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Original Research

Management of Hospitalized Asthmatic Children Before Transport

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A B S T R A C T

Asthmatic children are at risk for respiratory failure and should be appropriately treated before transport. The objectives were to find out if the Pediatric Advanced Life Support guidelines for asthma treatment were followed in the emergency department (ED); to determine if additional treatment during transport or within the first 2 hours of admission was needed; and to compare the management of intubated asthmatics by the ED, transport team, and the intensive care unit (ICU) physician. The records for children diagnosed with acute asthma over 7 years who were transported by the intensive care transport team were reviewed. The use of albuterol, steroids, oxygen, heliox, continuous positive airway pressure or bilevel positive airway pressure, and ventilator settings was recorded. Two hundred seventy-nine children were transported during a 7-year time period (age, 5 mo-17 y), and 62% were male. Eighty percent received oxygen, albuterol, and steroids in the ED. Heliox was initiated more often by the transport team when compared with the ED or hospital physician (77% vs. 7.7% vs. 15.3%, $P < .0001$). Forty-five were mechanically ventilated and were more likely to receive volume control ($P < .0001$) and higher rates ($P = .007$) in the ED than the ICU. We conclude that most children with acute asthma were treated with oxygen, albuterol, and steroids in the ED. If used, heliox was most likely started during transport. Intubated children were more likely to receive volume control with higher rates compared with lower rates and pressure control in the ICU.

Asthma is a chronic disease affecting the airways. Asthma exacerbation consists of coughing, wheezing, and difficulty in breathing. The National Surveillance of Asthma reports that from 2001 to 2010, 25.7 million people in the United States suffered from asthma, 7 million being children.[1] In 2009, 1 in 5 children with asthma was reported to have an emergency room visit. The Centers for Disease Control and Prevention found that 10.7 asthma visits per 100 children occurred between 2007 and 2009, with the highest number of visits in the 0- to 4-year age group.[1] In this same period, hospitalizations occurred in 2.1 per 100 cases of children with asthma exacerbation.[1]

Classification and treatment guidelines for the emergency management of pediatric asthma are published in the provider manual of Pediatric Advanced Life Support (PALS), which is endorsed by the American Heart Association and the American Academy of Pediatrics.[2] Most physicians who treat pediatric patients in an emergency department (ED) are PALS certified and have had the opportunity to review these treatment guidelines. Humidified oxygen delivered by a nasal cannula or mask, albuterol administered by a nebulizer or a metered dose inhaler, and corticosteroids are recommended for mild to moderate asthma. Ipratropium bromide and magnesium sulfate are recommendations for moderate to severe asthma in addition to those recommendations for mild to moderate asthma. In severe asthma, all of the previously mentioned recommendations should be considered in addition to terbutaline subcutaneously or by intravenous infusion or epinephrine subcutaneously or intramuscularly and bilevel positive airway pressure ventilation. Intubation and mechanical ventilation may be considered in children with refractory hypoxemia and/or worsening clinical conditions such as a decreasing level of consciousness or irregular breathing.

The intensive care transport team routinely transports children from multiple EDs, with asthma exacerbation requiring specialty care transport to Children's Hospital of Michigan where the child is admitted to the pediatric intensive care unit (ICU) or general ward. The primary objective was to find out if the PALS guidelines for asthma treatment were followed in the ED. The secondary objectives were first to determine if additional treatment during transport or within the first 2 hours of admission was needed and second to compare the management of intubated asthmatics by the ED, transport team, and ICU physician.

Material and Methods

This study was approved by the Institutional Review Board at Wayne State University, Detroit, MI. The records for all children

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Table 1
Demographic Data

Total Number	279
Age (y)	7 (0.4-17.8)
Median (range)	
Sex	62% male
Race	Black: 76.3%
	White: 19.7%
	Other: 4%
Allergies	24.7% total
	12.4% environmental
Previous hospitalizations for asthma	None: 42.8%
	1: 24.1%
	2: 13.7%
	3: 19.45
Days of illness before admission	1 (0-21)
Median (range)	
Albuterol at home	91%
Steroid at home (inhaled)	37%
Steroid at home (oral)	11%
Intubated for asthma in the past	15.8% total
	1: 72%
	2: 23%
	≥3: 5%

diagnosed with acute asthma over a 7-year time period who were transported by ICTT were reviewed for the study. Children were excluded if they were transported by ICTT but not admitted to the hospital or transported by ICTT to another institution.

The ICCT was established at Children's Hospital of Michigan in the Detroit Medical Center in 1985 as a dedicated critical care transport team providing advanced pediatric and neonatal life support to children in the state of Michigan; surrounding states; and Ontario, Canada. The team transports more than 1,200 patients per year by ground, helicopter, or Learjet. Team members are registered nurses with prior extensive experience in 1 or more of the following 3 areas: neonatal ICU, pediatric ICU, or pediatric ED.

The first 10 charts reviewed by each investigator were then double checked by 1 of the investigators (R.B.) for inconsistencies. Age, race, weight, allergies, number of days ill in conjunction with home care management of maintenance and rescue medications, and past history of prior asthma exacerbation hospitalizations and intubations were obtained. Physical assessment findings such as wheezing, retractions, rales/crackles, and oxygen saturations on arrival to the referral hospital were recorded as well as chest roentgenographic findings of hyperinflation, perihilar infiltrates, or pneumonia. Treatments including albuterol; corticosteroids; supplemental oxygen; magnesium; terbutaline; subcutaneous epinephrine; helium oxygen administration; the need for continuous positive airway pressure or bilevel positive airway pressure; intubation; and, if applicable, ventilator settings were noted. Barotraumas and the need for cardiopulmonary resuscitation were documented.

Statistical Analysis

Descriptive statistics were used for demographic data and clinical variables. Categoric data were expressed in absolute counts and percentages. For continuous data, the mean and standard deviation were used if normally distributed, whereas median and interquartile range were used for skewed data. Unavailable values were excluded. The chi-square or Fisher exact test were used for categoric variables and the Wilcoxon rank sum test for continuous variables. Significance was determined at $P < .05$.

Results

Two hundred seventy-nine children with asthma were transported from multiple referring hospitals in the metropolitan Detroit area over a 7-year time period from January 1, 2005, through December 31, 2012. All children were seen initially in an ED that cared for both adults and children.

Demographic Data

Demographic data are presented in Table 1.

Initial Treatment

Of 279 children, 45 (16%) were intubated before transport, and none were intubated during transport or within 2 hours after admission to the hospital. The decision to intubate was made by the ED physician before the arrival of the transport team. Of these intubated children, 36 (80%) were black. Five of 279 children required cardiopulmonary resuscitation, 4 in the ED and 1 during transport. Basic therapies included albuterol, oxygen, and steroids, which are recommended for all asthma classifications according to PALS. Only 80.3% of the patients received all 3 of these therapies. The transport team gave these therapies if not given in the ED.

Secondary Treatment

Seventy percent received ipratropium in the ED. Magnesium was administered in 39% of the asthmatics who presented to the ED. This therapy was not usually given by the transport team or within 2 hours of hospitalization. Subcutaneous epinephrine was administered in 25% of the asthmatics presenting to the ED. Rarely did the children require epinephrine by the transport team or after hospitalization. Only 3 patients of the 279 were treated with noninvasive positive pressure ventilation, all of whom had this therapy started in the ED. Children who required intubation initially were intubated in the ED. A helium-oxygen mixture (heliox) was used in 78 (28%) and was most commonly instituted by the transport team (77%) and not in the ED (7.7%) or at the time of hospital admission (15.3%) ($P < .0001$, Table 2 [a]). Fluid boluses were commonly given in patients with asthma in the ED, by the transport team, and after hospital admission (Table 2).

Intubated Asthmatics

Forty-five children required intubation in the ED, whereas none of the children were intubated initially during transport or within the first 2 hours of intensive care treatment. In the emergency department, volume control ventilation was more likely used compared with pressure control ventilation. The transport team usually used hand bagging rather than the ventilator because the transport ventilator did not give the same effect. In the ICU, nearly all of the children received pressure control ventilation over volume control ventilation. A child was more likely to receive pressure control rather than volume control ventilation in the ICU than in the ED ($P < .0001$, Table 3). The ordered respiratory rate for mechanically ventilated patients was lower in the ICU when compared with the ED ($P < .007$, Table 3 [a]).

Intubated asthmatics were more likely to receive fluid boluses than nonintubated asthmatics in the ED, during transport, and within 2 hours of hospital admission ($P \leq .002$). Blood glucose levels were higher initially in the ED when comparing the intubated with the nonintubated group (206 ± 67 [$n = 16$] vs. 141 ± 40 [$n = 70$], $P \leq .002$).

Discussion

The treatment and stabilization of asthmatic children are important before transporting these children from a referring emergency department to a pediatric hospital. Supplemental oxygen, a bronchodilator, and corticosteroid administration are recommended to treat children who are sick enough to be admitted to the hospital because of asthma. In our study, 80% of the children received this therapy in the ED before the arrival of the transport team. Several recent studies support the early administration of