Prevalence and Risk Factors of Incorrect Inhaler Technique in Asthmatic Children at Faculty of Medicine Vajira Hospital

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Vajira Med J. 2018; 62(5): 345-56
http://dx.doi.org/10.14456/vmj.2018.38

Abstract

Introduction: Diagnosis of asthma has been increasing among young children. The inhaled corticosteroids can reduce the risk of asthmatic attack. The effectiveness of inhaled corticosteroids depends on the appropriate and regular use of inhaled corticosteroids. Improper methods of use of inhaled corticosteroids can lead to suboptimal dosage and unsatisfactory control. The correct use lies on the skills of the affected children as well as their caregivers. This cross-sectional study was to assess the prevalence of and factors associated with incorrect use of inhaled corticosteroids in children with asthma and their caregivers.

Methods: Pediatric patients aged 1-15 years old who were having their treatment for asthma with inhaled corticosteroids in our institution during March 1, 2017 to August 31, 2017 were included. Data were collected by an interview the patients and/or their caregivers according to the prepared questionnaire. The demonstration of metered dose inhalation (MDI) procedure using spacer and no spacer by the patients or caregivers was assessed.

Results: Among 85 children aged 1–15 years who were receiving corticosteroids through MDI with (n=76) and without (n=9) spacers. The inhalers were used incorrectly in 51 children (60%). The most frequent incorrect method was breathing normally 5-6 times via spacer in the spacer group (27 children, 35.5%) whereas inappropriate placing of the mouthpiece or a 30-second interval between puffs were found in the no-spacer group (2 children in each step, 22% each). Risk factors for the incorrect use were non-maternal primary caregivers. Having fathers and other caregivers as supervisors increased the risk of incorrect use for 5.50 times [95% confidence interval (CI), 1.12–25.50, p = 0.034] and 6.38 times (95%CI, 1.47–26.62, p = 0.009) respectively higher than having mothers as the supervisors. Incorrect use was found 7.20 times (95% CI, 2.31–21.40, p = 0.001) more likely in children with prior acute asthma exacerbation and 5.55 times (95%CI 1.02–28.54, p = 0.047) among children and caregivers who did not understand and failed to clarify the procedures with the instructor during the hospital teaching class.

Conclusion: Incorrect corticosteroid inhalation was found in 60% and was directly correlated with hospital admission from acute exacerbation. Important factors related to incorrect use were the primary caregivers being children's non-maternal and difficulty in learning during the hospital-teaching class.

Keywords: Asthma, inhaled corticosteroids, incorrect inhalation technique, acute asthmatic exacerbation, metered dose inhaler

ความชุกและปัจจัยเสี่ยงของการใช้ยาสูดพ่นไม่ถูกต้องในผู้ป่วยเด็กโรคหืดที่มารับการรักษาที่คณะแพทยศาสตร์วชิรพยาบาล

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Vajira Med J. 2018; 62(5): 345-56
http://dx.doi.org/10.14456/vmj.2018.38

บทคัดย่อ

บทนำ: ปัจจุบันเด็กอายุน้อยได้รับการวินิจฉัยว่าเป็นโรคหืดมากขึ้น การใช้ยากลุ่มสเตียรอยด์ชนิดสูดพ่นช่วยลดความเสี่ยงในการเกิดโรคหืดกำเริบรุนแรงได้ ผลของการใช้ยาสูดพ่นเพื่อควบคุมอาการนี้ขึ้นอยู่กับการรักษาอย่างถูกต้องและสม่ำเสมอ เนื่องจากการใช้ยาสูดพ่นที่ไม่ถูกวิธีจะทำให้ผู้ป่วยได้รับยาไม่ถึงขนาดที่ต้องการ ซึ่งปัจจัยที่ส่งผลต่อความสำเร็จนั้นจะขึ้นอยู่กับทั้งตัวผู้ป่วยเด็กเองและผู้ดูแล การศึกษานี้จึงมีวัตถุประสงค์เพื่อศึกษาหาความชุกของการใช้ยากลุ่มสูดพ่นที่ไม่ถูกต้องของผู้ป่วยเด็กโรคหืด และหาปัจจัยของผู้ป่วยเด็กโรคหืดและผู้ดูแลหลักที่อาจมีผลต่อการใช้ยากลุ่มสูดพ่นที่ไม่ถูกต้อง

วิธีการวิจัย: เก็บข้อมูลด้วยแบบสอบถามโดยการสัมภาษณ์ผู้ป่วยเด็กโรคหืดและ/หรือผู้ดูแล ที่มารับการรักษาด้วยยาสูดพ่นที่ภาควิชากุมารเวชศาสตร์ คณะแพทยศาสตร์วชิรพยาบาล มหาวิทยาลัยนวมินทราธิราช ตั้งแต่ 1 มีนาคม พ.ศ. 2560 ถึง 31 สิงหาคม พ.ศ. 2560 ประเมินวิธีการใช้ยาโดยให้เด็กไม่อยู่ในสภาวะหอบที่ต้องรักษาทันทีหรือผู้ดูแลของเด็กแสดงวิธีการใช้ยาสูดพ่นชนิด metered dose inhaler (MDI) โดยใช้อุปกรณ์ spacer หรือไม่ใช้อุปกรณ์ spacer

ผลการวิจัย : ผู้ป่วยเด็กโรคหืดเข้าร่วมวิจัยทั้งหมด 85 ราย โดยเป็นผู้ป่วยเด็กโรคหืดใช้ยาสูดพ่น MDI ร่วมกับอุปกรณ์ spacer จำนวน 76 ราย และผู้ป่วยไม่ใช้อุปกรณ์ Spacer จำนวน 9 ราย พบมีความชุกการใช้ยาสูดพ่นที่ไม่ถูกต้องโดยรวม 51 ราย คิดเป็นร้อยละ 60 พบขั้นตอนการหายใจเข้าออกผ่าน spacer ไม่ถูกวิธีบ่อยที่สุดในการใช้ยาสูดพ่นชนิด MDI ร่วมกับอุปกรณ์ spacerโดยพบใน 27 ราย คิดเป็นร้อยละ 35.5 ส่วนขั้นตอนที่ใช้ยาสูดพ่นชนิด MDI โดยไม่ใช้ร่วมกับอุปกรณ์ spacer ที่ไม่ถูกวิธีมากที่สุด คือ การใช้ริมฝีปากอมรอบ mouthpiece หรือการเว้นระยะเวลาอย่างน้อย 30 วินาทีก่อนการสูดพ่นยาครั้งถัดไป คือ พบขั้นตอนละ 2 รายหรือร้อยละ 22 ปัจจัยเกี่ยวข้องกับการใช้ยาสูดพ่นไม่ถูกต้องคือ ผู้ดูแลหลักที่ไม่ใช่มารดาเป็นผู้พ่นยาให้เด็ก โดยพบว่าผู้ดูแลที่เป็นบิดาจะมีโอกาสสูดพ่นไม่ถูกต้องสูงกว่า 5.5 เท่า (95%CI 1.12–25.50, p = 0.034) และผู้ดูแลอื่นโอกาสสูงกว่า 6.38 เท่า (95%CI 1.47–26.62, p = 0.009) ผู้ป่วยเด็กโรคหืดที่เคยได้รับการนอนโรงพยาบาลด้วยโรคหืดกำเริบมีความเสี่ยงที่ใช้ยาสูดพ่นไม่ถูกต้อง 7.20 เท่า (95% CI , 2.31–21.40, p = 0.001) ผู้ป่วยและผู้ดูแลที่ให้ข้อมูลว่าไม่เข้าใจคำแนะนำหรือการสอนเกี่ยวกับการใช้ยาสูดพ่นจากบุคลากรในโรงพยาบาลมีโอกาสใช้ยาสูดพ่นไม่ถูกวิธีสูงกว่า 5.55 เท่า (95%CI 1.02–28.54, p = 0.047) โดยปัญหาที่พบคือการไม่กล้าซักถามบุคลากรทางการแพทย์ระหว่างการสอนใช้ยาสูดพ่น

สรุป: พบความชุกของการใช้ยาสูดพ่นที่ไม่ถูกวิธีในผู้ป่วยเด็กโรคหืด ร้อยละ 60 โดยวิธีการสูดพ่นยาที่ไม่ถูกต้องมีผลต่อการนอนโรงพยาบาลด้วยโรคหืดกำเริบ โดยปัจจัยที่สำคัญคือผู้ดูแลหลักที่ไม่ใช่มารดาและผู้ดูแลหลักที่มีปัญหาการได้รับข้อมูลของโรงพยาบาลเกี่ยวกับการใช้ยาสูดพ่นเป็นปัจจัยที่มีผลต่อการใช้ยาสูดพ่นที่ไม่ถูกต้อง

Introduction

Asthma is a chronic respiratory illness that affects both short- and long-term quality of life of the adults and pediatric patients. Previous studies showed affected children with asthma tended to be younger comparing to historical data[1, 2]. Patients with asthma are more likely to have a poor quality of life with respect to their physical health, mental health, and socialization[3, 4].

Over the past century, the treatment for asthma has been advanced. With a development of new drugs, a better symptom control is achieved. Inhaled corticosteroids have an important role and are commonly used in asthma treatment at present. The drug must be administered regularly and appropriately to achieve the best control of the condition. Many studies have found a relationship between good adherence to treatment and decreased risk of severe asthma exacerbation[5, 6].

In addition to the regular drug use, another important factor is the correct technical use of drugs which would deliver an appropriate dose of drug to optimize the efficacy[7]. The incorrect use of inhaled corticosteroids may significantly become acute exacerbations and deterioration of lung function. Few studies investigating the use of inhaled drugs reported that 32% to 44% of patients were unable to dispense the drug properly due to the wrong techniques[8-10]. These rates have not been changed over the last 40 years[11, 12]. Aside from a direct impact of a non-adherence or incorrect use of drug on the patients themselves, the chronic morbidity certainly increases family burden, higher costs of medical resources, and overall national health budget[13-16].

Because the incorrect inhalation technique is still a major problem and can result in loss of resources without any benefit[17]; hence, the identification of the risk factors of the incorrect use is important. Research studies have analyzed factors related to incorrect inhalation technique[7, 18-21]. These included a lack of knowledge about asthma and the importance of effective treatment, use of complex equipment, and inadequate parental or caregiver education information from public health personnel from limited numbers of teaching sessions or methods used to teach, parent's age, communication problems between the instructor and audience, etc.[7, 18-21]. Most previous studies were conducted in other countries when the environments and constraints may differ from Thailand wherein only one study was reported[9].

Objectives

We aimed to investigate the prevalence of incorrect inhalation technique by children with asthma who were treated in the outpatient clinic in the Department of Pediatrics, Faculty of Medicine Vajira Hospital. The risk factors for the incorrect inhalation were also studied.

Study Methods

This descriptive cross-sectional study was approved by the Research Ethics Committee of the institution. We identified children with asthma aged 1–15 years who were treated in the outpatient clinic in the Department of Pediatrics, Faculty of Medicine Vajira Hospital between March 1, 2017 and August 31, 2017. The patients must be in good condition and were not in a state of suffocation. A written informed consent/ assent to participate in the study was obtained from the child or the parents as appropriate. The children and parents who could not communicate in Thai were excluded.

As a general practice in our department, a diagnosis of asthma was made according to the Global Initiative for Asthma criteria for 2015[22]. The procedure of inhalation was instructed to the newly diagnosed asthmatic patients and their caregivers by either medical doctor, pharmacist, nurse, along with an educational video demonstration prepared according to recommendations of the National Institute of Health (NIH) [23].

Controller drug to treat asthma in this study was inhaled corticosteroids. Correct inhalation was determined according to the recommendations of the NIH[23]. Our study combined the steps of metered dose inhaler (MDI) with and without spacer, divided a few steps into detail, and added 2 steps of checking the expiry date and the presence of drug remained in the MDI bottle, making a total of 13-step inhalation. The expiry date was taken from the drug label whereas the presence of drug remained prior to the use was checked by MDI bottle shaking. Incorrect inhalation was diagnosed when any of its steps was not performed or misconducted.

Data were collected by an interview the children and/or their caregivers according to the structured questionnaires. The children or the caregivers who agreed to participate in the study were also asked to perform the inhalation with an MDI. Each step of the inhalation was observed and recorded by the researcher (T.J.). The study was stopped in any events of increasing tiredness of children or their consent withdrawal. At the end of the interview and inhalation process, the researcher educated the children and their caregivers if the use of inhaler was incorrect.

Clinical factors of children and the primary caregivers which may influence the process of inhaler use were collected: age, gender, and education of children and the primary caregiver, the primary caregiver, family income, and knowledge about asthma and inhaler of the caregiver, history of asthmatic exacerbation in the preceding year. Knowledge about asthma and inhaler of the caregiver was grouped into good if there were ≥ 8 corrected answers or poor with 0–7 correct answers. The primary caregiver was defined as the parents or any person who was mainly in charge of the inhalation.

Statistical Analysis

Data were analyzed by SPSS statistical analysis for Windows version 22.0 (IBM Corp, Armonk, NY). Descriptive data were presented as mean age with standard deviation (SD) or median with interquartile range (IQR), or number with percentage. Features associated with incorrect inhalation technique were determined by univariate analysis. Median ages of children and caregiver were used as the reference to categorize them into 2 groups to study the association. Significant factors from univariate analysis were entered for multivariate analysis by multivariate logistic regression (LR) (stepwise backward LR), and were presented with odds ratios [ORs] and 95% confidence intervals [CIs]. P-value <0.05 was considered as statistically significant.

Result

From a total of 85 children with asthma included in the study, 63.5% were male. A median age (25^{th}-75^{th} IQR) was 5.4 (4.3-8.0) years. Approximately half were kindergarten (50.6%). We found 44 children (51.8%) had comorbidity, most commonly allergic rhinitis (34.1%). Most patients in our study received fluticasone propionate (71.8%) with a spacer device (89.4%).

Regarding the characteristics of the primary caregivers, a median age (25^{th}-75^{th} IQR) was 40 (33-48) years. More than half of the primary caregivers were mothers (56.5%). Approximately 25% were uneducated or had an education in primary school whereas 25% worked as a housekeeper. More than half (56.5%) had family income < 30,000 baht. Table 1 shows the basic characteristics of the children and their primary caregivers. Out of 10 questions about knowledge about asthma and inhaler, 46 (54.1%) had the good score with correct answers of 8 or more. The most common question about asthma knowledge which had incorrect answer was “loss of using of MDI may worsen lung function in long term” found in 37 respondents (43.5%) (Table 2).

Table 1:

The basic characteristics of the children and their primary caregivers

General characteristics of children	N (%)
Age, median (25^{th}-75^{th} IQR)	5.4 (4.3–8.0)
Sex:	
Male	54 (63.5)
Female	31 (36.5)
Educational background:	
Preschool	16 (18.8)
Kindergarten	43 (50.6)
Primary school	16 (18.8)
Secondary school	10 (11.8)
Comorbidity (*n*=44):	
Allergic rhinitis	29 (34.1)
Atopic dermatitis	13 (15.3)
Allergic conjunctivitis	4 (4.7)
Others	7 (8.2)
General characteristics of caregivers	**N (%)**
Age, median (25^{th} -75^{th} IQR)	40 (33–48)
Primary caregiver:	
Mother	48 (56.5)
Father	15 (17.6)
Others	22 (25.9)
Level of education of primary caregiver:	
Uneducated or Primary school	21 (24.7)
Secondary school or Vocational school	37 (43.5)
Bachelor of Arts or Master of Arts	27 (31.8)
Career of primary caregiver:	
Company employee and government officer	33 (38.8)
Shopkeeper and general job	31 (36.5)
Housekeeper	21 (24.7)
Family income/ month:	
<30,000 Baht	48 (56.5)
>30,000 Baht	37 (43.5)

Note: More than one comorbidity may be found in one child
IQR= Interquartile range

Table 2:

Knowledge score of the primary caregivers about asthma and inhaler (N=85)

Knowledge about asthma	True	False
Asthma is a chronic disease.	54 (63.5%)	31 (36.5%)
Asthma is curable without treatment.	75 (88.2%)	10 (11.8%)
Asthma will be improved when the child grow up without treatment.	56 (65.9%)	29 (34.1%)
Asthma is not a dangerous disease.	61 (71.8%)	24 (28.2%)
Knowledge about MDI		
MDI is always used everyday.	69 (81.2%)	16 (18.8%)
MDI is used when the child has symptoms	67 (78.8%)	18 (21.2%)
MDI is an asthma controller.	73 (85.9%)	12 (14.1%)
Loss of using of MDI may aggravate asthma symptoms	64 (75.3%)	21 (24.7%)
Loss of using of MDI may worsen lung function in long term	48 (56.5%)	37 (43.5%)
Regular use of MDI without correct method is enough to control asthma.	60 (70.6%)	25 (29.4%)

MDI= Metered dose inhaler

Of the 85 patients, 76 patients and 9 patients used MDI with a spacer and without a spacer respectively. Incorrect inhalation techniques were found in 51 patients (60.0%) : 47 patients (61.8%) using MDI with spacer and 4 patients (44.4%) using MDI without a spacer (p=0.178). The numbers and percentages of the incorrect inhalation technique steps are shown in Table 3.

The 3 most common incorrect inhalation techniques when using MDI with a spacer in order of frequency were failure of: normal breathing for 5-6 times via spacer (27 patients, 35.5%), expiry date checking (19 persons, 25.0%), and presence of remaining drug checking (12 persons, 15.8%). The 2 most common mistakes using MDI with no spacer were an inappropriate placing the mouthpiece between the teeth (farther than 2 inches) and a failure for a ≥ 30-second interval before the next actuation (2 persons in each step, 22.0% each).

By univariate analyses, we found 8 factors were significantly associated with incorrect inhalation technique. The risk factors in order of their impacts (ORs) were: previous admission with status asthmaticus (7.82 times), poor understanding of proper use during the hospital teaching class (7.55 times), education of primary school or lower (7.13 times), other caregiver (6.15 times), having father as a caregiver (5.55 times), instruction duration < 5 min (5.20 times), caregiver aged >40 years (2.73 times) and poor knowledge of asthma and inhaler (2.56 times).

Table 3:

Steps required for proper MDI (n = 9) and MDI-spacer use (*n*=76)

Steps of inhalation	Incorrect inhalation technique (N/total: %)	
	MDI with a spacer (47/76: 61.8%)	MDI (4/9: 44.4%)
1. Checking expiry date	19 (25.0)	1 (11.1)
2. Checking drug amount	12 (15.8)	0
3. Remove cap	3 (3.9)	0
4. Shaking MDI	11 (14.5)	1 (11.1)
5. Exhale slowly	0	0
6. Connecting MDI to spacer	1 (1.3)	-
7. Holding MDI upright	3 (3.9)	0
8. Apply a face mask covering the mouth and nose or a mouthpiece between teeth (or to mouth approximately 2 inches)	1 (1.3)	2 (22.2)
9. Actuation once	3 (3.9)	0
10. Breathing in while pressing down the inhaler	-	1 (11.1)
11. Breathing normally 5-6 times via spacer	27 (35.5)	-
12. Breathe in slowly	9 (11.8)	0
13. Hold breathe for 10-second	-	0
14. Wait at least 30-second before next actuation	9 (11.8)	2 (22.2)
15. Rinse the mouth after use	5 (6.6)	0

Note: More than one step of mistakes may be found in one child/ caregiver
MDI= Metered dose inhaler

By multivariate analyses, 3 factors were independently associated with incorrect inhalation technique: history of prior hospital admission due to acute asthma exacerbation, non-maternal caregiver, a lack of understanding the correct inhalation. The risk of incorrect inhaler use were 7.20 times higher (95% CI, 2.31–21.40, P = 0.001) in children with prior acute asthma exacerbation, 5.50 times with paternal [95% confidence interval (CI), 1.12–25.50, P = 0.034] and 6.38 times (95%CI, 1.47–26.62, P = 0.009) with other caregivers compared to having mothers as the caregiver. On the other hand, the risk was 5.55 times (95%CI 1.02–28.54, P= 0.047) among children and caregivers who did not understand and failed to clarify the procedures with the instructor during the hospital teaching class. Data of findings from uni- and multi-variate analyses are shown in Table 4.

Table 4:

Factors associated with incorrect inhaler technique

Factors	Inhaler technique		Univariate		Multivariate	
	Incorrect *n*=51 (%)	Correct *n*=34(%)	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Sex: female, n =31	18 (35.3)	13 (38.2)	1.10 (0.45-2.85)	0.654		
Age of patient:>5 years, n=45	26 (51.0)	19 (55.9)	1.15 (0.50-2.82)	0.615		
Primary caregiver:						
Mother, n=48	21 (41.2)	27 (79.4)	1.00	Reference	1.00	Reference
Father, n=15	12 (23.5)	3 (8.8)	5.55 (1.41–22.93)	0.014*	5.50 (1.12–25.50)	0.034*
Others, n=22	18 (35.3)	4 (11.8)	6.15 (1.81–21.24)	0.004*	6.38 (1.47–26.62)	0.009*
Age of caregiver: >40 years, n=36	25 (49.0)	11 (32.4)	2.73 (1.10–6.90)	0.024*	NS	NS
Career of caregiver:						
Employee/ government officer, n=33	17 (33.3)	16 (47.1)	1.00	Reference		
Shopkeeper/ general job, n=31	18 (35.3)	13 (38.2)	1.44 (0.59-3.70)	0.444		
Housekeeper, n=21	16 (31.4)	5 (14.7)	2.90 (0.90-9.70)	0.070		
Education of caregiver:						
Primary school or lower, n=21	18 (35.3)	3 (8.8)	7.13 (1.79–25.6)	0.005*	NS	NS
Secondary/ Vocational school, n=37	22 (43.1)	15 (44.1)	1.98 (0.70-5.45)	0.200		
Bachelor degree or higher, n=27	11 (21.6)	16 (47.1)	1.00	Reference		
Family income per month:						
>30,000 Baht, n=37	21 (41.2)	16 (47.1)	1.16 (0.57-2.69)	0.712		
Knowledge of asthma and inhaler:						
Good, n=46	23 (45.1)	23 (67.6)	1.00	Reference		
Poor, n=39	28 (54.90)	11 (32.4)	2.56 (1.20–6.40)	0.025*	NS	NS

Table 4:

Factors associated with incorrect inhaler technique (Con.)

Factors	Inhaler technique		Univariate		Multivariate	
	Incorrect *n*=51 (%)	Correct *n*=34(%)	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Previous admission with status asthmaticus, n=51	38 (74.5)	13 (38.2)	7.82 (2.95–20.95)	< 0.001*	7.20 (2.31–21.40)	0.001*
Person teaching the use of inhaler:						
Medical doctor n=64	37 (72.5)	27 (79.4)	1.00	Reference		
Pharmacist or nurse, n=21	14 (27.5)	7 (20.6)	1.55 (0.55-4.60)	0.310		
Watching a video of hospital's inhalation, n=17	10(19.6)	7 (20.6)	1.10 (0.35-3.34)	0.670		
Misunderstanding of proper use during the hospital teaching class, n=16	14 (27.5)	2 (5.9)	7.55 (1.55–34.86)	0.009*	5.55 (1.02–28.54)	0.047*
No repeat demonstration of inhalation, n=25	16 (31.4)	9 (26.5)	1.56 (0.54-4.15)	0.259		
Other medication, n=39	19 (37.3)	20 (58.8)	1.55 (0.63-3.78)	0.252		
Duration of instruction ≤5 min, n=13	11 (21.6)	2 (5.9)	5.20 (1.08–25.45)	0.030*	NS	NS
MDI with spacer, n=76	47 (92.2)	29 (85.3)	2.07 (0.89-5.55)	0.178		

*$P < 0.05$ statistically significant. NS=not statistically significant.
MDI= Metered dose inhaler

Discussion

This study found 60% the asthmatic children had incorrect use of the inhaler. This was higher than 44% reported in the previous study in Thailand[9]. However, this was in the ranges with findings from one systematic review which summarized 11% to 100% rates of incorrect use of MDI with a spacer and 3% to 82% of MDI without spacer[24]. The main reason for this wide range of incorrect use may depend on the criteria or number of incorrect steps used in each study. Another possible reason may be because we detailed the steps of inhalation which had not been addressed in previous studies: checking of the expiry date and the amount of drugs genuinely inhaled. Although these 2 steps were not the actual procedure in the inhalation, but we agreed in our group that they were crucial for the effective use of the drugs. This was evidenced that they were the second and third common mistakes found in 25% and 16% respectively in our study.

Among all the steps assessed, failure to breathe normally via a spacer was the most common mistake identified among patients using MDI with spacer (35.5%). This was also found in the study of Capanoglu et al[8] which found 24% error of this step in their patients using MDI. Aside from the 3 most common errors mentioned, our study also found a failure to shake MDI before use, failure for a > 30-second interval before the next actuation and failure to breathe in slowly were also frequently found in 14.5%, 11.8% and 11.8% respectively. Regarding the incorrect use of MDI without a spacer, one of the two most common mistakes found in our study (failure for a ≥ 30-second interval before the next actuation) was also found as common in the systematic review[24]. One previous study from Thailand by Deerojanawong et al who reported 44% incorrect use of inhaler found failure for a ≥30-second interval before the next actuation and failure to breath in slowly as the most common mistakes in MDI with spacer and without spacer respectively[9]. The aforementioned systematic review also found breathing in slowly and holding the breath for 5-10 seconds as common mistakes in MDI without spacer, however, errors were not found in any patients in our study. The main reason for this common mistake of waiting for 30 seconds before the next actuation (in both MDI use with or without spacer) was probably because most caregivers were the one who pressed the MDI making the coordination with the children's breath more difficult. Although each step of the inhalation was taught during the educational session, some caregivers still made mistakes. These common errors should be emphasized during the education session[19].

Among the 8 factors which were significantly associated with incorrect inhalation technique in univariate analyses, our study found 3 factors as independent factors for the correct inhaler use: history if acute asthmatic attack necessitating hospitalization, the non-maternal caregiver, and a lack of knowledge. Among the 3 independent risk factors identified, a history of the previous admission with status asthmaticus (7.20 times) was the most important factor found in our study. This was also demonstrated in previous study that an absence of severe attack or no history of hospital admission in the preceding year was associated with the correct use of the device[18, 25]. The incorrect use resulted in an inadequate dosage, which aggravates asthma complications.

Regarding the type of caregiver, we found that paternal caregivers and other caregivers were significantly correlated with the incorrect use of inhalers (P= 0.034 and 0.009, respectively). This reflected the nature of bonding that mothers may give more attention to details than other caregivers. Unfortunately, there had been no previous studies which addressed the type of caregivers among the asthmatic children. This factor should be explored further in future studies on this subject. Previous studies reported the education of caregiver or mother as important factors affecting the correct use of inhaler: the higher education especially a mother with higher education tended to do the correct inhalation [8, 18, 25].

Our study found no education or primary school as the risk factor for the incorrect use, however, only in univariate analysis. Another independent influencing factor for the incorrect use of inhaler in our study was the problem in understanding the proper inhalation techniques. Few previous studies demonstrated a repeated video education, regular follow-up with demonstration to the physician, or trained by the clinical trainer were important factors for the correct use of the device[18, 26]. Children who received comprehensive inhalation instructions with repeated checks of proper inhalation technique were more likely to perform all essential steps correctly than children who had received only a single instruction[10] . Comprehensive device training by a clinical trainer and repeated lessons as recommended by few previous studies[10, 18] as well as specific emphasis on the items which were frequently the gap of knowledge e.g. “loss of using of MDI may worsen lung function in long term”, “asthma is a chronic disease”, “asthma will be improved when the child grow up without treatment”, etc., as found in our study should be focused to assure a correct inhalation technique.

Conclusion

In our study, 60.0% of children with asthma used the inhaled corticosteroid device incorrectly. The independent risk factors of incorrect use were previous hospital admission from acute exacerbation, non-maternal caregivers, and poor understanding of inhalation technique during the hospital teaching class.

References

1. Masoli M, Fabian D, Holt S, Beasley R. Global Initiative for Asthma (GINA) Program. The global burden of asthma: executive summary of the GINA Dissemination Committee report. Allergy. 2004; 59: 469-78.
2. Trakultivakorn M, Sangsupawanich P, Vichyanond P. Time trends of the prevalence of asthma, rhinitis, and eczema in Thai children-ISAAC (International Study of Asthma and Allergies in Childhood) Phase Three. J Asthma. 2007; 44: 609-11.
3. Sritipsukho P, Viriyaudomsir O. Health-related quality of life in Thai children with allergic respiratory diseases. J Med Assoc Thai. 2015; 98: 457-63.
4. Ban GY, Ye YM, Lee Y, Kim JE, Nam YH, Lee SK, et al; Premier Researchers Aiming New Era in Asthma and Allergic Diseases (PRANA) Study Group. Predictors of asthma control by stepwise treatment in elderly asthmatic patients. J Korean Med Sci. 2015; 30: 1042-7.
5. Makhinova T, Barner JC, Richards KM, Rascati KL. Asthma controller medication adherence, risk of exacerbation, and use of rescue agents among Texas Medicaid patients with persistent asthma. J Manag Care Spec Pharm. 2015; 21: 1124-32.
6. Puranik S, Forno E, Bush A, Celedón JC. Predicting severe asthma exacerbations in children. Am J Respir Crit Care Med. 2017; 195: 854-9.
7. Melani AS, Bonavia M, Cilenti V, Cinti C, Lodi M, Martucci P, et al. Inhaler mishandling remains common in real life and is associated with reduced disease control. Respir Med. 2011; 105: 930-8.
8. Capanoglu M, Dibek Misirlioglu E, Toyran M, Civelek E, Kocabas CN. Evaluation of inhaler technique, adherence to therapy and their effect on disease control among children with asthma using a metered dose or dry powder inhalers. J Asthma. 2015; 52: 838-45.
9. Deerojanawong J, Promsaka Na Sakolnakorn V, Prapphal N, Hanrutakorn C, Sritippayawan S. Evaluation of metered-dose inhaler administration technique among asthmatic children and their caregivers in Thailand. Asian Pac J Allergy Immunol. 2009; 27: 87-93.

10. Kamps AW, van Ewijk B, Roorda RJ, Brand PL. Poor inhalation technique, even after inhalation instructions, in children with asthma. Pediatr Pulmonol. 2000; 29: 39-42.
11. Sanchis J, Gich I, Pedersen S. Aerosol Drug Management Improvement Team (ADMIT). Systematic review of errors in inhaler use: has patient technique improved over time? Chest. 2016; 150: 394-406.
12. Price D, Bosnic-Anticevich S, Briggs A, Chrystyn H, Rand C, Scheuch G, et al; Inhaler Error Steering Committee. Inhaler competence in asthma: common errors, barriers to use and recommended solutions. Respir Med. 2013; 107: 37-46.
13. Williams LK, Pladevall M, Xi H, Peterson EL, Joseph C, Lafata JE, et al. Relationship between adherence to inhaled corticosteroids and poor outcomes among adults with asthma. J Allergy Clin Immunol. 2004; 114: 1288-93.
14. Williams LK, Joseph CL, Peterson EL, Wells K, Wang M, Chowdhry VK, et al. Patients with asthma who do not fill their inhaled corticosteroids: a study of primary nonadherence. J Allergy Clin Immunol. 2007; 120: 1153-9.
15. Lasmar L, Camargos P, Champs NS, Fonseca MT, Fontes MJ, Ibiapina C, et al. Adherence rate to inhaled corticosteroids and their impact on asthma control. Allergy. 2009; 64: 784-9.
16. Camargo CA Jr, Ramachandran S, Ryskina KL, Lewis BE, Legorreta AP. Association between common asthma therapies and recurrent asthma exacerbations in children enrolled in a state Medicaid plan. Am J Health Syst Pharm. 2007; 64: 1054-61.
17. Lewis A, Torvinen S, Dekhuijzen PN, Chrystyn H, Watson AT, Blackney M, et al. The economic burden of asthma and chronic obstructive pulmonary disease and the impact of poor inhalation technique with commonly prescribed dry powder inhalers in three European countries. BMC Health Serv Res. 2016; 16: 251.
18. Topal E, Celiksoy MH, Catal F, Sinanoglu MS, Karakoc HT, Sancak R, et al. Assessment of skills using a spacer device for a metered-dose inhaler and related independent predictive factors in caregivers of asthmatic preschool children. Int Forum Allergy Rhinol. 2016; 6: 130-4.
19. Zhao J, Shen K, Xiang L, Zhang G, Xie M, Bai J, et al. The knowledge, attitudes, and practices of parents of children with asthma in 29 cities of China: a multi-center study. BMC Pediatr. 2013; 13: 20.
20. Blaiss MS. Part II: Inhaler technique and adherence to therapy. Curr Med Res Opin. 2007; 23 Suppl 3: S13-20.
21. Fink JB, Rubin BK. Problems with inhaler use: a call for an improved clinician and patient education. Respir Care. 2005; 50: 1360-74.
22. Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention. Ontario, Canada: GINA; 2015
23. National Institutes of Health. National Heart, Lung, and Blood Institute. National Asthma Education and Prevention Program. Clinical Practice Guidelines. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. Full Report 2007.
24. Gillette C, Rockich-Winston N, Kuhn JA, Flesher S, Shepherd M. Inhaler Technique in Children With Asthma: A Systematic Review. Acad Pediatr. 2016; 16: 605-15.
25. Reznik M, Silver EJ, Cao Y. Evaluation of MDI-spacer utilization and technique in caregivers of urban minority children with persistent asthma. J Asthma. 2014; 51: 149-54.
26. Shaw N, Le Souëf P, Turkovic L, McCahon L, Kicic A, Sly PD, et al. Pressurised metered dose inhaler-spacer technique in young children improves with video instruction. Eur J Pediatr. 2016; 175: 1007-12.