Infant Flow® SiPAP
Objectives

• nCPAP overview
• Review of physiologic and desired effects of nCPAP
• Discuss indications, goals, contraindications, injuries, and issues associated with nCPAP application
• Discuss Variable and Bi-Level nCPAP
• Identify the components of the Infant Flow® LP System and its application
• Discuss the final check and routine inspection, application tips, warnings and cautions of nCPAP
• Review the clinical management, monitoring, assessment, positioning and failure of nCPAP
• Summary of nCPAP
nCPAP - Overview

- nCPAP is the application of a continuous distending pressure to the airways
- Primarily used for maintaining lung expansion in conditions in which the alveoli tend to collapse or fill with fluid
nCPAP – Overview (cont.)

• Technique used on spontaneously breathing neonates in an attempt to prevent the need for mechanical ventilation

• Initial goal was to attempt a new strategy to reduce the already high mortality rates (75%) and chronic morbidities common to premature infants receiving mechanical ventilation during this time \(^1,^2\)

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1 Von Reuss AR. *Diseases of the Newborn*. London: John Bale and Sons, 1921.
Physiologic and desired effects of nCPAP
Physiologic effects of nCPAP

• Major fundamental difference between nCPAP and mechanical ventilation
  ◦ nCPAP is unable to effectively sustain alveolar ventilation during apnea, and, therefore, patients must be able to generate all of the breathing efforts

Physiologic effects of nCPAP (cont.)

• Spontaneous breathing at a sustained distending pressure augments:
  ◦ Venous return
  ◦ Promotes improved alveolar recruitment and stabilization

• nCPAP mimics the natural physiologic reflex, “grunting” that is frequently exhibited in infants with low lung compliance and low end-expiratory volume

2 DiBlasi, R. Nasal continuous positive airway pressure (CPAP) for the respiratory care of the newborn infant. RC Journal. 2009, September; 54(9).
Physiologic effect of nCPAP

• nCPAP does not have the same high risks of barotrauma and infection that accompany mechanical ventilation\(^1\)

• “Open lung approach” used to manage newborns predisposed to developing airway instability, edema and atelectasis\(^2\)

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\(^2\) DiBlasi, R. *Nasal continuous positive airway pressure (CPAP) for the respiratory care of the newborn infant*. Respir Care. 2009, September; 54(9).
Desired effects of nCPAP

The presence of positive pressure during the expiratory phase prevents alveolar collapse when surfactant is not present.
Desired effects of nCPAP (cont.)

• Increased transpulmonary pressure and functional residual capacity (FRC)\(^1,2\)
• Prevention of alveolar collapse and decreased intrapulmonary shunt\(^1,2\)
• Improved compliance\(^1\)
• Surfactant conservation\(^1,2\)
• Increased airway diameter\(^1,2\)
• Splinted airway and diaphragm\(^1,2\)
• Stimulated lung growth\(^1\)
• Reduced apnea, work of breathing, and lung injury\(^1,2\)

\(^1\) DiBlasi, R. *Nasal continuous positive airway pressure (CPAP) for the respiratory care of the newborn infant*. Respir Care. 2009, September; 54(9).

With an increased FRC, you anticipate:

• Lung compliance improves

• Work of breathing improves

• $\text{PaO}_2$ increases

• $\text{PaCO}_2$ decreases

1 Bonner, K., Mainous, R. *The nursing care of the infant receiving bubble CPAP therapy*. Advances in Neonatal Care. 2008; 8:78-95

Discuss indications, goals, contraindications, injuries, and issues associated with nCPAP application
Indications for nCPAP

• Apnea of Prematurity - obstructive and/or mixed apnea

• Respiratory Distress - tachypnea, and/or retractions
  ◦ Respiratory Distress Syndrome (RDS)
  ◦ Transient Tachypnea of the Newborn (TTN)
  ◦ Bronchopulmonary Dysplasia (BPD)

• Weaning/Liberation from the ventilator

Goals of nCPAP

• nCPAP is a method that achieves optimal lung inflation with results in adequate oxygenation and ventilation, and hopefully, less chronic lung disease

• The goal is to achieve the lowest possible pressure to maintain open alveoli without over-distention

• Generally well tolerated in part because infants are “obligatory” nasal-breathers

DiBlasi, R. Nasal continuous positive airway pressure (CPAP) for the respiratory care of the newborn infant. Respir Care. 2009, September; 54(9).
Contraindications for using nCPAP

- Upper airway abnormalities\textsuperscript{1,2}
- Tracheoesophageal fistula\textsuperscript{1}
- Severe cardiovascular instability\textsuperscript{1,2}
- Unstable respiratory drive with frequent apneic episodes resulting in desaturations and bradycardia\textsuperscript{1,2}
- Ventilatory failure as indicated by the inability to maintain $\text{PaCO}_2 < 60$ torr and pH $> 7.25$\textsuperscript{1,2}
- Diaphragmatic hernia\textsuperscript{1}

\textsuperscript{1} Nicks, J. \textit{CPAP, SiPAP, High Flow Nasal Cannula in Infants: Which should you choose, when, and why?} 2014.
Nasal injury
Leading factors

- Tight fitting interfaces
- Frequency of assessment /adjustment
- Duration of nCPAP
- nCPAP level required
- Birth weight

Nasal injury (cont.)

Types

- Nasal excoriation\textsuperscript{1,2}
- Scarring\textsuperscript{1,2}
- Pressure necrosis\textsuperscript{1,2}
- Septal distortion\textsuperscript{1,2}

\textsuperscript{1} Deakins, K. \textit{Non-invasive respiratory support in the neonatal intensive care unit}. Clinical Foundations. 2009; 1-11.
Nasal injury (cont.)

Septal erosion

A, B, and C: Columnella necrosis from short-term CPAP.¹,²

Nasal injury (cont.)

Nasal stubbing

Nicks, J. *CPAP, SiPAP, High Flow Nasal Cannula in Infants: Which should you choose, when, and why?* 2014.
Issues

Equipment

• Complete obstruction of nasal prongs results in continued pressurization of the nCPAP system without activation of low or high airway pressure alarms

• Activation of a manual breath

• Insufficient gas flow to meet inspiratory demand

*Issues (cont.)*

**Equipment**

- Excessive flow results in over-distension from increased work of breathing\(^1\)

- Decannulation or incorrect positioning of prongs causing fluctuating or reduced nCPAP levels\(^1\)

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Issues (cont.)

Equipment

• Nasal excoriation, scarring, pressure necrosis and septal distortion\textsuperscript{1,2}

• Skin irritation of the head and neck from improperly secured bonnets or nCPAP head harnesses\textsuperscript{1}

\textsuperscript{1} Deakins, K. *Non-invasive respiratory support in the neonatal intensive care unit*. Clinical Foundations. 2009; 1-11.

Issues (cont.)
Affecting outcomes

- Lung over-distention leading to:\textsuperscript{1,2}
  - Air leak syndromes
  - V/Q mismatch
  - $\text{CO}_2$ retention and increased work of breathing
  - Impedance of pulmonary blood flow
  - Gastric insufflation and abdominal distention potentially leading to aspiration
  - Nasal mucosal damage due to inadequate humidification

\textsuperscript{1} Deakins, K. \textit{Non-invasive respiratory support in the neonatal intensive care unit}. Clinical Foundations. 2009; 1-11.
\textsuperscript{2} Nicks, J. \textit{CPAP, SiPAP, High Flow Nasal Cannula in Infants: Which should you choose, when, and why?} 2014.
Issues (cont.)
Affecting outcomes

• Increase work of breathing
• Respiratory failure
• Pneumothorax
• Changes in cerebral blood flow
• “CPAP” belly

Variable Flow and Bi-Level nCPAP
Variable Flow nCPAP

CareFusion Infant Flow

CareFusion SiPAP
Variable Flow nCPAP (cont.)

• A variable flow device uses:
  ◦ Fresh gas through a dedicated flow generator¹
  ◦ Sophisticated technology with visual and audible alarms¹

• Provides a very stable mean airway pressure²,³
  ◦ Bernoulli effect via dual injector jets directed toward each nasal prong²,³

Variable Flow nCPAP (cont.)

• If the infant requires more inspiratory flow, the Venturi action of the injector jets entrains additional flow\(^1,2,3\)

• When the infant makes a spontaneous expiratory breathing effort, there is a “fluidic flip” that causes the flow to flip around\(^1,2\)

• Flow leaves the generator chamber via the expiratory limb\(^1,2\)

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1 Nicks, J. *CPAP, SiPAP, High Flow Nasal Cannula in Infants: Which should you choose, when, and why?* 2014.
Variable Flow nCPAP (cont.)
The Coanda effect

Nicks, J. *CPAP, SiPAP, High Flow Nasal Cannula in Infants: Which should you choose, when, and why?* 2014.
The Fluidic effect

Variable Flow nCPAP (cont.)

The fluidic CPAP produces a very stable CPAP pressure compared to conventional CPAP.¹

Variable Flow nCPAP (cont.)

Advantages

• Decreases work of breathing$^{1,2,3}$

• Increases lung volume recruitment$^{1,2}$

• Improves lung compliance$^{3}$

• Free standing system with internal monitors, functioning as either VF-NCPAP or bilevel$^{4}$

• Improved synchrony$^{4}$


Variable Flow nCPAP
Disadvantages

• Requires:
  ◦ Dedicated flow driver\(^1,^2,^3\)
  ◦ Special prongs\(^1,^2,^3\)
  ◦ Product specific headgear or bonnet\(^1,^3\)
  ◦ Product specific masks and/or nasal prongs\(^1,^3\)
  ◦ Proprietary circuit\(^3\)

\(^2\) Nicks, J. *CPAP, SiPAP, High Flow Nasal Cannula in Infants: Which should you choose, when, and why?* 2014.
**B-NCPAP vs. VF-NCPAP**

**Objective – Mazzella**¹

- To compare the effectiveness of the Infant Flow Driver (IFD), also referred to as VF- NCPAP nCPAP in preterm neonates affected by respiratory distress syndrome

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Study Design – Mazzella¹

- 36 infants

- Randomly selected to either nCPAP or IFD

- nCPAP provided by a single prong with an oxygen blender, flowmeter, heated humidifier, circuit and a bottle with sterile water to a depth of 7 cm

- Studied prospectively for changes in oxygen requirement and/or respiratory rate

B-NCPAP vs. VF-NCPAP (cont.)
Outcome – Mazzella¹

• Use of the VF-NCPAP had a significantly beneficial effect on both oxygen requirement and respiratory rate when compared with B-NCPAP

• \(O_2\) requirement and respiratory rate were significantly decreased by four hours

• The probability of remaining supplementary oxygen free over the first 48 hours of treatment was significantly higher in patients treated with VF-NCPAP than with B-NCPAP

**B-NCPAP vs. VF-NCPAP (cont.)**

**Outcome – Mazzella**

<table>
<thead>
<tr>
<th></th>
<th>B-NCPAP</th>
<th>VF-NCPAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning Rate</td>
<td>72%</td>
<td>94%</td>
</tr>
<tr>
<td>Shorter duration of treatment (hours)</td>
<td>56</td>
<td>49.3</td>
</tr>
</tbody>
</table>

Those patients treated with VF-NCPAP had a higher success with weaning and a shorter duration of treatment than compared to B-NCPAP.

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B-NCPAP vs. VF-NCPAP (cont.)

Outcome – Mazzella\(^1\)

- VF-NCPAP appears to be a feasible device for managing RDS
- Future evaluation in a multicenter randomized clinical trial is needed to evaluate the trend towards:
  - fewer days on mechanical ventilation,
  - shorter clinical recovery time,
  - and shorter duration of treatment

B-NCPAP vs. VF-NCPAP (cont.)
Objective – Lipsten¹

• To compare work of breathing and breathing asynchrony in premature infants during bubble nasal continuous airway pressure (B-NCPAP) vs. variable flow nasal continuous positive airway pressure (VF-NCPAP)

B-NCPAP vs. VF-NCPAP (cont.)

Study Design – Lipsten

1. 18 premature infants < 1500 g
2. Required nCPAP for mild RDS
3. Each infant was studied on B-NCPAP and VF-NCPAP at 8, 6, 4, and 0 cmH₂O
4. Esophageal pressure estimated intrapleural pressure
5. Inspiratory and resistive work of breathing (RWOB) were calculated from pressure-volume data

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B-NCPAP vs. VF-NCPAP (cont.)

Outcome – Lipsten¹

• The more labored and asynchronous breathing seen with B-NCPAP may lead to higher failure rates over the long-term than with VF-NCPAP

B-NCPAP vs. VF-NCPAP (cont.)

Outcome – Lipsten\(^1\)

- B-CPAP resulted in a greater RWOB
- More labored and asynchronous breathing was related to B-CPAP

Bi-level nCPAP
SiPAP

• Currently the only product offering bi-level for nCPAP

• Enables the infant to spontaneously breathe throughout the cycle
Bi-level nCPAP (cont.)

SiPAP

• Small increases in Infant Flow nCPAP
• Pressure can change lung volume by 4-6 mL/kg.
• Unlike NIPPV, SiPAP pressure rise is only 2-3 cmH$_2$O

Bi-level nCPAP (cont.)

SiPAP

• Bi-level mode: cycles between high and low CPAP levels on a timed basis\(^1\)
  ◦ A small (2-3 cmH\(_2\)O), slow, intermittent increase in nCPAP pressure\(^2,3\)
  ◦ Duration up to 3.0 seconds\(^2,3\)
  ◦ “Sigh” like effect\(^2,3\)

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Bi-level nCPAP
SiPAP waveform

Courtesy of CareFusion
Bi-level nCPAP (cont.)

Advantages

• Periodic increases of baseline CPAP may:
  
  ◦ Stimulate respiratory drive\(^1,2\)
  
  ◦ Recruit more alveoli, potentially maintaining a stable FRC\(^1,2\)
  
  ◦ Assist in off-loading the work of breathing\(^2\)
  
  ◦ Stimulate surfactant production\(^1,2\)


Bi-level nCPAP (cont.)
Advantages

• Ability to provide escalation or de-escalation of care based on the infant’s clinical condition if:

  ◦ More frequent apnea/bradycardia episodes are observed$^{1,2}$

  ◦ Higher oxygen concentrations are required to maintain adequate oxygen saturations$^{1,2}$

  ◦ Increased work of breathing$^{1,2}$

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Bi-level nCPAP (cont.)

Disadvantages

• Potential of hypocarbia

• Bi-level CPAP device, not a ventilator

• No synchronization ability in United States

Bi-level nCPAP (cont.)

Objective - Riley’s Children’s Medical Center

• Describe the goals for use of bi-level CPAP (SiPAP) in very low birth weight infants with respiratory failure

• Review the limitations of bi-level CPAP

1 Rose, R. Results of QI project introducing bi-level CPAP (SiPAP) into a level III NICU. Abstract Snowbird 2013.
Bi-level nCPAP (cont.)

Study Design - Riley’s Children’s Medical Center¹

• Infants < 32 weeks gestation

• Had respiratory distress within 1 hour of birth

• Were extubated from invasive positive pressure ventilation and were considered to be at high risk for resumption of invasive positive pressure

¹ Rose, R. Results of QI project introducing bi-level CPAP (SiPAP) into a level III NICU. Abstract Snowbird 2013.
Bi-level nCPAP (cont.)
Outcomes - Riley’s Children’s Medical Center

<table>
<thead>
<tr>
<th></th>
<th>Prior to SiPAP</th>
<th>SiPAP Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 554</td>
<td>n = 438</td>
</tr>
<tr>
<td>Length of Stay</td>
<td>60 ± 47</td>
<td>59 ± 44</td>
</tr>
<tr>
<td>Pneumothorax n(%)</td>
<td>31 (6)</td>
<td>20 (5)</td>
</tr>
<tr>
<td>Number of Days on MV</td>
<td>17.4</td>
<td>13.3</td>
</tr>
<tr>
<td>Death or oxygen at 28 days n(%)</td>
<td>368 (66)</td>
<td>282 (64)</td>
</tr>
</tbody>
</table>

1 Rose, R. Results of QI project introducing bi-level CPAP (SiPAP) into a level III NICU. Abstract Snowbird 2013.
nCPAP vs. Bi-level nCPAP

Objective – Lista¹

• To evaluate the clinical course, respiratory outcomes and markers of inflammation in preterm infants with moderate respiratory distress syndrome (RDS) assigned from birth to nasal continuous positive airway pressure (nCPAP) or bi-level nCPAP.

nCPAP vs. Bi-level nCPAP (cont.)

Study design – Lista¹

- 40 infants with moderate respiratory distress
- 28 to 34 weeks GA
- Randomly selected to receive
  - nCPAP 6 cmH₂O, or
  - Bi-level pressure low 4.5 cmH₂O; pressure high 8 cmH₂O
  - 0.6 Time High
- Equipment
  - Infant Flow™ nCPAP driver for CPAP therapy
  - Infant Flow™ SiPAP driver for bi-level therapy

nCPAP vs. Bi-level nCPAP (cont.)
Outcomes – Lista¹

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Infant Flow</th>
<th>SiPAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days of respiratory support</td>
<td>6.2 days</td>
<td>3.8 days</td>
</tr>
<tr>
<td>Days on oxygen</td>
<td>13.8 days</td>
<td>6.5 days</td>
</tr>
<tr>
<td>Gestational age at discharge</td>
<td>36.7 wks</td>
<td>35.6 wks</td>
</tr>
</tbody>
</table>

•Conclusion:
“Bi-level nCPAP was associated with better respiratory outcomes versus nCPAP, and allowed earlier discharge”

nCPAP vs. Bi-level CPAP (cont.)

Objective – Migliori

• To compare the effects of nCPAP and bi-level on gas exchange in a population of preterm infants, enrolled after weaning from mechanical ventilation and needing noninvasive support

nCPAP vs. Bi-level CPAP (cont.)

Study Design – Migliori¹

- 20 infants
- 24 – 31 weeks
- Un-blinded crossover design
- Alternated from nCPAP to Bi-level every 4 hours
- Transcutaneous and arterial blood gas was used to monitor and evaluate gas exchange
- Bi-level settings
  - RR – 30bpm
  - I time – 0.5 seconds
  - $P_{\text{high}}$ – 4 cmH$_2$O above CPAP on all infants

nCPAP vs. Bi-level CPAP (cont.)

Outcome – Migliori

- Bi-level mode had:
  - Significant increase in TcPO$_2$
  - Significant decrease in TcPCO$_2$
  - Reduction in respiratory rate

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nCPAP vs. Bi-level CPAP (cont.)

Outcome – Migliori¹

- All patients completed the study without the need for reintubation

- For the two bi-level periods, there was a significant increase in PaO₂ and a decrease in PaCO₂ compared to the nCPAP periods

- No cardiovascular differences were noted during any of the phases

Infant Flow®
LP System
Infant Flow LP System

Components

- Prongs and Masks
- Bonnet
- Headgear
- Mask/prong sizing guide
- Generator
- Tape measure
Infant Flow LP System
Generator assembly

- Generator
- Sizing Guide
- Nasal Prongs: small, medium, large
Infant Flow LP System (cont.)
Generator assembly

- Generator head
- Securing strap
- Exhalation tube
- Pressure and drive lines
- Support cradle
- Fixation tab
- Mask/prong attachment base
Infant Flow LP System (cont.)

Generator assembly

- Improved performance
  - Dual jet fluidic technology
  - Quieter
    - Up to 6 decibels
  - Lighter
    - 26% lighter
  - Lower drive pressure
    - 80% less
  - Lower WOB
Infant Flow LP System (cont.)

Generator assembly

• Lower drive pressure
  ◦ Prevents pressure backup into the water auto-feed system

• Pressure relief valve
  ◦ Built into the generator assembly

• Fixation tab
  ◦ Secures the bonnet straps to the generator
  ◦ Enables easy of application
Infant Flow LP System (cont.)

Generator assembly

- Flexible and expandable tubing aids in positioning of exhaust tube
- Unique swivel feature helps maintain position of generator assembly
- Slits allow a path for gas to escape should the exhalation tube become kinked or occluded
Infant Flow LP System (cont.)

Generator assembly

- Accurate pressure reading directly at the patient’s nare
- Stable pressure delivery throughout the breath cycle
Infant Flow LP System (cont.)

Generator assembly

Solution Time = 13.5 (s)

Tangential Velocity (m/s)

0.0036088  8.1814  16.359  24.537  32.715  40.892

Velocity: Magnitude (m/s)

0.00000  8.1143  16.229  24.343  32.457  40.572
# Infant Flow LP System (cont.)
## Generator assembly

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual jet</td>
<td>Two jets per nostrils aids in delivery of a constant level of nCPAP throughout the breath cycle, maintaining optimal nCPAP therapy</td>
</tr>
</tbody>
</table>
| Fluidic technology   | • Exhalation - redirects the incoming gas flow away from the infant during exhalation (Fluidic Flip), allowing the infant to exhale freely and conserving precious calories  
• Inhalation - provides a constant level of CPAP pressure. The fluidic jets entrain flow instantly when needed to match the patient’s inspiratory demand.                                                                                                                                                                                                                                                                                 |
| Low WOB               | Helps increase patient comfort and effectiveness of the therapy; allowing calories to be utilized for growth vs. breathing efforts                                                                                                                                                                                                                                                                                                                                   |
| Quieter               | Decreases noise level around the infant inside and outside of the isolette. Lower noise level for the caregivers                                                                                                                                                                                                                                                                                                                                                  |
| Lighter               | Up to 26% lighter than previous generation, less weight applied to infant’s nasal area reducing risks of skin irritation                                                                                                                                                                                                                                                                                                                                  |
| Corrugate exhalation tube | Expandable tubing directs flow and noise away from patient and caregiver. The swivel and flexible exhalation tube allows for movement without placing additional torque on the generator and interface. Saves clinician time in having to reposition the tubing                                                                                                                                                                                                                       |
| Low drive pressure    | Prevents pressure backup into humidifier auto-feed system, no need for pressure cuffs, increases clinicians productivity                                                                                                                                                                                                                                                                                                                               |
| High profile design   | Minimizes the interface’s contact with the infant’s delicate skin, helps increase patient comfort, increase visibility of the infant’s septum and skin without removing the device and interrupting CPAP therapy.                                                                                                                                                                                                                                                                 |
| Support cradle        | Aids in proper positioning of the generator and acts as a shock absorber, helping to absorb torque during movement, aids in minimizing pressure points, secures the tubing and increases stabilization                                                                                                                                                                                                                                                                                  |
Infant Flow LP System
Generator assembly preparation

• Expand the collapsible corrugated exhaust tubing

• Remove the support cradle from the generator assembly
Infant Flow LP System
Support cradle

• Provides stabilization and security for the generator
• Aids in proper alignment of the generator and interface
• Transfers weight of generator assembly away from nasal area
Infant Flow LP System
Generator placement in support cradle

Correct

Incorrect
Infant Flow LP System
Nasal prongs and masks

- Anatomically designed
- 5 sizes and color-coded
Infant Flow LP System
Nasal Prongs

- Key design
- Septal relief
- Flared tip
- Anatomical curvature
- Size designation
- Flexible bellow
Infant Flow LP System
Nasal prongs - anatomical insertion

Flexible bellows
Anatomical curvature
Flared tip
Infant Flow LP System
Nasal Mask

- Eye relief
- Key design
- Assessment window
- Size designation
- Deep nasal cavity
- Nasal bridge cushion
- Flexible bellow
**Infant Flow LP System**

**Nasal prong and mask sizing**

Use Sizing Guide to determine appropriate mask/prong size

- Nasal prongs: choose dots that fill the nare space
- Nasal masks: choose the triangle that fits over the nose
- Note: the size of the prongs may differ from the size of the mask for a given patient
# Infant Flow LP System

## Nasal prongs and mask: features and benefits

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mask:</strong> Contour shape (eye relief)</td>
<td>A contoured area around the infant’s eyes aids in minimizing air leaks, helps maintain a proper fit, and leads to less intervention from caregivers and less interruption in therapy</td>
</tr>
<tr>
<td><strong>Mask:</strong> Observation window</td>
<td>Allows the clinician to view the infant’s septum and nares. Enables to check for proper fit and check for skin damage without having to interrupt therapy</td>
</tr>
<tr>
<td><strong>Mask:</strong> Flexible, collapsible bellows</td>
<td>Enables the mask to float and self-align during movement, therefore reducing leaks and evenly distributes pressure applied to patient.</td>
</tr>
<tr>
<td><strong>Mask:</strong> Large, deep nasal cavity</td>
<td>Large, deep nasal cavity to reduce pressure points and fit wide range of patients.</td>
</tr>
<tr>
<td><strong>Mask:</strong> Variable-wall thickness</td>
<td>Selective, controlled collapsible and non-collapsible sections for an improved fit, reduces pressure points and leaks by moving with the patient and provides large cushion area at the bridge of the nose reducing skin irritation in that area</td>
</tr>
<tr>
<td><strong>Mask &amp; prongs:</strong> Color-coded sizes</td>
<td>Available in 5 sizes to treat VLBW infants down to 450 grams, color coded for easy identification of sizing</td>
</tr>
<tr>
<td><strong>Prongs:</strong> Anatomically designed</td>
<td>Longer anatomically designed prongs provide a better seal minimizing leaks and nursing intervention.</td>
</tr>
<tr>
<td><strong>Prongs:</strong> Flexible bellows</td>
<td>Allows prongs to float and self-align reducing leaks and distributes pressure applied to the patient’s nostrils evenly. Self-adjusts to a wide range of septal widths. Reduces caregivers need for intervention. Kinked resistant</td>
</tr>
<tr>
<td><strong>Prongs:</strong> Flared tips</td>
<td>During therapy fan out, to provide a better seal inside the nares reducing leaks and pressure points</td>
</tr>
</tbody>
</table>
Infant Flow LP System
Attaching nasal prongs to generator assembly

Align the notch on the nasal prongs to sit above the pressure lines.

Note: the nasal mask attaches in the same manner.
Infant Flow LP System
Fixations: two options

Bonnet

• Familiar design
• **10 sizes**
• Modified to include support block
  o Secures tubing
  o Relieves nasal pressure

Headgear

• **6 sizes**
  o Each size is adjustable for a custom fit
• Intuitive design, easy to apply
• Support block, improve stabilization
• Open area for easy access for scalp IV
Infant Flow LP System
Fixation Sizing: headgear vs. bonnet

• Headgear sizing cm

• Bonnet sizing color
## Infant Flow LP system overview

### Headgear and bonnets: features and benefits

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Headgear:</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Intuitive design    | A single clinician can gently wrap the headgear device around the infant’s head
|                     | Helps increase patient comfort
|                     | Ease of application, saves clinician time                                                                                                     |
| **Adjustability**   |                                                                                                                                          |
|                     | Custom fit aids in comfort and flexibility
|                     | Aids in minimizing pressure points that may cause head molding
|                     | Helps increase patient comfort
|                     | Simplifies inventory management (5 sizes vs 12)                                                                                                    |
| **Stabilization**   |                                                                                                                                          |
|                     | Unique design secures generator at the proper angle
|                     | Aids in minimizing pressure points
|                     | Helps increase patient comfort
|                     | Aids in minimizing air leaks                                                                                                                      |
| **Open top**        |                                                                                                                                          |
|                     | Head not completely covered
|                     | Provides easy access to the scalp
|                     | Allows other therapies to be performed at the same time (head IV, head ultrasound)                                                                 |
| **Bonnet:**         |                                                                                                                                          |
| Familiarity         | Staff familiar with fixation, minimal training required                                                                                     |
| **Several sizes**   |                                                                                                                                          |
|                     | Available in 10 sizes to provide a custom fit                                                                                                  |
| **Cotton material** |                                                                                                                                          |
|                     | Soft cotton bonnets is breathable
|                     | Slight stretch                                                                                                                                     |
Head Gear
Infant Flow LP System

Headgear sizing

Measure the circumference of the infant’s head, from crown at back of head to brow line (in centimeters)
Infant Flow LP System
Headgear application

Align headgear with the midline of face
Align bottom of the headgear with the nape of neck

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Infant Flow LP System (cont.)

Headgear application

Place #1 strap just above brow line
Note: straps are labeled 1, 2, 3

Place #2 strap midline over strap #1
Infant Flow LP System (cont.)

Headgear application

Place #1 strap just above brow line

Place #2 strap midline over strap #1
Infant Flow LP System (cont.)

Headgear application

Place #3 strap on top of #1 and #2 straps

Fold #2 strap up and over #3 strap, secure
Place #3 strap on top of #1 and #2 straps

Fold #2 strap up and over #3 strap, secure
Infant Flow LP System (cont.)

Headgear – correct application

Back of headgear rests on nape of neck

Forehead straps placed on brow line
Infant Flow LP System (cont.)

Headgear – front too high

Horizontal strap rest close to eye

Forehead strap is too far above the brow line
Infant Flow LP System (cont.)
Headgear – back too high; top strap too tight

Above the nape of the neck, creates a fold/bulging of headgear

Top strap too tight, forehead strap #3 pulled back
Infant Flow LP System
Support cradle application

Align support block properly; parallel with brow straps #1 and #3

Press center tab down on #2 strap
Infant Flow LP System
Generator assembly application

- Center the generator and interface over patient nose and support cradle
- Use a gentle rocking motion to insert the nasal prongs
- Place the drive line and pressure line into the support cradle with the exhaust tubing resting on top
Infant Flow LP System (cont.)
Generator assembly application

• Wrap the locking strap over the exhaust tubing and attach to the side of the support cradle

• Position the small slit over the ridge in the exhaust tube
Infant Flow LP System (cont.)
Generator assembly application

• Wrap the side straps around the generator tabs
• Use the Velcro tip to secure strap
• Looser is better
• Use side straps to adjust tension on interface
• Do not overtighten
Infant Flow LP System (cont.)
Generator assembly: correct application

Support cradle tabs secured to headgear

Generator aligned and centered with nose

Side straps properly placed

Note: Straps should be snug, but not tight

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Infant Flow LP System
Nasal prongs: correct placement

• Bellows are visible (Do not insert prongs beyond anatomical curve)
• Septum is visible
• Generator assembly has minimal contact with skin
Infant Flow LP System (cont.)
Nasal prongs: incorrect placement

- Too tight, bellows compressed
- Prong outside nare
- Base not seated on the generator head
Infant Flow LP System
Nasal mask: correct placement

- Mask covers nasal profile
- Mask rests below the eyes
- Bellows not compressed
- Side strap low on check
- Support cradle tabs secure on headgear

Note: Do not overtighten
Infant Flow LP System (cont.)

Nasal mask: incorrect placement

• Bellows compressed
• Strap tension too tight (one side)
• Mask collapsed
• Strap tension too tight (both sides)
• Mask collapsed
• Nares and septum not visible
Infant Flow LP System (cont.)

Nasal mask: correct size

• The nares and septum should be visible in the assessment window

• The mask cushion should fit on the outer side of the nose
Infant Flow LP System (cont.)
Nasal mask: incorrect size - too large

- High on bridge of nose
- Rests against eyes

- Rests on upper lip
Infant Flow LP System (cont.)
Nasal mask: incorrect size – too small

- Mask blocks the nares and rests on septum
- Mask unable to cover nose and rests on septum

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Bonnet
Infant Flow LP System
Bonnet measurement

• Measure from the center of the forehead to the nape of the neck and back to the forehead
  Note: Do not measure head circumference

• Match the color area and number on the tape with bonnet size

• Re-assess size of bonnet at regular intervals
Infant Flow LP System
Bonnet application

- Position the bonnet with the tip of launching pad in alignment with the center of the forehead and nose
- Gently pull the bonnet down
- Make sure the ears are covered and in normal position
Infant Flow LP System
Support cradle application

• Align center of bonnet with the midline of the forehead and nose
• Center the support cradle on the pad
• Press the three tabs down to secure
Infant Flow LP System
Generator assembly preparation

1. Insert end of strap through the slit

2. Pull until a small loop is formed

3. Place loop over fixation arm

4. Pull tight and attach second strap
Infant Flow LP System
Generator assembly application

- Center the generator assembly over patient nose and support cradle
- Use a gentle rocking motion to insert the nasal prongs
- Place the drive line and pressure line into the support cradle with the exhaust tubing resting on top
Infant Flow LP System (cont.)
Generator assembly application

- Wrap the locking strap over the exhaust tubing and attach to the side of the support cradle

- Position the small slit over the ridge of the corrugated exhaust tube
Weave gray strap through the bonnet holes, starting from the inside of the colored hole.

Thread up through the colored hole, down through the second, and up through the third.
Infant Flow LP System (cont.)
Generator assembly application

- Tie the ends of the bonnet (optional)
- Use the gray straps to adjust tension
- Note: Straps should be snug, but not tight
- Tuck strap ends under the bonnet folds
Infant Flow LP System (cont.)
Generator assembly – correct application

- Generator assembly centered with nose
- Side straps low on cheek
- Locking strap in place
Final check and routine inspection, application tips, warnings and cautions
Final check and routine inspection

Inspect the system at least every 3 to 4 hours to:

• Ensure the patient is receiving the prescribed level of CPAP

• Ensure the generator is stable, secure and not pulling upward on the nose

• Check for deformation or irritation to the nose or surrounding tissue

• Ensure that the patient’s septum is clearly visible when using prongs
Final check and routine inspection

Inspect the system at least every 3 to 4 hours to:

• Ensure that the patient’s eyes are clearly visible and that the nares are not blocked when using masks

• Inspect the fixation device and straps for proper tension and adjust as needed to maintain a proper fit

• Monitor the patient for gastric insufflation and abdominal distension

• Monitor for excessive condensation in circuit and generator
Application tips

• Select the appropriate size nasal mask to minimize leaks and dead space

• Select the appropriate size nasal prongs; if between sizes, select the larger size

• Application of an incorrectly sized prong, mask, bonnet, or headgear will affect stability of the generator

• Consider alternating the use of prong and mask interfaces at set intervals to change pressure points on the infant’s face
Application tips (cont.)

• Continuously monitor patient’s respiratory status, (respiratory rate, heart rate, oxygen saturation)

• Cover both ears evenly; ensure the ears are not folded

• Adjust the straps to stabilize the generator and maintain a seal at the nose using the least tension possible
Application tips (cont.)

• Recommend humidification be used with nCPAP systems

• The Infant Flow LP has a built in “pop-off”, which is activated if the drive pressure exceeds 60 cm H₂O
Warnings and Cautions

• Use this product only as directed in the product literature to reduce the risk of nasal irritation, septal distortion, skin irritation and pressure necrosis

• To be used by a trained practitioner, under the direct supervision of a qualified physician

• Only use the Infant Flow LP generator with variable flow nCPAP drivers

• Do not overtighten the fixation straps

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Clinical management, monitoring, assessment, positioning and failure
Clinical management

• Based more on anecdotal experience, opinion and conventional wisdom

• These practices vary greatly from one institution to another

• No consensus regarding the proper initial level, weaning strategies or appropriate timing for implementation and weaning
Monitoring

- Recommended system checks at least every 4-6 hours\(^1,\ 2\)
- Documentation of nCPAP level and FiO\(_2\)^1
- Oxygen and carbon dioxide monitoring\(^1\)
- Periodic arterial blood gas sampling\(^1,\ 2\)
- Continuous electrocardiogram and respiratory rate\(^1,\ 2\)
- Clinical assessment of breath sounds and signs of increased work of breathing\(^1\)
- Periodic x-ray evaluation\(^2\)

\(^1\) Bonner, K., Mainous, R. *The nursing care of the infant receiving bubble CPAP*. Advances in Neonatal Care. 2008; 8:78-95.
Assessment of outcome

• Trending of FiO$_2$ requirement using SaO$_2$

• Reduced work of breathing

• Improved lung volume

• Improvement in patient comfort
Patient positioning

• Swaddling may be helpful\(^1\)

• Can prone patient

• Pacifier may help reduce pressure loss if using variable flow\(^1\)

\(^1\) Nicks, J. CPAP, SiPAP, High Flow Nasal Cannula in Infants: Which should you choose, when, and why? 2014.
nCPAP failure

• pH < 7.25

• Increased PCO$_2$

• Increased FiO$_2$ requirement

• Severe apnea
Summary of nCPAP

- Use of nCPAP in neonates is not a new concept

- Represents a noninvasive method of respiratory support that may lesson iatrogenic injury to newborns, particularly very low birth weight (VLBW) infants

- Major areas of use are for post-extubation management, apnea, and primary treatment of RDS
Thank you