High Humidity
High Flow
Oxygen Delivery

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Sponsored by Fisher & Paykel
Below is a figure from the book, showing a woman inhaling oxygen from a device that stored enough O2 for intermittent use in 1887.
PRICE OF OFFICE TREATMENT

- The fee for this Treatment is $30.00 per month, payable in advance. This calls for thirty treatments, whether in as many consecutive days or otherwise.
1881 Oxygen therapy

PRICE OF HOME TREATMENT

- The HOME TREATMENT is sent by Express, at the cost of the person ordering it, on the receipt of the price, which is $15.00. It contains two months' supply of "Compound Oxygen," with inhaling apparatus, and full and explicit directions for use. If sent C.O.D. the cost of collection will be added to the Express charges.

- NO EXTRA CHARGE FOR ADVICE OR CONSULTATION
PNEUMONIA -- Treatment

- OXYGEN GAS -- It is doubtful whether the inhalation of oxygen in pneumonia is really beneficial. Personally, when called in consultation to a case, if I see the oxygen cylinder at the bedside I feel the prognosis to be extremely grave. It does sometimes seem to give transitory relief and to diminish the cyanosis. It is harmless, its exhibition is very simple, and the process need not be at all disturbing to the patient. The gas may be allowed to flow gently from the nozzle directly under the nostrils of the patient, or it may be administered every alternate 15 minutes through a mask.
Case Study

57 year old man

- Past medical hx hypogammaglobulinemia for about 30 years characterized by recurrent pneumonias
- In Feb 2012 presents with
  - 48 hr hx of ↓oral intake
  - Cough, clear to green
  - Upper clavicular chest pain
  - Posterior back pain
  - SOB mild to moderate
  - Small amount of vomiting and loose stool
Patient History

- Recurrent lobar pneumonia
- Has had one UTI
- Non-smoker, minimal alcohol usage
- Jehovah’s witness
Arrives in ER Vital signs include:

- T 36.5
- HR 123
- BP 79/45
- Mild to moderate SOB, able to speak in half sentences
- Labs Hgb 125, White count 21.6, platets 226, bands 4.34, INR 1.5, PTT 45, Na 141, K 502, anion gap 14 urea 13, creatinine 266, CK 339 and Trop 0.01
Chest x-ray results
- L lower lobe consolidation
- Lingular air space disease
- Loss of L hemidiaphragm
- R lower lobe infiltrates
- R upper air space disease

Comparison to Dec. 2011 the L lower and the R upper air space disease is new
Assessment and issues
- Hx of hypogammaglobulinemia
- Recurrent pneumonia with new pulmonary infiltrates
- Hypotension
- Worsening renal function
- Decrease perfusion to tissues

Plan to follow in ICU
- Patient may require ventilation
Treatment recommended by Intensivist

- 5 liters of fluid in ER while waiting for ICU bed
- Levo
- Azithromycin, Tazocin and Vancomycin
- Manage respiratory status with appropriate oxygen therapy
High humidity High flow therapy initiated at 50% oxygen and flows of 40lpm

ABG after 2.5 hrs
- pH 7.22, PaCO2 45, PaO2 115, HCO3 18, sat 98%

Over next 72 hours patient tried off HHHF therapy after 24 hours respiratory status worsened returned to HHHF for another 48 hours and then weaned down to low volume neb and face mask
Nasal High Flow

- Comfortable, Effective Oxygen Delivery
Objectives

- What is Nasal High Flow?
- Key benefits of Nasal High Flow
- Which Patients?
- Delivering NHF
Nasal High Flow allows you to **comfortably** and **effectively** deliver oxygen to your hypoxemic patients with mild to moderate respiratory distress.
High Humidity
High Flow
Oxygen Therapy

- Key benefits of Nasal High Flow
High humidity high flow systems provide humidification technology which emulates the body's natural balance of temperature and humidity in healthy human lungs.

The air/oxygen blend delivered with a High Flow High Humidity device is conditioned to provide optimal humidity.

The optimal level of humidity is shown to be 37 °C, 44 mg/L

This conditioning makes the delivery of Nasal High Flow possible.
Optimized Mucociliary Clearance

Delivering Optimal Humidity, 37 °C, 44 mg/L, optimizes mucociliary clearance\(^6,7,8\)

- Improved secretion quality
- Maintenance of the mucosal function
- Secretions remain mobile for transport out of the airway
Hasani et al., 2008 used a radio-aerosol technique to measure mucociliary clearance before and after 7 days of domiciliary nasal high flow with humidification.

- Delivered optimally humidified flow of 20 to 25 L/min through nasal cannula for 3 hrs each night.

- Following humidification, mucociliary clearance significantly improved.
Four Key Benefits of Using HHHF

- Optimized mucociliary clearance
- Positive airway pressure during the Respiratory cycle
- Effective oxygen delivery
- Washout of anatomical dead space
Positive Airway Pressure during the Respiratory Cycle

- Research has indicated that **low levels** of positive airway pressure are generated with Nasal High Flow.

- The amount of pressure is dependent on a number of variables including:
  - Flow rate (10-60l/min)
  - Upper airway anatomy
  - Size of cannula relative to the nares
  - Mouth position (closed or open)
Positive Airway Pressure during the Respiratory Cycle

- Parke et al., 2008 compared nasopharyngeal airway pressures with Nasal High Flow and face mask oxygen therapy with mouth open and mouth closed.
Four Key Benefits of Using HHHF

- Optimized mucociliary clearance
- Positive airway pressure during the Respiratory cycle
- Effective oxygen delivery
- Washout of anatomical dead space
Provides prescribed/set FiO$_2$
Effective Oxygen delivery

- The flow delivered using High Humidity High Flow aims to meet or exceed the patient’s inspiratory demand:
  - Room air entrainment is minimized
  - Dilution of prescribed oxygen and humidity is reduced
Four Key Benefits of Using HHHF

- Optimized mucociliary clearance
- Positive airway pressure during the Respiratory cycle
- Effective oxygen delivery
- Washout of anatomical dead space
Washout of Anatomical Dead Space

- There is a continuous washout of the upper airway (anatomical dead space) caused by the continuous delivery of high flows.

- Two key benefits of this flushing effect:
  - Reduces re-breathing of expired CO₂
  - Provides a reservoir of fresh gas in the upper airway for each and every breath

- This may assist in more efficient gas exchange in the patient.
Which Patients could benefit from HHHF?

- Comfortable, effective oxygen delivery
How do I know there will be enough oxygen when I next inhale?

I'd better hold on to the breath I already have.
Case Study

- 60 year old man who is morbidly obese with end stage COPD, on home oxygen, developed atrial fib, hx of CAD and chronic lymphocytic leukemia and newly diagnosed diabetes
Admitted with acute exacerbation of COPD, BIPAP initiated and admitted to ICU

Temp 39.6

12 hours after BIPAP initiated it was removed and patient tried on oxymask at 8 lpm resulted in acute respiratory distress with oxygen saturation dropping to 80% and increase WOB
- Patient placed on HHHF as the BIPAP was limiting mobility
- Discussions with family members as to patients health conditions and resuscitation wishes, DNR initiated
- Patient remained on HHHF until his death 3 days later
Which Patients Could Benefit from NHF?

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>Examples</th>
<th>Clinical Issues</th>
<th>Gas Exchange Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstructive Pulmonary Disease</td>
<td>Asthma Emphysema Lung Cancer</td>
<td>Abnormal Secretions Blocked Airways (structural or secretions)</td>
<td>Mild – moderate hypoxemia</td>
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<tr>
<td>Restrictive Lung Disease</td>
<td>Pulmonary Fibrosis Pneumoconiosis</td>
<td>Loss of FRC Loss of Gas Exchange Units</td>
<td>Mild – moderate hypoxemia</td>
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<tr>
<td>Pneumonia</td>
<td>Flu Complication secondary to ...</td>
<td>Airway Obstruction due to secretions Lung Consolidations</td>
<td>Mild – moderate hypoxemia</td>
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<tr>
<td>Atelectasis</td>
<td>Post-Op patient Chest Trauma</td>
<td>V/Q Mismatch</td>
<td>Mild – moderate hypoxemia</td>
</tr>
</tbody>
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Where does HHHF fit in the continuum of care?
Nasal High Flow

Weaning Phase

Acute Phase

Level of Acuity

Acute Phase

Weaning Phase

Low Flow Nasal $O_2$ Therapy <4LPM
High Concentration Face Mask
NIV
Invasive Ventilation
NIV
High Concentration Face Mask
Low Flow Nasal $O_2$ Therapy <4LPM

Respiratory Therapy
Nasal High Flow

Acute Phase

Level of Acuity

Weaning Phase

Low Flow Nasal $\text{O}_2$ Therapy $<4$LPM

Optiflow NHF™

NIV

Invasive Ventilation

NIV

Optiflow NHF™

Low Flow Nasal $\text{O}_2$ Therapy $<4$LPM

Respiratory Therapy
Case Study

- Elderly lady of 86 years
- Post op knee surgery, day 2
- Develops
  - Vomiting
  - SOB worsens overnight
  - O2 sat on RA 67% in am
• Critical Care rapid response team called
• Patient assessed
  • patient now on non-rebreather mask at 15 lpm O2 sats now 86-88%
  • Hx of angina
  • Hypotension
  • High cholesterol on meds well controlled
Treatment

- Patient started on HHHF
  - 50 lpm
  - 95% oxygen
- Sent to CT for scan (used NRB for transport)
- Patient moved to surgical step down for observation
- Heparin started once CT confirmed PE diagnosis
Results

- Patient remained on HHHF for 26 hours, weaned oxygen levels and discontinued to nasal prongs with an O2 saturation of 93%
High Flow
High Humidity
Oxygen Therapy

- Delivering High Flow Therapy
Delivering Nasal High Flow

A combination of:

- **Heated Humidifier**
  - Delivery circuit that preserves humidity

- **Air/Oxygen Blender**
  - **Maxventuri blender (10-60l/min)**
  - Standard blender with high flow flowmeter
  - Manual method with air and O₂ source
  - Some ventilators with O₂ therapy mode

- **Nasal Cannula Interface**
Optiflow Setup Pictures

Blender

Air/O₂ Flow Meters
Mode Button

- Choice between two operating modes
  - invasive
  - non-invasive
Benefits

- Patients rate as more comfortable
- Compliance increases (reduces claustrophobia)
- Allows patients to eat & drink
- Maintain dignity
Take home messages

- Provides prescribed FiO₂
- Optimal Humidity Ensures Comfort and Compliance
- Delivers low level positive airway pressure
- Helps improve mucociliary clearance
High Humidity High Flow

Thanks to Fisher and Paykel

Questions?

Comfortable effective oxygen delivery