an Increased Oxygen Demand in COVID-19 → **Clinical signs of hypoxemia**:
  - Increased work of breathing
  - Increased **respiration rate**
  - Decreased peripheral **oxygen saturation (SpO_2)**
  - Abnormal CXR (i.e. pneumonia, effusion, etc)
- **Estimate Oxygen Demand & Treat:**
  - Take **blood gas analysis (BGA)**
  - Calculate A-a DO_2
  - Calculate required **FiO_2**
  - Oxygen supplementation



https://dx.doi.org/10.4103%2F0970-2113.197116
https://www.ncbi.nlm.nih.gov/books/NBK482316/
https://www.covid19treatmentguidelines.nih.gov/critical-care/oxygenation-and-ventilation/

A-a DO_2

- In normal young adult, A-a DO_2 < 10 mmHg
- Increases with age:
  - Age 20: 4 to 17 mmHg
  - Age 40: 10 to 24 mmHg
  - Age 60: 17 to 31 mmHg
  - Age 80: 25 to 38 mmHg

A-a DO_2	Hypoxemic Condition Associated with A-a DO_2	Oxygen response
Normal	**Hypoventilation Drive** • Neuromuscular disorders • Central nervous system disorder	Responsive
	Low inspired FiO_2 (e.g. high altitude, **inadequate oxygen**)	
Increased	**Dead space** • Pulmonary embolism • **Atelectasis** • **Pneumonia** • Obstructive lung disease (e.g. Asthma, COPD) • Pneumothorax	
	Altered diffusion/blood-gas barrier • **Interstitial lung disease, incl pulmonary fibrosis**	
	Shunt • Congestive heart failure • **Lobar/diffuse pneumonia** • **Adult Respiratory Distress Syndrome (ARDS)**	Unresponsive

https://dx.doi.org/10.4103%2F0970-2113.197116
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PaO_2:FiO_2

- Identify **current FiO_2**
- Obtain **PaO_2** from BGA
- Calculate **PaO_2:FiO_2** **target >300**
- **Re-adjust FiO_2 → re-adjust device & flow rates**
- **Keep in mind: Patient's Comfort**

Device	Flow Rates	Delivered O_2*
Nasal cannula	1 L/min	21%-24%
	2 L/min	25%-28%
	3 L/min	29%-32%
	4 L/min	33%-36%
	5 L/min	37%-40%
	6 L/min	41%-44%
Simple oxygen face mask	6-10 L/min	35%-60%
Face mask with O_2 reservoir (nonrebreathing mask)	6 L/min	60%
	7 L/min	70%
	8 L/min	80%
	9 L/min	90%
	10-15 L/min	95%-100%
Venturi mask	4-8 L/min	24%-40%
	10-12 L/min	40%-50%

*Percentage is approximate.

*Room air, FiO_2 = 21%

https://dx.doi.org/10.4103%2F0970-2113.197116
https://www.ncbi.nlm.nih.gov/books/NBK482316/

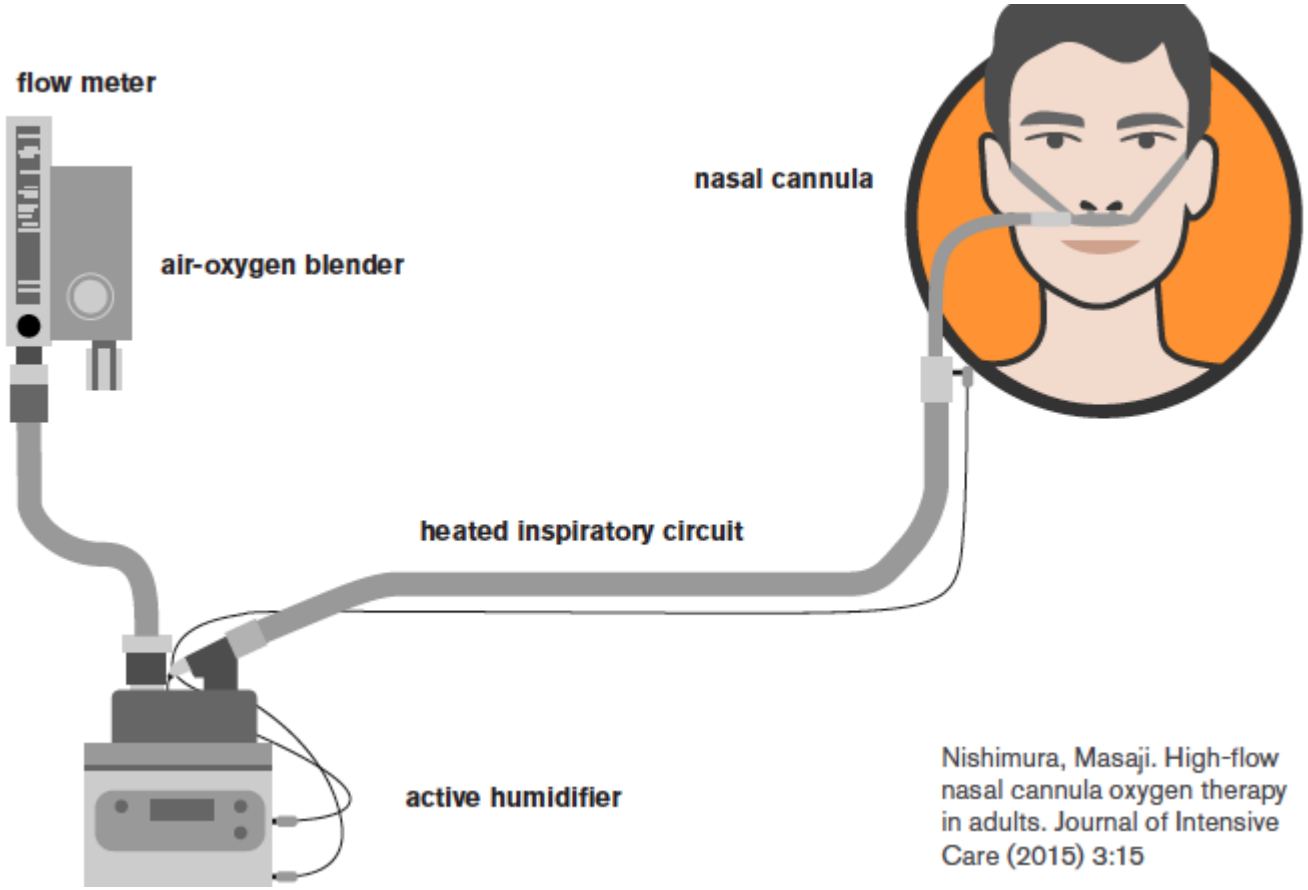
NIH COVID-19 Treatment Guidelines Panel's (the Panel's) recommendations

- **Goal of Oxygenation: SpO_2 92 – 96%**
- **Why should SpO_2 >92%?**
- In a trial of non-COVID-19 ARDS, target SpO_2 88 – 92%:
  - Increased mortality at 90 days (between-group risk difference 14%; 95% CI, 0.7% to 27%)
- **Why should SpO2 <96%?**
- In a meta-analysis of 25 RTs, non-COVID-19, median SpO_2 96%:
  - Increased risk of in-hospital mortality vs lower SpO_2 (RR 1.21; 95% CI, 1.03–1.43)

https://www.covid19treatmentguidelines.nih.gov/critical-care/oxygenation-and-ventilation/

High-flow Oxygen Therapy

- Advanced oxygen therapy
- Provide **heated** & **humidified** oxygen at flow 15-60 L/min
- Terminology:
  - High-flow nasal cannula (HFNC)
  - High-flow oxygen therapy
  - Nasal high-flow
  - Trans-nasal insufflation
  - *Kanal hidung arus cepat* (KHAC)
  - (By respective existing brand)



Nishimura, Masaji. High-flow nasal cannula oxygen therapy in adults. Journal of Intensive Care (2015) 3:15

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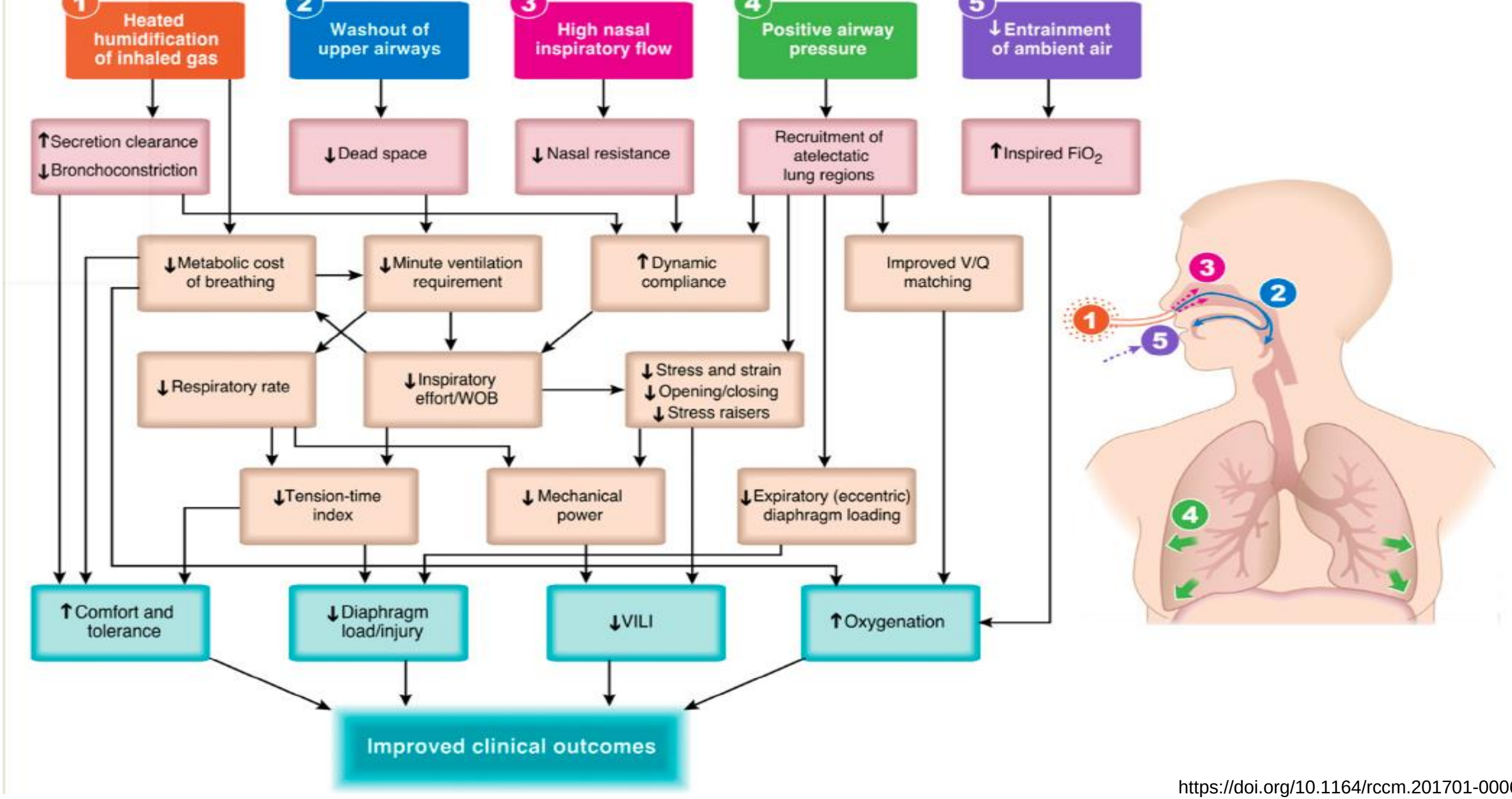


https://doi.org/10.1164/rccm.201701-0006ED

NIH COVID-19 Treatment Guidelines Panel's (the Panel's) recommendations

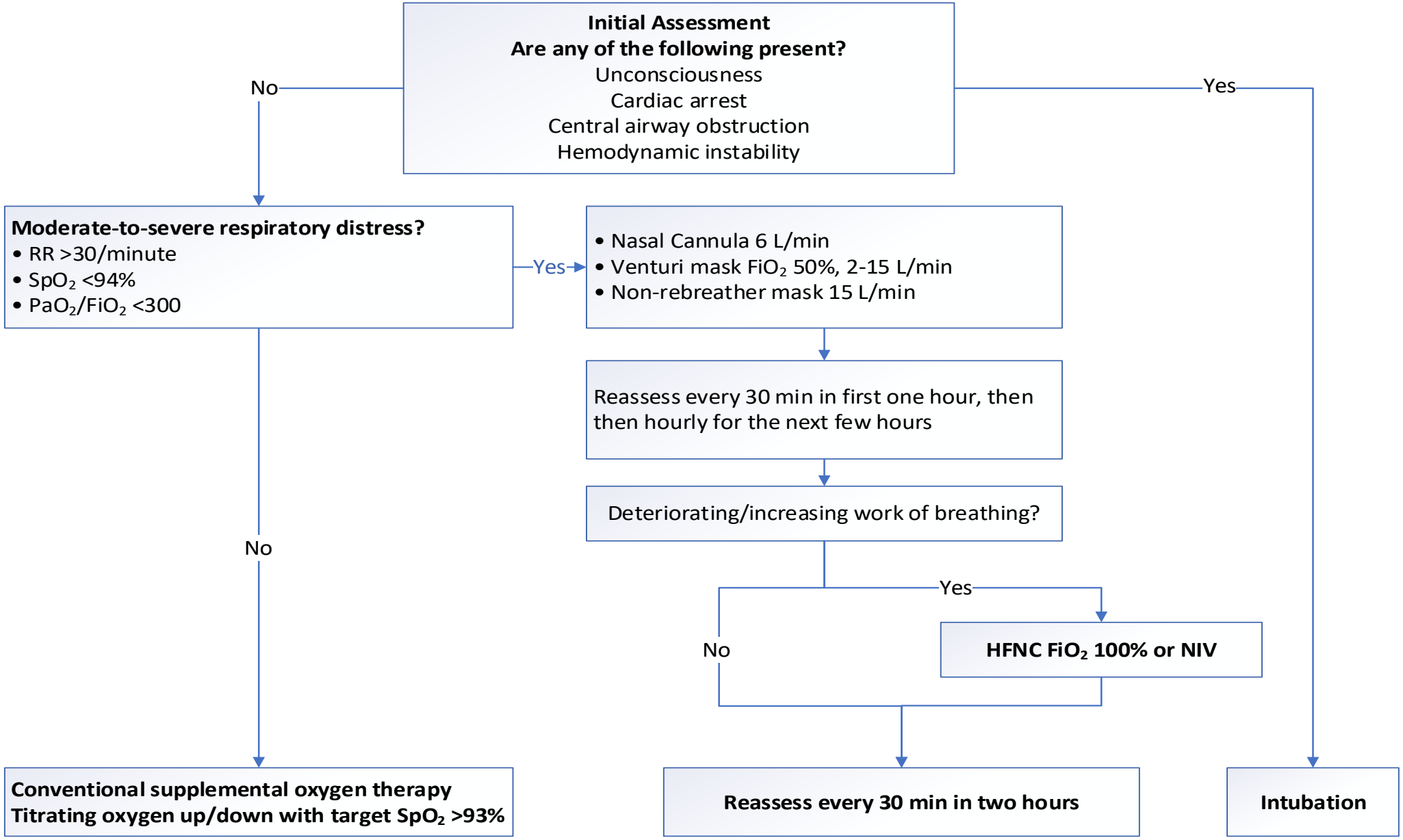
- ~~Adults w/ COVID~~-19 & acute respiratory failure after conventional oxygen therapy → **high-flow nasal cannula (HFNC) vs NIV** (BI)
  - **Recommends a closely monitored trial of NIV for whom HFNC is not available** (BIII)
- **HFNC group had more ventilator-free days** (24 days) vs conventional oxygen therapy group (22 days) or NIPPV group (19 days) (P = 0.02)
- **90-day mortality lower in the HFNC group** vs conventional oxygen therapy group (HR 2.01; 95% CI, 1.01–3.99) vs NIV (HR 2.50; 95% CI, 1.31–4.78)
- **HFNC reduced the rate of intubation** (OR 0.48; 95% CI, 0.31–0.73) & **ICU mortality** (OR 0.36; 95% CI, 0.20–0.63) vs NIV

https://www.covid19treatmentguidelines.nih.gov/critical-care/oxygenation-and-ventilation/

High-flow Oxygen Therapy Practical Recommendations

Flow rate	• Start at 30-40 litres min-1 and increase to meet the patient's demand • Increase the delivered flow until a reduction in respiratory rate and stable SaO_2 is achieved
Temperature	Set at 37 C
FiO_2	• Increase the FIO_2 until satisfactory SaO_2 is achieved • FiO_2 might set 100% in acute respiratory failure
Monitoring	Continuous monitoring of heart rate, respiratory rate, SaO_2
Positive response and weaning	• Gas flow rate and FiO_2 adjusted according to the clinical response • Reduce FiO2 by 5-10% and reassess after 1-2 h. • Reduce the flow rate by 5 litres/min and reassess after 1-2 h. • Consider weaning from HFNC with flow rates 25 litres/min and FiO_2 <0.4.
Ineffective response	• If there is no improvement, treatment escalation must be considered • Do not delay intubation

https://doi.org/10.1016/j.bja.2017.11.010



https://doi.org/10.4103/smj.smj_64_20

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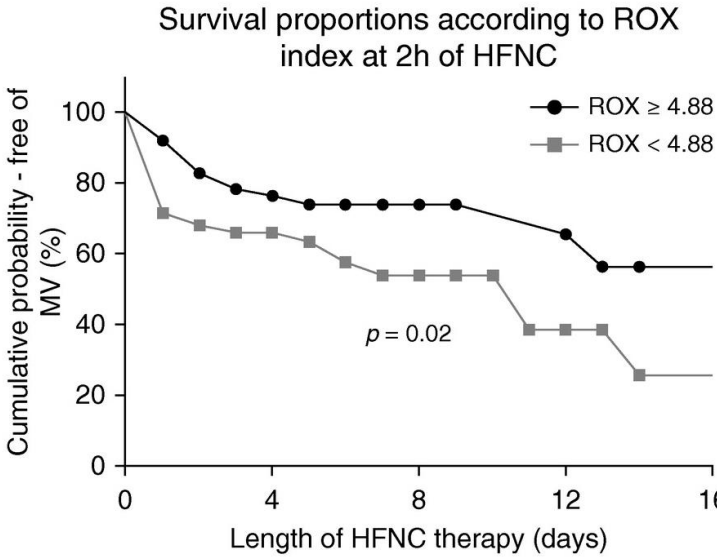
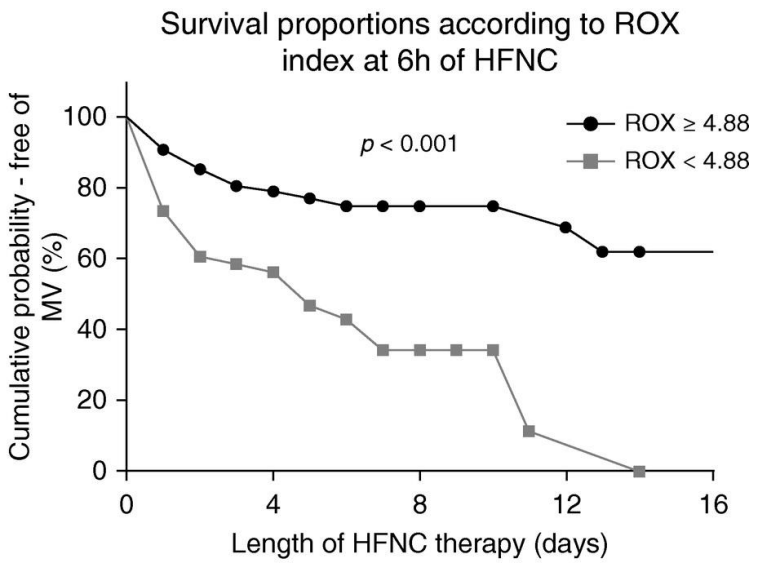
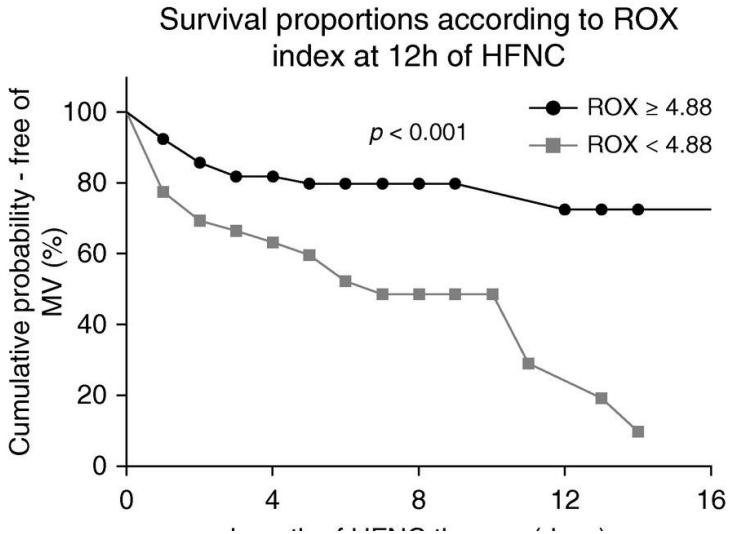
- **ROX index:** prediction tool to identify need for mechanical ventilation in pneumonia patients with hypoxemic acute respiratory failure treated with HFNC

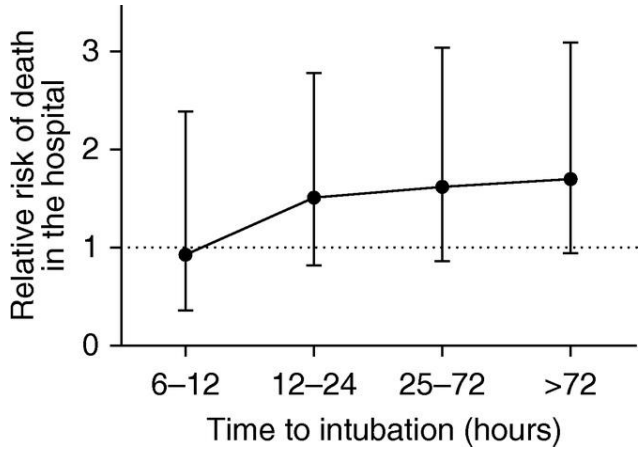
$$ROX = \frac{SpO_2/FiO_2}{\text{Respiratory Rate}}$$

- **ROX index ≥4.88 at 2, 6, and 12 hrs → predict HFNC success**

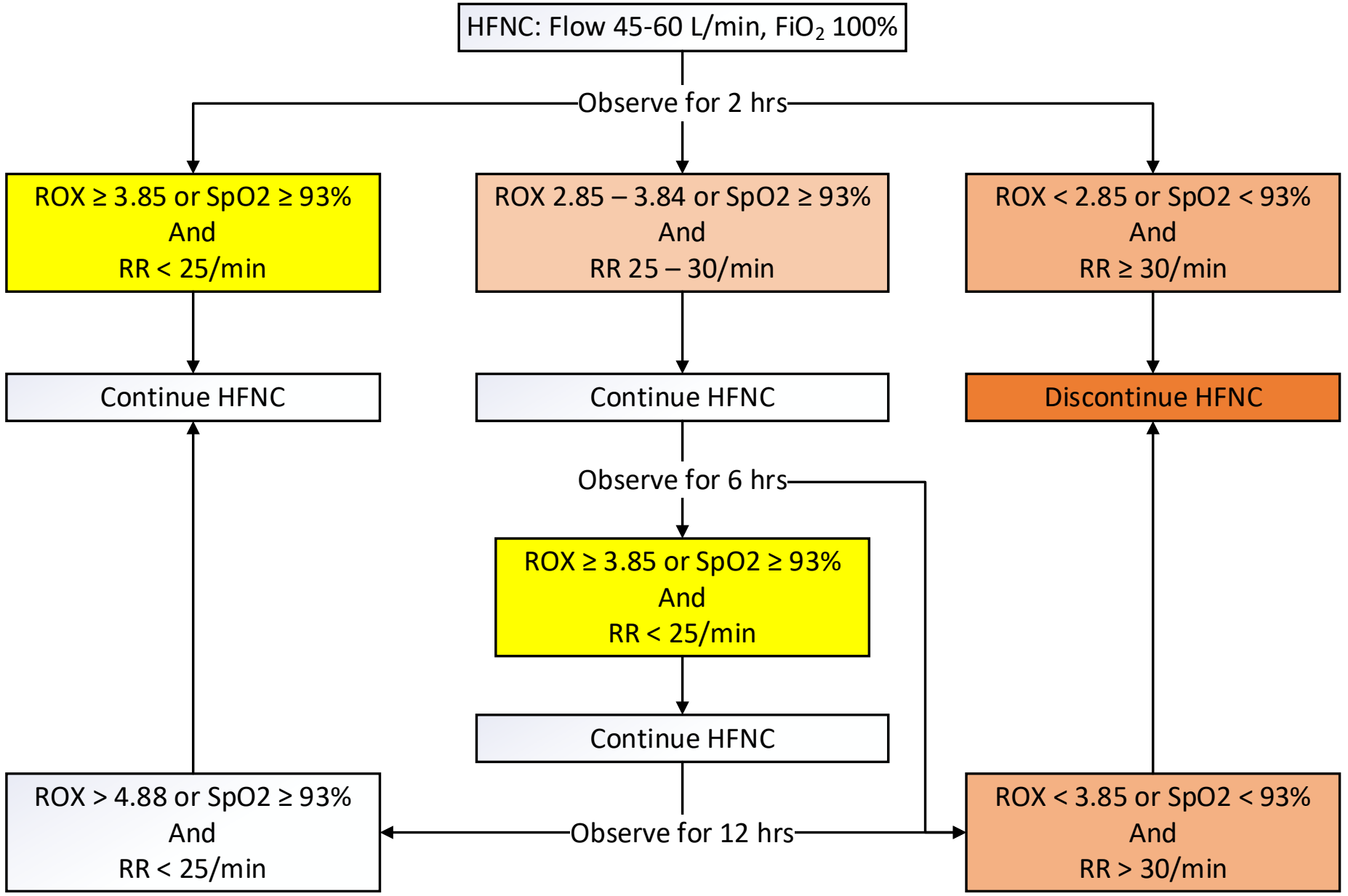








https://doi.org/10.1164/rccm.201803-0589oc
https://doi.org/10.1016/j.jcrc.2016.05.022



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Preparation & Unfavored Events of High-flow Oxygen Therapy

A. Related to the devise
1. Settings
i. Flow ii. FiO_2
2. PaO_2:FiO_2 interpretation
3. Start of treatment
4. Ventilation slots patency
5. Filter cleaning
6. Disinfection
7. Lack of internal battery
B. Related to oxygenation
1. O_2 tube connection
2. FiO_2 delay
3. Internal alarms menu settings
4. Adjusting flowmeter
5. No smoking

C. Related to humidification
1. Sterile water
2. Plastic bags
3. Cap
4. Avoid water runs out
5. Permeable circuit
D. Related to the tubing
1. Tube electric resistance
2. Tube breaks
3. Tube position
4. Tube weight
E. Related to nasal cannulas
1. Cannula size
2. Appropriate cannulas
3. Cannula placement
4. Adequate nasal hygiene

F. Related to alarms
1. Internal alarm menu setting
2. Alarm identification
G. Related to the patient
1. Nose 2. Paradoxical suffocation
3. Chest pressure
4. Understanding HFNC
5. Mobility
6. Noise
7. Claustrophobia
8. Intolerance
9. Barotrauma

https://doi.org/10.23937/2474-3674/1510048
https://doi.org/10.4187/respcare.04577

Conclusion

- Features of acute respiratory failure in **COVID-19**:
  Alveolar dead space, altered blood-gas barrier, shunt
- Signs of increased oxygen demand/**hypoxemia**:
  Increased RR, decreased SpO_2, abnormal CXR
- **Oxygen therapy "dosage" → FiO_2**
- **Therapeutic target → PaO_2:FiO_2 >300**
- **HFNC** in **COVID-19**
  →beneficial at correct timing (vs NIV)
- **When giving HFNC → consider patient's comfort & close monitoring + ROX index during first 12 hrs**

To be published soon:

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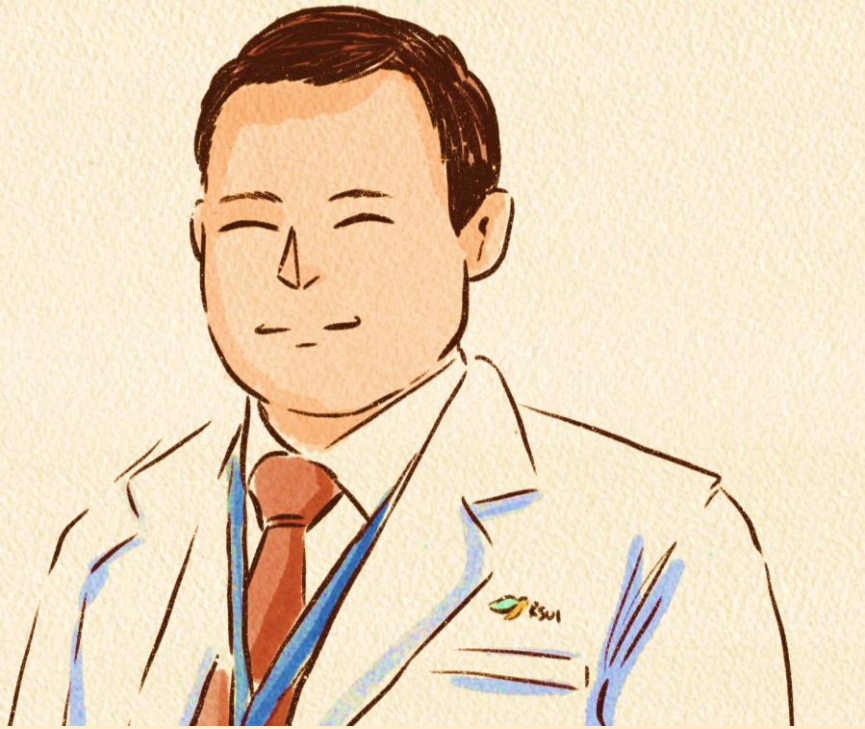

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