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Research Article

Managing Acute Asthma Exacerbations in Pediatric Patients: Should Peak Flow Measurements (PFM) or Pediatric Respiratory Assessment Measure (PRAM) Scores be used to Titrate Bronchodilator Treatment?

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Abstract

Asthma is common in pediatric patient populations, and acute asthma exacerbations are one of the leading causes for emergency department visits in pediatric hospitals. Several methods are used to evaluate the severity of asthma exacerbations, including the pediatric respiratory assessment measure and peak flow measurements. This study aims to determine which method is superior for advancing treatment intervals in a pediatric patient population. Fifty-six asthmatic patients between the ages of 12 and 16 were included in the study. Treatment intervals for those in Groups 1 and 2 were advanced based on peak flow measurements and pediatric respiratory assessment measure scores, respectively. The total number of treatments and the number of q2h treatments required before discharge were significantly lower for the group for which treatment intervals were advanced based on peak flow measurements. Protocols utilizing peak flow measurements may be more cost effective than protocols based on pediatric respiratory assessment scores. This may be especially relevant in resource-poor settings, and further investigation is warranted.

INTRODUCTION

Asthma exacerbations lead to over two-million emergency department visits annually in the United States [1]. Nearly two-thirds of children with asthma have at least one acute attack annually, and a child with asthma misses about ten days each school year due to their asthma [2]. Relapse and additional hospital admissions are common for asthmatic patients. Emergency department relapse rates are between 7 and 15% [3], and under treatment, especially at rural and suburban hospitals, is common [4].

The National Heart, Lung, and Blood Institute (NHLBI) defines an exacerbation of asthma by a quantifiable decrease in lung function [5] and recommends utilization of objective measures for assessing asthma severity and for guiding treatment. Spirometry and Peak Flow Measurements (PFM) are considered gold standards for quantitative, objective assessments. PFMs quantify the air flow a patient expels during forceful expiration, and PFM devices are inexpensive and widely available [5]. Spirometry requires a pulmonary function laboratory or a portable spirometry machine to measures lung volumes. Peak flow can be a difficult measure to obtain in younger children, but most children over five years of age can successfully perform the measurement [3]. The NHLBI characterizes a mild asthma

exacerbation by a measured peak flow value between seventy and seventy-nine percent of a patient's best or predicted value; a value less than sixty-nine percent is considered to be a severe exacerbation [6]. Criticisms of the NHLBI's recommended method of assessing asthma attacks include the following: the objective measures utilized may be too complicated for younger children, the techniques are user-dependant, and the machines necessary are not always readily available in the acute setting [6,7]. Less complicated assessment methods have been investigated, but consistency among observers has not been optimal and their capability for determining severity and prognosis appear to be inferior compared to the methods incorporating objective measures.

The Pediatric Respiratory Assessment Measure (PRAM), developed by Chalut, Ducharme, and colleagues, has been implemented in pediatric populations and relies on evaluating air entry, wheezing, oxygen saturation, and the retractions of the suprasternal and scalene muscles retractions. These evaluations are combined to produce a score of 0-12, with 12 being the most severe. Many hospitals have developed standard care protocols based on PRAM scores, and those care management protocols are described elsewhere [8].

Asthma burden in third-world pediatric populations can be staggering. Patients and providers in third world countries often have less access to asthma assessment equipment, treatment, and education. Innovative devices and strategies have recently been studied as a means to circumvent these deficiencies: home-made spacers are often utilized [9], peak-flow meters are available for as low as 12 USD, and allied healthcare providers have been effectively employed to provide low-cost care to asthma patients in areas with limited numbers of physicians [10]. This study aims to determine whether peak flow measurements can reduce the number of treatments needed in acute asthma exacerbations in pediatric patients already being evaluated with the PRAM method.

METHODS

Fifty-six patients, aged 12 to 16 years, were enrolled during the six-month period of June 2012 to December 2012 and randomly assigned to one of two groups. All patients had previously been diagnosed with mild or moderate persistent asthma and were presenting to the Children's Clinic with an acute asthma exacerbation. No significant differences were determined between groups for the following clinical characteristics: number of previous admissions for acute asthma exacerbations, number of previous intubations, age of asthma diagnosis or symptom onset, regular use of daily steroid, and regular use of inhaled bronchodilators. Information regarding the trigger of each asthma exacerbations was collected. Although the level of detail regarding a potential trigger was inconsistent, there appeared to be no significant difference in the type of trigger between the two randomly-assigned groups. At admission, all patients were started on a 5-day daily regimen of oral prednisone 2mg/kg and received breathing treatments (2.5mg of nebulized albuterol) at 2-hour intervals. Indication for treatment-interval progression, from q2h to q3h to q4h of 2.5 mg of nebulized albuterol, was determined by PRAM scores for patient in Group 1 (n=31) and was determined by peak flow measurements for patients in Group 2 (n=25). By convention, treatment intervals were increased when PRAM scores were < 4 or when measured peak flows were < 79% of the patient's predicted maximum. Patients in Group 2 were also evaluated by the PRAM scoring system, but PRAM scores were not used to determine advancement of their treatment intervals. Patients qualified for discharge after their respiratory status was optimized and stable with treatments at four-hour intervals. Their medical conditions were followed for an additional week after discharge from the clinic.

Two-tailed Student's t-tests were used to determine whether statistically significant differences existed between the two groups for the following variables: age, gender, PRAM scores, total number of treatments before discharge, number of q4h treatments, number of q3h treatments, and number of q2h treatments.

RESULTS

The results of the statistical analyses are tabled in (Table 1). No significant differences between the two groups were determined for the following variables: age, gender, PRAM scores, number of q4h treatments, and number of q3h treatments. However, the total number of treatments required before discharge and the number of q2h treatments were significantly lower for Group 2. No patients from either group experienced a relapse of their asthma exacerbation during the one-week follow-up period.

CONCLUSIONS

Pediatric patients in this cohort recovered from acute asthma exacerbations more rapidly (i.e., the number of required treatments prior to discharge was lower) when their treatment intervals were advanced based on PFMs rather than PRAM scores. These findings suggest that protocols utilizing PFM may be more cost effective, and this may be especially relevant in resource-poor settings. The sample size and age range of the study population were small; therefore, the study findings can't be generalized to all pediatric patient populations. Larger randomized trials in pediatric patient populations with a broader age range will be necessary to determine whether our findings are applicable to pediatric practice in general. Another weakness of our study is that PFM and PRAM data were not both collected for both groups. In the design of future studies, both PFM and PRAM should be

Table 1: Statistical Analyses Results: A Pediatric Respiratory Assessment Measure (PRAM‡) score of 0 indicates the lowest severity, and a score of 12 indicates the highest severity. Student's t-tests were used to determine p-values†. Albuterol treatment intervals were advanced based only on PRAM scores for Group 1 and only on peak flow measurements for Group 2.

	Group 1	Group 2	*p*-Value†
Age (years)	13.16 (1.24)	13.48 (1.23)	0.3415
Male (%)	68.00	68.00	0.9840
Initial PRAM‡ Score (0 -12)	4.48 (1.18)	4.48 (1.08)	0.9900
Number of q2hTreatments	6.00 (2.78)	3.44 (1.53)	0.0001
Number of q3h Treatments	4.13 (2.05)	4.24 (2.67)	0.8607
Number of q4h Treatments	1.87 (0.62)	1.64 (0.49)	0.1342
Number of Treatments Prior to Discharge	12.00 (4.34)	8.92 (2.29)	0.0022

collected for all patients regardless of the randomly-assigned treatment-advancement modality. Collection of such data will allow for the use of more robust statistical analyses, significantly increasing the validity of the study findings.

Although it has previously been recommended that PRAM scores should be used to guide treatment decisions in acute exacerbations of asthma, this study suggests that PFM is a good alternative and may provide a superior measure for advancing treatment intervals.

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