"Inadvertent Hyperventilation during CPR – Are We Squeezing the Life Out of Our Patients"?

The most commonly used method of ventilation during cardiac arrest, respiratory arrest or trauma is the bag-valve-mask (BVM) manual resuscitator. There have however, been numerous studies published that show the inconsistent ventilation properties and poor skill levels of the majority of rescuers using these devices[1-4]. More recent clinical evidence has gone on to show that the use of these devices during resuscitation may be contributing to poor patient outcomes.

During BVM ventilation in the "unprotected airway", there are a number of factors that influence the distribution of gas between the lungs and the stomach. Some are inherent in the patient's physiology (lower esophageal sphincter pressure, airway compliance and resistance) whilst others are created by the rescuer (inspiratory time, inspiratory flow and peak airway pressure).

These factors give rise to three areas of concern:

1. **Gastric insufflation (gas in stomach) leading to the aspiration of stomach contents and subsequent complications.**

2. **Decreased Coronary Perfusion Pressure due to the high intrathoracic pressures**

3. **Increased brain ischemia in traumatic brain injured patients.**

These three problems are caused by the rescuers inadvertently squeezing the bag too hard and/or too fast. What is now called "Inadvertent Hyperventilation"!

The Guidelines 2000 for CPR[5], represented the world's first international application of evidence - based science applied to cardiopulmonary resuscitation and a fundamental step forward to improve the chain of survival of CPR. These Guidelines clearly stated that – ***"When the airway is unsecured (as with a mask versus a tracheal tube), the possibility of hyperventilation with gastric insufflation, vomiting, and inhalation of vomit becomes a significant concern".***

The extent of "Inadvertent Hyperventilation" was clearly shown by Aufderheide et al[8] in 2004. In a clinical observational study of ventilation rates by paramedics, even immediately after training, ventilation rates were twice the Guidelines recommended levels and inspiratory times were only 50% of those recommended. This led the authors to conclude that: ***"any incidence of hyperventilation is likely to have detrimental hemodynamic and survival consequences during low flow states such as CPR".***

This was reiterated in an editorial by Pitts and Kellerman in the "The Lancet" in 2004[9] stated: ***"Unrecognized and <u>unintentional</u> hyperventilation may be contributing to the currently poor survival rates from cardiac arrest".*** They also stated that ***"...Additional education of CPR providers is urgently needed to reduce these newly identified and deadly consequences of hyperventilation during CPR".***

In a 1995 publication from the American College of Neurosurgeons and the Brain Trauma Foundation the issue of hyperventilation for Traumatic Brain Injury, a commonly used technique for increasing oxygenation of

the brain, was addressed and it was clearly stated that ***"Hyperventilation in brain injured patient's increases brain ischemia".*** This is certainly a major change in thinking and certainly links in with the issue of reduced Coronary Perfusion Pressure from inadvertent Hyperventilation reducing blood flow to the vital organs.

Products like O-Two's "Mini Ventilation Training Analyzer" have been developed to train rescuers in proper BVM ventilation techniques, to show the problems of inadvertent hyperventilation and to assist in the reduction of gastric insufflations and to. View the product at http://www.otwo.com/prod_tv.htm.

So what is the answer?

1. Training: As these problems appear to be an issue of applied skills, we could institute improved and more frequent training although training in the class room does not take into account incident stress which is possibly the biggest cause of inadvertent hyperventilation. Back as far as 1986, Cummins et al,[10] published an article entitled: "Ventilation skills of emergency medical technicians: A teaching challenge for emergency medicine**".** This problem was also reported in Resuscitation in 2004 in a paper entitled "Retention of Ventilation Skills by Emergency Nurses" by De Regge et al[11]. In this study of resuscitation skills using Bag-Valve-Mask resuscitators" the authors concluded that ***"Skill retention, even immediately post training, was insufficient using current technology".***

2. Technology: With the current, seemingly ineffective transfer of skills from a class room setting to the field, it may be that technology, not the skill and training of the rescuer, is the way forward to improving ventilation performance.

In our next newsletter, we will look at advancements in BVM designs (see the SmartBag http://www.otwo.com/prod_bmv.htm#feature\) and automatic ventilators/resuscitators http://www.otwo.com/prod_arv.htm) as two technological solutions.

As always, please send your thoughts, comments, suggestions and solutions to streetsense@otwo.com.

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