"The Iowa Way" Have We Got This All Wrong?

Rob Graham, R.R.T./N.R.C.P.

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 recently had the pleasure of watching a webinar from Iowa Children's Hospital presented by Dr. Jonathan Klein focusing on their management of the sub-24 week gestation infant. To say the least, I was gobsmacked. This unit reports chronic lung disease rates of 11% in this population."

I recently had the pleasure of watching a webinar from Iowa Children's Hospital presented by Dr. Jonathan Klein focusing on their management of the sub-24 week gestation infant. To say the least, I was gobsmacked. This unit reports chronic lung disease rates of 11% in this population.

How can this be? The unit I practice in has of yet had little success with those infants of 22 weeks gestation and a chronic lung disease rate of 50% in the 23-week gestation strata. Our chronic lung disease rates in higher gestational age groups are considerably better, giving an overall rate of approximately 9%. This number is impressive in itself, given the number of micro-premature infants we treat, but the Iowa data is humbling.

What are we doing wrong? When it comes to premature infants, we know that all are not created equal, and the degree of pulmonary maturity dictates our approach to ventilation. Since resuscitation has only recently been offered to those infants of less than 23 weeks gestation and discouraged until recently at 23, we have limited experience and data in this group. Our approach to their ventilation to date has been the same as those of 24-25 weeks gestation. Perhaps this is the first mistake we are making.

For decades we have been advocating an "open lung" approach to ventilation, aiming for full recruitment. Even here, there is disagreement as to what that is. In conventional ventilation, ten ribs of lung inflation is considered "hyperinflated"; however, this should not be considered hyperinflation when ventilating with a high-frequency mode. Sheer forces with high-frequency ventilation are considerably less than those imposed by conventional ventilation. (This assumes the chest film is relatively clear and not hazy, indicating under-recruitment or gas trapping. Simply counting ribs is an inadequate measure of proper recruitment.)

What about the 22-23 week gestation lung? We have been using the same targets in this population as the rest of our patients, aiming for ten ribs of inflation in high-frequency modes. We know that the lung is not as developed at this age as the "older" infant. There are fewer alveolar ducts to recruit, and the conducting airways are fragile. Alveolar duct formation and later alveolar development do not happen all at once. Instead, they develop more like flowers on a plant that appear in stages. The terminal bronchioles and alveolar ducts are capable of some gas exchange. The challenge here is to provide enough minute volume to support gas exchange without damaging the lung structure and inhibit the alveolar duct and subsequent alveolar development. This process is a challenge as a mountain of evidence shows that mechanical ventilation interferes with pulmonary development (this may not be as severe with high-frequency jet ventilation) (1) as does oxidative stress, two factors that are unavoidable at this gestational age.

"We know that the lung is not as developed at this age as the "older" infant. There are fewer alveolar ducts to recruit, and the conducting airways are fragile. Alveolar duct formation and later alveolar development do not happen all at once."

Iowa reports using PEEP as low as 5 cmH_2O in 22-23 week gestation patients, a number most of us would consider too low. But is it? Could it be that this relatively low level of PEEP is enough to maintain airway patency in these patients without creating microtears and resulting air leak? Are we asking for more inflation than the lungs can provide? Could we be creating chronic lung disease in the pursuit of lung-protective ventilation? This practice is the

standout difference between ventilation of these infants in Iowa with their management in the NICU I practice in. The difference in pulmonary outcomes is difficult to dismiss.

There is more. We have all been conditioned to consider ventilation with an endotracheal tube to be bad and, as a result, aim to extubate even the smallest babies at the earliest opportunity. I have stated before the relative success with early extubations depends in no small part on the level of expertise when invasively ventilating as well as the use of adequate CPAP levels post-extubation to maintain recruitment. As a result, it is not uncommon to extubate the extremely premature infant after a week or so of ventilation. Perhaps this, too, is a mistake.

"As a result, it is not uncommon to extubate the extremely premature infant after a week or so of ventilation. Perhaps this, too, is a mistake."

Iowa does not practice early extubations when treating these infants; they are not left to struggle on CPAP in high FiO_2, something that in and of itself may be more harmful than gentle, lung-protective ventilation. The role of oxidative stress in pulmonary development is well known, producing smooth muscle hypertrophy, reactive airways disease, and altering alveolar development. (2) Interestingly, the main interface for non-invasive support in Iowa is the good old fashioned nasal pharyngeal tube (NPT), a standard endotracheal tube cut at approximately 4 cm with a standard 15 mm connector attached to a ventilator circuit. (In my experience, there are fewer issues with nasal bridge or septal breakdown with the NPT).

As a long-time proponent of high-frequency ventilation and high-frequency jet ventilation in particular, it made sense to me that Iowa also utilizes high-frequency jet ventilation as their primary form of invasive ventilation. It has been suggested that high-frequency jet ventilation allows for somewhat normal apoptosis and pulmonary development. A study by Dr. Dick Bland and Dr. Kurt Albertine showing this was presented at the Snowbird conference in 1999; however, that study was never published. (3)

"Third generation oscillators with volume targeted options are to date unavailable in the United States. It remains to be seen whether or not volume targeted oscillation would result in similarly better outcomes when compared to high-frequency jet ventilation."

Third generation oscillators with volume targeted options are to date unavailable in the United States. It remains to be seen whether or not volume targeted oscillation would result in similarly better outcomes when compared to high-frequency jet ventilation. I suspect there is some benefit here, but the tiny radius of the 22-23 week gestation infant greatly attenuates the oscillatory waveform—physics favour high-frequency jet ventilation in these infants, in my opinion.

It is difficult to extract a single practice from a unit with successful outcomes and apply them alone in another setting. Ventilation is no exception; there are so many local variations, even within the scope of a study that replicating results can prove difficult. With high frequency ventilation, even the user may affect the outcome. The "gentle resuscitation" approach from Cologne, Germany comes to mind, as does Dr. Roberta Ballard's study on inhaled nitric oxide to prevent chronic lung disease; the whole is indeed greater than the sum of the parts.

"Ventilation is no exception; there are so many local variations, even within the scope of a study that replicating results can prove difficult. With high frequency ventilation, even the user may affect the outcome."

Several other Iowa practices stand out. Not using humidity is one. Instead, their approach uses high total fluid intakes to counter insensible losses and aims for more rapid skin keratinization. This approach seems to reduce the incidence of sepsis. This makes sense because very humid environments are breeding grounds for pathogens, and sepsis is one of the biggest contributors to mortality and poor outcomes. (3)

In this column, I have stated before that one's NICU ventilation toolbox is incomplete without the availability of high-frequency jet ventilation. I believe "the Iowa way" gives credence to this view.

Perhaps when dealing with 22-23 weeks gestation, it's the Iowa way or the highway! It is, after all, difficult to argue with success.

References:

1. *16th Annual Snowbird Conference on High-Frequency Ventilation of Infants and Children program agenda.*
2. https://www.hindawi.com/journals/omcl/2016/2768365/
3. https://www.ncbi.nlm.nih.gov/books/NBK531478/

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.

NT

Corresponding Author

Rob Graham, R.R.T./N.R.C.P.
Advanced Practice Neonatal RRT
Sunnybrook Health Science Centre
43 Wellesley St. East
Toronto, ON
Canada M4Y 1H1
Email: Rob Graham <rcgnrcp57@yahoo.ca>
Telephone: 416-967-8500