Provider Demonstration and Assessment of Child Device Technique During Pediatric Asthma Visits

WHAT'S KNOWN ON THIS SUBJECT: Little is known about the extent to which providers model proper use of asthma devices to children or the extent to which providers have the children demonstrate how they use their devices during medical visits.

WHAT THIS STUDY ADDS: The majority of providers did not demonstrate or assess child use of metered dose inhalers, turbuhalers, diskuses, or peak flow meters during pediatric asthma visits.

abstract

OBJECTIVE: The purposes of this study were to (*a*) describe the extent to which children use metered dose inhalers, turbuhalers, diskuses, and peak flow meters correctly, and (*b*) investigate how often providers assess and demonstrate use of metered dose inhalers, turbuinhalers, diskuses, and peak flow meters during pediatric asthma visits.

PATIENTS AND METHODS: Children ages 8 through 16 with mild, moderate, or severe persistent asthma and their caregivers were recruited at 5 pediatric practices in nonurban areas of North Carolina. All of the medical visits were audiotape-recorded. Children were interviewed after their medical visits, and their device technique was observed and rated by the research assistants.

RESULTS: Of the patients, 296 had useable audiotape data. Only 8.1% of children performed all of the metered dose inhaler steps correctly. Older children were more likely to get more of the metered dose inhaler steps correct. Of the children, 22% performed all of the diskus steps correctly, 15.6% performed all of the turbuhaler steps correctly, and 24% performed all of the peak flow meter steps correctly. The majority of providers did not demonstrate or assess child use of metered dose inhalers, turbuhalers, diskuses, or peak flow meters during pediatric asthma visits.

CONCLUSIONS: There is a need for providers to demonstrate proper asthma medication and monitoring device techniques to children and to have children demonstrate to proficiency. The 2007 National Heart, Lung, and Blood Institute expert panel report on the diagnosis and management of asthma encourages providers to educate children on these techniques. *Pediatrics* 2011;127:642–648

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KEY WORDS

asthma, asthma knowledge, provider participation, patient-provider relationship

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Asthma is a worldwide problem, and it is the most common chronic condition among American children.[1,2] Health care costs for asthma are estimated at more than $6 billion a year, and loss in productivity by working parents caring for children who miss school because of asthma is estimated at $1 billion a year.[3,4]

It has been demonstrated in previous research that children often do not properly use metered dose inhalers, turbuhalers, and other asthma devices.[5–7] Children's improper use of inhalers and other asthma medication devices can lead to poor asthma control, increased number of hospitalizations, and increased health care costs.[8–10]

Social cognitive theory is a relevant theoretical framework for understanding children's use of asthma devices, including devices to administer medication and monitor symptoms.[11] Self-efficacy is 1 of the key constructs in social cognitive theory.[12] According to the theory, individuals with higher levels of self-efficacy to perform a certain behavior such as using an inhaler or peak flow meter are more likely to undertake the behavior.[13,14] Providers can model the use of inhalers, peak flow meters, and other devices during asthma visits, and they can have children demonstrate how they use inhalers and peak flow meters during medical visits. In fact, a 2007 National Heart Lung and Blood Institute expert panel report emphasizes that providers should demonstrate proper inhaler technique and other asthma device techniques and have the child return the demonstration.[3]

To our knowledge, no previous study has examined the extent to which providers model proper use of asthma devices to children or the extent to which providers have the children demonstrate how they use their devices so they can identify children who are not using them properly. Therefore, the purposes of this study were to (*a*) describe the extent to which children use metered dose inhalers, turbuhalers, diskuses, and peak flow meters correctly, and (*b*) investigate how often providers assess and demonstrate use of metered dose inhalers, turbuinhalers, diskuses, and peak flow meters during pediatric asthma visits.

METHODS

Participants

The study was approved by the University of North Carolina's institutional review board. Providers were recruited at 5 pediatric practices in North Carolina, and consent was obtained. Children and their caregivers of these participating providers were recruited. Children were eligible if they (*a*) were ages 8 to 16, (*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, asthma-related nighttime symptoms more than twice a month, or receiving 1 or more long-term controller therapies for asthma.[15,16]

Clinic staff referred to a research assistant potentially eligible patients who were interested in learning more about the study. 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 audiotape-recorded. Children were interviewed after their medical visits, and their device technique was observed and rated by the research assistants. Caregivers completed self-administered questionnaires.

Audiotape Coding

All of the medical visit audiotapes were transcribed verbatim. A detailed coding tool was developed and tested during a 1-year period. All of the transcripts were coded. Two research assistants coded 20 of the same transcripts throughout the study period to assess inter-coder reliability.

Measures

Demographic and Sociodemographic Characteristics

Medication use was assessed on the caregiver screener. The research assistants showed caregivers a list of asthma medications and asked them to indicate which one or ones the child was taking. Responses were dichotomized on the basis of whether the caregiver reported that the child was on a controller medication versus not on a controller medication. Asthma severity was classified as mild versus moderate/severe by a research assistant on the basis of recent symptoms and medication use reported by the caregivers when research assistants administered the eligibility screening instrument for the study.[4,15,16] Our eligibility screening instrument used the primary asthma severity classification system that was being used when the study was designed and conducted.[4,15,16]

All child study information was then reviewed by a pediatric pulmonologist or a clinical pharmacist with expertise in asthma to verify the severity classification as mild or moderate/severe persistent asthma. Severity was classified using 2 different methods. In situations in which the 2 methods resulted in discordant classification, the more severe category was used. The first method was medication use; any child

who received a single long-term control agent was considered to have mild persistent asthma. Any child who received 2 or more long-term control agents was categorized as moderate to severe persistent asthma. The second method classified severity on the basis of symptom frequency. Any child who reported the occurrence of any 1 of 8 symptoms as occurring 2 or more times a week or who reported awakening with asthma symptoms 2 or more times a month was classified as mild persistent. Reports of daily symptom occurrence or of awakening ≥5 times a month resulted in a classification as moderate or severe persistent.

A variety of demographic and sociocultural factors were examined as potential confounders. For descriptive purposes, child race was recoded into 4 categories: white; black; Native American/American Indian; or other. However, for the bivariate analyses, child race was recoded into a dichotomous variable (white versus nonwhite). The child's insurance status was measured using the following categories: none; private insurance; Medicaid; the State Children's Health Insurance Program; and other.

Asthma Medication and Peak Flow Meter Technique

The pediatric pulmonologist and clinical pharmacist who specializes in asthma on our team developed how device technique would be assessed using the peer-reviewed literature and their clinical experience.[17–19] Five research assistants underwent training to assess inhalation device technique. These research assistants who assessed device technique were different from those who coded the audiotape 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, (2) dry powder inhaler (DPI-Diskus), (3) dry powder inhaler (DPI-Turbuhaler), and (4) a peak flow meter. 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 about the research assistant scoring on the basis of his clinical judgment. Each research assistant was asked to review the DVD recording again until concordance was reached among all participants.

Immediately after the audiotaped medical 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 using placebo devices provided by the research staff. There were 43 children who brought their own devices with them to their medical visits. Metered dose inhaler technique had 8 possible correct steps (Table 1). 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 8 possible steps correct (Table 1). Diskus technique had 7 possible correct steps (Table 2). Turbuhaler technique had 7 possible correct steps (Table 3). Peak flow technique had 8 possible correct steps (Table 4).

TABLE 1 Metered Dose Inhaler Device Technique

	Percent (*N*)
Steps used by all children who stated they used a metered dose inhaler (*N* = 270)	
Remove cap from inhaler	97.3 (256)
Shake inhaler 4–6 times	44.4 (116)
Exhale normally	36.2 (93)
Tilt head back slightly, with inhaler upright, place mouthpiece between lips or 1–2 inches in front of a wide open mouth	83.9 (218)
Between a slow deep breath	81.7 (214)
Press inhaler canister once at beginning of breath	84.0 (220)
Continue to inhale for 3–4 s	63.9 (166)
Hold breath for 10 s	32.6 (85)
Wait at least 30 s and repeat steps 2–8 if using another puff[a]	27.2 (69)
Children who performed all steps correctly	8.1 (22)
Steps used by children who stated they usually used a spacer who demonstrated spacer use (*N* = 69)	94.1 (64)
Remove cap from inhaler	
Attach inhaler into holding chamber	95.5 (64)
Shake inhaler 4–6 times	42.4 (28)
Exhale normally	52.2 (35)
Tilt head back slightly, place holding chamber mouthpiece between lips, holding inhaler upright	80.6 (54)
Press inhaler canister once to place dose in holding chamber	91.0 (61)
Begin a slow deep inhalation immediately after placing dose in holding chamber (3–4 s)	83.6 (56)
Hold breath for 10 s	46.3 (31)
Wait at least 30 s and repeat steps above if using another puff[a]	40.3 (27)
Children who performed all steps correctly	20.3 (14)

[a] This step was not included in the calculation of children who performed all steps correctly because some children may or may not have been prescribed a second dose.

Provider Demonstration and Assessment of Child Technique During Visits

Coders of the transcripts of the medical visits recorded the following: provider demonstrates metered dose inhaler technique; diskus technique; turbuhaler technique; and peak flow technique. Coders also recorded whether the provider asked the child to demonstrate how they use their metered dose inhaler, diskus, turbuhaler, and peak flow meter (if applicable). Two research assistants coded 20 of the same transcripts throughout the study period to as-

TABLE 2 Diskus Device Technique ($N = 105$)

	Percent (*N*)
Step	
Open device until it clicks	99.0 (103)
To load a dose, hold device horizontal and slide the lever away from you until it stops (there should be a second click)	72.8 (75)
Exhale gently away from mouthpiece	39.6 (40)
Place mouthpiece in lips	99.0 (103)
Take a forceful breath in steadily and deeply	89.2 (91)
Hold breath for 10 s	42.2 (43)
Close device by sliding thumb grip toward self until it clicks	96.1 (99)
Children who performed all steps correctly	21.9 (23)

TABLE 3 Turbuhaler Device Technique ($N = 45$)

	Percent (*N*)
Step	
Lift off white cover to reveal mouthpiece	63.6 (28)
Hold device with mouthpiece up and twist the grip at the base, back and forth 1 time to load dose	69.1 (29)
Hold device horizontal and exhale gently, away from mouthpiece	29.3 (12)
Place mouthpiece between lips	100.0 (40)
Take a forceful breath in steadily and deeply	87.8 (36)
Hold breath for 10 s	41.5 (17)
If second dose is required, repeat steps 2–6[a]	35.1 (13)
Replace white cover	60.0 (24)
Children who performed all steps correctly	15.6 (7)

[a] This step was not included in the calculation of children who performed all steps correctly because some children may or may not have been prescribed a second dose.

TABLE 4 Peak Flow Device Technique ($N = 67$)

	Percent (*N*)
Step	
Set marker to 0	68.2 (45)
Hold meter upright	90.9 (60)
Do not block marker movement	86.6 (57)
Deep breath in with mouth open	84.6 (55)
Place meter in mouth and close lips tightly around meter	92.5 (62)
Exhale hard and fast into meter	87.9 (58)
Check the result	83.6 (56)
Repeat steps 1–7 two more times	56.9 (37)
Children who performed all steps correctly	23.9 (16)

sess 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 on 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.

Statistical Analysis

All analyses were conducted using SPSS (SPSS Inc, Chicago, IL). First, we presented descriptive statistics for the variables. Second, we examined bivariate relationships between the demographic variables using correlation coefficients, *t* tests, or Pearson χ^2 statistics. If there was a significant bivariate relationship between a demographic characteristic and device technique, then a multivariable analysis was conducted to investigate whether the relationship was still significant after controlling for other variables. Child age, gender, race, years with asthma, asthma severity, and caregiver education were included in the multivariable models that predicted metered dose inhaler technique and peak flow technique.

RESULTS

The 5 participating clinics were all primary care pediatric practices. There were 41 providers who agreed to participate in the study. Two providers refused to participate for a participation rate of 95.3%. Eighty-eight percent of the families approached agreed to participate in the study. There were 296 patients who had useable audiotape 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. Of the providers, 51% were female. Twenty-seven of the providers were white, 2 were American Indian, 3 were black, 1 was Asian, and 2 classified their race as other. Providers ranged in age from 30 to 70 years (mean: 44.8 years; SD: 9.4). Table 5 presents the child and caregiver demographic characteristics.

Metered Dose Inhaler Technique

Of the children, 91% ($N = 270$) reported that they used metered dose inhalers. As shown in Table 2 only 8.1% of children performed all of the steps correctly. Older children were significantly more likely to get more of the steps correct (Pearson's $r = 0.20$, $P = .001$). Children of caregivers who had more years of education were significantly more likely to get more of the steps correct (Pearson's $r = 0.14$, $P = .03$). Child age remained significant in the multivariable analysis (Table 6). However, years of caregiver education became insignificant ($P = .05$).

Providers asked only 5.4% of all children who reported using metered dose inhalers and only 2.3% of children (3 of 129) who got fewer than 6 steps correct on metered dose inhaler technique to demonstrate their

TABLE 5 Child and Caregiver Demographic Characteristics ($N = 296$)

	Percent (N)
Child age, y	
Mean (SD) (range)	11.1 (2.4) (8–16)
Child gender	
Male	53.7 (159)
Female	46.3 (137)
Child race	
White	61.5 (182)
Black	30.1 (89)
Native American/American Indian	10.1 (30)
Other	6.1 (18)
Asthma severity	
Mild persistent	28 (83)
Moderate/severe persistent	72 (213)
No. years living with asthma	
Mean (SD) (range)	6 (3.9) (9–16)
Child's caregiver marital status	
Never	16.2 (48)
Married	57.8 (171)
Separated	9.5 (28)
Divorced	12.5 (37)
Widowed	3.0 (9)
Caregiver age, y	
Mean (SD) (range)	42 (8.4) (27–81)
Caregiver gender	
Male	14.2 (42)
Female	85.8 (253)
Caregiver education, y	
Mean (SD) (range)	12.8 (2.5) (2–20)
Insurance type	
None	1.0 (3)
Private	26.4 (78)
Medicaid	51.7 (153)
State Children's Health Insurance Program	17.6 (52)
Other	2.7 (8)
Device use	
Metered dose inhaler	91.2 (270)
Diskus	35.5 (105)
Turbuhaler	15.2 (45)
Peak flow	22.6 (67)

technique during the medical visit. The provider demonstrated metered dose inhaler technique to only 3.8% of all children and to only 2.3% (3 of 129) of the children who got fewer than 6 steps correct when demonstrating their metered dose inhaler technique. Only 1 child who got fewer than 6 steps correct was asked to demonstrate their technique and also was shown proper technique by the provider during the visit.

TABLE 6 Multiple Linear Regression Examining Factors Associated With Child Metered Dose Inhaler Technique ($N = 270$) and Peak Flow Technique ($N = 67$)

Independent Variables	Inhaler Technique β	Peak Flow Technique β
Child's gender is female	0.03	0.18
Child's age, y	2.96[a]	0.24
Child's race is white	0.03	−0.39[b]
Severity of asthma is moderate/severe	−0.02	−0.23
Years with asthma	0.01	0.24
Caregiver years of education	0.12	0.06

[a] $P < .01$.
[b] $P < .05$.

Diskus Technique

Thirty-six percent ($N = 105$) of the children reported that they used diskus devices. As shown in Table 2, only 22% of children performed all of the diskus steps correctly. Providers asked 14.3% of all children who used a diskus and only 9.4% of children (3 of 32) who got fewer than 5 steps correct on diskus technique to demonstrate their technique during the medical visit. Providers demonstrated diskus technique to only 11.4% of all children who reported using 1 and to only 9.4% of children (3 of 32) who got fewer than 5 steps correct when demonstrating their diskus technique. Only 1 of the children who got fewer than 5 steps correct was asked to demonstrate their technique and also was shown proper technique by the provider during the visit.

Turbuhaler Technique

Fifteen percent ($N = 45$) of the children reported that they used turbuhalers. Table 3 illustrates that only 15.6% of the children performed all the steps correctly. Providers asked only 4.4% of all children using turbuhalers and none of the children (0 of 16) who got fewer than 5 steps correct on turbuhaler technique to demonstrate their technique. Providers demonstrated turbuhaler technique to only 1 of the children who were on turbuhalers, and they did not demonstrate how to use a turbuhaler to any of the children who got fewer than 5 steps correct when their turbuhaler technique was assessed.

Peak Flow Technique

Twenty-three percent of the children reported that they used peak flow meters. In Table 4 it is shown that only 24% of children who reported using peak flow meters performed all of the peak flow meter steps correctly. Nonwhite children were significantly more likely to get more of the peak flow meter steps done correctly than were white children ($t$test $= 2.43$, $P = .018$). Child race remained significant in the multivariable analysis (Table 3). Providers asked only 2 of all of the children who reported using peak flow meters and none of the children who got <5 of the steps correct on peak flow technique to demonstrate how they used a peak flow meter. Providers demonstrated peak flow technique to only 2 of all children who reported using peak flow meters, and they did not demonstrate peak flow technique to any of the children who got <5 of the steps correct on peak flow technique.

DISCUSSION

The majority of providers are not taking the time to demonstrate or assess child use of metered dose inhalers, turbuhalers, diskuses, or peak flow meters during pediatric asthma visits despite the fact that our results indicate that many children are not using them correctly. Providers should demonstrate any asthma devices that a specific child needs to use to the child and his/her family and then have the child demonstrate back how he/she would use the devices. This is what the National Heart Lung and Blood Institute expert guidelines suggest that providers do when educating patients with asthma. Future research should examine what barriers exist to providers

demonstrating and assessing child use of devices.

The more that children can be shown how to use devices and have time to practice using them during medical visits and receive feedback on their technique, the more opportunity there is to build behavioral capacity and self-efficacy. If children have greater behavioral capacity and self-efficacy for using the devices, they are more likely to use them and to use them correctly, which could lead to better health outcomes. Modeling and skill development are important components of social cognitive theory[11,12] and are instrumental for improving behavioral capacity and self-efficacy.

We found that many children with asthma are not correctly using their metered dose inhalers, diskuses, turbuhalers, or peak flow meters. Practices should consider using allied health professionals to demonstrate or assess device technique with children with asthma when their providers do not have time to do so.[20–24]

In addition to providers showing patients how to correctly use asthma devices, patients and their families could be encouraged to ask their community pharmacists about proper use of these devices.[8] Pharmacists can be a valuable resource for patients in providing counseling and education regarding inhaler use.[25–27] Improving proper use of inhalers and other devices could lead to improved patient outcomes.[8–10]

Metered dose inhalers and diskuses were the most common devices that children reported using. The most common steps that children missed for metered dose inhaler and diskus technique were (*a*) exhaling normally before using the metered dose inhaler or diskus, and (*b*) holding their breath for at least 10 seconds after inhaling. Providers could emphasize the importance of these steps to children and their families.

It is interesting that children of more educated caregivers were significantly more likely to get more of the correct metered dose inhaler steps right in the bivariate analysis. Although caregiver education became insignificant in the multivariable analysis, it might have been significant with a larger sample size. This finding illustrates the importance of educating children and caregivers about the proper use of inhalers so that they can practice proper use of them before leaving the clinic. Involving children directly in the demonstration and practice of device use is consistent with the US Pharmacopeia principles regarding the rights of children and adolescents to receive developmentally appropriate and direct communication about medicines.[28]

Older children were significantly more likely to get more of the metered dose inhaler steps correct. Therefore, care must be taken to help ensure that younger children know how to properly use their inhalers. Demonstrating proper use and having children practice while at the clinic could help improve use of the devices.

The study is limited in generalizability in that it was conducted in 5 pediatric clinics in nonurban areas of North Carolina. A second limitation is that we do not know how many patients who 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. A fourth limitation is that we did not assess whether the adult caregiver was the primary caretaker of the child. Another limitation is that we chose audiotaping rather than videotaping the medical visits because it is less intrusive, and fewer individuals mind being audiotaped as opposed to being videotaped. Another limitation is that we do not know if these children were referred for asthma education or specialist care. Despite the limitations of the study, it presents observed data on children's use of asthma devices and audiotaped data on the extent to which providers model and have children demonstrate their use of asthma devices during medical visits.

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REFERENCES

1. 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 March 1, 2009
2. National Center for Health Statistics. Summary health statistics for US children: National Health Interview Survey. 2008. Centers for Disease Control and Prevention. Available at: www.cdc.gov/nchs/data/series/sr 10/sr10 244.pdf. Accessed March 1, 2009
3. National Asthma Education and Prevention Program. Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma-Summary Report 2007. *J Allergy Clin Immunol*. 2007;120(5 suppl):S94–S138
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 02-5075

5. Goren A, Noviski N, Avital A, et al. Assessment of the ability of young children to use a powder inhaler device (Turbuhaler). *Pediatr Pulmonol*. 1994;18(2):77–80
6. 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(3):217–221
7. Larsen JS, Hahn H, Ekholm B, Wick KA. Evaluation of conventional press-and-breathe metered-dose inhaler technique in 501 patients. *J Asthma*. 1994;31(3):1993–1999
8. Basheti IA, Armour CL, Bosnic-Anticevich SZ, Raddel HK. Evaluation of a novel educational strategy, including inhaler-based reminder labels, to improve asthma inhaler technique. *Patient Educ Couns*. 2008;72(1):26–33
9. Chopra N, Oprescu N, Fask A, Oppenheimer J. Does introduction of new "easy to use" inhalational devices improve medical personnel's knowledge of their proper use? *Ann Allergy Asthma Immunol*. 2002;88(4):395–400
10. Giraud V, Roche N. Misuse of corticosteroid metered-dose inhaler is associated with decreased asthma stability. *Eur Respir J*. 2002;19(2):246–251
11. Baranowski T, Perry CL, Parcel GS. How individuals, environments, and health behavior interact: social cognitive theory. In: Glanz K, Rimer BK, Lewis FM, eds. *Health Behavior and Health Education*. Hoboken, NJ: John Wiley and Sons; 2002:165–184
12. Bandura A. *Social Foundation of Thought and Action: a Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall; 1986
13. Bandura A. Human agency in social cognitive theory. *Am Psychol*. 1989;44(9):1175–1184
14. DeVellis BM, DeVellis RF. Self-efficacy and health. In: Baum A, Revenson TA, Singer JE, eds. *Handbook of Health Psychology*. Mahwah, NJ: Lawrence Erlbaum Associates; 2000:235–247
15. National Heart Lung and Blood Institute. *Guidelines for the Diagnosis and Management of Asthma, Expert Panel Report 2*. Bethesda, MD: National Institutes of Health; 1997. Publication No. 97-4051
16. Cabana MD, Slish KK, Nan B, Clark NM. Limits of the HEDIS criteria in determining asthma severity for children. *Pediatrics*. 2004;114(4):1049–1055
17. Erickson SR, Horton A, Kirking DM. Assessing metered-dose inhaler technique: comparison of observation vs. patient self-report. *J Asthma*. 1998;35(7):575–583
18. Gray SL, Nance AC, Williams DM, Pulliam CC. Assessment of interrater and intrarater reliability in the evaluation of metered dose inhaler technique. *Chest*. 1994;105(3):710–714
19. Melani AS, Zanchetta D, Barbato N, et al. 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(5):439–446
20. Wroth TH, Boals JC IV. Application of quality-improvement methods in a community practice: the Sandhills Pediatrics Asthma Initiative. *N C Med J*. 2005;66(3):218–220
21. Garvey C. Advances in asthma care: asthma educator certification. *Californian J Health Promot*. 2003;1(1):87–90
22. Bravata DM, Gienger AL, Holty JE, et al. Quality improvement strategies for children with asthma: a systematic review. *Arch Pediatr Adolesc Med*. 2009;163(6):572–581
23. Bunting BA, Cranor CW. The Asheville Project: long-term clinical, humanistic, and economic outcomes of a community-based medication therapy management program for asthma. *J Am Pharm Assoc (2003)*. 2006;46(2):133–147
24. Bosnic-Anticevich SZ, Sinha H, So S, Reddel HK. Metered-dose inhaler technique: the effect of two educational interventions delivered in community pharmacy over time. *J Asthma*. 2010;47(3):251–256
25. Basheti IA, Reddel HK, Armour CL, Bosnic-Anticevich SZ. Improved asthma outcomes with a simple inhaler technique intervention by community pharmacists. *J Allergy Clin Immunol*. 2007;119(6):1537–1538
26. Holzheimer L, Mohay H, Masters IB. Educating young children about asthma: comparing the effectiveness of a developmentally appropriate asthma education video tape and picture book. *Child Care Health Dev*. 1998;24(1):85–99
27. Jowers JR, Schwartz AL, Tinkelman DG, et al. Disease management program improves asthma outcomes. *Am J Manag Care*. 2000;6(5):585–592
28. Basheti IA, Reddel HK, Armour CL, Bosnic-Anticevich SZ. Counseling about Turbuhaler technique: needs assessment and effective strategies for community pharmacists. *Respir Care*. 2005;50(5):617–623
29. Bush P, Ozias J, Walson P, Ward R. Ten guiding principles for teaching children and adolescents about medicines. *Clin Ther*. 1999;21(7):1280–1284