

A Pediatric Hospital-wide Asthma Severity Score (HASS): Reliability and Effectiveness

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Abbreviations:

HASS: Hospital-wide Asthma Severity Score

Abstract

Background. Asthma is a leading cause of pediatric hospitalization in the United States. Children hospitalized with asthma are often cared for in different care settings during a single hospitalization. Our objective was to study the reliability and safety of a new pediatric hospital-wide asthma severity score (HASS) across different care units within a single tertiary-care pediatric center.

Methods. 150 patients between the ages of 2 and 18 years hospitalized with a principal diagnosis of status asthmaticus were included in this study. Study patients were followed from the time of initial triage in the emergency department until the time of medical readiness for discharge. Rates of medical errors, early transfers to a higher level of care and medically indicated hospital length of stay (LOS) were compared between 75 patients prior to and 75 patients after implementation of the HASS using retrospective chart and anonymous staff reporting. Inter-rater reliability was determined by collecting independent HASS scores from blinded staff members after tandem or simultaneous patient assessment.

Results. Inter-rater reliability among untrained staff members using the HASS was high. Rates of adverse events, medical errors and early transfer to a higher level of care were not significantly different before and after implementation of the HASS. LOS was shorter after implementation of the HASS but without statistical significance.

Conclusion. The HASS is a reliable asthma severity tool that can be used throughout hospitalization and also among multiple clinical providers to trend clinical progress and optimize communication, particularly during times of care handoffs.

Introduction

An estimated 8.4% of children suffer from asthma in the United States.¹ Asthma is the third-ranking cause of hospitalization among children younger than 15 years of age.² In 2017, the hospitalization rate for pediatric asthma was 5.6 per 10,000 children.³ While the pathophysiology of asthma is well understood, the clinical presentation and progression of children hospitalized for status asthmaticus can be diverse and may change rapidly, requiring diligent attention to trends in respiratory assessments. Developing a reliable

pediatric respiratory assessment tool for patients with status asthmaticus has been an ongoing effort. Several asthma severity scores have been trialed in the past for pediatric asthma exacerbations with variable limitations.⁴⁻¹⁰ These asthma scores have been primarily used for initial respiratory evaluation among children presenting to the emergency room to predict a need for hospitalization.^{5, 6, 7, 8, 10} In addition, many clinical components of asthma scoring systems are based upon subjective assessments which can impact score reliability when used among different care providers.

Larger medical centers may care for pediatric asthma in different inpatient care settings; emergency departments, intensive care step-down units, intensive care units, short stay or extended emergency care units and inpatient medical wards. Children hospitalized for status asthmaticus are commonly treated in two or more of these care settings during a single hospital admission, making unit transfers and care “handoffs” a time of potential communication breakdown. A severity assessment score for pediatric asthma in the hospital setting could add value to clinical care and communication among providers if it were able to reliably trend individual patient progress during treatment for asthma in the emergency department, inpatient wards and intensive care units.

Finally, children hospitalized for asthma may require higher levels of care for intensive respiratory management, which may be associated with greater risk for complications. A severity score that aids in early recognition of clinical worsening and affords time to escalate medical management in a step-wise manner may avoid unplanned or urgent escalations in care with associated unit transfer.

Materials and Methods

Patients were eligible for inclusion in this study from triage in the Boston Children’s Hospital Emergency Department if they were admitted to any general medical service on an inpatient ward, ICP or ICU with a principal diagnosis of status asthmaticus, asthma or asthma exacerbation and were between 2-18 years old. Patients with competing acute or chronic respiratory illnesses, active cardiac disease or an immunologic disorder were excluded.

Score development

The HASS was developed by an expert committee consisting of 20 members from multiple clinical disciplines at Boston Children's Hospital involved in the care of hospitalized children with asthma including staff physician representatives from the emergency department, inpatient medicine, pulmonary, allergy, intermediate care and intensive care units, staff nurses, nurse educators, nurse practitioners, respiratory therapists and pharmacists. The committee voted by consensus on the components of the HASS and the scores assigned to each component. The panel was responsible for determining the face validity of the HASS as a tool that would allow multiple providers to communicate their respiratory assessments using both subjective and objective clinical data.

Patient inclusion

We used a systematic chart review method for data abstraction from electronic patient records from the time of initial triage in the emergency department to the time of medical readiness for discharge. We determined the medically indicated duration of hospitalization by calculating the elapsed time between the first albuterol treatment given in the emergency department and the time of the second treatment given at a 4 hour dosing interval.

Early transfer to a higher level of care was captured using electronic nursing flow sheet records that indicated a patient was admitted to the inpatient ward from our emergency department and then subsequently transferred to an intensive care unit setting within 6 hours of arrival to the inpatient ward. The temporal relationship between ward admission and decision to transfer or actual transfer to an intensive care unit was recorded.

HASS reliability testing

We tested the HASS for inter-rater reliability among paired random staff with variable training backgrounds and degrees of clinical experience (i.e. attending and resident physicians, respiratory therapists, staff nurses, nurse practitioners). These raters were not given specific education in use of the

HASS tool. Each clinical staff rater independently completed a HASS score at the bedside of the same patient during their respiratory assessment. The first assessment occurred simultaneously or immediately prior to the second. HASS users were blinded to each other's score responses. Kappa scores were used to calculate inter-rater reliability.

Analysis

Statistical analysis was carried out using SAS software. Copyright, SAS Institute Inc.

Univariate analyses were performed using χ^2 tests to compare demographic and clinical variables between patient groups. LOS and rates of early transfer were compared using 2-sided *t*-tests.

Outcome measurement

Hospital outcomes before and after implementation of the HASS were measured including 1. medically-indicated duration of hospitalization, 2. rates of early transfer to a higher level of care and 3. rates of preventable adverse events and medical errors.

Results

150 children hospitalized with a principal diagnosis of status asthmaticus were included in this study. 75 of these patients were hospitalized in the fall and winter months prior to wide spread implementation of the HASS (year 1) and 75 patients were hospitalized during the subsequent year's fall and winter months, after formal HASS implementation (year 2). The patient characteristics were similar between study years (Table 1). Nearly one third of all hospitalized patients had an ICU or intermediate care unit stay during their hospital course but none required intubation. Less consistent use of the HASS in the emergency department during the time of this study was observed compared to its use on the inpatient wards (19% vs. 95%, respectively). In addition, there was some degree of pilot use of the HASS in year 1, prior to hospital-wide implementation (12% in the emergency department and 35% on the inpatient wards).

When reviewing HASS results for a single bedside encounter, inter-rater reliability among providers was moderate for complete score agreement at 0.6 and almost perfect at 0.89 for a score margin difference of 1 HASS point between providers.

HASS values were also compared among different patients receiving albuterol treatments at the same frequency. Their score ranges were found to be narrow and minimally overlapping (Figure 1). The mean HASS for 34 patients receiving albuterol continuously was 10.8 ± 2.0 . The mean HASS for 29 patients receiving albuterol every 2 hours was 7.8 ± 1.3 . 27 patients who were assessed while receiving albuterol every 4 hours had a mean HASS of 5.8 ± 1.0 . 23 patients who were deemed ready for discharge home had a mean HASS of 5.35 ± 0.57 .

The HASS was also reliable in reflecting hospital care unit assignment upon admission. Study patients admitted from the emergency department underwent HASS scoring upon their arrival from the emergency department to various inpatient wards, step-down and intensive care units. These score margins using the HASS on various care unit assignments from the emergency department were found to be narrow and minimally overlapping as well.

Outcomes related to discharge and frequency of transfer to higher levels of care did not differ significantly between pre and post-HASS study years. Time to medical readiness for discharge was slightly shorter in year 2 but without statistical significance (Table 2). Rates of early transfer to a higher level of care were unchanged between study year 1 and 2 (0.04 ± 0.20 and 0.05 ± 0.22 , respectively). No preventable adverse events or medical errors were captured among study patients.

Discussion

The management of status asthmaticus in pediatrics can be challenging due to the rapid onset and progression of respiratory distress. The ability to accurately measure and report asthma severity at the time of initial assessment is crucial to guiding early medical management. Once treatment is initiated, a reliable and consistent severity tool can be used to gauge patient response to medical therapies and tailor further clinical management. A standardized assessment tool can also optimize communication, particularly during times of care handoffs. The HASS aligned well with pre-existing inpatient asthma management, showing consistency among blinded scores for patients receiving equivalent medical therapies. Similarly, no formal education was necessary prior to HASS implementation and use by multiple hospital care providers with varied medical training backgrounds.

Measurements of respiratory distress can be objective or subjective. Due to inherent difficulty in obtaining peak flow measurements from children with acute asthma as an objective measure of illness severity, several pediatric asthma severity scores have been developed and tested.⁴⁻¹⁰ Some scores have been validated against an objective pulmonary function measurement such as spirometry or peak expiratory flow rate,^{5,6,7,8,10} and the majority have demonstrated good inter-rater reliability among providers. However, these scores have generally been used in the emergency room setting to predict initial response to therapy or hospital admission. One such score, the Pediatric Asthma Severity Score (PASS), comprised of three components, showed reliability in two pediatric emergency rooms in predicting the need for hospital admission.⁶ The Pediatric Respiratory Assessment Measure (PRAM), a five item score based upon the original Preschool Respiratory Assessment Measure, has also demonstrated reliability for predicting hospitalization from the emergency room.¹¹ A Modified Pulmonary Index Score (MPIS) was tested among 30 patients in the emergency room setting and found to be useful in predicting disposition upon admission to the inpatient ward versus intensive care unit.¹² Recently, the HASS and PRAM have demonstrated acceptable inter-rater and intra-rater agreement among children hospitalized for asthma at a tertiary, free-standing children's hospital.¹³ Furthermore, the HASS was used to create a Critical Asthma Standardized

Clinical Assessment and Management Plan (SCAMP) to successfully decrease length of critical asthma management time and reduce intensive care utilization.¹⁴

The HASS is devised from a combination of both objective and subjective respiratory exam findings. Its five components provide more clinical detail than some pediatric asthma severity scores, allowing for detection and communication of smaller interval changes in disease severity throughout hospitalization. Importantly, the reliability of HASS for trending clinical response to treatment throughout a patient's hospital course makes it a unique and a valuable tool among hospital care providers on different inpatient units. Individual score components can be referenced during care handoffs as specific markers of improvement or lack thereof. Clinical staff reported ease of HASS use at the bedside during their respiratory assessments without interruption in workflow and reported added value in communication, particularly during patient care transitions. The HASS was subsequently automated at this study's institution and embedded within the electronic patient flowsheet, making charting and HASS trending easier among clinical staff at the time of care delivery. A hospital-wide clinical practice guideline for asthma management was subsequently developed using HASS ranges as a guide [mild <7, moderate (7-9) and severe (10-15)] with input from all care units within the hospital.

Limitations of this study include its single-center and limited sample size. In addition, pilot use of the HASS in year 1, and inconsistent use of HASS in year 2 may have impeded the ability to detect differences in outcomes between study years. Larger studies that include multiple centers could further validate the HASS with greater ability to detect potential differences in clinical outcomes. Further treatment-focused studies may also find the HASS to be a useful tool in guiding escalation or de-escalation of medical therapies used for management of acute asthma. In addition, clinicians may find the HASS to be a valuable tool in outpatient and urgent care settings where children with acute asthma exacerbations are also managed and may require subsequent referral to the emergency department.

Implementation of a novel hospital-wide asthma severity scoring system (HASS) proved to be a safe intervention at a single, large pediatric institution. No preventable adverse events or medical errors were detected. A decrease in time to discharge readiness after implementation of the HASS was detected but not statistically significant. Rates of early transfer to a higher level of care following admission were similar before and after implementation of the HASS. The HASS is a novel respiratory assessment tool that affords a systematic approach for rating asthma severity throughout hospitalization and across varied clinical care settings.

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