Pediatric Airway Series

Case 1: Bag Mask Ventilation
The Case

Christina is an 8 week old female infant who presents to the triage nurse in the ED with:

• fever
• cough
• increased respiratory rate.

During the triage examination the infant becomes mottled, blue, and apneic. Her heart rate drops to 40.
The tendency for BVM ventilation in children is press down with force in effort to obtain a tight seal and ventilate rapidly. The flexed position can cause obstruction of the airway precluding gas entry.

The fast rate does not allow for adequate gas exchange.
The **key to effective ventilation** is to do the opposite, i.e. to **lift the head / face up and bag slowly** to allow gas entry and a cadence that allows sufficient time for gas escape.

The flexed neck causes the tongue and to fall back on the pharyngeal wall resulting in airway obstruction that level. By extending the neck the tongue is lifted up alleviating the obstruction.
First place the child in the sniffing position.
Then, using the one handed “C-clamp” method, tilt the head back, elevating the tongue off the posterior pharynx.

An alternative method is the two handed “jaw thrust,” which seals the mask and elevates the tongue off the posterior pharynx. By opening the jaw slightly it allows the mandible to be further elevated with the jaw thrust, relieving any obstruction at that level.

MRI images demonstrate the superiority of the jaw thrust over the C-clamp in the degree of opening the airway obtained.
A quick evaluation from across the room can recognize poor versus good BVM technique.
The oral airway can be used as adjunct to help lift the tongue off the posterior pharynx, relieving obstruction at that level.
In the drawing above both of patients have decreased lung compliance and are being ventilated with a BVM. Both patients also have air leaks. The leak in the adult patient is obvious as air can be heard and also seen to escape around the mask. The leak in the infant is not obvious as there is no visual leaking around the mask. In the child air is escaping from the pop off valve which is in the open position.

As obvious as this may seem, there have been case reports of late recognition of this problem which have resulted in delays in ventilation and oxygenation.
A pop-off valve is **designed to prevent the delivery of excessive pressure**, and therefore excessive volume, to the lungs. At a preset level, an escape valve opens and keeps the delivered pressure below a predetermined level, approximately 40 centimetres of water pressure. Normal lungs usually require less than 15-20 cm water pressure for adequate ventilation.

However, certain conditions require higher pressures, for example upper-airway obstruction or to open noncompliant lungs. In these situations, the operator should assure the pop-of valve is in the closed position.

Before concluding that ventilatory difficulty is caused by intrinsic lung resistance, however, one must exclude inadequate airway patency as the cause; that is, attempt manipulating the airway position to optimize patency.
This is the pop-off valve in open position.
This is the pop-off valve in closed position
Negative Leak Test

With the face mask removed and one hand over the patient port, the bag is squeezed. The bag remains tight with minimal give as it is squeezed. Arrows point to the closed pop-off valve (white arrow) and the closed manometer port (black arrow).
**Positive Leak Test**
With the face mask removed and one hand over the patient port, the bag is squeezed. The bag collapses as it is squeezed. Arrow points to an open pop-off valve (white arrow) which allows escape of gas and a closed manometer port (black arrow).

If one does not see critically ill children frequently it may be difficult to remember whether the pop-off valve should be open vs closed, or whether the Leak Test should be positive vs negative. Remember, just as you open the laryngoscope prior to use and the light should be on, always squeeze the bag prior to using it, and it should be tight. If not, change the position of the pop-off valve. Just as the adult bag should be tight prior to use so should the pediatric bag.

Then place the bag in proper position and gently begin ventilations, slowly increasing the force until chest rise is achieved.

**Case progression**
After closing the pop-off the saturations increase to 100% valve with BVM ventilation, and preparations are made for endotracheal intubation.
What if you can’t ventilate/oxygenate while bagging?
## Differential for Failure to Ventilate/oxygenate with a BVM

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action/Rationale</th>
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<tbody>
<tr>
<td>Inadequate seal</td>
<td>Observe. Assure good one hand and two handed technique with no leak around the mask.</td>
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<tr>
<td>Improper mask fit</td>
<td>The mask should cover the nose and mouth without covering the eyes.</td>
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<tr>
<td>Head/Neck in flexed position causing obstruction</td>
<td>Extreme neck flexion as in over aggressive attempts to obtain a tight seal may result in obstruction by itself, exacerbated by the tongue anatomy being pushed against the posterior pharyngeal wall. Rx= Extension of the neck.</td>
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<td>Obstruction secondary to tongue</td>
<td>Neck extension, followed by OA insertion if not corrected.</td>
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<tr>
<td>OA mal-positioned</td>
<td>Can be actually pushing down on the tongue causing obstruction. Assure correct position and insertion technique.</td>
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<tr>
<td>Equipment failure</td>
<td>Most commonly results from an open Pop-off valve in the face of the need for increased ventilation pressures, but there could be other causes of a poor seal (open manometer port or equipment malfunction).</td>
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<tr>
<td>Distended Abdomen</td>
<td>Complication from prior over aggressive ventilation efforts. Rx= Placement of an NG or OG tube.</td>
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