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Performance of the Acute Asthma Intensity Research Score (AAIRS) for acute asthma research protocols

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There are limited validated severity measures for acute asthma exacerbations that can be measured in all subjects regardless of age or ability to cooperate and that are sufficiently comprehensive and sensitive to be used as an outcome measure for research protocols. The 13-point (0 – 12) Pediatric Respiratory Assessment Measure (**PRAM**) was developed in young children with exacerbations using airway resistance as the reference measure and discriminated baseline severity and responsiveness after treatment.[1] We have reported that the RAD score, a simple bedside severity score for pediatric patients with acute asthma exacerbations, performs as well as the PRAM score.[2]

The PRAM includes scalene retractions (Table), a sign that the PRAM developers noted in only 2% of their participants before treatment. Although the PRAM developers note that a training lecture and demonstration were used for score assessors, to our knowledge this teaching tool has not been reported.[1] In addition, it has long been recognized that scalene retractions may be consistently ascertained only by palpation or electromyography and that this assessment may be difficult.[3] In a prospective research protocol of pediatric patients with acute asthma exacerbations, we experienced the same difficulty in being able to visually discern scalene muscle retractions. Because of this, we studied the substitution of scalene muscle retractions with visual intercostal and subcostal retractions and expiratory phase prolongation.

This modification also allows for an acute asthma severity score with a greater number of relevant components that have been used in previous scores, are easy to observe, and might

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more fully capture the variability of exacerbation severity needed for research protocols.[4] These modifications resulted in a 17-point (0 – 16) Acute Asthma Intensity Research Score (**AAIRS**) that excludes scalene and includes intercostal and subcostal retractions, as well as expiratory phase prolongation. Our objectives were to assess discrimination of baseline severity and responsiveness of the PRAM and AAIRS and the distributions of score values in children with exacerbations.[5–7]

To assess score discrimination and responsiveness, we studied a prospective cohort aged 5–17 years presenting to a tertiary, academic pediatric emergency department with acute asthma exacerbations. AAIRS component values were specified *a priori* (as done by the PRAM developers) and corresponded to those of the PRAM to facilitate comparative assessment of performance.[1] Each score was calculated on presentation and after 2 hours of treatment. Predictor variables were baseline PRAM and AAIRS and change of each score after 2 hours of treatment (**ΔPRAM, ΔAAIRS)**. Criterion standard outcome variables used to examine discrimination and responsiveness of each score were percent-predicted forced expiratory volume in 1-second (**$\%FEV_1$**) and 2-hour proportionate change expressed as percent (**$\Delta\%FEV_1$**) in those who could perform this test at each time point. We performed linear regression of baseline $\%FEV_1$ on baseline PRAM or AAIRS in two separate models. In two other models, $\Delta\%FEV_1$ was regressed on ΔPRAM or ΔAAIRS, baseline $\%FEV_1$, and the baseline value of the corresponding score. Linear spline functions were used in both sets of models to allow for nonlinear relationships between each predictor and the respective outcome. Ninety-five percent confidence intervals (**95% CI**) were calculated using bootstrap resampling techniques with 1,000 replications. The study protocol was approved by our institutional IRB.

Of 661 unique subjects, median [IQR] age was 8.8 [6.9, 11.3], 60% were male, and 59% were African-American. Accessory muscle use was visually observed in: Scalene, 2 (0.3%); sternocleidomastoid, 362 (55%); intercostal, 110 (17%); and subcostal, 113 (17%). Prolonged expiratory phase was noted in 329 (50%) and severely prolonged expiratory phase in 45 (7%). Baseline scores were: PRAM 4 [1, 5], range 0–9 (SD 2.32); AAIRS 5 [1, 8], range 0–14 (SD 3.53). Baseline $\%FEV_1$ was 51 [36, 72; n = 430] and $\Delta\%FEV_1$ 27 [9.6, 62; n = 282]. Both scores discriminated baseline severity assessed using $\%FEV_1$ (n = 430): PRAM, R^2 0.44 (95% CI, 0.37–0.51); AAIRS, R^2 0.47 (95% CI, 0.41–0.51). In addition, the adjusted models that included change of each score demonstrated responsiveness in predicting $\Delta\%FEV_1$ (n = 282): ΔPRAM, R^2 0.28 (95% CI, 0.17–0.37); ΔAAIRS, R^2 0.28 (95% CI, 0.18–0.34).

The AAIRS demonstrates discrimination and responsiveness comparable to the PRAM. Scalene retractions were observed rarely, whereas intercostal and subcostal retractions and expiratory phase prolongation were observed frequently, accounting for the greater range and variability (SD 3.53 vs. 2.32) of AAIRS. The greater range of values of the AAIRS, which substitutes relevant signs we have found to be easier to identify, might provide more comprehensive assessment of acute asthma exacerbation severity for research protocols.[2]

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Abbreviations

AAIRS	Acute Asthma Intensity Research Score

ΔAAIRS	AAIRS change over the first 2 hours of treatment for acute asthma
%FEV_1	percent predicted forced expiratory volume in one second
Δ%FEV_1	%FEV_1 change over first 2 hours of treatment for acute asthma
PRAM	pediatric respiratory assessment measure
ΔPRAM	PRAM change over the first 2 hours of treatment for acute asthma

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Table

PRAM and AAIRS acute asthma severity score components, values assigned by severity of each component, and ranges of component values comprising each score

	Component values				Component range	
Component	**0**	**1**	**2**	**3**	**PRAM**	**AAIRS**
Retractions[a]						
Scalene	No		Yes		0 or 2	
SCM	No		Yes		0 or 2	0 or 2
Intercostal	No		Yes			0 or 2
Subcostal	No		Yes			0 or 2
Air entry	Normal	Decreased at bases	Widespread decrease	Absent or minimal	0 to 3	0 to 3
Wheezing	Absent	Expiratory	Inspiratory and Expiratory	Audible without stethoscope or silent chest	0 to 3	0 to 3
SpO_2	≥ 95%	92–94%	< 92%		0 to 2	0 to 2
Expiratory phase	Normal	Prolonged	Severely prolonged			0 to 2
Possible total score range					**0 to 12**	**0 to 16**

Abbreviations: PRAM, pediatric respiratory assessment measure; AAIRS, Acute asthma intensity research score; SCM, sternocleidomastoid; SpO_2, oxygen saturation by pulse oximetry

[a]Any visible use of accessory muscle group (Yes/No)