

PEDIATRIC

Communication during Pediatric Asthma Visits and Child Asthma Medication Device Technique 1 Month Later

BETSY SLEATH, PH.D.,^{1,2,*} DELESHA M. CARPENTER, PH.D., M.S.PH.,¹ GUADALUPE X. AYALA, PH.D., M.PH.,³ DENNIS WILLIAMS, PHARM.D.,¹ STEPHANIE DAVIS, M.D.,⁴ GAIL TUDOR, PH.D.,⁵ KARIN YEATTS, PH.D.,⁶ AND CHRIS GILLETTE, PH.D.⁷

¹*Division of Pharmaceutical Outcomes and Policy, University of North Carolina Eshelman School of Pharmacy, Chapel Hill, NC, USA.*

²*Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill University of North Carolina at Chapel Hill, Chapel Hill, NC, USA.*

³*Division of Health Promotion and Behavioral Science, Graduate School of Public Health, San Diego State University, San Diego, CA, USA.*

⁴*Department of Pediatrics, University of North Carolina School of Medicine at Chapel Hill, Chapel Hill, NC, USA.*

⁵*Department of Science and Mathematics, Husson University, Bangor, ME, USA.*

⁶*Epidemiology, Gillings School of Global of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA.*

⁷*Marshall University School of Pharmacy, Huntington, WV, USA.*

Objective. This study investigated how provider demonstration of and assessment of child use of asthma medication devices and certain aspects of provider–patient communication during medical visits is associated with device technique 1 month later. **Methods.** Two hundred and ninety-six children aged 8–16 years with persistent asthma and their caregivers were recruited at five North Carolina pediatric practices. All of the medical visits were audio-tape recorded. Children were interviewed 1 month later and their device technique was observed and rated. **Results.** If the provider asked the child to demonstrate metered dose inhaler technique during the medical visit, then the child was significantly more likely to perform a greater percentage of inhaler steps correctly 1 month later. Children with higher asthma management self-efficacy scores were significantly more likely to perform a greater percentage of diskus steps correctly. Additionally, children were significantly more likely to perform a greater percentage of diskus steps correctly if the provider discussed a written action plan during the visit. Children were significantly more likely to perform a greater percentage of turbuhaler steps correctly if they asked more medication questions. **Conclusions.** Providers should ask children to demonstrate their inhaler technique during medical visits so that they can educate children about proper technique and improve child asthma management self-efficacy. Providers should encourage children to ask questions about asthma medication devices during visits and they should discuss asthma action plans with families.

Keywords device technique, medication questions, self-efficacy, written action plans

INTRODUCTION

Asthma is the most common chronic condition among US children (1, 2). In the United States, asthma affects more than 6 million children and accounts for an estimated 20 billion dollars in health-care costs annually (3). The clinical practice guidelines of the National Asthma Education and Prevention Program of the National Heart Lung and Blood Institute encourage physicians to discuss medications with patients at every follow-up asthma visit (3). The guidelines also recommend that providers show children how to use asthma medication devices and that they assess how well children are using the devices (3, 4). The national guidelines suggesting this were published in 2002 (4). Our prior work demonstrated that providers rarely demonstrated or assessed asthma medication device technique during audio-taped medical visits and that child asthma

medication device technique was poor immediately after the visits (5). This article extends our prior work by examining how provider demonstration and assessment of child use of asthma medication devices during medical visits is associated with child asthma medication device technique 1 month later.

The national guidelines also emphasize the importance of jointly determining the goals of treatment with the patient and family and providing the patient with a written action plan (3). Moreover, the 2001 US Institute of Medicine report endorsed patient-centered care and recommended that health-care professionals implement the shared decision-making model in clinical settings (6, 7). However, little is known about how well physicians involve children when creating an asthma treatment plan and how this impacts their asthma medication device technique.

Therefore, this article also extends our prior work by examining whether certain aspects of provider–patient communication that are recommended in the national asthma guidelines (i.e., the number of control medication areas educated about, the written action plan being discussed, the total number of medication questions asked by children, and the provider including child input into the

*Corresponding author: Betsy Sleath, Ph.D., Division of Pharmaceutical Outcomes and Policy, University of North Carolina Eshelman School of Pharmacy, CB # 7590, Chapel Hill, NC 27599-7573, USA; Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill University of North Carolina at Chapel Hill, CB # 7590, Chapel Hill, NC 27599-7590; Tel: +011-1-919-966-8969; Fax: +011-1-919-966-1634; E-mail: betsy_sleath@unc.edu

asthma management treatment plan) are associated with child asthma medication device technique 1 month after the audio-taped visit.

METHODS

Participants

The study was approved by the University of North Carolina Institutional Review Board. Providers were recruited at five pediatric practices in North Carolina and consent was obtained. The research design is an observational study of provider–patient communication about asthma medication devices during primary care clinic visits. The study did not include an intervention.

Children and their caregivers of these participating providers were recruited between 2006 and 2009. Children were eligible if they (a) were 8–16 years of age, (b) were able to speak English, (c) could read the assent form, (d) had been seen at the clinic at least once before, (e) were present at the visit with an adult caregiver (parent or legal guardian) who could read and speak English and who was at least 18 years of age, and (f) had mild, moderate, or severe persistent asthma. Persistent asthma was defined as experiencing asthma-related daytime symptoms more than twice a week, experiencing asthma-related nighttime symptoms more than twice a month, or receiving one or more long-term controller therapies for asthma (8, 9).

Clinic staff referred potentially eligible patients who were interested in learning more about the study to a research assistant. The research assistant explained the study, obtained caregiver consent and child assent, and administered the eligibility screener (4). Providers and families were told that the study was examining communication during pediatric visits. All of the medical visits were audio-tape recorded. A home visit was conducted 1 month later. Children were interviewed and their asthma medication device technique was observed and rated by the research assistants. Caregivers completed self-administered questionnaires.

Audio-Tape Coding

Each medical visit audio-tape was transcribed verbatim and then coded by two research assistants. The research assistants used a detailed coding tool that contained code definitions and example quotations to code for asthma-related communication. The two research assistants coded 20 of the same transcripts throughout the study period to assess inter-coder reliability. More detail about how communication variables were coded is provided below in the measures section.

MEASURES

Demographic and Sociodemographic Characteristics

The caregiver screening instrument assessed children's medication use. The research assistants showed caregivers a list of asthma medications and asked them to indicate

which one(s) the child was taking. Responses were dichotomized based on whether the caregiver reported that the child was taking a controller medication versus not taking a controller medication. Asthma severity was classified as mild versus moderate/severe by a research assistant based on recent symptoms and medication use reported by the caregivers when research assistants administered the eligibility screening instrument for the study (4, 8, 9). Our eligibility screening instrument utilized the primary asthma severity classification system that was being used when the study was designed and conducted (4, 8). More detail about the asthma severity classification system is provided by Sleath and colleagues (4).

A variety of demographic and sociocultural factors were examined as potential confounders. For descriptive purposes, child race was recoded into four categories: White, African American, Native American/American Indian, or Other. Hispanics, Asian Americans, and other racial or ethnic categories were included in the Other category. However, for the bivariate and multivariable analyses, child race was recoded into a dichotomous variable (White vs. non-White). The child's insurance status was measured using the following categories: none, private insurance, Medicaid, the State Children's Health Insurance Program (SCHIP), and other. Number of years the child has had asthma was measured as a continuous variable. Caregiver education was measured in years. Child asthma management self-efficacy was measured at the home visit using a 14-item scale that has a reliability of 0.87 (10). We calculated the mean asthma management self-efficacy score as a continuous measure for each child.

Communication during Visits

Coders of the medical visit transcripts recorded whether the provider demonstrated (1) metered dose inhaler technique, (2) diskus technique, and (3) turbuhaler technique. Coders also recorded whether the provider asked the child to demonstrate how they use their metered dose inhaler, diskus, and turbuhaler. Each of these items was coded dichotomously as yes or no. Additionally, coders recorded the number of controller medication areas that the provider educated about during the visit. The different areas of control medication education included: adherence, fears/concerns, frequency/timing, generic/brand, how well it works, purpose, side effects, strength/dose, and supply. The coders also recorded the number of medication questions asked by the child, whether a written action plan was discussed, and whether the provider included child input into the asthma management treatment plan.

Two research assistants coded 20 of the same transcripts throughout the study period to assess inter-coder reliability. However, provider demonstration of device technique and asking the child to demonstrate device technique happened so infrequently that inter-coder reliability statistics could not be calculated. However, there was 100% coder agreement for the provider demonstrating metered dose inhaler technique, the provider asking the child to demonstrate their metered dose inhaler technique, and the provider asking the child to demonstrate their diskus technique.

There was 95% coder agreement for provider demonstrating peak flow technique and diskus technique and the provider asking the child to demonstrate turbuhaler technique and peak flow technique. There was 90% coder agreement for the provider demonstrating turbuhaler technique.

Inter-rater reliability varied between 0.80 and 0.96 for the following communication variables: (1) the number of control medication areas educated about was 0.80, (2) a written action plan being discussed was 0.93, (3) the total number of medication questions asked by children was 0.96, and (4) the provider including child input into the asthma management treatment plan was 0.88.

Asthma Medication Device Technique

The pediatric pulmonologist and clinical pharmacist specializing in asthma on our team developed how device technique would be assessed using the peer-reviewed literature and their clinical experience (11–13). Five research assistants underwent training to assess inhalation device technique, and these research assistants were different from those who coded the audio-tape data. A DVD was created with examples of optimal technique with each device, and scoring sheets for research assistants were developed. Three children were then recorded using the various devices with varying omissions and errors. The devices used for the DVD were (1) metered dose inhaler

(MDI), (2) dry powder inhaler (DPI Diskus), and (3) dry powder inhaler (DPI Turbuhaler). The research assistants viewed and scored the example techniques using the study criteria. These results were reviewed by a clinical pharmacist investigator who provided feedback based on his clinical judgment. Each research assistant was asked to review the DVD recording again until concordance was reached among all participants.

At the home visit, all children were asked if they used each of the devices. If they reported that they did, they were then asked to demonstrate their technique. Metered dose inhaler technique had eight possible correct steps (Table 1) and a variable “percentage of inhaler steps gotten correct” was calculated. After demonstrating the metered dose inhaler, children were asked if they usually used a spacer. If they stated “yes”, they were asked to then demonstrate using an inhaler with a spacer. Using a metered dose inhaler with a spacer had eight possible correct steps (Table 1). Diskus technique had seven possible correct steps (Table 2) and a variable “percentage of diskus steps gotten correct” was calculated. Turbuhaler technique had seven possible correct steps (Table 3) and a variable called “percentage of turbuhaler steps gotten correct” was calculated. In addition, we calculated an “average percentage of asthma medication device steps gotten correct” variable (it was calculated by adding together the percentage of steps gotten correct for each of

TABLE 1.—Number of inhaler steps children with asthma performed correctly.

<i>Metered dose inhaler (N = 250)</i>		
Steps	Percentage (N)	
	Children aged 8–12 years (N = 174)	Children aged 13–16 years (N = 76)
• Remove cap from inhaler	92.5 (161)	98.7 (75)
• Shake inhaler 4–6 times	48.9 (85)	69.7 (53)
• Exhale normally	40.2 (70)	43.4 (33)
• Tilt head back slightly, with inhaler upright, place mouthpiece between lips or 1–2 inches in front of a wide open mouth	87.4 (152)	93.4 (71)
• Begin a slow deep breath	78.7 (137)	89.5 (68)
• Press inhaler canister once at beginning of breath	79.3 (138)	80.3 (61)
• Continue to inhale for 3–4 seconds	59.2 (102)	68.4 (52)
• Hold breath for 10 seconds	36.8 (64)	39.5 (30)
• Children who performed all steps correctly	16.7 (29)	21.1 (16)
<i>Metered dose inhaler with spacer (N = 65)</i>		
Steps	Percentage (N)	
	Children aged 8–12 years (N = 55)	Children aged 13–16 years (N = 10)
• Remove cap from inhaler	98.2 (54)	100.0 (10)
• Attach inhaler into holding chamber	100.0 (55)	100.0 (10)
• Shake inhaler 4–6 times	45.5 (25)	90.0 (9)
• Exhale normally	56.4 (31)	60.0 (6)
• Tilt head back slightly, place holding chamber mouthpiece between lips, holding inhaler upright	83.6 (46)	70.0 (7)
• Press inhaler canister once to place dose in holding chamber	98.2 (54)	100.0 (10)
• Begin a slow deep inhalation immediately after placing dose in holding chamber (3–4 seconds)	80.0 (44)	100.0 (10)
• Hold breath for 10 seconds	38.2 (21)	70.0 (7)
• Children who performed all steps correctly	27.3 (15)	40.0 (4)

TABLE 2.—Diskus device technique ($N = 104$).

Steps	Percentage (N)	
	Children aged 8–12 years ($N = 71$)	Children aged 13–16 years ($N = 33$)
• Open device until it clicks	100.0 (71)	100.0 (33)
• To load a dose, hold device horizontal and slide the lever away from you until it stops (there should be a second click)	71.8 (51)	66.7 (22)
• Exhale gently away from mouthpiece	45.1 (32)	39.4 (13)
• Place mouthpiece in lips	98.6 (70)	100.0 (33)
• Take a forceful breath in steadily and deeply	91.5 (65)	93.9 (31)
• Hold breath for 10 seconds	28.2 (20)	48.5 (16)
• Close device by sliding thumb grip toward self until it clicks	98.6 (70)	100.0 (33)
• Children who performed all steps correctly	23.9 (17)	33.3 (11)

TABLE 3.—Turbuhaler device technique ($N = 38$).

Steps	Percentage (N)	
	Children aged 8–12 years ($N = 29$)	Children aged 13–16 years ($N = 9$)
• Lift off white cover to reveal mouthpiece	86.2 (25)	66.7 (6)
• Hold device with mouthpiece up and twist the grip at the base, back and forth one time to load dose	65.5 (19)	66.7 (6)
• Hold device horizontal and exhale gently, away from mouthpiece	37.9 (11)	33.3 (3)
• Place mouthpiece between lips	96.6 (28)	100.0 (9)
• Take a forceful breath in steadily and deeply	93.1 (27)	100.0 (9)
• Hold breath for 10 seconds	31.0 (9)	33.3 (3)
• Replace white cover	69.0 (20)	66.7 (6)
• Children who performed all steps correctly	20.7 (6)	22.2 (2)

the three devices and divided by 3). We did this, so we could examine the association between the percentage of steps gotten correct and the number of devices a child was on.

Statistical Analyses

All analyses were conducted using SPSS (SPSS-Statistical Package for Social Sciences, IBM). First, we present descriptive statistics for the variables. We also present whether children performed device steps correctly by age group (8–12 years and 13–16 years) because our generalized estimating equation (GEE) model revealed that child age was associated with the number of metered dose inhaler steps performed correctly. Second, we examine bivariate relationships between the variables using correlation coefficients, *t*-tests, or Pearson chi-square statistics. Next, we utilized the GEE model to predict the percentage of metered dose inhaler steps the child performed correctly and the percentage of diskus steps the child performed correctly. Child age, gender, race, number of years living with asthma, severity of asthma, caregiver education, and child self-efficacy were included in all GEE models. For the metered dose inhaler analysis, we focused on all children who reported and demonstrated using a metered dose inhaler ($N = 249$) rather than just focusing on those who reported using it with a spacer ($N = 62$).

Due to the infrequent occurrence of many of the communication variables, we included only those communi-

cation variables that were significant in the bivariate analysis in the GEE models to preserve statistical power. Provider age and gender were omitted from the GEE analyses because they were not significantly associated with the percentage of inhaler or diskus steps children performed correctly. Provider race was omitted from the GEE analysis predicting metered dose inhaler technique because it was significantly associated with whether the provider asked the child to demonstrate their inhaler technique, thus creating collinearity issues (the results are presented below). Provider race was not significantly associated with correct diskus technique and was therefore not included in the GEE analyses predicting the percentage of diskus steps the child performed correctly. We did not conduct a GEE analysis for turbuhaler technique because only 38 children were on a turbuhaler, so only bivariate results are presented. Each GEE analysis was clustered by the provider.

RESULTS

The five participating clinics were primary care pediatric practices. Forty-one providers agreed to participate in the study. Two providers refused to participate with a participation rate of 95.3%. Eighty-eight percent of the families approached agreed to participate in the study. Three hundred and twenty-three families agreed to participate in the study. There were unusable audio-tape data for 27 of the

visits (tapes were either inaudible or recorded incorrectly). Two hundred and ninety-six patients had useable audio-tape data and these patients were seen by 35 of the 41 providers who agreed to participate in the study. Four of the 35 providers were nurse practitioners or physician assistants and they saw 17 of the participating children. Fifty-one percent of the providers were female. Twenty-seven of the providers were White, two were American Indian, three were African American, one was Asian, and two classified their race as other. Providers ranged in age from 30 to 70 years (mean = 44.8 years, standard deviation = 9.4).

This article focuses on 259 of 296 children (88%) who completed a home visit interview approximately 1 month after their audio-taped medical visit. Table 4 presents the child and caregiver demographic characteristics. Child age ranged from 8 to 16 years (mean age = 11.1 years, standard deviation = 2.4). Close to 30% of the sample was African American and 50.6% of the sample was male. Seventy-one percent of the children had moderate/severe persistent asthma. Child self-efficacy scores ranged from 2 to 5 (mean = 4.05, standard deviation = 0.62).

Providers educated about control medications during 60% of visits (range 0–7 areas educated about, mean = 1.54, standard deviation = 1.66). Providers discussed written action plans during 20% of visits. Children asked medication questions during 13% of visits (range 0–6 questions). Providers included child input into the asthma management plan during only 6% of the visits. None of the provider characteristics were significantly associated with any of the communication variables.

TABLE 4.—Child and caregiver demographic characteristics ($N = 259$).

	Percentage (N)
Child age	
8–12 years old	69.9 (181)
13–16 years old	30.1 (78)
Child gender	
Male	50.6 (131)
Female	49.4 (128)
Child race	
White	61.4 (159)
African American	29.7 (77)
Native American/American Indian	10.8 (28)
Other	5.0 (13)
Asthma severity	
Mild persistent	28.6 (74)
Moderate/severe persistent	71.4 (185)
Caregiver age	
Mean (SD) range	40.9 (8.6) 26–80 years
Caregiver gender	
Male	13.2 (34)
Female	86.8 (224)
Caregiver education (years)	
Mean (SD) range	12.7 (2.5) 2–20 year
Insurance type	
None	1.2 (3)
Private	27.2 (70)
Medicaid	52.9 (136)
State children's health insurance program	16.3 (42)
Other	2.3 (6)

Metered Dose Inhaler Technique

One hundred and eleven children were on one device, 133 were on two devices, and 1 child was on three devices. If a child was on two or more devices, then they were significantly more likely to have a higher “average percentage of asthma medication device steps gotten correct” than children just on one device (t -test = 15.4, $p = .000$).

Two hundred and forty-nine children (96.1%) reported using a metered dose inhaler at the home visit. Among children who used inhalers, providers demonstrated inhaler technique during 6 visits (2.4%) and asked the child to demonstrate technique during 11 visits (4.3%). Table 1 presents the steps the children performed correctly. As shown in Table 1, only 18% of children performed all the steps correctly. Children got an average of 70% of steps correct (standard deviation = 22.4, range 12.5–100%).

In the bivariate analyses, if the provider asked the child to demonstrate his/her use of a metered dose inhaler during a medical visit, then the child performed a greater percentage of steps correctly 1 month later (t -test = 2.54, $p = .03$). Additionally, if the provider included child input into the asthma treatment plan, then the child performed a greater percentage of steps correctly 1 month later (t -test = 2.56, $p = .03$). Children with higher self-efficacy scores for asthma management were significantly more likely to perform a greater percentage of metered dose inhaler steps correctly (Pearson correlation = 0.18, $p = .007$).

Older children were significantly more likely to perform a greater percentage of steps correctly (Pearson correlation = 0.25, $p < .00$) than younger children. When looking at specific steps performed correctly, children aged 13–16 years were significantly more likely to shake the inhaler than children aged 8–12 years (Pearson chi-square = 9.0, $p = .003$). Children who saw non-White providers were significantly more likely to perform a greater percentage of inhaler steps correctly than children who saw White providers (t -test = -4.78 , $p < .00$). Provider race and the provider asking the child to demonstrate metered dose inhaler technique were significantly associated (Pearson chi-square = 9.08, $p = .003$). Seventeen percent of non-White providers asked children to demonstrate metered dose inhaler technique compared to 3% of visits with White providers. Table 5 presents the GEE analysis predicting the percentage of metered dose inhaler steps the child performed correctly. If the provider asked the child to demonstrate metered dose inhaler technique during the medical visit, then the child was significantly more likely to perform more inhaler steps correctly 1 month later (beta coefficient = 12.65, 95% confidence interval = 2.93, 22.37). Also, older children were significantly more likely to have better metered dose inhaler technique than younger children (beta coefficient = 2.34, 95% confidence interval = 1.37, 3.30). Whether the provider included the child input into the asthma treatment plan and child self-efficacy became insignificant in the multivariable analysis.

TABLE 5.—GEE predicting percentage of metered dose inhaler steps child performed correctly ($N = 214$).

Independent variables	Beta coefficient (95% confidence interval)
Number of years living with asthma	-0.01 (-0.07, 0.05)
Child asthma severity	4.06 (-1.58, 9.69)
Child age	2.34 (1.37, 3.30)**
Child gender	-3.33 (-8.05, 1.39)
Child race	0.62 (-4.52, 5.76)
Caregiver education (years)	-0.13 (-1.03, 0.78)
Child self-efficacy	0.28 (-0.06, 0.62)
Provider asked child to demonstrate inhaler technique	12.65 (2.93, 22.37)*
Provider included child input in asthma management plan	4.70 (-3.39, 12.80)

Note: * $p < .05$, ** $p < .001$.

Diskus Technique

One hundred and four children (40.1%) reported using a diskus at the home visit. Among children who used a diskus, providers demonstrated the diskus technique during only 12 visits (11.5%) and asked the child to demonstrate the diskus technique during 15 visits (14.4%). Table 2 presents the number of diskus steps the children performed correctly. Only 26.9% of children had perfect diskus technique. Children got an average of 77% of the steps correct (standard deviation = 17.3, range 42–100%).

In the bivariate analyses, children were significantly more likely to perform a greater percentage of diskus steps correctly if the provider gave more education about control medications (Pearson correlation = 0.21, $p = .03$) and the child's self-efficacy for asthma management was higher (Pearson correlation = 0.20, $p = .04$). Also, children were significantly more likely to perform a greater percentage of steps correctly if the provider discussed a written action plan with them during the visit (t -test = 2.22, $p = .03$). When looking at specific steps performed correctly, children aged 13–16 years were significantly more likely than children aged 8–12 years to hold their breath for 10 seconds (Pearson chi-square = 4.1, $p = 0.04$).

Table 6 presents the GEE analysis predicting the number of diskus steps the child performed correctly. Children

TABLE 6.—GEE predicting percentage of diskus steps performed correctly ($N = 95$).

Independent variables	Beta coefficient (95% confidence interval)
Number of years living with asthma	0.93 (-0.12, 1.98)
Child asthma severity	-2.05 (-11.84, 7.74)
Child age	0.01 (-1.47, 1.49)
Child gender	-4.26 (-10.27, 1.75)
Child race	-7.42 (-14.96, 0.13)
Caregiver education (in years)	0.58 (-0.67, 1.82)
Child self-efficacy	0.57 (0.30, 0.84)**
Provider provides child with written asthma action plan	8.27 (1.78, 14.76)*
Number of controller medication areas provider educated about written asthma action plan	0.77 (-1.18, 2.72)

Note: * $p < .05$, ** $p < .001$.

with higher self-efficacy for asthma management were significantly more likely to perform a greater percentage of diskus steps correctly than those with lower self-efficacy scores (beta coefficient = 0.57, 95% confidence interval = 0.30, 0.84). Additionally, children were significantly more likely to perform more diskus steps correctly if the provider discussed a written action plan during the visit (beta coefficient = 8.27, 95% confidence interval = 1.78, 14.76).

Turbuhaler Technique

Thirty-eight children (14.7%) reported using a turbuhaler at the home visit. Providers asked children who were using turbuhalers to demonstrate their turbuhaler technique during two visits (5.3%) and modeled turbuhaler technique during only one visit (2.6%). Table 3 presents the number and type of turbuhaler steps the children performed correctly. Children got an average of 70% of steps correct when demonstrating turbuhalers (standard deviation = 24.2, range 29–100%). Children were significantly more likely to perform a greater percentage of turbuhaler steps correctly if the children asked more medication questions during the medical visit (Pearson correlation = 0.34, $p = .04$).

DISCUSSION

We found that asthma medication device use by children was frequently incorrect and that health-care providers rarely discussed technique or asked children to demonstrate technique during medical visits. However, if providers asked children to demonstrate their inhaler use during pediatric visits, then children were significantly more likely to get more steps correct on their metered dose inhaler technique 1 month later. Our findings provide data that support the expert opinion used to develop the National Heart Lung and Blood Institute expert guidelines which emphasize that providers should demonstrate proper inhaler technique and have children return the demonstration (3).

We found that if providers included the child input into the asthma management plan during their audio-taped visit, then they got more metered dose inhaler technique steps correct 1 month later in the bivariate analysis. However, the result became insignificant in the multivariable analysis, suggesting that other variables may be more important in predicting technique. Nevertheless, future work should examine ways to increase provider inclusion of child input into the asthma treatment plan since a recent report from the Institute of Medicine (6) emphasizes the need for shared decision making during medical visits.

We also found that child age was significantly associated with the number of metered dose inhaler steps a child got correct. Younger children were significantly more likely to get fewer metered dose steps correct than older children. Only 50% of children aged 8–12 years shook the inhaler 4–6 times before use compared to 70% of children aged 13–16 years. Regarding diskus use, 48% of children aged 13–16 years held their breath for 10 seconds compared to only 28% of children aged 8–12

years. Providers should make sure to explain asthma medication device technique to younger children and their caregivers.

The steps of device technique that were missed most often across devices were the children exhaling before using the device and the children holding their breath for 10 seconds after use. Providers should make sure to discuss proper breathing technique when using these different devices and explain how breathing properly can help ensure that the child receives the correct dose of medication.

Consistent with Social Cognitive Theory (14), child self-efficacy for managing asthma was significantly related to children getting more steps correct on the metered dose inhaler and diskus techniques in the bivariate analyses. However, self-efficacy became insignificant in the metered dose inhaler multivariate analysis, but it remained significant in the diskus analysis.

According to Social Cognitive Theory, individuals with higher self-efficacy to perform a behavior such as asthma medication device technique are more likely to undertake the behavior (14, 15). Our findings suggest that providers need to help build child self-efficacy in using their asthma medication devices. One way to do this is to demonstrate inhaler use and then assess the child's use of the devices which is what the national asthma guidelines suggest doing as well (3). Moreover, provider modeling of behavior is related to the observational learning construct in Social Cognitive Theory.

Only 20% of providers discussed a written asthma management action plan with families. We found that if providers discussed an asthma action plan with families during the medical visits, then children were significantly more likely to perform more diskus steps correctly in the multivariable analysis. Our findings are important and provide support for the National Heart Lung and Blood Institute guidelines which suggest that children should have a written action plan to help them adequately manage their asthma (3). More providers need to discuss and provide written action plans to families with children with asthma so that self-management can be improved. Future research needs to investigate how the content of the asthma action plans that are discussed during visits are associated with child asthma medication device technique.

If children asked more asthma medication questions during their medical visits, then they were significantly more likely to have better turbuhaler technique 1 month later. The results suggest that child question asking about asthma medications is important and that providers should encourage children to ask questions. Future work should examine how communication impacts turbuhaler technique using large sample sizes since only 38 children in our study used turbuhalers.

Another important finding from our bivariate analyses was that if providers educated patients more about control medications, then patients performed a significantly greater percentage of diskus steps correctly 1 month later. This

makes sense, since the diskus device delivers an asthma control medication. The result became insignificant in the multivariable analysis. Future research should examine how education about control medications during pediatric asthma visits impacts diskus technique, since our sample only had 104 children who were using diskus devices.

Also, we are not sure why we found that non-White providers were more likely to demonstrate metered dose inhaler technique. Future research should examine whether this could be due to differences in training, attitudes toward asthma management, or other reasons. The study is limited in generalizability in that it was conducted at five pediatric clinics in nonurban areas of North Carolina. Another limitation is that we do not know how many patients that the clinic staff referred chose not to talk with the research assistant. However, we could not ask the clinic staff to track these numbers because of the busyness of the clinic and our promise not to interrupt clinic flow. A third limitation is that we measured provider type as physician versus nurse practitioner or physician assistant. We cannot distinguish between nurse practitioners and physician assistants. The study is also limited in the number of children on diskuses and turbuhalers. Another limitation is that we chose to audio-tape rather than video-tape the medical visits because it is less intrusive and fewer individuals mind being audio-taped as opposed to being video-taped. Another limitation is that we do not know if these children were referred for asthma education or specialist care. Additionally, we only know if an asthma action plan was discussed, but we do not know what was contained in the asthma action plan. Despite the limitations of the study, it presents observational data about children's use of asthma devices and it examines how certain aspects of communication during pediatric asthma visits impact child device technique 1 month later.

CONCLUSIONS/KEY FINDINGS

Providers assessed inhaler technique during only 4% of the audio-taped visits. We found that if providers assessed metered dose inhaler technique during the visit, then the children were significantly more likely to perform a greater percentage of steps correctly 1 month later. Similarly, children were significantly more likely to perform a greater percentage of turbuhaler steps correctly if they asked more questions during their medical visits. Only 20% of providers discussed a written asthma action plan with families, yet we found that if providers discussed a written action plan with families, then the children performed a greater percentage of diskus steps correctly 1 month later.

Providers should ask children to demonstrate their inhaler technique during medical visits so that they can demonstrate to children how to use their inhaler correctly and improve their asthma management self-efficacy. Providers should encourage children to ask questions about asthma medication devices during visits.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

This project was funded by the National Heart Lung and Blood Institute (Grant no. HL069837). The project was also supported in part by grant UL 1RR025747 from the National Center of Research Resources, NIH.

REFERENCES

1. NAAS, National Academy on an Aging Society. Childhood asthma: the most common chronic disease among children. 2000. Available at: www.agingsociety.org/agingsociety/pdf/asthma.pdf. Accessed June 11, 2012.
2. MMWR. Centers for Disease Control and Prevention (CDC). Vital signs: asthma prevalence, disease characteristics, and self-management education—United States, 2001–2009. *Morbidity and Mortality Weekly Report* 2011; 60:547–552.
3. National Heart Lung and Blood Institute. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. 2007, Publication Number 08-5846. Bethesda, MD: National Institutes of Health; National Heart Lung and Blood Institute. Available at: <http://www.nhlbi.nih.gov/guidelines/asthma/index.htm>. Accessed June 11, 2012.
4. National Asthma Education and Prevention Program. Expert Panel Report: Guidelines for the Diagnosis and Management of Asthma, Update on Specific Topics. Washington, DC: National Institutes of Health, 2002, Publication Number 02-5075.
5. Sleath B, Ayala GX, Gillette C, Williams D, Davis S, Tudor G, Yeatts K, Washington D. Provider demonstration and assessment of child device technique during pediatric asthma visits. *Pediatrics* 2011; 127(4): 642–648.
6. Institute of Medicine (IOM), Committee on Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System of the 21st Century*. Washington, DC: National Academy Press, 2001.
7. Berwick D. A user's manual for the IOM's quality Chasm report. *Health Aff* 2002; 2002(21):80–90.
8. National Heart Lung and Blood Institute. Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma. Bethesda, MD: National Institutes of Health, 1997, Publication No. 97-4051.
9. Cabana MD, Slish KK, Nan B, Clark NM. Limits of the HEDIS criteria in determining asthma severity for children. *Pediatrics* 2004; 114:1049–1055.
10. Bursch B, Schwankovsky L, Gilbert J, Zieger R. Construction and validation of four childhood asthma self-management scales: patient barriers, child and parent self-efficacy, and parent belief in treatment efficacy. *J Asthma* 1999; 36:115–128.
11. Erickson SR, Horton A, Kinking DM. Assessing metered-dose inhaler technique: comparison of observation vs. Patient self-report. *J Asthma* 1998; 35:575–583.
12. Gray SL, Nance AC, Williams DM, Pulliam CC. Assessment of inter-rater and intrarater reliability in the evaluation of metered dose inhaler technique. *Chest* 1994; 105:710–714.
13. Melani AS, Zanchetta D, Barbato N, Sestini P, Cinti C, Canessa PS, Aiolfi S, Neri M; Associazione Italiana Pneumologi Ospedalieri Educational Group. Inhalation technique and variables associated with misuse of conventional metered dose inhalers and newer dry powder inhalers in experienced adults. *Ann Allergy Asthma Immunol* 2004; 93:439–446.
14. Bandura A. Human agency in social cognitive theory. *Am Psychol* 1989; 44:1175–1184.
15. DeVellis BM, DeVellis RF. Self-efficacy and health. In: Baum A, Revenson TA, Singer JE, eds. *Handbook of Health Psychology*. Mahwah, NJ: Lawrence Erlbaum Associate, 2000:235–247.

Copyright of Journal of Asthma is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.