

# Respiratory Report: the Outborn Micro-prem: A Horse of a Different Colour

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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.*

TA common lament amongst NICU respiratory therapists and nurses is "Oh great! Another outborn." Premature infants born in a tertiary setting do not fare as well as those born in a facility offering level three care.

During the thirty years in which I have been managing the ventilation of premature infants, I have seen many changes, advancements, and a volley of smaller and smaller patients. While one might assume improvements in all aspects of neonatal care would make clinicians' work easier, the continued pushing of the envelope has resulted in a net-zero effect on workload. Frequently it has resulted in increasing that workload. As population increases as infants of increasingly lower birth weights and gestation age are offered resuscitation, the number of NICU admissions and the acuity of patients grows.

There are many living their lives thanks to the advancements in neonatology, and we can be justly proud of that fact. Chronic lung disease (CLD) rates have continued to improve. However, there is a sub-set of our patients who are less likely to benefit from technical and clinical advances: those born in a tertiary setting. (1,2)

Some of the reasons behind the poorer outcomes of these babies are lack of available technology, outdated clinical practice, demographics, socioeconomic, and the transport process. Each plays a part.

## Technology

Typically in Canada, hospitals that do not have specialised paediatric services or care for premature infants in house often do not have dedicated neonatal equipment such as ventilators or access to special modes, such as oscillation (HFO) or high-frequency jet ventilation (HFJV). Although there are adult ventilators with a neonatal mode (some even offering volume targeted ventilation), these are not ideal for the extremely premature. Volume targeted ventilation is a good thing but may lead to a false sense of security, particularly when recruiting the immature lung. It is worth noting that ventilating at 4 ml/kg volume is equivalent to using 8 ml/kg if the lung is only half recruited.

The transport to a proper facility is an additional source of potential difficulty. While there are some very well-equipped transport services that offer HFO, nitric oxide, and even HFJV, some teams operate with antiquated equipment, with only non-triggered and/or non-volume limited ventilation available. The latest, most modern transport ventilator offers volume control among but HFO mode is yet to be certified. It is my strong belief that the premature lung is not optimally served by conventional ventilators, and the longer it is subjected to conventional ventilation, the more damage is

likely to occur. Transport incubators often lack humidification and struggle to maintain a thermoneutral environment which resulting in hypothermia (particularly in colder climates) that is known to affect outcomes adversely.

## Clinical Practice

Many tertiary hospitals are staffed by paediatricians rather than neonatologists, and they are not always in house. Paediatricians have neonatal training, but this training and knowledge deteriorates. "PEEPaphobia" (3) continues to exist in NICU's despite evidence showing its damaging effects. Those removed from the specialty are likely to suffer from this affliction. Without adequate PEEP premature lungs are even more prone to gas trapping and iatrogenic injury.

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Surfactant has been a standard treatment for premature infants for almost 30 years, yet there are still hospitals that, for whatever reason, do not give it or wait for the transport team to arrive before it is given. This compounds the problem since, without surfactant, the lung is stiff and prone to collapse; higher pressures are required to ventilate, and insufficient PEEP exacerbates the problem.

In this regard, there are also transport teams that operate under rigid, dated protocols in relation to PEEP. I often lament PEEP set at 5 cmH<sub>2</sub>O on a baby with a FiO<sub>2</sub> of 40% or more. It is not my intent to denigrate transport teams; I am well aware they play the hand that they have been dealt and play it as well as possible.

Antenatal steroids are routinely given to mothers in preterm labour, although it is only recently that evidence supports their use in the sub-25-week gestation population. (4) This important treatment may not be given in a tertiary setting, or there may be insufficient time prior to delivery for it to be effective. This makes ventilation even more challenging for the clinician at the receiving end.

Finally, there may be respiratory therapists in house, but when confronted with a premature baby, there is often abject terror. Most respiratory therapists have a NICU rotation, but it is not long enough to achieve competency in the field and is quickly forgotten through lack of exposure to this patient population.

## Demographics

Specialty services like neonatology are typically located in larger, urban centres. There are two reasons for this: higher population density means more premature deliveries are likely, and the high costs involved equipping a level three NICU. A woman in premature labour is not likely to consider the facilities available at a hospital. Even in urban centres it is not uncommon for women in premature labour to head to the nearest facility instead of one properly equipped and staffed to handle the situation. In a suburban or rural setting, this is a given, and outcomes are significantly worse in this case. (4) The longer a premature infant must be transported to an appropriate facility, the more detrimental that trip is likely to be.

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### **Socioeconomics**

Studies indicate a significant correlation between maternal education and the risk of premature birth, but a similar correlation between income and preterm birth has been more elusive. (5) Smoking has been linked to lower levels of education and, perversely, income. As smoking is a known risk factor for low birth weight and premature birth (7), it may be difficult to separate income and smoking as risk factors. A population-based study out of Missouri found a moderately increased risk of preterm birth in areas with the highest poverty levels. (8) Other studies have failed to identify this as a risk factor. Denmark, for instance, failed to identify income as a major factor. (5) This may (or may not) be reflective of the American health care system compared to countries with free universal health care. It is a fact that the poor are less likely to seek medical attention where free universal health care is not offered, and are more likely to have limited or poor antenatal care. For instance, the rate of inadequate antenatal care in Canada is 18.9% compared to 25% in the U.S. New Canadians, first-time mothers, drinkers, and smokers are less likely to receive (or seek) antenatal care while those whose pregnancies are managed by their family physician are more likely to receive recommended care. In the U.S. African American (32%), Native Americans, and Alaskan Native women (41%) are less likely to receive recommended care. (9,10)

Socioeconomics also plays a role after discharge from NICU. Neurodevelopmental morbidities are costly to deal with not just for the family but also for the educational system and society at large. These morbidities are most successfully treated with early remedial action and extensive parental involvement, but must first be identified. Those who struggle to put food on the table are clearly less able to devote time to the needs of the child. Those without the financial resources and family support are not as likely to seek a diagnosis than the more affluent. Even where a socialised medical system, infants born to those of low socioeconomic status are most likely to have poor outcomes, a classic “catch 22”. (12)

### **The Transport Process**

Premature infants are fragile and as such, are far more prone to being harmed by environmental factors, particularly in the hours

following birth. Aside from pulmonary issues, intraventricular hemorrhage (IVH) and hypothermia are common. While every effort should be made to have premature babies delivered where level three care is readily available, this is often not possible. Noise, positioning, less than ideal ventilation and cold stress are all more likely to contribute to morbidities in the outborn, resulting in more IVH and CLD than those born in house. (11) Where these babies are transported to and who does the transporting also play a role. Those taken to a neonatal facility rather than a general children's hospital and those retrieved by a specialised team fare better. (13,14)

Now what?

You may be asking what this to do with respiratory care?”. While respiratory therapists' primary focus is the pulmonary system, navel-gazing leads us to forget the impact our care has on other systems and pathologies and, just as importantly, families. Poor respiratory outcomes bode poorly for every other outcome measure, something that should always be kept in mind. The needs of our patients do not magically disappear after discharge. Knowing the risk factors and susceptibilities of outborn infants should help guide clinicians in managing their ventilation as well as other care.

It is my opinion that outborn micro-prems should be ventilated as gently as possible to mitigate the inflammatory response triggered by ventilation in transport and initial management at the referring hospital. I prefer to place these babies on HFJV immediately on arrival if they are near 25 weeks gestation or less, or have had high ventilatory requirements during transport. Since their airways are more likely to have micro-tears, they are more prone to air leak; something HFJV is well suited for. Older, less acute babies may be placed on HFO, and sometimes I find can be extubated on arrival or soon thereafter.

While I am not a big fan of steroids, they do have their place and are sometimes necessary. Early use of hydrocortisone may be of particular benefit in this group of patients. An ounce of prevention? Perhaps. The caveat here is that steroids cannot be given with indomethacin; hence, indomethacin prophylaxis cannot be offered. (14) Prophylactic indomethacin remains somewhat controversial, but recent data suggest a positive impact not only on the instance of patent ductus arteriosus (PDA) but CLD as well. (15) The increased risk of CLD in outborns may favour the use of hydrocortisone in this population, but data is lacking regarding the use of either hydrocortisone or indomethacin in this subgroup. It is difficult indeed to choose between a rock and a hard place, but the increased risk of intestinal perforation and necrotizing enterocolitis in outborns may lead clinicians to prefer hydrocortisone (16). (Is that the rock or the hard place?) Administering budesonide combined with a surfactant may circumvent this problem, but more study is required regarding the efficacy and to determine if risks associated with concomitant administration of steroids and indomethacin remain using this method.

One must recognize that an infant who has not received antenatal steroids is not the same as one who has and must be managed accordingly. Because HFJV offers a combination of gentle ventila-



tion, excellent CO<sub>2</sub> clearance, and reduction of air trapping without exacerbating air leak makes it the go-to mode in a patient population whose ventilatory management is challenging.

If an ounce of prevention is worth a pound of cure, then the way we manage expectant mothers in preterm labour could use an overhaul. The current approach of getting the baby to an appropriate facility once delivered necessitates the whole transport process, even if a specialised team arrives prior to delivery. In my opinion, a better approach would be to avoid the transport process entirely. Telemedicine is underutilised and could be very helpful to those in a tertiary facility managing less acute prems. If the state of the art equipment is available to the referring centre, then consultative management during the critical first 72 hours may be an option. The best scenario would involve a highly specialised team, and a mobile operative delivery suite /neonatal resuscitation room sent to the facility instead of the other way around, a medical “SWAT” team if you will. (At least dreams are free!)

Delaying transport until the risk of IVH is decreased itself should improve outcomes. Economic constraints may make this difficult, but if such an approach improves outcomes, the cost would later be recouped. If the team is not linked to any particular facility but rather is part of a larger regional system, then costs associated with duplication of effort could be eliminated. We focus on immediate costs associated with the NICU stay; we forget the later cost associated with morbidities, not just in expense to the health care system, but the patient’s quality of life. That cost is beyond what can be measured in dollars and cents.

Provided I can liaise with Dr. Paige Church, who specialises in neonatal follow-up and developmental care, next month’s focus will be on the impact of bedside care and ventilatory management on neurodevelopment and how we can reduce the impact of what we do on developmental outcomes.

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