lung. These results are consistent with other reports using newborn rats or mice. They also show that the combination of hyperoxia and nutritional restriction further interfere with alveolarization. Their results further support the hypothesis that the lung abnormalities in BPD are caused by multiple adverse effects on lung development that compound each other.

Malnutrition comes in many forms: total caloric inadequacy, insufficient protein, and vitamin deficiency, for example. Before routine vitamin E supplementation, Ehrenkranz et al.[8] demonstrated that supplementation of preterm infants with vitamin E could decrease BPD. Subsequently, Tyson et al.[9] found that vitamin A supplementation decreased BPD, and a large experimental literature demonstrates that retinoids are mediators of alveolarization. Protein and caloric undernutrition also can interfere with alveolarization, as shown by Mataloun et al.[1] and previously by others.[10] There is no integrated body of clinical or experimental information that can tell us the relative importance of adequate nutrition vs. mechanical ventilation, oxygen, infection and other factors in the development of BPD. No doubt the balance of adverse factors is somewhat different for each case. However, with the information presently available, it seems prudent to feed the baby – enterally or parenterally – with a goal of feeding the lung. Perhaps the decrease in severe BPD in very low birth weight infants results from our greater emphasis on early and sustained nutritional support.

References

1. Mataloun MM, Rebello CM, Mascaretti RS, Dohlnikoff M, Leone CR. Pulmonary responses to nutritional restriction and hyperoxia in premature rabbits. J Pediatr (Rio J). 2006;82:179-85.
2. Massaro D, Massaro GD. Hunger disease and pulmonary alveoli. Am J Respir Crit Care Med. 2004;170:723-4.
3. Coxson HO, Chan IH, Mayo JR, Hlynsky J, Nakano Y, Birmingham CL. Early emphysema in patients with anorexia nervosa. Am J Respir Crit Care Med. 2004;170:748-52.
4. Massaro GD, Radaeva S, Clerch LB, Massaro D. Lung alveoli: endogenous programmed destruction and regeneration. Am J Physiol Lung Cell Mol Physiol. 2002;283:L305-9.
5. Massaro D, Massaro GD, Baras A, Hoffman EP, Clerch LB. Calorie-related rapid onset of alveolar loss, regeneration, and changes in mouse lung gene expression. Am J Physiol Lung Cell Mol Physiol. 2004;286:L896-906.
6. Sakuma T, Zhao Y, Sugita M, Sagawa M, Toga H, Ishibashi T, et al. Malnutrition impairs alveolar fluid clearance in rat lungs. Am J Physiol Lung Cell Mol Physiol. 2004;286:L1268-74.
7. Jobe AH. The new BPD: an arrest of lung development. Pediatr Res. 1999;46:641-3.
8. Ehrenkranz RA, Ablow RC, Warshaw JB. Prevention of bronchopulmonary dysplasia with vitamin E administration during the acute stages of respiratory distress syndrome. J Pediatr. 1979;95:873-8.
9. Tyson JE, Wright LL, Oh W, Kennedy KA, Mele L, Ehrenkranz RA, et al. Vitamin A supplementation for extremely-low-birth-weight infants. National Institute of Child Health and Human Development Neonatal Research Network. N Engl J Med. 1999;340:1962-8.
10. Frank L, Sosenko IR. Undernutrition as a major contributing factor in the pathogenesis of bronchopulmonary dysplasia. Am Rev Respir Dis. 1988;138:725-9.

Music is medicine for the heart

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Music as medicine for the mind and body is an ancient concept. Apollo, the Greek god of mythology, was the giver of medicine *and* music. While there has been for centuries an appreciation of the benefits of music for those who are ill, it is only in recent years that this benefit has been more scientifically studied. Music has been shown to affect physical, emotional, cognitive and social needs of individuals of all ages.

Music has been of beneficial effect on patients' experience of pain,[1] allaying preoperative anxiety in children,[2] acting on the autonomic nervous system by reducing heart rate, blood pressure and pain postoperatively,[3] and having a positive effect after acute myocardial infarction.[4] Music reduces anxiety and pain following open-heart surgery in adults.[5] In a study of pain following abdominal surgery, the introduction of both relaxation and music was effective in reducing the degree of pain.[6] Music's effect in blunting pain works through the gate-control theory of pain by acting as a competing stimulus that distracts the patient and directs the patient's attention away from the pain, thus modulating noxious stimuli. Imaging studies of the brain have shown activity in the auditory pathway, auditory cortex and limbic system in response to music. Music has been shown to lower

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increased stress levels and, with certain types of music, such as meditative or slow classical, to produce a reduction in neurohormonal markers of stress. Music has been found to lessen confusion and delirium in elders undergoing elective knee and hip surgery.[7] Music is also helpful in reducing patients' mood distress when undergoing high dose therapy with autologous stem cell transplantation.[8]

Recently, Bernardi et al.[9] studied the cardiovascular, cerebrovascular and respiratory changes induced by different types of music in musicians and nonmusicians. In this study, slow (tempo) or meditative music produced a relaxing effect with a reduction in heart rate, blood pressure, and ventilation, with raga music producing the greatest decrease in heart rate. On the other hand, increasing the speed (tempo) of the music can produce an arousal effect, which would increase breathing rate, blood pressure and heart rate due to sympathetic activation. Auditory inputs, such as prayer or yoga mantra carried out with rhythmic repetition, can modify cardiorespiratory function. In the case of music, it is the ability of music tempo to affect the heart rate or circadian rhythms and entrain breathing frequency proportionate to the tempo of the music. In the study by Bernardi et al., it is of interest to note that a pause provided after a musical piece was played led to the greatest evidence of relaxation and cardiovascular benefit.

The study by Hatem et al.[10] in this issue of the Jornal de Pediatria on the therapeutic effects of music in children following cardiac surgery is an important contribution to an appreciation of the potential benefits of music in controlling pain and anxiety and moderating vital signs. In the study, the authors were able to demonstrate significant changes in reduction of pain, heart rate and respiratory rate. While postoperative pain is routinely managed with pharmacological agents, the addition of non-pharmacological agents is important because of its potential for reducing drug doses and side effects. Postoperative pain can exacerbate the child's stress and contribute to a difficult postoperative course. Helping to control the pain and anxiety, often interrelated, can provide a more optimal postoperative course. The authors of the study recognize that the results are potentially affected by the sample size and the non-randomization by age group. Also, an observer, as opposed to the child's participation, performed the analysis of the pain scale, which may affect the validity of this assessment. The effect of other factors, such as cardiovascular sedative drugs, while not altered during the 30-minute experiment, could nevertheless have some impact, depending on the timing of the drugs prior to the study.

See related article on page 186

In optimizing the benefits of music, we need to recognize that while this modality can be effectively provided in a passive manner, as in the study by Hatem et al., its effects can be enhanced by the participation of a music therapist. Music therapists integrate their technique into the care of cardiac patients, assisting them with coping with the stress of the illness. This integration considers the age, sex and cultural background of the patient, amongst other variables.[11] In studies comparing passive listening to the participation of a music therapist, the latter has always been found to be more advantageous. In the study by Hatem et al., a single piece of music (Spring, from Vivaldi's Four Seasons) was played. With music therapy, the individual's previous musical experience is considered to optimize the choice and tempo of music. In this study, too, the children in the control group had headphones attached without music. Headphones may help by masking the intense disrupting sounds common in the intensive care unit and contribute to reduction in stress. However, the validity of this control without music is open to question.

Hatem et al. have contributed to our understanding of the importance of the introduction of music to the intensive care unit in optimizing patient care by providing pain relief, allaying stress, and reducing sympathetic activity. We need to recognize that music is an important and humane addition to the care of children post-cardiac surgery.

On a personal note, for the past few years, we have had a harpist in our pediatric intensive care unit at Massachusetts General Hospital helping to calm not only the patients, but also the families, who often have responded very positively. In addition, the nursing and physician staffs have told me how much the harpist's playing has helped to calm them too!

References

1. Nilsson U, Rawal N, Enqvist B, Unosson M. Analgesia following music and therapeutic suggestions in the PACU in ambulatory surgery: a randomized controlled trial. Acta Anaesthesiol Scand. 2003;47:278-83.
2. Kain ZN, Caldwell-Andrews AA, Krivutza DM, Weiberg ME, Gaal D, Wang SM, et al. Interactive music therapy as a treatment for preoperative anxiety in children: a randomized controlled trial. Anesth Analg. 2004;98:1260-6.
3. Ikonomidou E, Rehnstrom A, Naesh O. Effect of music on vital signs and postoperative pain. AORN J. 2004;80:269-78.
4. White JM. Effects of relaxing music on cardiac autonomic balance and anxiety after acute myocardial infarction. Am J Crit Care. 1999;8:220-30.
5. Voss JA, Good M, Yates B, Baun MM, Thompson A, Hertzog M. Sedative music reduced anxiety and pain during chair rest after open-heart surgery. Pain. 2004;112:197-203.

6. Good M, Anderson GC, Ahn S, Cong X, Stanton-Hicks M. Relaxation and music reduce pain following intestinal surgery. Res Nurs Health. 2005;28:240-51.
7. McCaffrey R, Locsin R. The effect of music listening on acute confusion and delirium in elders undergoing elective hip and knee surgery. Int J Older People Nurs. 2004;13:91-6.
8. Cassileth BR, Vickers AJ, Magill LA. Music therapy for mood disturbance during hospitalization for autologous stem cell transplantation: a randomized controlled trial. Cancer. 2003;98:2723-9.
9. Bernardi L, Porta C, Sleight P. Cardiovascular, cerebrovascular, and respiratory changes induced by different type of music in musicians and non-musicians: the importance of silence. Heart. 2006;92:445-52.
10. Hatem TP, Lira PI, Mattos SS. The therapeutic effects of music in children following cardiac surgery. J Pediatr (Rio J). 2006;82: 186-92.
11. Hanser SB, Mandel SE. The effects of music therapy in cardiac healthcare. Cardiol Rev. 2005;13:18-23.

Nitric oxide in children with persistent asthma

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Chronic inflammation characterized by the presence of lymphocytes, eosinophils and mast cells is considered to be the hallmark of asthma, yet airway inflammation is not measured directly and routinely in clinical practice.[1] Probably this is one of the factors that makes management of asthma difficult, because it is based only on indirect measurements, such as symptoms and lung function. There is now evidence that inflammation may precede the onset of asthma, suggesting that asymptomatic children may already suffer from chronic airway inflammation.[2] Current evidence suggests that early detection of this might have an important therapeutic impact.[3]

See related article on page 193

Airway inflammation can be detected by several methods, such as bronchial biopsy and bronchoalveolar lavage. However, because all of the above are invasive tests with a very low practical applicability, these methods are not suitable for routine use in children. Today we rely on clinical symptoms and lung function measurements, but these do not directly reflect airway inflammation. Subjective measures of asthma control include patient-derived parameters, such as number of wheezing episodes, nocturnal symptoms, exercise-induced symptoms, short-acting beta-agonist use, steroid bursts, emergency department visits, and hospitalizations. Asthma-related quality of life is related to asthma morbidity, and patients with better baseline quality of life have improved outcomes. Asthma-related costs include direct costs, mostly comprised of hospitalizations and emergency room visits, and indirect costs, including school absenteeism. Symptoms may not reflect the extent of the underlying inflammation due to differences in perception, and lung function may have little role especially in pediatric mild persistent or intermittent asthma.[4] None of these parameters are able to distinguish the effect of different doses of inhaled corticosteroids (IC).

Although nitric oxide (NO) was first identified 200 years ago, its physiological importance was not recognized until the early 1980s. Many studies have established the role of NO as an essential messenger molecule in body systems. NO is present in the exhaled breath of humans and other mammalian species. It is generated in the lower airways by enzymes of the nitric oxide synthase (NOS) family, although nonenzymatic synthesis and consumptive processes may also influence levels of NO in exhaled breath. The biological properties of NO in the airways are multiple, complex, and bidirectional. Under physiological conditions, NO appears to play a homeostatic bronchoprotective role. However, its proinflammatory properties may also potentially cause tissue injury and contribute to airway dysfunction in disease states such as asthma and chronic obstructive pulmonary disease (COPD). In addition, studies have demonstrated a significant relationship between changes

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