Perinatal-Pediatrics Bulletin
May/June '01

American Association for Respiratory Care

Notes from the Chair

by Timothy R. Myers BS, RRT

By the time this edition of the *Bulletin* reaches you, the summer season will be well underway. Unfortunately, this season is also known as "Trauma Season" at many Children's Hospitals across the country. The mix of sunny days and warm weather coincide with an increase in motor vehicle accidents and near drownings. This is also the time of year that most Children's Hospitals have an increase in surgical activity. Given these facts, I think you'll find Jenni Raake's article on summertime injuries particularly enlightening.

As I write this column, however, it is still spring, and I have just returned from Sao Paulo, Brazil, where Rich Branson and I were invited to speak at the Sirio-Libanes Hospital System's 5th International Course on Fisiotherapy. That's right — fisiotherapy (and not "physiotherapy," as you might expect)! In Brazil, there are no "traditional" respiratory therapists in the hospital setting. Instead, one group handles the roles and functions of both respiratory and physical therapy and are known as fisiotherapists. The practitioners at the Sirio-Libanes Hospital do not provide care for neonates, but they do provide pediatric care and cardiothoracic surgery to newborns — although they do not have a separate ICU for these patients. It was most interesting to observe a 3-kilogram post-operative cardiothoracic patient in their ICU in a bed space between a 30ish trauma patient and a 70ish COPD patient with pneumonia. Our hosts explained to us that their hope and desire is to develop a PICU in the next 3-5 years.

Approximately 400 fisiotherapists were present at the Conference, and were most interested in the management and care provided to neonatal/pediatric patients by respiratory therapists in the United States. The Conference organizers were particularly interested in the neonatal/pediatric topics of asthma, specialty gas delivery (heliox, nitric oxide, and subambient), care of children with tracheostomies, and airway clearance. Rich Branson was cornered by a number of fisiotherapists also interested in humidification techniques used with children in the United States. I hope in the near future to convince one of the fisiotherapists I met in Brazil to write a short article for the *Bulletin* describing their role in the care of neonatal/pediatric patients.

As many of you are aware, every year the Specialty Sections honor a Specialty Practitioner of the Year (SPOY) at the Awards Ceremony during the International Conference. As the nomination deadline for Perinatal/Pediatric SPOY approaches, I encourage all members to start brainstorming names of worthy candidates and submitting nominations. A nomination form can be found on the AARC's web site (www.aarc.org), or you can simply mail, email, or fax your nominations to me at the addresses/numbers listed on page 2. A committee of volunteers has been assembled to assist with the selection of our SPOY. These individuals will be identified in an upcoming edition of the *Bulletin*. ■

Notes from the Co-Editor

by Doug Petsinger, BS, RRT/RCP IV

Thanks to some terrific contributions from some exceptional authors, we have put together another great *Bulletin*. I would like to thank Jenni Raake, Frank Rando, Jan Dodd, Mary Rumbo, and Wade Rich for their excellent and informative articles. I also would like to applaud Jenni Raake on her abstract for the 30th International Educational and Scientific Symposium of the Society of Critical Care Medicine, "Supplemental Inhaled Gases Do Not Alter Delivered Tidal Volume But Cause A Marked Inaccuracy In Ventilator Expired Tidal Volume Measurements." This abstract helped me figure out how to deliver carbon dioxide (CO_2) with a Servo 300 without having to utilize a double blender method. Bleeding CO_2 into the circuit does give peaks and valleys of the % CO_2, which ranges about 1.0 to 1.5%. I do believe that with nitrogen (N_2) ventilation you have better control of the FiO_2 by powering the oxygen side of the blender with N_2.

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I would also implore everyone to give Frank Rando's article on "Childhood Cancer: Childhood Brain Tumors and the Environment" (Part One in this issue, Part Two in the next) a serious read. I realize that, as a cancer survivor myself, I am sensitive to issues concerning cancer, but we all need to be more aware of this horrible disease so that we can minimize the risks for our children. ■

From Adult to Peds: *An Incredible Journey*

by Jan Dodd, BS, RRT, Children's Healthcare of Atlanta, Sibley Heart Center, CICU, Atlanta, GA

I graduated from Georgia State University in 1993 and since then have been fortunate enough to work with adult, neonatal, and pediatric patients. The first year after graduating I worked exclusively with adult patients. The second year I was introduced to pediatric and neonatal patients. My experience includes adult, neonatal, and pediatric intensive care as well as emergency room, general floor care, and labor and delivery. I now work full time for Children's Healthcare of Atlanta, Sibley Heart Center, in the cardiac intensive care unit.

One of the first observations I made upon entering the profession was that respiratory therapy is a diverse field, with a lot of opportunity available for RTs. But we have to recognize the opportunities that are available. For example, each patient population we work with requires learning about the unique problems associated with that type of patient and developing new skills or adapting old skills to fit a particular patient care situation.

I also learned that one of the worst statements or assumptions that can be made is, "Neonatal and pediatric patients are just small adults." There are several differences between these patient populations, both obvious and subtle.

Size is, of course, one of the most obvious differences. In the adult population, the RT can most often assume the endotracheal tube will be size 7.0mm to 8.5mm. The laryngoscope blade will usually be a size 3 or 4 Macintosh or Miller, and the handle will be large. Neonatal and pediatric patients require a little more thought due to the large size variation between patients. Endotracheal tube size can vary from a 2.5mm to an adult size, such as a 7.5mm. The laryngoscope blade can range from a size 00 to an adult size, such as a 4 Macintosh or Miller. The laryngoscope handle can be large or small.

The actual size of the patient is also a major difference between patient populations. RTs who are comfortable with patients weighing less than 1000 grams may not be as comfortable with a patient who weighs 136 kilograms. Of course, the reverse is also true; adult RTs may not welcome the size of neonatal or even small pediatric patients.

Assessment skills are another factor to consider when caring for the adult, neonatal, and pediatric patient. First of all, the physiologic and laboratory normal ranges are different between patient populations. Second, an adult or vocal pediatric patient can say, "I hurt." Neonatal and smaller pediatric patients cannot vocalize their pain. The caregivers at the bedside have to work together to recognize pain in order to control pain. For example, a sign of pain may be an increase in respiratory rate, heart rate, or work of breathing. There are several factors that could cause these clinical changes, but pain also has to be a consideration. Pain control can become a challenge while weaning ventilatory support or while assessing the deteriorating arterial blood gasses of a nonverbal patient.

Adult, neonatal, and pediatric modes of ventilation can also be different. There are currently several modes of ventilation available, including synchronized intermittent mandatory ventilation in pressure or volume control, pressure control ventilation, continuous positive airway pressure, pressure regulated volume control, pressure control ventilation, high frequency oscillatory ventilation, and high frequency jet ventilation. Adults are generally ventilated with some form of volume ventilation. Pressure ventilation is usually reserved for extremely ill adult patients. Neonatal and pediatric patients can be pressure or volume ventilated. High frequency oscillatory ventilation and high frequency jet ventilation are usually reserved for the patients with air leaks or those requiring maximum support with a minimal risk of lung injury.

Choosing the correct ventilation mode may involve several different variables. These variables include patient size, diagnosis, and even which mode the facility is accustomed to using. It is sometimes easier to decide a tidal volume based on a patient's weight than it is to choose the correct peak inspiratory pressure. Pressure ventilation can require additional information, especially if the ventilator does not have an exhaled tidal volume monitor. Pressure ventilation requires close attention to several different parameters. These parameters include arterial blood gases, chest radiograph, chest rise, and hemodynamics. These parameters are also considered when volume ventilating, but with pressure ventilation the ventilator settings may not always be as clear.

Neonatal and pediatric patients can also be more difficult to take care of secondary to the social issues that may be involved. The stress and anger level of these families tends to be higher. Society as a whole does not expect a baby to be born sick or a child to be diagnosed with a potentially fatal disease. The diagnosis may be sudden and unexpected in these populations. A family may have a hard time accepting the fact that their child is sick, and the loss of a

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child means the loss of hopes and dreams. Some children may develop severe disabilities, forcing families to accept new or revised hopes and dreams for their children. Caregivers at the bedside have to deal with these issues. When an adult dies you often hear, "at least they lived a full life" or "at least they got to do these things." When children die you hear, "they will never get to do these things," or "they will never get to experience life."

Working with children and their families can be a "soul trying" experience. The health care team often becomes a part of these families. A family member was overheard saying, "You (the caregiver) sometimes comfort them (the patient) and they (the patient) sometimes comfort us (the family and the caregivers)." That's a profound statement for anybody in the health care field.

These differences between adult, neonatal, and pediatric respiratory care, along with many others, illustrate the diversity in the respiratory therapy profession. RTs have learned to apply the basic fundamentals of the profession to new patient care settings and illnesses unique to each group of patients. The ability to adapt has allowed RTs to become an integral part of the patient care management team. ■

Summer . . . Time for Fun and Time for Trauma

by Jenni L. Raake, BS, RRT

Summertime is here. The kids are out of school and they have plenty of time to play — usually outside, away from the watchful eyes of their parents. They also have plenty of time to get into mischief, and to get hurt. And some of them will suffer major, traumatic injuries.

For the last 20 years, injuries have claimed more lives of U.S. children than all other diseases combined. According to the National Trauma Registry, one in five children every year requires medical care for injuries. This translates into 16 million ER visits for the pediatric population (age 1 -19).

The top ten severe injuries among children include:

1. Pedestrian accidents (children hit by motor vehicles)
2. Drowning
3. Bike accidents
4. Falls from heights
5. Scald burns
6. Flame burns
7. Suicides
8. Assaults
9. Choking
10. Smoke inhalation

Most, if not all, of these traumatic injuries result in damage to the lungs, with great potential for the development of a pneumothorax, a hemothorax, or a hemopneumothorax. Traumatic pneumothorax results from blunt or penetrating chest trauma. Blunt trauma (closed pneumothorax) includes crush injuries and injuries from cardiopulmonary resuscitation, which may lacerate or bruise a lung (with or without rib fracture). Bullet and knife wounds are common examples of penetrating (open pneumothorax) traumatic injuries.

Signs and symptoms of a pneumothorax include: shortness of breath, chest pain, decreased breath sounds on the affected side, and subcutaneous emphysema. The patient will also exhibit tachycardia and tachypnea.

Sometimes these pneumothoraces develop into a tension pneumothorax, where air enters the pleural space and becomes trapped. Resuscitation efforts rely on manual (bag-valve) ventilation or mechanical ventilation, which can exacerbate a tension pneumothorax. The increased positive pressure in the chest can rapidly impair venous return, reducing cardiac output and shifting the mediastinum away from the affected side. Signs and symptoms may deteriorate into severe respiratory distress, hypotension, tachycardia, jugular vein distension, increased central venous pressure, and cyanosis. If a hemothorax is present, the patient is also at risk for hypovolemic shock.

In addition to acute lung injuries, the pediatric trauma patient is also at risk for developing acute respiratory distress syndrome (ARDS). ARDS is a disease characterized by an acute onset of pulmonary inflammation, increased capillary permeability, and severe hypoxemia. Some lung areas are atelectatic and consolidated while other areas appear normal.

According to Dr. Marita Thompson, a physician at Children's Medical Center of Dallas, the disease progresses through three phases: exudative, proliferative, and fibrotic. The exudative phase occurs over the first four days and is characterized by diffuse alveolar damage due to leaky alveolar epithelium and capillaries. Alveoli are filled with neutrophils, hyaline membranes, and protein rich fluid. The proliferative phase occurs during the next three weeks and is characterized by proliferation of type II pneumocytes, fibroblasts, and myofibroblasts into the alveoli. And finally, if lung injury progresses, the chronic phase develops. In this phase, the normal alveolar architecture is destroyed and replaced by collagen and fibrin.

Patient management involves mechanical ventilatory support and treatment of traumatic injuries. While mechanical ventilation is the primary therapy, it has also been known to contribute to lung injury. Lung protective strategies involving alveolar recruitment without alveolar damage are of utmost importance. Some ventilator strategies that have been successfully used in pediatric patients include high PEEP levels combined with low tidal volumes, permissive hypercapnia, and in some cases, high frequency oscillatory ventilation.

Additional therapies have been used as well, including inhaled nitric oxide, which has been approved by the FDA for use in neonates with pulmonary hypertension. Unfortunately, it has not been shown to decrease either mortality or duration of mechanical ventilation in ARDS.

ECMO is usually the last modality available to treat ARDS. ECMO allows the lung time to recover without further barotrauma from mechanical ventilation. Aggressive pediatric critical care using these treatments has helped decrease the mortality from 90% to its present level of 40-60%.

Finally, prevention is perhaps the ultimate treatment for traumatic injuries. Prevention involves identification of common factors of traumatic injuries. Of the over 26,000 injuries that were reported in one calendar year, the following information was obtained:

Who is injured most often?

Boys have a higher rate of injury. In fact, they are injured twice as often as girls.

What age group is injured most often?

Children age 5-9 are most often the victims of traumatic injury. Toddlers ranging in age from 1-4 years constitute the next largest group to suffer injuries. Preteens (ages 10-14) suffer traumatic injuries more frequently than teenagers, who are injured least frequently.

When do injuries occur?

Most injuries occur between noon and midnight. This is when children are most active in the summertime.

Where do these traumatic injuries happen?

Most injuries occur on the road. Nearly half of all injuries happen while the children are either a passenger in a car or a pedestrian crossing the road. In the year in question, only 27% of those children who were involved in a motor vehicle accident were restrained either through a seat belt or a car safety seat! The remaining traumatic injuries occurred in either the home or areas such as a local swimming pool, a park, a playground, or other public places. Of those injuries that

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took place in the home, falls — usually of more than 8 feet — were the largest group.

How do we prevent these injuries?

Injury prevention is perhaps one of most important actions that can take place. Traumatic injuries can be greatly reduced by seat belt usage alone. Other positive prevention measures include car safety seat checks and instructing children on safety measures, such as never swimming alone, looking before walking across the street, and not leaning on screen windows.

Of course, the most important action that can occur is for parents to monitor and participate in their children's activities. Children of all ages need supervision. This positive action can help prevent some trauma for both the child and the parent.

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National Pediatric Trauma Registry
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The Development of a Bronchiolitis Protocol: *An Alaskan Experience*

by Mary A. Rumbo, RRT, CPFT, Perinatal-Pediatric Specialist

This story begins at the Alaska Native Medical Center in Anchorage, a tertiary care facility for the Indian Health Service.

In the winter of 1996, the respiratory syncytial virus (RSV)/bronchiolitis season, which in Alaska stretches from October to May, was once again in full force. Standardization of care was lacking, while days and nights seemed to last forever for the weary respiratory therapy department. The "treatment of the day" for any child admitted to the pediatric ward with this probable diagnosis was an onslaught of therapy. Nebulized bronchodilators of varying doses given at different intervals, consistently followed by chest physiotherapy and suctioning. This often called for yet another bronchodilator to counteract the effects of suctioning. Oxygen taped to the patients' noses was "tweaked" with each therapy to maintain "numbers everyone could feel good about." Acceptable saturation varied depending on the nurse, doctor, or respiratory therapist of the day.

As the spring season began, a pediatric redesign committee was formed to facilitate a smooth transition to a newly built, state-of-the-art hospital across town. The opportunity to transform the system for treating children with bronchiolitis was set in motion. The initial objectives were:

- Standardization of care: medication delivery and dose prescribed.
- Decrease length of stay.
- Decrease number of treatments.
- Decrease time on oxygen.

After completing a literature search, benchmarking with other facilities, and tabulating records of the past season, the real work began. Our hospital's average length of stay was identified to be seven days. The number of nebulizer treatments averaged 59 per patient.

After many lengthy discussions, historical data collection, and lots of paper, the first protocol was introduced. A pre-printed admitting form was developed, along with a flow sheet to document the treatments delivered. The option to use Racemic Epinephrine or Albuterol was based on efficacy. Chest physiotherapy and suctioning were provided on an as needed basis. Acceptable oxygen saturation ranges were revised. Stable children with an oxygen requirement less than 1/4 LPM could be maintained with an oxygen saturation of 90% when awake and 88% while asleep, without causing widespread panic among the staff.

The 1997-98 season began and data were gathered to evaluate progress towards the stated objectives. Post-season data revealed the following outcomes:

- Length of stay decreased from seven to six days.
- Number of aerosol and chest physiotherapy treatments decreased.
- Time on oxygen decreased.
- Type of suctioning varied more, but quantity decreased.

Data indicated that further improvement opportunities could be targeted. We would need:

- More targeted education for the respiratory therapy staff.
- More data related to types of suctioning being performed.
- More timely feedback to hospital staff (doctors and RTs) to help with rapid cycle improvement.

So, the project was brought back to the table to discuss other options to meet the newly stated objectives in the next season. The education of the staff began with the physiology of bronchiolitis. An updated assessment form and scoring outline were designed, which would drive the treatment frequency. The scoring criteria included work of breathing, breath sounds, and oxygen requirements. Other important protocol changes included:

- Racemic Epinephrine as the first drug of choice, with criteria on when to change to Albuterol.
- The development of criteria for appropriateness of chest physiotherapy.
- The frequency of therapy was driven by a scoring system and patient assessment.
- Less invasive suctioning techniques were employed to decrease trauma.
- The collection and reporting of data in real time to facilitate rapid cycle improvements during the season.

These changes were put into place as the 1998-99 season commenced. Discussions were held on a weekly basis with the pediatricians and RTs regarding the data collected. The RTs found that by using the scoring system and the assessment tools put into place, the following objectives were being accomplished:

- Nebulized aerosol therapy decreased to an average of 12 treatments per patient.
- Chest physiotherapy was almost eliminated, with no detrimental effects.
- Time spent on oxygen decreased by one day.
- Length of stay decreased to three and a half days.
- No patients were being readmitted within 24 to 48 hours with the same diagnosis.

The following are the valuable lessons learned over the three years of developing a protocol for RSV:

- A multidisciplinary team was needed to make the changes happen more efficiently.
- Frequent feedback accelerated the charge process.
- Using data helped target where change would have the biggest impact on patient care.
- Evidence-based medicine addressed how to best make change occur.
- Patient outcomes were improved, length of stay decreased, and only necessary therapies were provided.
- Staff were more satisfied working under a process that was efficient, standardized, and provided good patient outcomes.

Today, the objective process continues. We have maintained our standard of excellence and an average length of stay of three days. What the staff had hoped to achieve has finally become a reality. ■

Videotaping Resuscitations in the Delivery Room: *Let There Be Light*

by Wade Rich, RCP, UCSD Medical Center, San Diego, CA

Neonatal resuscitation is arguably the most frequently practiced and least understood form of resuscitation in medicine. Respiratory therapists working in NICUs frequently attend high-risk deliveries, along with a nurse, physician, or both. Despite a recent survey indicating that therapists have a small role in the formal teaching of pediatric house staff in neonatal resuscitation, our experience indicates that the role of the therapist in the Neonatal Resuscitation Program (NRP) training can be significant.

In 1987, the NRP Steering Committee of the American Heart Association /American Academy of Pediatrics developed guidelines that are now the accepted standard for neonatal resuscitation in the United States. Competency in the course material is demonstrated by successful completion of a written exam and demonstration of skills as well as a mega code. It is assumed that individuals who have completed the NRP course will follow the NRP guidelines. Studies, however, have shown a significant deterioration of resuscitation knowledge and skills when providers were re-tested six to eight months after completion of the NRP course. Other evaluations of individuals completing the NRP course have also demonstrated that some individuals' knowledge level six months following completion of the program was below a passing level.

Video recordings have been used to review trauma resuscitations for some time and have become a part of the quality assurance process in many institutions. We felt that recording our delivery room resuscitations would provide us an opportunity to improve quality of care as well as provide valuable training to our pediatric house staff. To date we have reviewed over 200 deliveries, ranging from normal deliveries to full codes with medications and CPR.

A Hi-8 video camera was mounted on top of the radiant warmer in each of our delivery rooms. The respiratory therapists are responsible for bringing a tape with them to the delivery and replacing it when they leave. We have found this process to yield higher results in terms of completed recordings than other more complicated digital systems. Every two weeks an attending neonatologist reviews the tapes involved in the project, as do nurses, therapists, and house staff. Every video is subsequently reviewed by this group and scored with respect to adherence to NRP teaching. Tapes are erased after use, and because they are part of a quality assurance (QA) process, are protected by California law.

As reported previously (Carbine et al., Pediatr 2000;106:654-658), we identified techniques of ventilation, suctioning, stimulation, and communication which we felt could be improved upon. The simpler technical issues, such as not suctioning with a catheter and not overly stimulating the baby, were put into practice very quickly. The most difficult technical process in neonatal resuscitation, that of providing adequate manual ventilation to the non-intubated infant, presented a larger hurdle. In the process of defining the problems associated with bag and mask ventilation in the DR, we did a study looking at how effectively members of the resuscitation team could use the various devices available to them. We tested neonatologists, house staff, nurses, NNPs and RTs to determine whether they could deliver a consistent PEEP and PIP using various resuscitation devices. The results showed that therapists, who in our unit represent a stable and well experienced group, were better able to maintain PEEP than the other groups, who did not use these bags as part of their daily routine.

Because of these findings, the therapists in our unit are now expanding their role to include not only the instruction of the house staff in proper intubation techniques, but also on how to properly maintain a seal and ventilate a patient using self-inflating bags, non self-inflating bags, and the Neopuff®, a purpose built neonatal resuscitation device that delivers set pressures via a T-piece. The house staff has been very receptive to this training and, in fact, frequently solicits our advice after a failed intubation or a particularly complex resuscitation.

Another finding which we feel is perhaps even more significant was the lack of good communication in the DR. The importance of communicating the heart rate to the lead resuscitator, who has been identified prior to delivery, is critical to a successful resuscitation. We are currently including questions about leadership and communication in our review worksheet.

The use of videotaping will be worthwhile to any institution or department interested in improving the quality of care, and perhaps more importantly, communication, during their neonatal resuscitations. Respiratory therapists can and should take part in all phases of this process, including research into the many questions that still remain unanswered in the realm of neonatal resuscitation. ■

Agenesis of the Right Lung and Total Anomalous Pulmonary Venous Connection to the Coronary Sinus: *A Case Study*

by Doug Petsinger, BS, RRT/RCP IV

A 4-1/2 month-old white female was diagnosed shortly after birth as having agenesis of the right lung and total anomalous pulmonary venous connection to the coronary sinus. She had been relatively well balanced until recently, when she developed respiratory difficulties. Catheterization revealed a 1.9-1.0 right-to-left shunt with significant pulmonary artery hypertension (PAH). In the meantime, she deteriorated and developed respiratory distress requiring intubation in her hometown of Macon, GA. She was transferred to the Sibley Heart Center's CICU on the Egleston Campus of Children's of Atlanta. After much discussion with the family, we found she could not be weaned from the ventilator and felt it was reasonable to proceed with repair of her heart defects, recognizing the very high risks. She was on nitric oxide (iNO) and maximum ventilation at the time of transport to the operating room.

The findings in the operating room were an absent right lung and right pulmonary artery. The heart was distorted and positioned well over into the right chest. There was situs solitus with a large right superior vena cava and a small, 2 or 3 mm, left superior vena cava without a bridging innominate vein. The left pulmonary veins drained to a coronary sinus, which drained into the right atrium. There also was a patent foramen ovale, but the patent ductus arteriosus did not appear to be patent. Prior to initiation of cardiopulmonary bypass, suprasystemic pulmonary artery hypertension was noted.

The surgical procedure went as well as anticipated. The coronary sinus was

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unroofed all the way back to the insertion of the pulmonary veins into the left side of the coronary sinus near the left atrium. This allowed free communication of the left pulmonary veins into the left atrium. The patent foramen ovale/atrial septal defect was closed, and the small left superior vena cava was ligated. With some effort she was successfully disconnected from bypass on modest inotropic support and moderate ventilatory support. The mediastinum remained open.

The ICU course was rocky, with frequent bouts of suprasystemic pulmonary hypertension requiring hyperventilation by hand ventilation with 0.97 FiO_2 and 20 PPM iNO. The chest was closed three days after the operative procedure. The iNO was slowly weaned off under the insistence of the cardiothoracic surgeon, despite the patient being 2/3 systemic. After several days of denial (a big old river in Egypt), it was finally recognized that we were truly dealing with a very reactive pulmonary bed and restarted the iNO. Also, the team considered if this child had any hope for survival long-term with use of a prostacyclin. Epoprostenol (Flolan) was started at 2 nanograms/Kg/min and slowly titrated up to a max dose of 10 nanograms/Kg/min. The combination of iNO and Flolan stabilized the patient to pulmonary artery pressures which were noted to be less than 1/2 systemic. After surgical placement of a broviac double lumen catheter, we started to wean the ventilator while remaining on iNO.

Initially, we attempted to extubate to a nasal cannula with 20 PPM and an FiO_2 of 0.97, but unfortunately she desaturated into the mid 70s. What improved the saturations was +20 cm H_2O of mask CPAP and 20 PPM of iNO. We then placed a 4.0 nasopharengeal tube and placed her on +20 cmH_2O of NPCPAP, 97%, and 20 PPM iNO. The hemodynamics and acid-base remained stable, and both FiO_2 and CPAP were weaned to 0.50 and +15 cmH_2O. After four hours we started to wean the iNO by 1 PPM every four hours as long as acid-base and the hemodynamics remained in acceptable limits. In a 48-hour period we were able to wean off of both the CPAP and the iNO. The patient remains on Flolan and is awaiting discharge to home. ■

Childhood Brain Tumors and the Environment: *Part One*

by Frank G. Rando

The eminent surgeon, Harvey Cushing, once observed, "A physician is obligated to consider more than a diseased organ, more than even the whole man. He must view the man in his world."

The trend in health care today is to understand our patients utilizing a holistic approach; not to compartmentalize disease processes and label patients as diseases, but to obtain an understanding of the total human organism and the complex interrelationships between the internal and external milieus. In the area of perinatal and pediatric medicine, as in any branch of any of the healing arts, we need to become familiar with *all* forms of human pain and suffering and their real or potential etiologies. To this end, I have chosen to write about childhood cancer, or more specifically, childhood brain tumors and their environmental connections.

The epidemiology of cancer is complex, perplexing, multifactorial, and not always clear cut. Despite statistical correlations and other epidemiological evidence, environmental exposures and human health effects are not always indicative of direct disease causation. Even when coupled with positive laboratory evidence and significant clinical manifestations, environmental exposures still cannot satisfy some members of the medical and scientific communities. Many groups, especially offending industries, lobbyists, and even communities at risk, feel that environmental exposures pose a minimum or negligible risk to exposed populations. This is especially true for cancer, despite the fact that many environmental health and biomedical researchers, as well as some physicians, feel that 85% of all cancers are environmentally-induced.

The reasons for these disparities are varied and complex. One is the latency period for many cancers. Some cancers do not express themselves until mid- to late-adulthood. Another reason may be the difficulty in linking environmental factors to disease causation, e.g., the leukemia cluster in Woburn, MA as portrayed in the book and movie, *A Civil Action*. (Lagakos, S.W., An analysis of contaminated well water and health effects in Woburn, Massachusetts. J. AM. Stat. Assoc. 1986, 81:583-95.) Confounding factors, such as dietary intake (which is also a form of environmental exposure via the food chain) and lifestyle also play significant roles. Fear, denial, and various psychosocial and economic factors contribute to the controversy over environment and disease. Also, experimental animal evidence must be extrapolated to humans.

However, despite all of the complexities and controversy, the body of evidence connecting many disease processes to environmental degradation continues to mount. We know that asbestos causes pneumoconiosis (asbestosis), mesothelioma, and even has some association with gastrointestinal malignancies. Selikoff, et al., experts on asbestos and disease, have even connected some brain tumors to asbestos exposures. The scientific and medical communities have accepted the evidence that links tobacco use to bronchogenic carcinoma and other cancers and disease processes. The same acceptance exits for the relationship between acute myelogenous leukemia (AML) and aplastic anemia. Nuclear radiation and the induction of various cancers such as leukemia has been well established. Heavy metal contamination with lead, mercury, cadmium, and hexavalent chromium has also been positively correlated with various adverse health effects, including cancer. Vinyl chloride exposures and angiosarcoma of the liver and carbon tretrachloride and liver degeneration are also widely accepted by the medical and scientific establishments.

What happens when reproductive cells are exposed pre-conception or as embryos during fetal development? What occurs during the first few years of a child's development in the presence of environmental toxins? We do know that infants and children possess underdeveloped immune surveillance mechanisms and metabolic detoxification pathways. We do know that infants and children are disproportionately at risk for environmental exposures due to their increased physiological needs, behaviors, and phases of development. We do know that the placental barrier is not as selective as it should be, that human breast milk is tainted with persistent environmental toxins such as PCBs and DDE, and that many xenobiotics, such as pesticides, can induce endocrine disruption and genetic damage. We also know that the developing fetus is very susceptible during the first trimester of pregnancy and that many pharmaceuticals and environmental toxins are teratogenic, mutagenic, fetotoxic, genotoxic, and carcinogenic.

We are also learning that exposures that occur *in utero*, during infancy, and in childhood can influence cancer development later in life. The incidence of childhood cancer has increased over the years, garnering sufficient attention that former President Clinton directed the EPA to place childhood cancer as a priority concern of the agency's pediatric environmental health initiative.

Childhood brain tumors (CBT), viewed as a subtype of childhood cancers, have been increasing over the past 20 years

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"Childhood Brain Tumors" continued from page 6

(SEER — Cancer Statistics Review-NIH Publication No. 93-2789, Bethesda, MD). The two most common histologic types of CBTs are *astrocytomas* and *primitive neuroectodermal tumors* (PNET) (Cohen, ME, Duffner, PK, Brain tumors in children: principles of diagnosis and treatment. International Review of Child Neurology Series. New York: Raven Press; 1984:1-3).

Occupational and community environmental exposures to chemical and some physical agents appear to have significant correlations to CBT. Interestingly, parental occupational exposures have been associated with these tumors. Electrical workers, for example, are exposed to chlorinated hydrocarbons, soldering fumes, and solvents, as well as potent electromagnetic fields (EMFs). Parents working in the plastics and petrochemical industries may be exposed to toxic substances (benzene, toluene styiene, chlorinated hydrocarbons) during and after manufacture. Employment of mothers and fathers in the chemical industry has been associated with astroglial tumors in one study. (McKean-Coudin, et al. Parental occupation and childhood brain tumors: astroglial and primitive neuroectodermal tumors. J. of Occupational and Environmental Medicine, Vol. 40, No. 4, April 1998.) A secondary analysis in the same study revealed an elevated risk of CBT among children of mothers employed in the broadcasting and entertainment industry (motion picture, radio, television, theater) or whose job tasks included material packaging, plastic processing, office machine operation, and food service (exposure to cooking fumes and oven cleaners). Seven cases of mothers employed in plastic processing worked exclusively during the preconception period, and 86% (6 of 7) had children with atroglial tumors.

Elevated risk for children whose mothers were employed as hairdressers was found for PNET and in a previous report on astrocytomas (Kujiten RR, et al. Parental occupation and childhood astrocytoma: results of case-control study. Cancer Res. 1992; 52:782-786). Hairdressers are exposed to a myriad of volatile toxic substances, including the suspect human carcinogen formaldehyde, which has been shown to induced naso-pharyngeal cancers in animal models that are obligatory nasal breathers (Albert, RS, et al. Nasal cancer in the rat induce by gaseous formaldehyde and HCl. J. Natl. Cancer Inst., 1982, 597-603).

Agricultural exposures are also highly suspect in cancer causation in general, as well as in pediatric cancers (pesticides/agricultural chemicals). Community-wide exposures to heavy metals, radionuclides, pesticides, herbicides, motor vehicle emissions, industrial chemicals, and thousands of chemical intermedia, by products, and complex mixtures and blends (as found, for example, at several EPA superfund hazardous waste sites) contribute to the overall burden of adult and pediatric malignancies, including childhood brain tumors.

The combined synergy of toxic/carcinogenic exposures expressed in occupational and community environmental exposures poses a two-pronged health threat. The reproductive cells (sperm/ova) of employees exposed to a hazardous chemical environment at work can be infiltrated by these toxins. The exposed worker can also transfer toxic materials to the home via contaminated clothing or other fomites, e.g., shoes, where children can absorb toxins by hand to mouth behaviors, crawling, or inhaling volatile toxins. Now add the burden of a toxic community environment which includes air toxins, water contaminant, dietary exposures to pesticide/herbicide residues, environmental tobacco smoke, and countless other exposures. This is adverse synergy at work.

Watch for Part Two of Frank Rando's article on childhood brain cancer in your next issue of the Perinatal-Pediatrics Bulletin. ■

ARCF Receives Endowment from VIASYS Healthcare

The American Respiratory Care Foundation (ARCF) and VIASYS Healthcare* are pleased to announce the VIASYS Healthcare Fellowship for Neonatal & Pediatric Therapists.

This fellowship is designed to recognize outstanding original research in the field of neonatal and pediatric intensive care. Special focus will be on bench studies, clinical research studies, and other qualified studies that involve mechanical ventilation. Recipient will be selected by the ARCF Board of Trustees based on abstract submission (final deadline July 17, 2001).

The recipient of the VIASYS Healthcare Fellowship for Neonatal & Pediatric Therapists will be presented a $1,000 cash award, a plaque, registration and airfare to the American Association for Respiratory Care's (AARC) International Respiratory Congress and one night's lodging in the convention city. They will receive their cash prize and plaque at the 2001 AARC Congress Awards Ceremony, which will be held December 1-4 in San Antonio, Texas.

ARCF Chairman Mike Amato is very pleased with the new addition to the Foundation's line-up of respiratory therapy research awards. "As the respiratory therapy profession continues to grow, many therapists have devoted their careers to working with neonates and pediatric patients," he said. "It's time these therapists were encouraged to further advance their specialty field-this fellowship does exactly that."

Amato said donors establish endowments with the ARCF to recognize achievements made by individuals working in specific areas of research. He said endowments not only encourage furthering education and research in the field of respiratory care but also bring recognition to the named donor supporting the respiratory profession.

"The Foundation, and most importantly the profession, is grateful to VIASYS Healthcare for its continued support of respiratory therapy," Amato continued. "We look forward to a long and mutually beneficial relationship with VIASYS. This corporate group and the Foundation's other industry partners make everything we do possible." he said.

If you would like more information on the ARCF awards program, visit our website at www.aarc.org/arcf/awards.html or call Diane Shearer at 972/243-2272.

The American Respiratory Care Foundation is dedicated to furthering the art, science, quality, and technology of respiratory care. It is a not-for-profit organization involved in supporting research, education, and charitable purposes. The Foundation seeks to ensure a better, healthier future for all by promoting quality treatment and prevention of a variety of respiratory and related diseases.

* Bear Medical Systems, Bird Products Corporation and SensorMedics Critical Care are subsidiaries of VIASYS Healthcare. ■

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Don't forget to nominate a fellow section member for Perinatal - Pediatrics *Specialty Practitioner of the Year*!
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