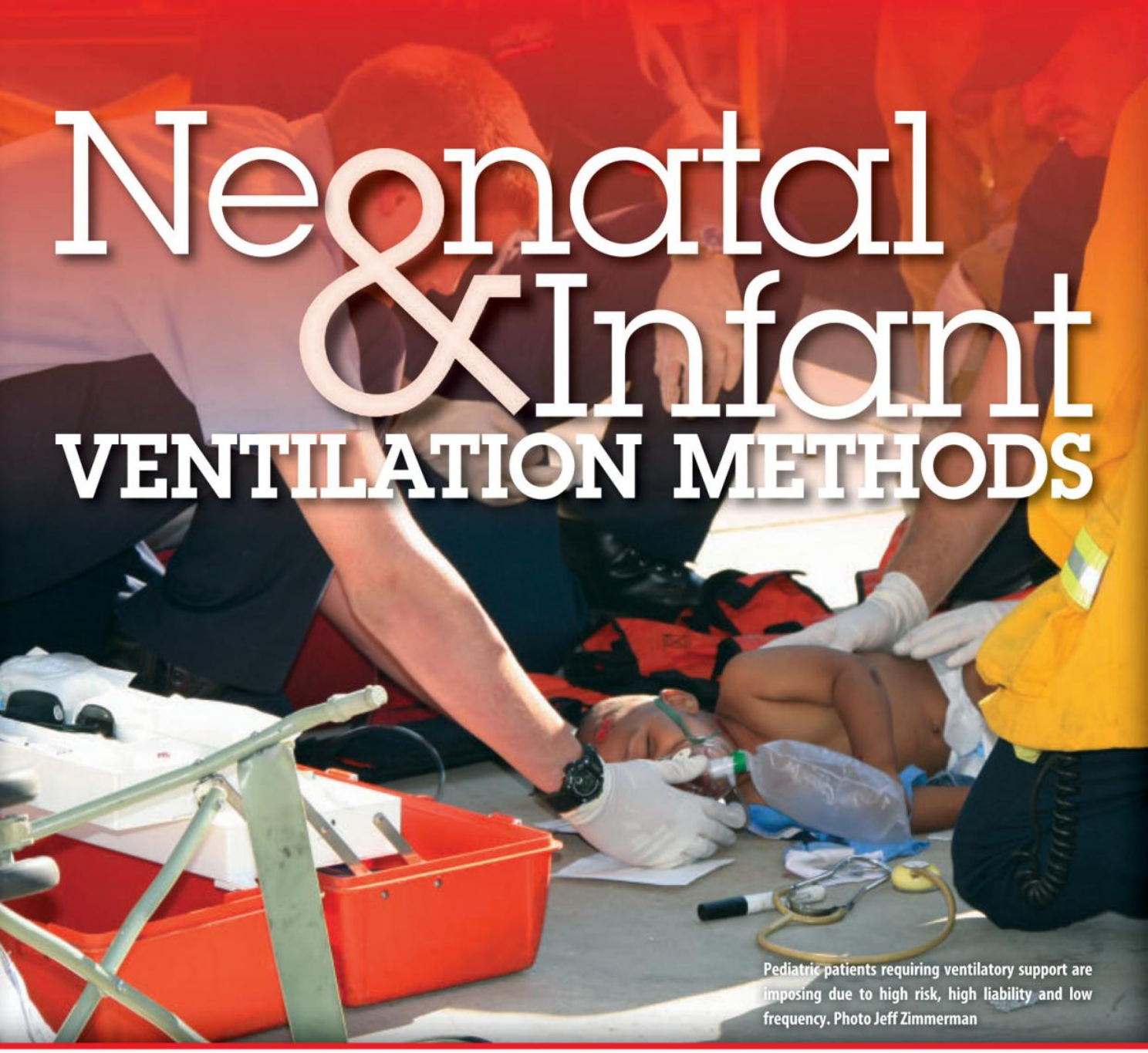
Neonatal & Infant VENTILATION METHODS



Pediatric patients requiring ventilatory support are imposing due to high risk, high liability and low frequency. Photo Jeff Zimmerman

A comparison of self-inflating bags, flow-inflating bags & infant T-piece resuscitators

By **Steven C. LeCroy**, MA, CRTT, EMT-P

Most prehospital healthcare providers are comfortable treating an adult patient with a chief complaint of difficulty breathing or who's in need of ventilator assistance. However, if the patient is 6 months old or a newborn, the same caregiver usually has a lot less confidence and a tendency to snatch the patient and run. Why is that?

I think it's a combination of a lack of experience treating this age group, a lack of formal training and the psychological pressure of treating small children. Non-breathing infants or infants needing ventilatory support are high-risk, high-liability and low-frequency events.

According to the American Heart Association (AHA), approximately 10% of neonates require some type of resuscitation at birth,[1] and research by Gouyon indicates an estimated 3.6 per 1,000 infants born at term require mechanical ventilation.[2]

The purpose of this article is to raise the awareness of prehospital providers on issues, both good and bad, of the three most often used pediatric and neonatal hand ventilation devices.

IMPORTANCE OF RESPIRATORY RATE

Ventilating very young patients is more than just getting the air in and out; it's a matter of the proper rate, tidal volume and not causing damage to immature lungs by using too much pressure.

Most clinicians have been taught proper respiratory rates for pediatric patients. (See Table 1.) However, many clinicians have no idea what the proper **tidal volume (Vt)** is for neonates (5 mL/kg), and have been taught to watch for chest rise. Watching chest rise

Table 1: Pediatric respiratory rates

Age	Rate (breaths per minute)
Infant (birth–1 year)	30–60
Toddler (1–3 years)	24–40
Preschooler (3–6 years)	22–34
School-age (6–12 years)	18–30
Adolescent (12–18 years)	12–16

Figure 1: Bag-valve mask Photo Courtesy Mercury Medical

may be the only choice to determine Vt using equipment currently being carried by many EMS agencies. And, most EMS clinicians lack the experience to properly ventilate a neonate or small infant without causing injury to the lungs, which may include chronic lung disease, pneumothorax and even death.

To prevent patient injury, you can find training or equipment solutions. Or, you can wait for an error to occur and end up defending your crew in court.

With the problem defined, and training available through a variety of pediatric courses, the best option is to look at available equipment to hand-ventilate newborns and small infants.

GLOSSARY

Centimeters of water pressure (cmH_2O): a commonly used measure of lung pressure.

Continuous positive airway pressure (CPAP): A respiratory therapy technique where pressure is constant during both the inspiratory and expiratory phase of breathing.

Peak inspiratory pressure (PIP): The highest level of pressure applied to the lungs during inhalation.

Positive end-expiratory pressure (PEEP): A technique where resistance is used so that pressure is maintained in the airway so that the lungs empty less completely on expiration to mitigate end expiratory alveolar collapse.

Tidal Volume (Vt): The amount of air inhaled or exhaled in a single resting breath.

AVAILABLE TOOLS

There are three types of devices being used to ventilate this age group: a self-inflating bag (bag-valve mask, or BVM), a flow-inflating or hyper-inflating bag (commonly called an anesthesia bag) and an infant T-piece resuscitator. It's recommended that all three devices be used with an oxygen blender, if possible, to enable the user to adjust the oxygen percentage.

It's important to remember the neonatal resuscitation program (NRP) supported by the AHA and the American Academy of Pediatrics recommends that the starting **peak inspiratory pressure (PIP)**—the highest level of pressure applied to the lungs during inhalation—should be 20 **centimeters of water pressure (cmH_2O)** and **positive end-expiratory pressure (PEEP)** resistance on expiration should be 5 cmH_2O to prevent lung damage and to open airways respectively.

The self-inflating bag is probably the most common hand-ventilating device because it's easy to use. (See Figure 1.) The BVM for this age group is less than 500 cubic centimeters and consists of a bag, reservoir, oxygen tubing, pressure pop-off valve, a mask and, in some cases, a PEEP valve and a pressure manometer.

With a reservoir, a BVM can provide approximately 100% oxygen and the pressure pop-off should activate at about 40 cmH_2O as a safety measure to prevent barotrauma to young lungs.

Using a BVM without a pressure manometer on newborns is risky. Many clinicians attest to being able to "feel" lung compliance with a BVM. However, I'm somewhat skeptical if this is true in inexperienced hands. In addition, **continuous positive airway pressure (CPAP)**, a technique used after delivery and in the neonatal ICU, is not an option with a BVM. However, the BVM will still function without oxygen or compressed air

Figure 2: Flow-inflating bag with manometer Photo Courtesy Mercury Medical

INFANT VENTILATION METHODS

>> CONTINUED FROM PAGE 47

Figure 3: Infant T-piece resuscitator Photo Courtesy Mercury Medical

since it self-inflates.

Another tool is the flow-inflating or hyper-inflating bag. (See Figure 2.) Flow-inflating bags feature a soft bag and are very effective in skilled hands. Most clinicians, including respiratory therapists, find ventilating with a flow-inflating bag to be difficult if they don't have neonatal ICU experience. However, in the hands of experienced providers, the flow-inflating bag gives a better "feel" for lung compliance and can be used to provide CPAP.

Flow-inflating bags must have oxygen or compressed air flow to function and, in most cases, require a higher liter flow than other devices to maintain the appropriate pressure.

The third device is the infant T-piece resuscitator. (See Figure 3.) An infant T-piece resuscitator has the ability to set and control PIP as well as PEEP. The infant T-piece attaches directly to the patient interface and ventilation is accomplished by placing a finger over a hole on the exhalation side. Most infant T-piece resuscitators have an in-line manometer for continuous monitoring of the pressure and can be used to provide CPAP.

Of the three devices, the infant T-piece resuscitator provides the most consistent PIP and PEEP. As with the first two devices, some models attach directly to a standard flow meter. The infant T-piece resuscitator is supported by the NRP and has been shown in many studies to be an effective, safe method of ventilation even in inexperienced hands.[3]

As for the clinician, there are no fatigue issues with extended use that may occur with the other devices. An article in *Resuscitation* in 2010 stated: "Use of infant T-piece devices guarantees reliable and constant Vt and PIP provision, irrespective of individual, operator dependent, variables."[4]

WHY LIVE DANGEROUSLY?

As a respiratory therapist and paramedic with neonatal ICU experience, I've used all three devices. Even with 30 years of experience, I've found it extremely difficult to keep and maintain the proper ventilation pressures with either the self-inflating or flow-inflating bags.

Many EMS systems still use a self-inflating bag without a manometer—the most dangerous method to ventilate a newborn or small infant. It's dangerous because it's almost impossible to maintain a safe pressure by observing chest rise only.

Each of the devices is disposable and costs about the same, and each can be used effectively in the right hands. So, my question to you and your EMS system: How comfortable are you with what you currently carry and what's the best option to take in the future to resuscitate the smallest of patients? JEMS

Steven C. LeCroy, MS, CRTT, EMT-P, is a retired captain/paramedic from St. Petersburg Fire & Rescue, an adjunct instructor at St. Petersburg College and a 30-year respiratory therapist. He has also been an expert witness in over 70 EMS cases across the U.S.

REFERENCES

1. American Academy of Pediatrics, American Heart Association: *Textbook of neonatal resuscitation, sixth edition*. American Academy of Pediatrics: Elk Grove Village, Ill., 2011.
2. Gouyon JB, Ribakovsky C, Ferdynus C, et al. Severe respiratory disorders in term neonates. *Paediatr Perinat Epidemiol*. 2008;22(1):22–30.
3. Chandler K. Benefits of the Neo-Tee versus the self inflating resuscitation bag in the delivery room and NICU. *Neonatal Intensive Care*. 2013;26(6):47.
4. Roehr CC, Kelm M, Fischer HS, et al. Manual ventilation devices in neonatal resuscitation: Tidal volume and positive pressure-provision. *Resuscitation*. 2010;81(2):202–205.

RESOURCES

- Karlsen K. (2013.) *The s.t.a.b.l.e. program*. Retrieved Jan. 16, 2014, from www.stableprogram.org.
- Perlman JM, Wyllie J, Kattwinkel J, et al. Part 11: Neonatal resuscitation: 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Circulation*. 2010;122(16 Suppl 2):S516–S538.