Respiratory Report: Between Rocks and Hard Places (And Things They Didn't Teach You in School)

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I dedicate this column to the late Dr. Andrew (Andy) Shennan, the founder of the perinatal program at Women's College Hospital (now at Sunnybrook Health Sciences Centre). To my teacher, my mentor and the man I owe my career as it is to, thank you. You have earned your place where there are no hospitals and no NICUs, where all the babies do is laugh and giggle and sleep.

I had the pleasure of speaking to Dr. Alison Froese, an anesthesiologist from Kingston, Ontario, following a conference. I asked her what she thought of the Glidescope® video laryngoscopy device. "Don't get me started," she replied. "I now spend my time teaching basic laryngoscopy because no one knows how to do it anymore!". (1) I laughed and replied that I tease anesthetists all the time, telling them "when I learned to do this, you actually had to do it." While Dr. Froese's practice is in the adult world, with the introduction of pediatric and neonatal video laryngoscopes combined with the transition to non-invasive respiratory support, it is only a matter of time before her experience is visited upon the world of neonatology.

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I have been practicing as a respiratory therapist for 30 years, 22 of those being exclusively in the NICU. In that time, I have encountered many situations where the standard practice simply wasn't working. As staff approach retirement age, there is a wealth of experience and practical bedside knowledge poised to leave with them. While technology has given us many tools to make our clinical lives easier, sometimes the cost of that technology is the loss of clinical skill sets that can be lifesaving in dire situations. I pres-

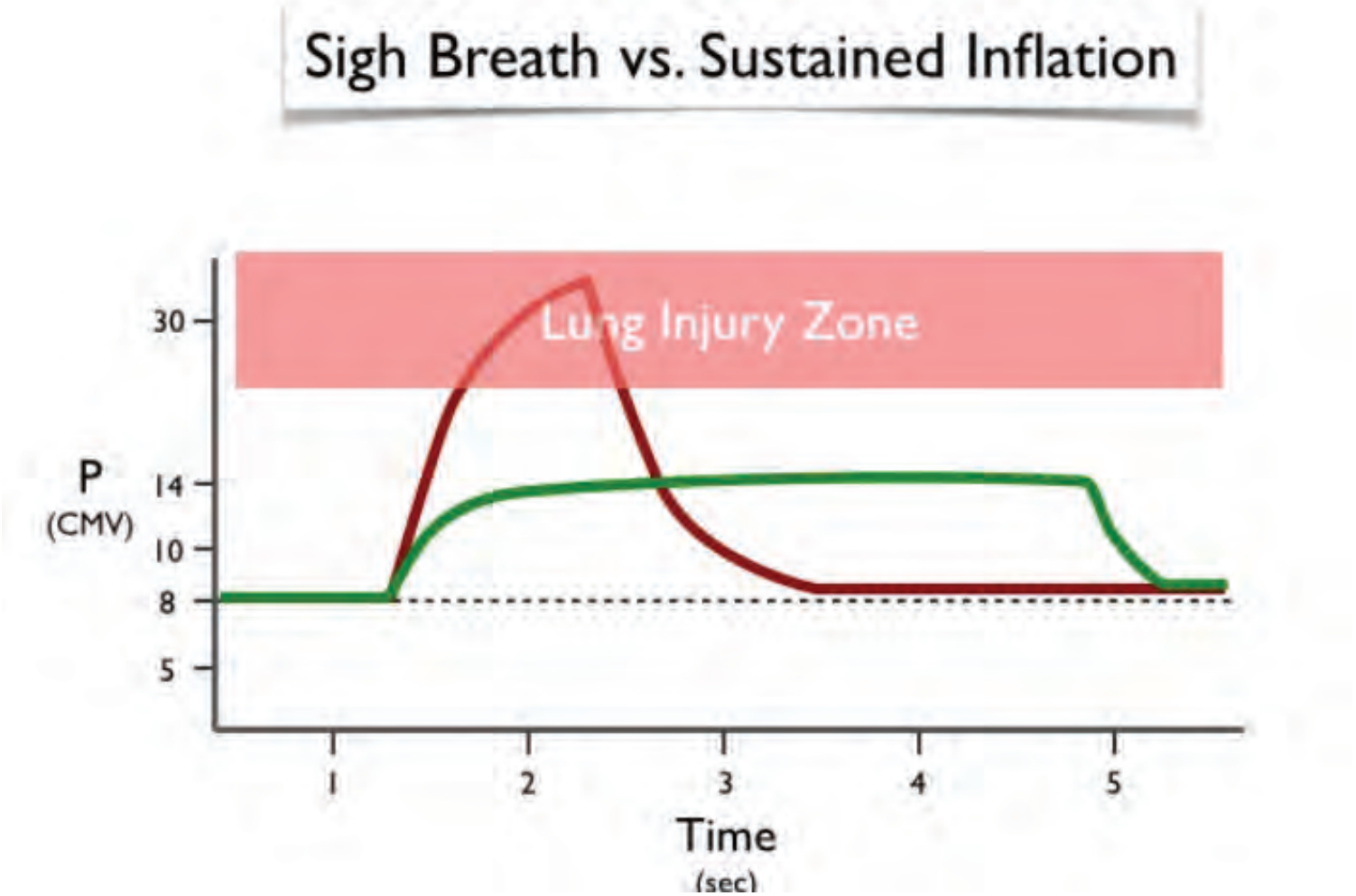

Figure 1 courtesy Bunnell Inc

Figure 2: Traditional grip

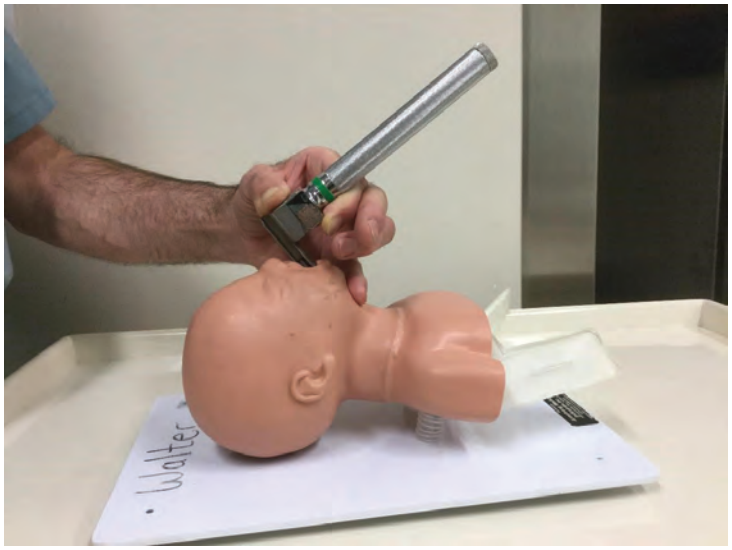

Figure 3 preferred grip: note position of pinkie

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When the Lungs Say "Yes" and the Heart (or Brain) Says "No."

There are times when the balance between perfusion and ventilation is almost impossible to achieve. While an under-recruited lung will impair venous return as much as an over-inflated one, there are times when the immature heart cannot pump effectively against the pressure required to maintain optimal pulmonary recruitment. Normal pulmonary arterial pressure (PAP) outside the neonatal period is 19 cmH_2O +/- 4 cmH_2O, and this value is independent of age. This pressure is higher in the newborn, and higher still in the premature infant. (2) It stands to reason that the closer mean airway pressure (MAP) is to PA pressure, the less perfusion pressure is available. Further, infants with chronic lung disease (CLD) often exhibit a degree of pulmonary hypertension, although structural in nature rather than reactive.

A normal, functioning, premature heart should not have difficulty pumping against a MAP of 10 cmH_2O. Unfortunately, pressures much higher than this are often required to maintain lung patency and provide adequate oxygenation without potentially damaging high oxygen concentrations, and occasionally this results in hypotension.

I rarely advocate for lower MAP, but when faced with this scenario will sometimes reduce PEEP/MAP while introducing recruitment maneuvers. This may seem counter-intuitive since recruitment maneuvers are best used sparingly and for short duration in concert with increasing PEEP/MAP. In this case, the maneuvers are meant to maintain alveolar stability, while the lower PEEP/MAP gives "windows" of lower pressure to lessen cardiovascular load: think of it as "biphasic PEEP."

Traditionally we have been taught as clinicians to use "standard" intermittent mandatory ventilation (IMV) breaths for recruitment, typically with an inspiratory time (Ti) of 0.5 seconds and peak inspiratory pressure (PIP) of 20 cmH_2O or more. We now know that large volume breaths are damaging to the developing lung, and a study by Pillow et al. showed increased inflammatory markers using IMV breaths with PIP of 25 cmH_2O at rates of 2 and 5 respectively, and with Ti of either 0.5 or 2 seconds. Markers were more prevalent with the increased Ti. (3) In addition, the low Ti does not provide sufficient time for proper pendelluft to occur, but provides enough time to over-inflate areas with high compliance. A more recent approach to recruitment maneuvers is to lower the PIP (typically to 5-6 cmH_2O above PEEP in high-frequency jet ventilation (HVJV)) and increase the Ti to 2-3 seconds. This approach provides a degree of lung protection for compliant areas while giving more time for pendelluft to occur and for less compliant areas to begin filling. (see figure 1) It should be noted that research by Drs. Jane Pillow and Gabrielle Musk (Australia) have shown inflammatory markers in tracheal aspirates using IMV pressures as low as 12 cmH_2O. Hence any recruitment strategy should be used judiciously and as briefly as possible.

Similarly, a high MAP can impair cerebral blood drainage. Very small babies with attending fragile cerebral vasculature are most prone to this, and cerebral blood congestion may cause blood vessels to leak with dire consequences. A case in my unit comes to mind. This was a baby who required very high pressures to ventilate and oxygenate, and we were happy to oblige. Unfortunately, a head ultrasound done prior to discharge revealed severe periventricular leukomalacia not present in previous scans and appearing much later in the infant's course than would be expected. The pri-

mary suspect was prolonged high MAP with cerebral congestion. While no treatment strategy offers 100% efficacy, lowering PEEP (the baby was on HFJV) and using recruitment maneuvers may have saved this patient's brain.

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While these maneuvers are typically used with HFJV, once 3rd generation ventilators are approved for use in the U.S. this option will be available in high-frequency oscillation mode (HFO) as these machines offer integrated and customizable sigh breaths with HFO and I have no doubt would provide the same effect. Also, these maneuvers should not be confused with sustained inflations as the duration of the breath is shorter than is typical of sustained inflations, and the PIP is also much lower. The SAIL trial, for example, used a PIP of 25 cmH_2O for 15 seconds.5 I do not recommend this strategy.

HFJV Maxed Out

There have been occasions when ventilating a baby with HFJV where even with maximum PIP of 50 and jet Ti 0.34 the CO_2 doesn't budge. The Bunnell Life Pulse® high-frequency jet ventilator measures and servo-adjusts pressure via the patient box. Since the diameter and length of the pressure line attached to the LifePort ® are of known length and diameter, the resistance associated with it is factored into the algorithm used to very accurately estimate tracheal pressure.

This procedure is off-label and not endorsed by Bunnell. Increasing the length of this pressure line increases the associated resistance and thus makes the machine "see" lower pressure than there actually is. In response, servo pressure is increased to provide set pressure. When using maximum settings, increasing the pressure line length will increase pressure delivered to the patient, this will not be reflected by measured pressure, and the actual pressure delivered will not be known. However, it will provide more ventilation, and the large attenuation of jet pressure still applies. I have seen this work very well and quite quickly; in one case, it was required for only a few minutes to achieve the desired reduction in CO_2 before being discontinued. In this case, the length of the pressure line was doubled by cutting the line off another LifePort® adaptor and joining the two with a blunt needle (further increasing resistance). When between a rock and a hard place, this off-label use of the ventilator can be a lifesaver. Proceed with caution and discontinue as quickly as possible.

Difficult Intubations

I have yet to meet a clinician who has not been unsuccessful in placing an endotracheal tube (ETT) in a baby at one time or another. One might say a healthy serving of humble pie should be on everyone's menu on occasion as it keeps us aware that even the best of us will inevitably fail sooner or later. Keeping in mind a few tools and tricks can help delay that meal.

Tools

The standard intubation kit is fine most of the time, but there are situations where having a few add-ons can make the task at hand much easier. To that end, I recommend having available an assortment of ETT's kept in a freezer, lubricant, and an assortment of suction catheters. The reason for frozen ETT's is that they are stiffer and less prone to bending, and the cold tube may mitigate inflammation.

Technique

At times, despite a clear view of vocal cords, the ETT simply will not pass through the vocal cords, other times it will not advance sufficiently below the vocal cords for one reason or another. If the ETT does not pass through the vocal cords, applying constant, gentle pressure while rotating the ETT may help. Dr. Andrew Shennan, my mentor, explained to us that the ETT bevel is designed such that it will slip between the vocal cords and open them while being rotated, a technique we refer to as "corkscrewing." Care must be taken to avoid too much pressure being applied, but the vocal cords themselves are relatively robust.

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If despite using the corkscrew maneuver, the ETT bends on itself rather than passing through the cords, there are two options. One is the use of a frozen ETT to prevent bending. The other is to use a suction catheter as an introducer. This is done by feeding the largest suction catheter that will pass through the ETT and then advancing the catheter through the vocal cords. It should be advanced far enough to ensure it does not become dislodged, and some lubricant may be used to aid in its removal once the ETT is properly positioned. This technique can help guide an ETT past a sub-glottic obstruction such as a granuloma, and it has saved my hide on more than one occasion. Another trick I have used and seen used is attaching a resuscitation bag to the end of the ETT and bagging when the tube is at the cords. This sometimes helps open the cords to allow the ETT to pass through, but it can be awkward and is best done with a second set of hands.

Sometimes vocal cords can be very difficult to visualize. I often will leave a feeding tube in situ while intubating as it serves as an easy landmark. Even if the glottis cannot be seen, its location can be estimated as about 1 cm due north of the feeding tube's location, and the ETT can often be placed simply aiming in that location using Magill forceps to direct it.

Finally, the way in which the laryngoscope is held can provide better control and visualization. Most clinicians learn to intubate adults or children first. This involves holding the laryngoscope by the handle. (See figure 2) With neonates and micro-prems, this grip does not work as well and increases the risk of damaging the gum and tooth buds and may increase the likelihood of hyperextending the neck and "levering" against the gum. I was taught to hold the blade, as shown in figure 3. Doing so gives finer control of the blade and reduces the risk of levering and hyperextension since the laryngoscope is held at the pivot point. This technique also frees the pinkie or ring finger to provide cricoid pressure dur-

ing visualization. Pressing down brings the trachea in line with the ETT, and since it is the intubating person themselves providing pressure, proper alignment is easier to obtain. This is particularly useful when intubating nasally, the preferred and usual placement in my unit for developmental reasons. Dr. Shennan would apply a significant amount of pressure this way, and his intubation skills were so good we nicknamed him "Slick." I am unaware of any sequelae as a result of using tracheal pressure this way, and it is the way I teach learners to hold a laryngoscope. It is particularly useful with very small babies.

I welcome input from other clinicians wishing to share their own "tricks" as well as suggestions for future articles. The purpose of this publication is, after all, the sharing of knowledge and practice.

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Disclosures: The author receives compensation from Bunnell Inc for teaching and training users of the LifePulse HFJV in Canada. He is not involved in sales or marketing of the device nor does he receive more than per diem compensation. Also, while the author practices within Sunnybrook H.S.C. this paper should not be construed as Sunnybrook policy per se. This article contains elements considered "off label" as well as maneuvers, which may sometimes be very effective but come with inherent risks. As with any therapy, the risk-benefit ratio must be carefully considered before they are initiated.

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