American Association for Respiratory Care's

Neonatal Pediatrics Bulletin

July / August 2002

Notes from the Co-Editor

by Melissa K. Brown, RCP, RRT

Many of you may have noticed some changes to the "Neonatal Pediatric Bulletin" starting with our last edition. Not only did we change the name of our newsletter, but the format has changed as well. To keep the content pertinent, but to the point, we are striving to keep our articles shorter. The "Bulletin" will be no more than four pages and will generally include one column, two articles, and some news that affects our profession.

We have two excellent articles in this edition. In the first, Kim Bennion and Julie Ballard of Primary Children's Medical Center (PCMC) in Salt Lake City summarize their findings after nine years of utilizing a bronchiolitis treatment protocol. The PCMC team has produced many Open Forum abstracts on this topic, and when I visited the facility earlier this year, their department hallways were lined with past posters. I was overwhelmed by the shear number of abstracts this group has presented, the quality of the work, and the variety of authors. Again, my kudos go out to everyone at PCMC!

Primary Children's is one of a group of children's hospitals that has been evaluating bronchiolitis therapies, the patient's response to those therapies, and outcomes. It is not surprising to those of us who work with these patients that very few patients at the participating hospitals actually responded to albuterol treatments. Hydration, oxygen, and suctioning are the interventions which are necessary and have been documented to be beneficial.

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A Bronchiolitis Treatment Protocol: A Nine Year Review

by Kim Bennion, BS, RRT, and Julie Ballard, BS, RRT, Primary Children's Medical Center, Salt Lake City, UT

Patients with respiratory disease (asthma, bronchiolitis, and/or pneumonia) are the largest admissions category at Primary Children's Medical Center, a standalone pediatric facility of Intermountain Health Care (IHC) in Salt Lake City, UT. Approximately ten years ago, we realized there was considerable variation in the utilization of respiratory care and monitoring of these patients. Most of this variation occurred outside the intensive care units and was considered a possible reason for unnecessary admissions, excess charges, and poor quality patient care.

A three-day retreat was scheduled for physicians, respiratory therapists, nurses, and financial analysts. Problems, concerns, and the latest research were reviewed. Clinical practice guidelines (CPGs) with a symptom-based score were developed by the multidisciplinary group using science-based practice. This meeting led to the eventual implementation of CPGs for the administration of aerosolized bronchodilators, chest physiotherapy (CPT), continuous pulse oximetry, and the care of bronchiolitis patients.

We define our "respiratory season" as November 1 through April 30 of the following year. While the bronchiolitis guidelines went into effect in the 1996-1997 season, very little, if any, progress was seen. A shared responsibility was adopted that year wherein RTs and RNs shared the delivery of high volume-low acuity therapies (i.e., aerosolized bronchodilator therapy, CPT, MDI, O_2, and pulse oximeter utilization). Despite a rather exhaustive attempt by the RC clinical supervisors to educate the nursing staff, little or no progress was made to standardize care or define patient severity or response to therapy. The responsibility for CPT was returned to RC when it became apparent that it was a challenge for nursing to remain proficient in an infrequently performed therapy.

In November of 1997, we implemented a specially trained, multidisciplinary care assessment team known as the Quality Care Assessment Team (QCAT). RT's assess patients daily outside the intensive care units who have respiratory needs or orders, meet with nurses and physicians, and develop care plans. RC team members also serve as instructors for the following courses: Asthma Education (taught six days a week), General Nursing Orientation, PALS, NRP, BLS, Pediatric Resuscitation (an IHC-developed resuscitation program for non-ICU nurses), and ongoing unit specific nursing and physician in-services.

We believe care effectiveness is best determined by measured outcomes. Our data over the past several years have produced numerous abstracts, which have been presented at Open Forums during the AARC International Respiratory Congress, and we are currently in the process of writing a manuscript.

A comparison of 1996-1997 (prior to QCAT implementation) and 1997-1998 (QCAT Team in place and functioning) seasons produced the following outcomes (internal, unpublished data):

1. Decrease of 38% in overall bronchodilator use.
2. Decrease of 34% in continuous pulse oximeter utilization.
3. Decrease of 28% in CPT utilization.

In addition, a convenience sample of 91 bronchiolitic patients who had a floor trial of albuterol on admission found only 17 (19%) had a positive response to therapy. Of the non-responders, 81% had no further treatment with albuterol. Prior to the use of practice guidelines on protocols, 85% of patients went on to have scheduled albuterol treatments, even when no response was documented.

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A BRONCHIOLITIS TREATMENT PROTOCOL: A NINE YEAR REVIEW

During the 1999-2000 respiratory season we found no shorter length of stay at two other IHC hospitals that were caring for a comparable number of bronchiolitic patients and delivering routine albuterol and/or CPT when compared to PCMC length of stay in this population.

The debate continues regarding the efficacy of respiratory interventions in bronchiolitis care. We use a respiratory symptom based bronchiolitis scoring system that helps to determine effectiveness of care and severity of illness. This system evaluates and assigns scores to each patient based on the respiratory rate, breath sounds, and retractions. Scores are classified as follows: 0-1 normal, 2-3 mild distress, 4-6 moderate distress, and 7-9 severe distress. An improvement is defined as a decrease in the bronchiolitis score by > 1. With the use of this bronchiolitis scoring system, we try to objectively determine which, if any, interventions result in patient improvement.

Data from both our 1999-2000 and 2000-2001 seasons showed that suctioning the nares using a catheter obviates the need for further treatment with albuterol. (The interaction of nasopharyngeal [NP] suction and albuterol in the treatment of bronchiolitis: a two-year comparison [abstract]. *Respir Care 2001*;46(10):1072.) Results were as follows:

	IMPROVED POST TX		NO CHANGE POST TX		WORSENED POST TX	
	99-00	00-01	99-00	00-01	99-00	00-01
IMPROVED POST SXN	9 (5)	10 (8)	70 (42)	58 (35)	9 (5)	18 (11)
NO CHANGE POST SXN	13 (8)	20 (12)	54 (32)	43 (26)	5 (3)	7 (4)
WORSENED POST SXN	4 (2)	6 (3)	2 (1)	4 (2)	0 (0)	1 (1)

DATA ARE REPORTED IN NUMBERS OF PATIENTS AND PERCENT.

Further support for NP suction use in the care of bronchiolitis patients can be noted in:

1. The effect of NP suctioning on symptom scores in bronchiolitis patients (abstract). Respir Care 2001;46(10):1071.
2. The association between NP suctioning and oxygen requirement in bronchiolitis patients (abstract). *Respir Care 2001*;46(10):1071.

All patients at our facility are classified in a severity category (1 through 4, lowest to highest) based on diagnostic and procedural coding using the All Patient Refined-Diagnosis Related Group, Severity of Illness (SOI). Over the past four years, we have observed the following increase in SOI in our bronchiolitis patients.

1. 1997-1998 season: SOI-1 (68%), SOI-2 (22%), SOI-3 (7%)
2. 2001-2002 season: SOI-1 (36%), SOI-2 (51%), SOI-3 (12%)

Despite an increase in SOI, and in the face of inflation, through the use of this protocol we have been able to keep length of stay to an average of 72 hours, hospital costs steady at $3,200 per case, and charges averaging $4,400 per case for the past five years. We also report a steady decrease in the number of patients incurring any ICU charges, down from 20% in 1996-1997 to 12% in the 2001-2002 season.

Care of the bronchiolitis patient continues to center around relieving symptoms. Hydration, oxygenation, and suction have become our mainstays. Based on current literature and our own experience, bronchodilators are effective in only 17%-20% of patients, and CPT is not only ineffective but may in some cases even be detrimental, causing episodes of desaturation.

With the increase in severity of illness and thus increased bronchiolitis scores, we have introduced the use of CPAP via mask/prongs. Preliminary results have produced a marked reduction in the bronchiolitis score and thus an alleviation of symptom severity, most appreciably by decreasing respiratory rate and retractions, and improving aeration. ◆

Hypoplastic Left Heart Syndrome: Altering Inspired Gases

by Durinda Mullins, RRT, St. Louis Children's Hospital

Infants born with hypoplastic left heart syndrome present practitioners with several clinical management problems, one of which is maintaining adequate systemic blood flow. In this syndrome, systemic blood flow is dependent on shunting blood from the pulmonary to systemic circulation, usually through a patent ductus arteriosis.[1]

Maintaining pulmonary ($\dot{Q}_p$) and systemic ($\dot{Q}_s$) blood flow at a ratio of 1:1 is critical to the survival of the patient. Low pulmonary vascular resistance may increase pulmonary and decrease systemic blood flow, resulting in hypotension, metabolic acidosis, and organ damage such as liver failure, necrotizing enterocolitis, and cerebral ischemia. High pulmonary vascular resistance may result in systemic hypertension and hypoxemia.[2]

Manipulating pulmonary vascular tone to achieve a $\dot{Q}_p$:$\dot{Q}_s$ of 1:1 can be done by altering inspired gases to achieve alveolar hypoxemia or respiratory acidosis.[3] By adding nitrogen to inspired gas, the patient can be given less than 21% oxygen, causing hypoxemia; and by adding carbon dioxide to inspired gas, the clinician will create a respiratory acidosis. (It is unknown if respiratory acidosis caused by inspiring carbon dioxide with a high minute ventilation is more or less beneficial than respiratory acidosis caused by hypoventilation.)[3] There are no data that support the use of one of these techniques over the others.[2]

Hypoxic gas mixtures

Delivering a hypoxic gas mixture to the patient can be accomplished in three ways: bleeding nitrogen into the inspiratory limb of the ventilator circuit, replacing compressed air to the ventilator with nitrogen, and replacing oxygen to the ventilator with nitrogen. With any of these systems, an oxygen alarm with tightly set parameters is an absolute requirement. Close monitoring of tank psi and gas consumption is a must. If the patient room/bedspace is not close to the nurses' station, some type of remote alarm may be used.

Bleed in: The ventilator FiO_2 is set at 21% and nitrogen from a tank is bled into the inspiratory limb of the circuit. The oxygen analyzer should be placed 6-12 inches after the bleed in point to allow mixing of gases before analyzing. Nitrogen should be slowly increased until the desired FiO_2 or SpO_2 is reached. The nitrogen tank will last the longest with this set up. Any change in ventilator parameters will alter the FiO_2, as will a spontaneously breathing patient on a demand valve ventilator. If the nitrogen tank should run out, the patient would receive 21% oxygen.

Replacing compressed air to ventilator: The ventilator compressed air hose is plugged into the nitrogen tank. Setting the ventilator blender at 38% will yield 21% oxygen; the blender is decreased until the desired FiO_2 or SpO_2 is reached. This set up allows for the delivery of FiO_2s greater than 21% if necessary, but if the nitrogen tank should run out, the patient will receive 100% oxygen.

Replacing oxygen to the ventilator: The ventilator oxygen hose is plugged into the nitrogen tank. Setting the ventilator blender at 100% will yield 21% oxygen; the blender is decreased until the desired FiO_2 or SpO_2 is reached. FiO_2s greater than 21% cannot be given with this system, but if the nitrogen tank should run out, the patient would receive 21% oxygen.

Inspired carbon dioxide

Adding carbon dioxide to a patient's inspired gas can be done in two ways: bleed in and premixing gas to the ventilator. With either set up, a CO_2 monitor capable of doing steady state (not end tidal) CO_2 measurement with alarms will allow for precise adjustment of inspired carbon dioxide. Patients receiving inspired carbon dioxide may attempt to increase their minute ventilation to normalize their PCO_2, and sedation and/or muscle relaxation may be required.[3]

In a compressed gas cylinder at room temperature, carbon dioxide is in a liquid-gas interface, and the pressure manometer on the regulator measures the vapor pressure of the gaseous carbon dioxide over the liquid carbon dioxide. Thus, the pressure reading will only begin to decrease when all the liquid carbon dioxide has become gas — when the tank is nearly empty. A spare cylinder with a regulator attached should be at the bedside of patients receiving inspired carbon dioxide for rapid tank changes.

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New Studies Look at Neonatal Intensive Care

Two new studies from Dartmouth Medical School investigators question whether the resources devoted to neonatal intensive care in the United States provide better outcomes

The first report, published in the May 16 issue of *The New England Journal of Medicine*, found that the availability of newborn specialists - which varies widely across the country - correlates poorly with improved survival. After adjusting for factors associated with greater risk of death, such as birth weight or prenatal care, investigators found no difference in the mortality rate once the supply of neonatologists exceeded the "very low" supply category. Low supply regions - with 4.3 neonatologists/10,000 births - had the same death rate as the highest supply regions - those with 11.6/neonatologists/10,000 births.

The second study, published in the June issue of *Pediatrics*, found premature infants born in the U.S. have similar survival rates as those in other developed countries, despite unrivaled resources devoted to neonatal intensive care in this country. The study analyzed reproductive, prenatal, and postnatal care in the U.S., Australia, Canada, and the United Kingdom. ◆

Viasys Sponsors Professor's Rounds Program

Viasys Healthcare sponsored the third program in this year's series of Professor's Rounds videoconferences offered by the AARC. The session "Neonatal and Pediatric Ventilators: What's the Difference?" featured Mark Heulitt, MD, FAAP, FCCP, who provided participants with an excellent overview of the issues and concerns regarding these ventilators. Moderating the program was Richard Branson, BA, FAARC.

A video of the session is available at the AARC store at store.yahoo.com/aarc.

By the time you read this notice, there will be only three live teleconferences left this year:

- Pressure Versus Volume Ventilation: Does It Matter?: September 10
- Inpatient Management of COPD: October 22
- High-Frequency Oscillatory Ventilation: November 19

Sign up for any or all of these informative programs at www.aarc.org. ◆

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NOTES FROM THE CO-EDITOR

Kim and Julie also mention the use of CPAP via mask/prongs in this patient group. Unfortunately, CPAP is often listed in the literature as contraindicated for bronchiolitis. I, personally, have found NCPAP to be extremely beneficial for bronchiolitis and have found it will usually prevent an intubation. A couple of years ago, I presented at the AARC Open Forum on the benefits of NCPAP and heliox combined to prevent intubation in bronchiolitis. Kim and I discussed this treatment at the Forum, and I strongly encourage the use of NCPAP for intubation prevention. This is a great topic for a randomized controlled trial, as there is only one good study in the literature documenting the benefit of NCPAP to prevent intubation in bronchiolitis and there is also mounting evidence on the effectiveness of heliox for the severe bronchiolitis patient in the ICU.

Kim and Julie also make a great case in their article for the use of RTs as decision makers on a dedicated assessment team for patients outside the ICU!

In the second article, Durinda Mullins, of St Louis Children's Hospital, provides us with a comprehensive description of the methods available to deliver specialty gases, such as nitrogen and carbon dioxide, to infants with cardiac disease. If you work in a unit that infrequently utilizes these set-ups, it can be difficult to identify the superiority of one technique over another. Thanks Durinda, for a well-done synopsis and for sharing your expertise! ◆

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HYPOPLASTIC LEFT HEART SYNDROME: ALTERING INSPIRED GASES

Bleed in: Carbon dioxide is bled into the inspiratory limb of the ventilator circuit. The steady state CO_2 monitor should be placed 6-12 inches after the bleed in port to allow mixing of gases before analyzing. Any change in ventilator parameters will alter the level of inspired carbon dioxide, as will a spontaneously breathing patient on a demand valve ventilator.

Premixing gases: Carbon dioxide and oxygen are mixed together using a Y adaptor; this gas mixture is introduced into the low pressure gas inlet of a Servo 900. This allows for a constant amount of carbon dioxide to be delivered to the patient regardless of any ventilator changes or spontaneous breathing. Carbon dioxide gas consumption with this set up is much higher than with a bleed in set up, and the carbon dioxide tank will run out much sooner.

Each of these altered gas mixtures has benefits and drawbacks; choice of mixture will depend upon physician preference and what equipment is available in each institution. ◆

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