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Acute Asthma Intensity Research Score: Updated performance characteristics for prediction of hospitalization and lung function

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The Acute Asthma Intensity Research Score (AAIRS) is a 7-component, 17-point (0 – 16 with 16 most severe) acute asthma exacerbation severity score. Components of the score include accessory muscle (suprasternal-sternocleidomastoid, intercostal, subcostal) retractions, air entry, wheezing, oxygen saturation on room air ($\geq 95\%$, 0 points; 92 – 94%, 1 point; $< 92\%$, 2 points), and expiratory phase prolongation.¹

We previously reported the performance of the AAIRS to measure baseline acute asthma exacerbation severity and responsiveness to change during treatment in a prospective cohort of 661 patients aged 5 – 17 years who were admitted to our tertiary children's hospital emergency department with acute exacerbations.¹ The criterion outcome measure for that analysis was %-predicted forced expiratory volume in 1-second (%FEV₁).

In this study we sought to examine the performance of the AAIRS to predict hospital or pediatric intensive care unit (PICU) admission.² In addition, we examined the performance of the AAIRS to predict %-predicted airway resistance by impulse oscillometry (%IOS), as well as to confirm prior findings of prediction of %FEV₁ after recruitment of the entire cohort of 933 participants.

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For each participant studied during an acute exacerbation in our pediatric emergency department we performed a comprehensive pulmonary examination and calculated the AAIRS before (baseline) and after 2 hours of treatment. Participants attempted spirometry for %FEV₁ and measurement of %IOS using a CareFusion MasterScreen™ PFT system (CareFusion, Yorba Linda, CA) at each time point. The clinical team was not provided study data, including values for the AAIRS, and followed an asthma clinical practice guideline that used an unvalidated severity score. The study (protocol #080058) was approved by our institutional review board.

We assessed predictive validity with multivariable logistic regression models to examine whether the baseline AAIRS or 2-hour change of the AAIRS is associated with hospital or PICU admission, adjusted for age, gender, race and, for the change-of-AAIRS analysis, baseline AAIRS.³ Construct validity was assessed as the accuracy of the AAIRS to predict %FEV₁ and %IOS at baseline. For these analyses we used multivariable linear regression with %FEV₁ or %IOS as the outcome variable and the AAIRS, age, gender and race as predictor variables. Responsiveness was assessed as the ability of change of the AAIRS to predict change of %FEV₁ and %IOS after 2 hours of treatment.^{3–6} We used multivariable linear regression models to examine 2-hour change of %FEV₁ or %IOS with change of the AAIRS, adjusted for age, gender, race, baseline AAIRS and baseline %FEV₁ or %IOS, respectively.

Of 806 unique participants amongst the cohort of 933 recruited participants, median [IQR] age was 8.9 [6.9, 11.3] years, 61% were male, 58% were African-American, and AAIRS was 5 [2, 8] at baseline and 2 [0, 5] at 2 hours. One-hundred forty-four (18%) were admitted to floor beds and 42 (5%) to the PICU. %FEV₁ was 50 [36, 72; n = 469] at baseline and 61 [43, 77; n = 351] at 2 hours. Corresponding values for %IOS were 162 [125, 219; n = 174] at baseline and 125 [103, 159; n = 133] at 2 hours. The results of multivariable regression models used to assess the AAIRS are displayed in Table 1.

We found associations of the AAIRS with hospital or PICU admission. For example, a 1-point increase of the AAIRS at baseline was associated with 1.3 times the odds for hospital floor admission. Similarly, beta-coefficients were clinically meaningful for the associations of the AAIRS with %FEV₁ and %IOS at baseline and in response to treatment. For example, a 1-point increase in the AAIRS score at baseline is associated with a decrease of %FEV₁ of approximately 5%.

Additionally, our children's hospital now uses the AAIRS as part of an asthma clinical practice guideline according to three levels of severity: mild (AAIRS 1 – 6); moderate (AAIRS 7 – 11); and severe (AAIRS 12 – 16). Hospitalization rates according to these severity levels for participants at baseline were: mild 72/517 (14%); moderate 101/267 (38%); and severe 13/22 (59%). Corresponding hospitalization rates for severity levels amongst participants remaining in the emergency department at 2 hours were: mild 111/493 (22%); moderate 58/79 (73%); and severe 1/1 (100%).

In summary, the AAIRS demonstrates predictive validity for hospitalization and PICU admission as well as construct validity and responsiveness to clinically meaningful changes

of lung function. Expert guidelines recommend use of a comprehensive exacerbation severity score to determine which patients should be admitted to the hospital to improve patient care and resource utilization.⁷ The AAIRS might also complement pediatric and adult clinical prediction rules for asthma hospitalization.^{8,9} Knowledge of the baseline AAIRS and change in response to treatment might inform clinical decision-making at the bedside.

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Abbreviations

AAIRS	Acute Asthma Intensity Research Score
%FEV₁	percent predicted forced expiratory volume in one second
%IOS	percent predicted airway resistance by forced oscillometry

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Table 1

Performance of the Acute Asthma Intensity Research Score (AAIRS) to discriminate baseline severity and to measure responsiveness to change of outcome measures in 806 unique children aged 5 – 17 years with acute asthma exacerbations

Association of AAIRS with outcome			
Outcome	n	Effect size ^a	95% CI
%FEV ₁			
Baseline	469	−4.7	−5.2, −4.3
2-hour change ^b	298	−2.3	−2.9, −1.7
%IOS			
Baseline	134	4.3	0.8, 7.8
2-hour change ^b	174	11.5	7.8, 15.1
Hospital or PICU admission vs. discharge to home			
Baseline	806	1.4	1.3, 1.4
2-hour change ^c	573	1.6	1.5, 1.8
Hospital floor admission			
Baseline	764	1.3	1.2, 1.4
2-hour change ^c	535	1.5	1.4, 1.7
PICU admission			
Baseline	806	1.5	1.3, 1.7
2-hour change ^c	573	1.7	1.4, 2.0

Abbreviations: CI, confidence interval; AAIRS, Acute Asthma Intensity Research Score; %FEV₁, %-predicted forced expiratory volume in 1-second; %IOS, %-predicted airway resistance by impulse oscillometry; PICU, pediatric intensive care unit.

^a Effect size is Beta-coefficient by multiple linear regression for %FEV₁ and %IOS. For hospital or PICU admission it is odds ratio by multiple logistic regression for a 1-point increase of the AAIRS at baseline or a failure to decrease by 1-point for 2-hour change. All analyses adjusted for age, gender and race.

^b 2-hour change of AAIRS to predict 2-hour change of %FEV₁ or %IOS, adjusted for baseline AAIRS and baseline %FEV₁ or %IOS, respectively.

^c 2-hour change of AAIRS to predict hospitalization or PICU admission