# HIGH FLOW NASAL CANNULA OXYGEN THERAPY IN END-OF-LIFE PATIENTS

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# OBJECTIVES

- Case presentation
- HFNC as an oxygen delivery system
- Use of HFNC in management of dyspnea
- Current evidence for HF weaning protocols
- Our experience with weaning in the pallative care unit

# CASE 1

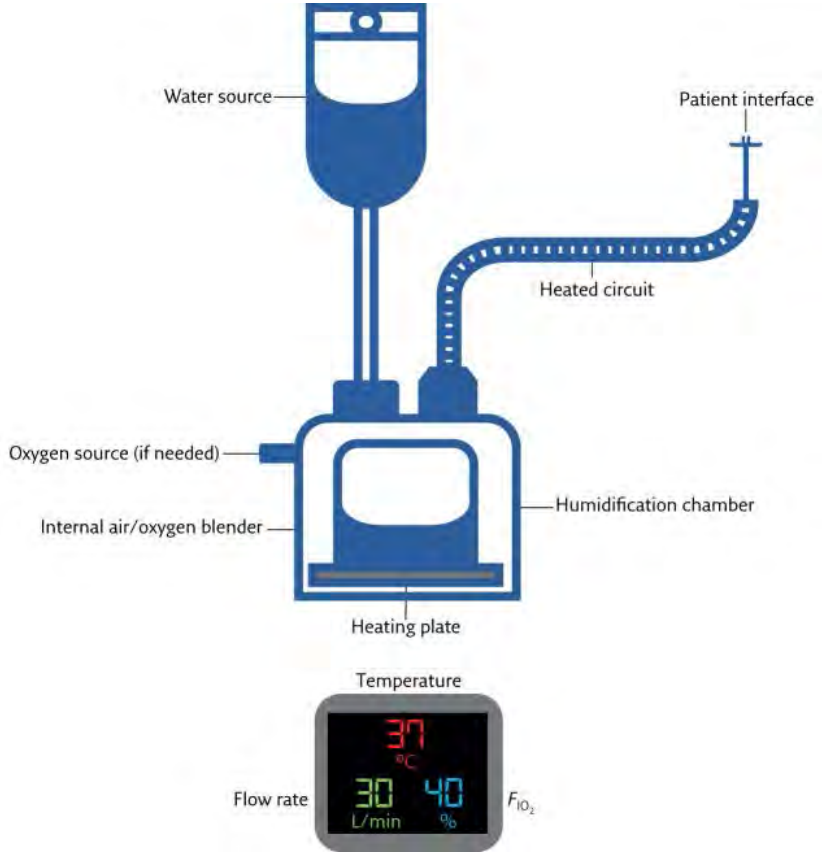
Mr. M is a 79 yo gentleman with CAD, COPD who was admitted to the hospital after presenting with dyspnea and acute hypoxic respiratory failure. He was positive for COVID-19 and received remdesivir and dexamethasone, along with CAP treatment. His hypoxemia progressively worsened, requiring escalating support from HFNC (on 50L/60%). Hospital course also complicated by delirium. After >2 weeks inpatient with no improvement, his family decided to pursue comfort care measures.

# CASE 2

Ms. S is a 55 yo lady with stage IV metastatic NSCLC with recurrent malignant pleural effusions who presented with worsening shortness of breath and acute hypoxic respiratory failure. On imaging she had a large pleural effusion as well as worsening metastatic disease despite treatment. After a prolonged hospital course, with multiple thoracentesis she decided to get a pleurX catheter placed and wanted to focus her care plan on comfort care measures. She was transferred to the palliative care unit on HFNC at 50L/70%.

# HIGH FLOW NASAL CANNULA

- Oxygen delivery system with a heated humidifer
- Parameters:
  - Flow/min – up to 60L/min
  - Fraction of inspired oxygen (FiO2) – up to 100%
  - Temperature
- First introduced in early 2000s for premature neonates and later pediatric patients with bronchiolitis.



# PHYSIOLOGICAL EFFECTS

- Reduction of anatomical deadspace and generation of positive end-expiratory pressures (PEEP)
  - Improved oxygenation
- Reduction in work of breathing
- Improvement in mucociliary clearance
- Improvement in patient's comfort due to:
  - optimal humidification
  - possibility of eating or talking while under treatment
  - lack of deleterious effects from the nasal/facial mask

| Patients or Subjects, *n* | Underlying Conditions | Comparators | Flow, L/min | Main Results | First Author |
|---|---|---|---|---|---|
| Case reports | | | | | |
| 1 | Fiberoptic bronchoscopy in ICU | | | | Diab[56] |
| 1 | Reperfusion pulmonary edema | | | | Moriyama[57] |
| 1 | Pulmonary fibrosis and DNR | | | | Boyer[58] |
| 1 | Dementia | | | | Calvano[59] |
| 1 | ARF of neuromuscular origin | | | | Diaz-Lobato[60] |
| Case series | | | | | |
| 5 | Acute cardiogenic pulmonary edema | VM 15 L/min | 60 | f decreased, dypnea improved | Carratalá Perales[22] |
| 5 | Oxygenation during BAL | | | | Miyagi[61] |
| Retrospective | | | | | |
| 37 | ARF in lung transplant recipients | SOT | | ETI: SOT 89%, HFNC 59% | Roca[62] |
| 45 | ARF in hematologic malignancies | | | 15: successful, 30: ETI | Lee[63] |
| 67 | Post-extubation | NRM | | Re-intubation HFNC (1) < NRM (6) | Brotfain[64] |
| 50 | DNR/DNI order (hypoxemic RF) | | | HFNC was well-tolerated, duration 30 h (range 2–144) | Peters[37] |
| 175 | HFNC failure | | | Late failure worsened ICU mortality, extubation success, and VFDs | Kang[65] |
| Sequential intervention | | | | | |
| 14 | Hypoxemic ARF | NIV and VM | 55 | Dyspnea score, HFNC < VM < NIV, subject rating: HFNC > VM > NIV<br>f HFNC < NIV, oxygenation NIV > HFNC > VM | Schwabbauer[36] |
| 17 | Severe COPD and hypercapnic RF | LFO | | f decreased with HFNC | Nilius[66] |
| 12 | OSA | | 20 | Apnea-hypopnea and arousal index decreased | McGinley[67] |
| 20 | Post-cardiac surgery | LFO | | EELI increased, $P_{aw}$ increased, f decreased, P/F increased | Corley[42] |
| 10 | Heart failure (NYHA III) | | 20/40 | IVC reduced | Roca[68] |
| 17 | ARF in ER | | 40 | 8 discharged from ER, 9 admitted to ICU and among them 2 intubated | Lenglet[69] |
| RCT | | | | | |
| 20 | ARF | FM | 20–30 | f decreased, comfort and oxygenation were better with HFNC | Roca[41] |
| 60 | Mild-moderate hypoxemic ARF | FM | 35 | More HFNC succeeded. NIV: HFNC 3/29 (10%), FM 8/27 (30%) | Parke[12] |
| 45 | Indications for BFS | VM | 40/60 | HFNC at end of BFS $S_{pO_2}$ was better than other 2 groups | Lucangelo[71] |
| 155 | Post-cardiac surgery, BMI ≥ 30 | SOT | 35–50 | Respiratory support escalation 5 in standard, 3 in HFNC | Corley[72] |
| 310 | Hypoxemic RF | SOT and NIV | 50 | VFD increased, mortality improved, f | Frat[10] |
| 830 | After cardiothoracic surgery | BPAP | 50 | Treatment failure ns, ICU mortality ns, Skin breakdown: BiPAP>HFNC | Stephan[11] |
| 105 | Post-extubation | VM | 50 | LOS_ICU, ICU mortality ns, re-intubation 4% vs 21%, timing of re-intubation na | Maggiore[73] |
| 340 | Post-cardiac surgery, post-extubation | NC | | LOS ICU ns, escalation of respiratory support 27.8% vs 45% | Parke[70] |
| 124 | Hypoxemic RF requiring ETI | FM | 60 | Lowest saturation, severe desaturation (<80%) ns | Vourc'h[74] |

Evidence-based indications for humidified high-flow therapy

| Clinical indication | Effects |
|---|---|
| **Acute hypoxaemic respiratory failure [8, 25]** | Similar rates of intubation compared with NIV and facemask oxygen |
| | Reduced risk of intubation in patients with moderate or severe hypoxaemia ($P_{aO_2}$:$F_{IO_2}$ ≤200) |
| | Reduced ICU and 90-day mortality |
| | Improved breathlessness following treatment initiation |
| **Prevention of post-extubation respiratory failure [9, 26]** | Low-risk patients: HFT superior to conventional oxygen |
| | High-risk patients: HFT noninferior to NIV |
| **Breaks from positive airway pressure [27]** | Permits oral intake (medication, nutrition) and communication |
| | More comfortable than conventional nasal cannula and NIV |
| **Oxygenation during airway procedures [28, 29]** | Pre-oxygenation prior to and during endotracheal intubation |
| | Improves oxygenation during bronchoscopy compared with conventional nasal cannula |

# High-flow nasal cannula oxygen therapy decreases postextubation neuroventilatory drive and work of breathing in patients with chronic obstructive pulmonary disease

Rosa Di mussi[1], Savino Spadaro[2], Tania Stripoli[1], Carlo Alberto Volta[2], Paolo Trerotoli[3], Paola Pierucci[4], Francesco Staffieri[5], Francesco Bruno[1], Luigi Camporota[6] and Salvatore Grasso[1*]

## Abstract

**Background:** The physiological effects of high-flow nasal cannula $O_2$ therapy (HFNC) have been evaluated mainly in patients with hypoxemic respiratory failure. In this study, we compared the effects of HFNC and conventional low-flow $O_2$ therapy on the neuroventilatory drive and work of breathing postextubation in patients with a background of chronic obstructive pulmonary disease (COPD) who had received mechanical ventilation for hypercapnic respiratory failure.

**Methods:** This was a single center, unblinded, cross-over study on 14 postextubation COPD patients who were recovering from an episode of acute hypercapnic respiratory failure of various etiologies. After extubation, each patient received two 1-h periods of HFNC (HFNC1 and HFNC2) alternated with 1 h of conventional low-flow $O_2$ therapy via a face mask. The inspiratory fraction of oxygen was titrated to achieve an arterial $O_2$ saturation target of 88–92%. Gas exchange, breathing pattern, neuroventilatory drive (electrical diaphragmatic activity (EAdi)) and work of breathing (inspiratory trans-diaphragmatic pressure-time product per minute ($PTP_{DI/min}$)) were recorded.

**Results:** EAdi peak increased from a mean (±SD) of 15.4 ± 6.4 to 23.6 ± 10.5 μV switching from HFNC1 to conventional $O_2$, and then returned to 15.2 ± 6.4 μV during HFNC2 (conventional $O_2$: $p < 0.05$ versus HFNC1 and HFNC2). Similarly, the $PTP_{DI/min}$ increased from 135 ± 60 to 211 ± 70 $cmH_2O/s/min$, and then decreased again during HFNC2 to 132 ± 56 (conventional $O_2$: $p < 0.05$ versus HFNC1 and HFNC2).

**Conclusions:** In patients with COPD, the application of HFNC postextubation significantly decreased the neuroventilatory drive and work of breathing compared with conventional $O_2$ therapy.

**Keywords:** High-flow nasal cannula oxygen therapy, Chronic obstructive pulmonary disease, Weaning from mechanical ventilation, Neuroventilatory drive, Work of breathing

# DYSPNEA

- It is a distressing symptom at end of life, for patients and caregivers
- Arises from the awareness of a respiratory supply-and-demand mismatch
- Causes anxiety, which in turn worsens dyspnea
- Treatment can be
  - Disease modifying:
    - diuretics in heart failure, inhalers in COPD, supplemental O2 with hypoxemia
  - Symptom based:
    - opioids, benzos for anxiety, steroids
  - Non–pharmacological:
    - NIV, HFNC, fans, pulmonary rehab, thoracentesis

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Symptom Management and Supportive Care

# High-Flow Oxygen and High-Flow Air for Dyspnea in Hospitalized Patients with Cancer: A Pilot Crossover Randomized Clinical Trial

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*Disclosures of potential conflicts of interest may be found at the end of this article.*

**Key Words.** Clinical trial • dyspnea • Hospital equipment • Neoplasms • Oxygen

## Abstract

***Background.*** The effect of high-flow oxygen (HFOx) and high-flow air (HFAir) on dyspnea in nonhypoxemic patients is not known. We assessed the effect of HFOx, HFAir, low-flow oxygen (LFOx), and low-flow air (LFAir) on dyspnea.

***Subjects, Materials, and Methods.*** This double-blind, 4×4 crossover clinical trial enrolled hospitalized patients with cancer who were dyspneic at rest and nonhypoxemic (oxygen saturation >90% on room air). Patients were randomized to 10 minutes of HFOx, HFAir, LFOx, and LFAir in different orders. The flow rate was titrated between 20–60 L/minute in the high-flow interventions and 2 L/minute in the low-flow interventions. The primary outcome was dyspnea numeric rating scale (NRS) "now" where 0 = none and 10 = worst.

***Results.*** Seventeen patients (mean age 51 years, 58% female) completed 55 interventions in a random order. The absolute change of dyspnea NRS between 0 and 10 minutes was −1.8 (SD 1.7) for HFOx, −1.8 (2.0) for HFAir, −0.5 (0.8) for LFOx, and − 0.6 (1.2) for LFAir. In mixed model analysis, HFOx provided greater dyspnea relief than LFOx (mean difference [95% confidence interval] −0.80 [−1.45, −0.15]; $p = .02$) and LFAir (−1.24 [−1.90, −0.57]; $p < .001$). HFAir also provided significantly greater dyspnea relief than LFOx (−0.95 [−1.61, −0.30]; $p = .005$) and LFAir (−1.39 [−2.05, −0.73]; $p < .001$). HFOx was well tolerated. Seven (54%) patients who tried all interventions blindly preferred HFOx and four (31%) preferred HFAir.

***Conclusion.*** We found that HFOx and HFAir provided a rapid and clinically significant reduction of dyspnea at rest in hospitalized nonhypoxemic patients with cancer. Larger studies are needed to confirm these findings (Clinicaltrials.gov: NCT02932332). ***The Oncologist*** 2021;26:e883–e892

# High-Flow Nasal Cannula Versus Conventional Oxygen Therapy in Relieving Dyspnea in Emergency Palliative Patients With Do-Not-Intubate Status: A Randomized Crossover Study

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**Study objective:** Palliative patients often visit the emergency department (ED) with respiratory distress during their end-of-life period. The goal of management is alleviating dyspnea and providing comfort. High-flow nasal cannula may be an alternative oxygen-delivering method for palliative patients with do-not-intubate status. We therefore aim to compare the efficacy of high-flow nasal cannula with conventional oxygen therapy in improving dyspnea of palliative patients with do-not-intubate status who have hypoxemic respiratory failure in the ED.

**Methods:** This randomized, nonblinded, crossover study was conducted with 48 palliative patients aged 18 years or older with do-not-intubate status who presented with hypoxemic respiratory failure to the ED of Siriraj Hospital, Bangkok, Thailand. The participants were randomly allocated to conventional oxygen therapy for 60 minutes, followed by high-flow nasal cannula for 60 minutes (n=24) or vice versa (n=24). The primary outcome was modified Borg scale score. The secondary outcomes were numeric rating scale score of dyspnea and vital signs.

**Results:** Intention-to-treat analysis included 44 patients, 22 in each group. Baseline mean modified Borg scale score was 7.6 (SD 2.2) (conventional oxygen therapy first) and 8.2 (SD 1.8) (high-flow nasal cannula first). At 60 minutes, mean modified Borg scale score in patients receiving conventional oxygen therapy and high-flow nasal cannula was 4.9 (standard of mean 0.3) and 2.9 (standard of mean 0.3), respectively (mean difference 2.0; 95% confidence interval 1.4 to 2.6). Results for the numeric rating scale score of dyspnea were similar to those for the modified Borg scale score. Respiratory rates were lower with high-flow nasal cannula (mean difference 5.9; 95% confidence interval 3.5 to 8.3), and high-flow nasal cannula was associated with a significantly lower first-hour morphine dose.

**Conclusion:** High-flow nasal cannula was superior to conventional oxygen therapy in reducing the severity of dyspnea in the first hour of treatment in patients with do-not-intubate status and hypoxemic respiratory failure. [Ann Emerg Med. 2020;75:615-626.]

# CHALLENGES

- Meant to be a temporary modality
- Nearly impossible to replicate at home, with or without hospice
- Large out-of-pocket expenses, difficult to manage equipment/troubleshoot issues
- Life prolonging measure, which may not be consistent with care goals – prolonged existential grief for patients and anticipatory grief for loved ones

# WEANING HIGH FLOW NASAL CANNULA

- Very little literature available for weaning protocols
- Much of our experience with weaning relies heavily on the understanding of HFNC as a supplementary oxygen modality and the effects of flow on dyspnea

# Compassionate Removal of Heated High-Flow Nasal Cannula for End of Life

## Case Series and Protocol Development

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## Abstract

Patients often receive burdensome care at the end of life in the form of interventions that may need to be removed. Heated high-flow oxygen delivered through a nasal cannula (HHFNC) is one such intervention that can be delivered in the hospital yet is rarely available outside of this setting. During the COVID-19 (coronavirus disease 2019) pandemic, health care systems continue to face the possibility of rationing critical life-sustaining equipment that may include HHFNC. We present a clinical protocol designed for weaning HHFNC to allow a natural death and ensuring adequate symptom management throughout the process. This was a retrospective chart review of 8 patients seen by an inpatient palliative care service of an academic tertiary referral hospital who underwent terminal weaning of HHFNC using a structured protocol to manage dyspnea. Eight patients with diverse medical diagnoses, including COVID-19 pneumonia, underwent terminal weaning of HHFNC according to the clinical protocol with 4 down-titrations of approximately 25% for both fraction of inspired oxygen and liter flow with preemptive boluses of opioid and benzodiazepine. Clinical documentation supported good symptom control throughout the weaning process. This case series provides preliminary evidence that the clinical protocol proposed has the ability to ensure comfort through terminal weaning of HHFNC.

1. Patient receiving comfort-focused care approach and Do Not Attempt to Resuscitate order in place; intent is to relieve suffering during the dying process.

2. Discontinue artificial nutrition/hydration and/or IV fluids to prevent excessive respiratory secretions and discomfort at end of life once decision for compassionate removal of HHFNC has been determined.

3. Communicate with pharmacy regarding symptom management medication supplies.

4. Communicate to the patient's bedside nurse, charge nurse and the respiratory therapist (RT) prior to the procedure.
    a. When possible, plan for the procedure 12-24 hours prior to ensure adequate bedside staffing.
    b. Review titration plan with the bedside RN and RT.
    c. RT assigned to decrease both the liter flow and the $FiO_2$ per hospital policy.
    d. Review and educate the family about the procedure and the signs/symptoms of actively dying.

5. Offer alternative ways for family to connect with patient, including virtual options.

6. If patient has COVID-19 and family present during compassionate removal of HHFNC procedure, then:
    a. Provide appropriate education on risks of exposure to aerosolized COVID-19 environment.
    b. Make sure that they are provided appropriate PPE.
    c. Have them be at least 6 feet away from the head of bed during the extubation to limit immediate exposure to droplets.

7. Consider an opioid continuous infusion to start prior to the procedure, to facilitate opioid bolus via the infusion pump.

8. Pre-medicate the patient with bolus dosing of opioid and benzodiazepine as indicated for anticipatory control of dyspnea, pain, anxiety
    a. Medication dosing is guided by the patient's recent medication dosing history and desired level of sedation. These patients are often sedated to a deep sedation (-4) or unarousable (-5) Richmond Agitation Sedation Scale (RASS) score.

9. Rebolus opioid and/or benzodiazepine every 10 minutes as needed for control of symptoms.

10. Dose titration of opioid and/or benzodiazepine:
    a. Increase dose by 25-50% for mild-moderate symptoms.
    b. Increase dose by 50-100% for moderate-severe symptoms.

11. Decrease both $FiO_2$ and liter flow in a step wise titration: 4 down titrations (25% each) of both liter flow and $FiO_2$ over a 40-minute period separated by 10-minute intervals with boluses of opioid every 10 minutes prn symptom control +/- benzodiazepine.
    a. **Decrease #1**: Premedicate with opioid and benzodiazepine 10 minutes prior to down titration; wait 10 minutes for peak effect. Decrease $FIO_2$ and liter flow by 25%. Assess for dyspnea, anxiety, agitation.
    b. **Decrease #2**: Consider anticipatory opioid bolus; wait 10 minutes for peak effect. Decrease $FIO_2$ and liter flow by another 25%. Assess for dyspnea, anxiety, agitation.
    c. **Decrease #3**: Consider anticipatory opioid bolus; wait 10 minutes for peak effect. Decrease $FIO_2$ and liter flow by another 25%. Assess for dyspnea, anxiety, agitation.
    d. **Decrease #4**: Consider anticipatory opioid bolus; wait 10 minutes for peak effect. Remove HHFNC.
        a. Rebolus opioid and/or benzodiazepine every 10 minutes as needed for control of symptoms.

# WEAN PATHWAY

# RDOS – RESPIRATORY DISTRESS OBSERVATION SCALE

| Variable | 0 Points | 1 Point | 2 Points | Sub-Total |
|---|---|---|---|---|
| Heart rate per min (beats / min = bpm) | less than 90 bpm | 90 – 109 bpm | greater than or equal to 110 bpm | |
| Respiratory rate per minute (auscultated) (breaths / min) | less than 19 breaths | 19 – 30 breaths | greater than 30 breaths | |
| Restlessness: non-purposeful movements | No | Yes - Occasional, slight movements | Yes - Frequent movements | |
| Paradoxical breathing pattern: abdomen moves in on inspiration | No | | Yes | |
| Accessory muscle use: rise in clavicle during inspiration | No | Yes - Slight rise | Yes - Pronounced rise | |
| Grunting at end-expiration: guttural sounds | No | | Yes | |
| Nasal flaring: involuntary movement of nares | No | | Yes | |
| Look of fear: ☐ Eyes wide open ☐ Facial muscles tense ☐ Brow furrowed ☐ Mouth open ☐ Teeth together | No | | Yes | |
| | | | **Total** | |

**Instructions for Use**

- Count respiratory and heart rates for one full minute;
- Grunting may be audible with or without auscultation;
- An RDOS score of less than 3 indicates respiratory comfort[2];
- An RDOS score greater than or equal to 3 signifies respiratory distress and need for palliation[2,3];

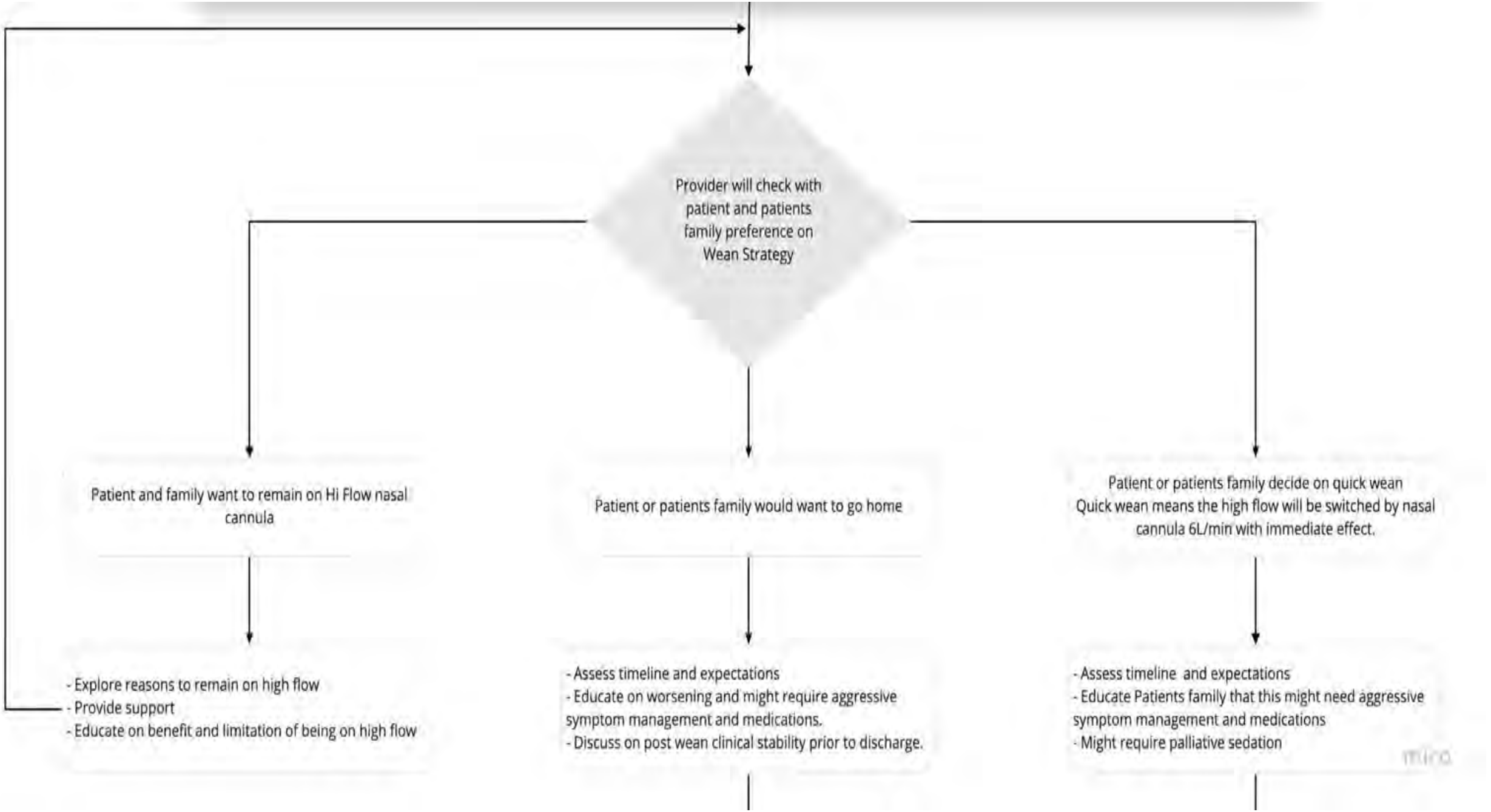
**COMMUNICATION**

With patient and / or  patients family

Responsibility Provider

Discuss

- Reason to wean
    - Uncomfortable when goals are comfort care only
    - Hypoxic respiratory failure -  irreversible pathology
    - Barrier to discharge home
    - Transition from ventilator
- Wean strategy
    - Gradually reduce high flow and transition to nasal cannula
    - Add opioids to help with symptoms
    - Wean will be based on comfort and tolerance
    - Add sedative only if required and symptoms worsen and not controlled by opioids
    - Add Haloperidol / Thorazine if agitation / delirium worsens
- Patient's cognition or presence or absence of delirium
    - Cognition might decline or delirium can worsen therefore discuss allowing patient interactive time with family.
    - Opioids to alleviate shortness of breath might also can cause more drowsiness


Provider will check with patient and patients family preference on Wean Strategy
Patient and family want to remain on Hi Flow nasal cannula
- Explore reasons to remain on high flow
- Provide support
- Educate on benefit and limitation of being on high flow
Patient or patients family would want to go home
- Assess timeline and expectations
- Educate on worsening and might require aggressive symptom management and medications.
- Discuss on post wean clinical stability prior to discharge.
Patient or patients family decide on quick wean
Quick wean means the high flow will be switched by nasal cannula 6L/min with immediate effect.
- Assess timeline and expectations
- Educate Patients family that this might need aggressive symptom management and medications
- Might require palliative sedation

**PRIOR TO WEAN PLEASE CHECK**

**Responsibility : Provider and Nursing**

- Check for patient position: upright, pillow arrangement for side-lying position if there is a "good" lung
- Table Fan
- Consider Energy conservation techniques: e.g. purewick, external catheter, indwelling urinary catheter to avoid having to use bedpan/incontinence brief etc
- Consider mindfulness based breathing techniques, distraction if possible
- Drain PleurX or therapeutic thoracocentesis if applicable and might benefit
- Continue effective therapies for underlying etiologies that are non-burdensome, and consistent based on patient and family's discussion including:
    - Antibiotics for pneumonia
    - Any pulmonary treatments to include albuterol/ipratropium nebulizers, steroids, pulmonary hypertension medications, etc.
    - Diuresis for suspected pulmonary edema (if diuretic naïve recommend Furosemide 10 mg IV as a trial)
    - Dobutamine/Milrinone for decompensated HF

- Check Allergies and Renal function. (Will determine opioid choice )

# CASE 1

Mr. M is a 79 yo gentleman with CAD, COPD who was admitted to the hospital after presenting with dyspnea and acute hypoxic respiratory failure. He was positive for COVID-19 and received remdesivir and dexamethasone, along with CAP treatment. His hypoxemia progressively worsened, requiring escalating support from HFNC (on 50L/60%). Hospital course also complicated by delirium. After >2 weeks inpatient with no improvement, his family decided to pursue comfort care measures.

# CASE 1

- Started on continuous fentanyl infusion at 10 mcg/hr with 20 mcg boluses PRN q15 minutes
- HFNC weaned 10 L at a time, premedication with fentanyl prior to each step
- Once down to 20 L, switched to 6 L with conventional nasal cannula
- Discharged home with hospice with:
  - Supplemental O2 with conventional nasal cannula
  - Fentanyl patch
  - Hydromorphone, lorazepam PO concentrate PRN for dyspnea

# CASE 2

Ms. S is a 55 yo lady with stage IV metastatic NSCLC with recurrent malignant pleural effusions who presented with worsening shortness of breath and acute hypoxic respiratory failure. On imaging she had a large pleural effusion as well as worsening metastatic disease despite treatment. After a prolonged hospital course, with multiple thoracentesis she decided to get a pleurX catheter placed and wanted to focus her care plan on comfort care measures. She was transferred to the palliative care unit on HFNC at 50L/70%.

# CASE 2

- Weaning process more complicate due to anxiety – managed with scheduled and PRN haloperidol
- Started on continuous fentanyl infusion
- Timed 10L wean at a time with daily/every other day thoracentesis with pleurX
- Patient was in the palliative care unit for about 10 days, becoming increasingly more somnolent
- She subsequently passed away on the palliative care unit

# QUESTIONS

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