

UNDERSERVED POPULATIONS

Asthma Medication Device Skills in High-Risk African American Adolescents

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Objective. To describe the asthma medication device skills of high-risk African American adolescents and associations between skills and other components of illness management, **Methods.** 170 African American adolescents, with at least one hospitalization or two emergency department visits in the last year, demonstrated how they use their asthma quick-relief and controller medication devices. Observations were scored using an in vivo observation asthma skills checklist. To assess other areas of asthma management, adolescents and their primary caregiver were interviewed using the Family Asthma Management System Scales, **Results.** Only 5% of adolescents correctly demonstrated all controller skills, and none of the adolescents correctly showed all quick-relief inhaler skills (5% showed between 90 and 95% of skills). Several components of asthma management predicting controller medication skills were attendance at an asthma specialty clinic, collaboration with provider, medication adherence, and quick-relief medication skills. These variables accounted for a total of 24% of the variance in controller medication skills, **Conclusions.** Results indicate the need for interventions directly targeting observed asthma management skills and the importance of relationship with providers.

Keywords adherence, children, illness management, inhaler, technique

INTRODUCTION

There are significant disparities in rates of asthma morbidity and mortality, with African American adolescents at highest risk (1–3). Poor asthma management (e.g., inadequate or incorrect use of inhalers for rescue and missed controller medications) may account for asthma morbidity (4, 5). Consistent with other chronic conditions, asthma management deteriorates in adolescence as responsibility may be inadequately transferred from parent to child before the adolescent has fully developed the knowledge and skill to manage the condition (6). Studies have inconsistently shown relationships between asthma knowledge and actual asthma management or health outcomes (7), but many have noted that behavioral skills for illness management may be more relevant for improved morbidity and mortality than the type of factual disease knowledge typically assessed (6, 8). While high rates of improper use of inhalers and other devices have been documented, these studies have not focused on African American adolescents at highest risk (9, 10) and did not report relationships between skills and medication adherence or health outcomes. The only study focusing on African American youth's equipment skills and asthma management enrolled 48 children ages 8 to 13 (11). Children with adequate MDI/spacer technique had higher total scores on the Family Asthma Management System Scale (FAMSS) as well as the Family and Child Response to Symptoms subscales. Relationship to health outcome was not reported, and skills for controller medication

versus quick-relief medication were not distinguished. The purpose of the present study was to describe the observed medication device skills of high-risk African American adolescents with moderate to severe persistent asthma. Furthermore, we assessed the associations between behavioral skills and other components of asthma management within an African American sample of high-risk youth.

METHODS

Data were drawn from the baseline data collection of a randomized trial comparing two home-based adherence interventions in high-risk African American adolescents (ages 12–16) with asthma. High risk was defined as having at least one asthma-related hospitalization or at least two asthma-related emergency department (ED) visits in the last 12 months at an urban children's hospital. Exclusion criteria included thought disorder, suicidality, mental retardation, having another chronic health condition, or not residing in a home setting. A study nurse obtained written releases for families to be contacted by the research team in the hospital's outpatient immunology clinic or during a hospital/ED stay. Research staff met with eligible families at their home to obtain caregiver consent and adolescent assent. Data collection subsequently occurred in the home, and families were reimbursed \$50. The study was approved by the university's Human Investigation Committee.

Medical record review revealed 303 adolescents were study-eligible based on having a hospitalization in the previous year; clinical staff approached 196, obtaining

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TABLE 1.—Scoring of asthma equipment checklist.

Medication device	# of Items	Total possible score ^a
Quick-relief medication devices		
Metered dose inhaler with spacer	10	20
Metered dose inhaler no spacer	9	18
Controller medication devices		
Metered dose inhaler with spacer	10	20
Metered dose inhaler no spacer	11	22
Diskus ®	10	20
Flexhaler ® /Turbuhaler ®	10	20

^aFor each skill, a score of 2 indicated full completion, 1 indicated partial completion, and 0 indicated incorrect or noncompletion.

184 releases (12 refusals). Clinical staff (e.g., physician and nurse) approached eligible participants during clinic appointments or in-patient hospitalizations. An additional 96 youth were found to be study-eligible based on having two ED visits in the previous year; the families were all sent recruitment letters from the asthma clinic. Eligibility based on ED visits was added 12 months prior to accrual end date. Of the 96 youths, 20 responded and 19 families were consented and enrolled before the study completed accrual (one refusal). An additional 13 families refused participation at the consent visit or prior to baseline data collection. A total of 170 families consented and completed baseline data collection.

Adolescents demonstrated how they use their own quick-relief and controller medication devices in their homes, and trained research assistants coded skills in vivo using an Equipment Skill Checklist (with the version relevant to the specific device) adapted from existing measures (9, 10). Scoring is shown in Table 1. Because of the variability of equipment used, percent knowledge score was calculated separately for controller and quick-relief medications by dividing the total score by the maximum possible points based on the equipment available in the home.

Asthma management was measured by the FAMSS, a 45-minute semi-structured joint interview with caregiver and adolescent (12). Raters were trained by the developers with regular checks of inter-rater reliability per the system protocol. The following 9-point rating scales were utilized in analyses: Asthma Knowledge, Assessment of Symptoms, Appropriateness of Family's and Child's Response to Symptoms/Exacerbations, Environmental Control, Asthma Medication Adherence, and Collaborative Relationship with Provider. Medical records were reviewed for attendance at the hospital's multidisciplinary asthma specialty clinic in the last 13 months (coded Yes for any appointment and No for no appointments). To describe the sample and confirm high-risk status, FEV1 was obtained using a portable calibrated recording spirometer (13).

RESULTS

Adolescents were 61% male. Sixty-five percent of the adolescents visited the hospital's asthma specialty clinic within the past 13 months. Most families had a single caregiver (59%) in the home, while 41% had at least two caregivers in the home. Half (52%) reported a household income of less than \$16,000 per year. Twenty-eight percent ($N = 48$) of caregivers were high school graduates, 42% ($N = 40$) were not high school graduates, 40% ($N = 68$) graduated high school and had some college education, and 8% ($N = 14$) graduated with an undergraduate college degree or higher. Only 5% ($N = 8$) adolescents reported trying cigarette smoking. Of those who tried cigarettes, only one participant reported smoking daily for the last 30 days, while the rest reported not smoking cigarettes in the last 30 days.

FEV1 ranged from 0.75 to 3.61 ($M = 2.13$; $SD = 0.58$), FEV1% ranged from 28.00 to 149.00 ($M = 79.32$; $SD = 19.30$), and FVC% ranged from 41.00 to 216.00

TABLE 2.—Equipment checklist: individual skills common to each equipment type.

Equipment skill	Skill Yes		Skill partial		Skill No	
	N ^a	%	N	%	N	%
Quick-relief skills						
Removes cover from mouthpiece	152	95.00	1	0.63	7	4.38
Shakes inhaler vigorously for at least 5 seconds	109	67.70	14	8.70	38	23.60
Breathes out to empty lungs	54	33.54	6	3.73	101	62.73
Stands up (head tilted back for MDI)	43	26.71	65	40.37	53	32.92
Puts in mouth correctly with head in the correct (horizontal) position	34	21.12	96	59.63	34	19.25
Breathes in and releases medicine correctly	142	88.20	15	9.32	4	2.48
Breathes in slowly for 3–5 seconds (for spacer, no spacer whistle)	124	77.50	15	9.38	21	13.13
Breathes deeply	135	83.85	4	2.48	22	13.66
Holds breath for 5–10 seconds	108	67.08	4	2.48	49	30.43
Controller skills						
Shakes controller properly (shake controller and spacer; do not shake diskus and turbuhaler)	108	72.48	7	4.70	34	22.82
Breathes out to empty lungs	52	34.90	4	2.68	93	62.42
Positions correctly in (spacer, diskus, turbuhaler) or near (controller) mouth	83	55.70	48	32.21	18	12.08
Breathes in correctly (diskus: steadily and deeply; turbuhaler: deeply and forcefully; others average items "slowly" and "deeply")	121	81.76	21	14.19	6	4.05

^aunequal Ns are the result of youth having different equipment that may not require a particular step.

($M = 97.56$; $SD = 22.36$). Quick-relief inhaler skill scores ranged from 0 to 95% ($M = 66\%$, $SD = 22$). Controller medication skill scores ranged from 0 to 100% ($M = 62\%$, $SD = 28$).

Only 5% correctly showed all controller medication skills, while none of the adolescents correctly showed all quick-relief inhaler skills (5% showed between 90 and 95% of skills). Table 2 gives details as to which skills were the most common problem causing improper inhaler technique. Table 3 demonstrates correlations between device skill scores, FAMSS, FEV1, and demographics. Controller medication skills were significantly associated with quick-relief inhaler skill, specialty asthma care clinic attendance, and two subscales of the FAMSS measure (collaboration with provider and medication adherence). Correlations between controller medication skills and the appropriateness of the family's response to asthma symptoms and exacerbations, asthma knowledge (both FAMSS measures) approached significance. Quick-relief inhaler skills were related to controller medication skills and appropriateness of child's response to symptoms and exacerbations (FAMSS measure), while only approaching significance for adherence with asthma medications (FAMSS measure).

Linear regression was used to assess the relative contribution of potential variables in accounting for variance in controller medication skill. Regression was not conducted with quick-relief inhaler because only one variable was significant in correlational analysis. Only variables that were associated at a significance of $p < .05$ in bivariate analyses (attendance at a specialty asthma clinic, quick-relief inhaler skill, collaboration with provider, and medication adherence) were included in the regression analysis. The overall model was significant ($F(4,165) = 14.17$, $p = .00$) and accounted for approximately 24% of the total variance in controller medication skill (adjusted $R^2 = 0.24$). In the multivariate analyses, attendance at a specialty asthma clinic ($\beta = 0.28$, $t(165) = 4.14$, $p = .00$), quick-relief inhaler skill ($\beta = 0.32$, $t(165) = 4.71$, $p = .00$), and collaboration with provider ($\beta = 0.22$, $t(165) = 3.01$, $p = .003$) were all independently significant predictors of controller medication skill.

DISCUSSION

This is the first study to conduct direct observation of asthma medication device skills in high-risk African American adolescents. Even though this sample was older than previous studies (10), very few adolescents were able to perform all required skills. Rates of accurate skill were lower than in a recent study of younger African American children (11) but consistent with an ethnically diverse non-urban sample of children and adolescents (9). Device skills were not associated with asthma knowledge, confirming the uniqueness of these constructs. The National Heart Lung and Blood Institute expert guidelines recommend that providers demonstrate the steps necessary for successful utilization of asthma

TABLE 3. — Bivariate correlations among study variables.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age	-															
2. Gender (female=1; male=2)	-.21**	-														
3. Specialty clinic (yes=1; no=0)	-.15***	.01	-													
4. % quick relief skills	.06	-.01	.05	-												
5. % controller skills	.02	-.04	.32**	.33**	-											
6. FAMSS: Asthma knowledge	.08	-.00	.23**	.02	.13***	-										
7. FAMSS: Symptom assessment	-.00	.02	.02	-.03	.05	.62**	-									
8. FAMSS: Family response	-.01	.01	-.04	.11	.14***	.46**	.47**	-								
9. FAMSS: Child response	.08	-.08	-.02	.17*	.06	.31**	.38**	.56**	-							
10. FAMSS: Environmental control	.02	.03	-.01	-.07	.01	.21**	.22**	.18**	.18*	-						
11. FAMSS: Medication adherence	-.02	.12	.12	.14***	.19*	.43**	.42**	.32**	.37**	.22**	-					
12. FAMSS: Provider collaboration	.09	-.13***	.11	-.05	.25**	.38**	.42**	.35**	.29**	.25**	.38***	-				
13. FEV1	.29**	.04	-.08	.12	.01	-.01	-.08	.06	.16*	-.08	.15***	-.10	-			
14. Single or multiple caregivers	-.15***	-.02	-.12	-.00	.02	-.03	.06	.07	-.02	-.00	-.04	.02	-.12	-		
15. Caregiver education level	-.13***	.11	.00	.09	.13***	.15*	.26**	.20**	.18*	.04	.11	.10	-.07	-.00	-	
16. Family income	.04	.08	-.03	.00	.01	.10	.06	.05	.05	.08	.00	.03	-.07	.15*	.24**	-

* $p < .05$; ** $p < .01$; *** $p < .10$

devices, and then have the child demonstrate back how he/she would use the devices (behavioral rehearsal). Studies have suggested that asthma healthcare providers demonstrate inaccurate ICS technique (9, 14–17) and rarely observe technique at regular asthma visits (9). However, device skills improve when providers tailor education to patients' health literacy (18).

The provider's role in improving skills is reinforced by the finding that more controller medication skills were associated with the collaboration with provider scale and with families accessing a multidisciplinary asthma specialty care clinic. These findings have implications for understanding health disparities in asthma as many studies have noted that quality of care is lower among African American children compared to White children (19). Collaboration was not associated with specialty care attendance, suggesting that high patient–provider collaboration in primary care contexts may also enhance skills. Intervention studies are needed to confirm these findings. Because these variables were assessed by interviewing the family together, further research is necessary to determine the relative importance of the adolescent's and caregiver's perception of provider relationships. Another limitation is that our sample had a restricted range of asthma severity and possibly medication adherence. Further research is necessary to test interventions emphasizing observation of asthma skills in the context of collaborative patient–provider relationships populations improve adherence in high-risk youth. Future research should consider including measures of adolescent health literacy as improving health literacy may be one avenue to improving asthma medication device skills (20).

CONCLUSIONS

High-risk African American adolescents with asthma have low levels of asthma medication device skills which may explain in part poor adherence. Improved patient–provider relationships and attendance in a multidisciplinary specialty care clinic were both associated with improved skills in this population.

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DECLARATION OF INTEREST

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REFERENCES

1. CDC Vital and Health Statistics. Asthma in the US: Growing every year. Available at: [</refOther>](http://www.cdc.gov/VitalSigns/Asthma/). Assessed October 2012.
2. Kruse LK, Deshpande S, Vezina M. Disparities in asthma hospitalizations among children seen in the emergency department. *J Asthma* 2007; 44:833–837.
3. Flores G, Tomany-Korman SC. Racial and ethnic disparities in medical and dental health, access to care, and use of services in US children. *Pediatrics* 2008; 121:e286–e298.
4. Bauman LJ, Wright E, Leickly FE, Crain E, Kruszon-Moran D, Wade S, Visness CM. Relationship of adherence to pediatric asthma morbidity among inner-city children. *Pediatrics* 2002; 110:e6–e6.
5. Adams RJ, Fuhlbrigge A, Finkelstein JA, Lozano P, Livingston JM, Weiss KB, Weiss ST. Impact of inhaled anti-inflammatory therapy on hospitalization and emergency department visits for children with asthma. *Pediatrics* 2001; 107:706–711.
6. McQuaid EL, Kopel SJ, Klein RB, Fritz GK. Medication adherence in pediatric asthma: Reasoning, responsibility, and behavior. *J Pediatr Psychol* 2003; 28:323–333.
7. Burgess S, Sly P, Devadason S. Adherence with preventive medication in childhood asthma. *Pulmonary Med* 2011; 2011: doi:10.1155/2011/973849.
8. Quittner AL, Modi AC, Lemanek KL, Levers-Landis CE, Rapoff MA. Evidence-based assessment of adherence to medical treatments in pediatric psychology. *J Pediatr Psychol* 2008; 33:916–936.
9. Sleath B, Ayala GX, Gillette C, Williams D, Davis S, Tudor G, Yeates K, Washington D. Provider demonstration and assessment of child device technique during pediatric asthma visits. *Pediatrics* 2011; 127:642–648.
10. Boccuti L, Celano M, Geller RJ, Phillips KM. Development of a scale to measure children's metered-dose inhaler and spacer technique. *Ann Allergy Asthma Immunol* 1996; 77:217–221.
11. Celano M, Klinnert MD, Holsey CN, McQuaid EL. Validity of the family asthma management system scale with an urban African-American sample. *J Pediatr Psychol* 2011; 36:576–585.
12. McQuaid EL, Walders N, Kopel SJ, Fritz GK, Klinnert MD. Pediatric asthma management in the family context: The family asthma management system scale. *J Pediatr Psychol* 2005; 30:492–502.
13. Stempel DA, Fuhlbrigge AL. Defining the responder in asthma therapy. *J Allergy Clin Immunol* 2005; 115:466–469.
14. Sleath B, Ayala GX, Gillette C, Williams D, Davis S, Tudor G, Yeates K, Washington D. Provider demonstration and assessment of child device technique during pediatric asthma visits. *Pediatrics* 2011; 127:642–648.
15. Kim SH, Kwak HJ, Kim TB, Chang YS, Jeong JW, Kim CW, Jee YK. Inappropriate techniques used by internal medicine residents with three kinds of inhalers (a metered dose inhaler, Diskus, and Turbuhaler): Changes after a single teaching session. *J Asthma* 2009; 46:944–950.
16. Nadi E, Zeraati ENF. Evaluation of the metered-dose inhaler technique among healthcare providers. *Acta Medica Iranica* 2005; 43:268–272.
17. Self TH, Arnold LB, Czosnowski LM, Swanson JM, Swanson H. Inadequate skill of healthcare professionals in using asthma inhalation devices. *J Asthma* 2007; 44:593–598.
18. Paasche-Orlow MK, Riekert KA, Bilderback A, Chanmugam A, Hill P, Rand CS, Brancati FL, Krishnan JA. Tailored education may reduce health literacy disparities in asthma self-management. *Am J Resp Crit Care Med* 2005; 172:980–986.
19. Flores G. Racial and ethnic disparities in the health and health care of children. *Pediatrics* 2010; 125:e979–e1020.
20. Manganello JA. Health literacy and adolescents: A framework and agenda for future research. *Health Educ Res* 2008; 23:840–847.