

therapy in moderate to severe disease.  $\beta$ -Aerosols used in maintenance therapy are now recommended on an as-needed basis with a steroid or cromoglycate derivative given regularly. In patients with mild to moderate disease, administering these drugs through a metered-dose inhaler coupled with a holding chamber is equivalent to handheld or mask nebulization.

Parenteral adrenergic agents (terbutaline, epinephrine) are appropriate when maximal inhalational therapy fails because of severe unremitting airway obstruction, and these agents can be lifesaving. Parenteral theophylline, however, produces less bronchodilation than  $\beta$ -aerosols and increases the toxicity but not the efficacy of treatment; dosing is problematic. In addition, signs of minor toxicity (nausea and vomiting) do not necessarily precede those of major toxicity (seizures and arrhythmias), and life-threatening toxicity is not always predicted by the magnitude of the serum level and can be particularly difficult to treat. The use of parenteral theophylline in patients with acute asthma should no longer be controversial but rather should be considered obsolete.

Anticholinergic agents have proved tremendously effective in patients with chronic obstructive pulmonary disease, but this is generally not so in asthma. Usually greater benefit will be obtained from one more dose of a  $\beta$ -aerosol than adding an anticholinergic.

The aphorism " $\beta$ -Aerosols treat the symptoms, steroids treat the disease" should always be kept in mind because asthma is an inflammatory disease. By modifying the immune response and increasing the responsiveness to  $\beta$ -agonists, steroids have particular benefit in decreasing the incidence of early recurrence and producing steady resolution of an acute exacerbation. The early use of parenteral steroids in emergency medicine has not been shown to reduce the incidence of admissions, but such therapy should be started in an emergency department. In addition, there is no advantage to the parenteral over the oral route of administration, unless the patient is unable to swallow. Magnesium, while safe and cheap, has been shown to be a mild, short-acting bronchodilator that offers little or no advantage over existing agents.

The use of mechanical ventilation should be avoided whenever possible, but it is the treatment of last resort. Once a patient has been intubated, oxygenated, paralyzed, and sedated, avoiding the occurrence of high peak airway pressures (>50 cm of water) is more important than that of hypercarbia. The former is associated with possibly fatal barotrauma whereas the latter can be managed with helium-oxygen mixtures. Helium-oxygen mixtures dramatically improve ventilation by decreasing resistance to flow and increasing carbon dioxide diffusion, among other effects. With asthma mortality rates still rising rapidly, the need for new approaches and technologies will continue. Patient education, prophylactic therapies, and earlier and more aggressive rescue treatment will form the basis of fighting this disturbing trend.

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## Dexamethasone Use in Croup

CROUP, or acute viral laryngotracheobronchitis, is the most common cause of acute upper airway tract obstruction in children aged 6 months to 6 years, resulting in more than 20,000 hospital admissions annually; its incidence peaks in fall and winter. Croup's characteristic symptoms of loud barking cough, inspiratory stridor, retractions, and variable respiratory distress are usually mild and self-limited, but the spectrum of disease is great. Severe cases require admission to a hospital and, even rarely, intubation for the airway obstruction. Traditional management has included the use of humidified air, with supplemental oxygen and nebulized racemic epinephrine in patients with severe or refractory presentations. The effect of nebulized epinephrine disappears within two hours, however, giving little long-term benefit.

Corticosteroid administration has been suggested as a treatment adjunct in the management of croup. Theoretically, steroids may act to reduce subglottic edema and obstruction by decreasing capillary permeability and suppressing the local inflammatory reaction seen in laryngotracheobronchitis. Early studies that failed to show benefit have been criticized for inadequate steroid doses, inconsistent diagnostic criteria, failure to choose appropriate outcome measures, and other methodologic flaws. Two recent randomized, double-blinded, placebo-controlled trials using intramuscular dexamethasone, 0.6 mg per kg of body weight, for patients admitted to a hospital with croup have shown substantial improvements in patients' clinical indices as measured using a "croup score." This is a numeric assessment of the severity of respiratory symptoms, including inspiratory stridor, retractions, air entry, cyanosis, and level of consciousness. The croup scores were measured at 12 and 24 hours after the drug's administration. A meta-analysis of nine earlier published reports of 1,126 patients admitted to a hospital also concluded that parenteral steroid use had beneficial effects when compared with the effects of placebo. Most recently, patients treated through an emergency department have also been shown to have abatement of their clinical symptoms when given intramuscular dexamethasone as compared with placebo at 24 hours.

There are few contraindications to a single dose of parenteral corticosteroids. The use of a single intramuscular dose of 0.6 mg per kg of dexamethasone can now be considered standard therapy for most children presenting to an emergency department with moderate or severe

croup. The drug's long half-life of 36 to 54 hours allows for a single-dose regimen. Equipotent doses of another corticosteroid given orally, intravenously, or intramuscularly could also be expected to improve the outcome, but there are fewer data supporting various alternative regimens than those for single-dose dexamethasone given intramuscularly.

The role of corticosteroids in emergency department management of croup may expand in the future to include the use of nebulized corticosteroids. Nebulized budesonide, a synthetic glucocorticoid with relatively strong topical anti-inflammatory effects and low systemic activity has recently been shown to allow earlier discharge from an emergency department and a reduced rate of subsequent hospital admissions compared with placebo. An advantage of this therapy is its relatively rapid onset of effect; improvements can be seen as early as an hour after administration. The exact role of this new therapy for croup, however, remains to be determined.

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## Ottawa Ankle Decision Rules

THE REVISED OTTAWA ankle and foot rules are simple, specific guidelines used to assist physicians in deciding which blunt ankle and foot injuries require radiographs to exclude fracture. With less than 15% of ankle injuries resulting in substantial fracture, the objective is to eliminate radiographs in patients with injuries with a low probability of fracture. The rules assume a patient has a normal level of consciousness and no competing pain.

The criteria for ankle radiographs are pain in the malleolar area plus one or more of the following:

- Bone tenderness at the posterior edge of the distal 6 cm or tip of the lateral or medial malleolus, or
- Inability to bear weight both immediately after the injury and in the emergency department. Weight-bearing is defined as the ability to take four steps, two on each foot, with or without a limp.

The foot rules require pain in the midfoot plus one or more of the following:

- Bone tenderness at the base of the fifth metatarsal or navicular, or
- Inability to bear weight immediately after the injury and in the emergency department, as described above.

Large studies assessing these rules have shown a 100% sensitivity in identifying important fractures. Fractures are defined as bone fragments greater than 3 mm in breadth, a size that makes a patient a more likely candidate for rigid immobilization. The rules have safely allowed the reduction of the number of emergency department radiographs of the ankle and foot by close to 30%. This leads to a reduction in time spent in the emergency department, less cost for the visit by eliminating the radiographs, and less radiation exposure to patients. This has been accomplished without compromising patient satisfaction when an effort is made to educate the patient on why a radiograph is not necessary.

Some smaller studies have questioned the sensitivity of the rules when used by health care providers other than emergency department physicians. When residents, nurses, physician assistants, interns, and medical students are included, however, the sensitivity remains at more than 93%. A thorough education process is necessary, including access to simple diagrams to ensure accuracy in applying the rules.

Other criteria often empirically thought to add important data points, such as mechanism of injury, a "cracking" sound, ecchymosis, decreased range of motion, a positive drawer sign, soft-tissue tenderness, and proximal fibular tenderness, do not prove to be helpful in increasing the sensitivity of the selection criteria.

The ankle part of the study has been validated in a small group of children (68 patients with 14 fractures), aged 2 to 18 years, again finding 100% sensitivity and a 25% decrease in the number of radiographs.

The rules have not been validated for use in pregnant patients, but there is no reason to expect that they would not apply as effectively. Furthermore, a reduction in radiation exposure would seem to be a particular benefit of the rules in these patients.

These decision rules, while having a low specificity, do not miss important fractures. Despite their implementation, about 77% of ankle radiographs are still negative for fracture. The rules are substantially better at identifying patients with fractures than are physicians applying personal clinical criteria.

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