Caregiver Knowledge and Delivery of a Commonly Prescribed Medication (Albuterol) for Children

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Objective: To evaluate caregiver knowledge and delivery of a prescription medication (albuterol) for children.

Design: Prospective convenience sample.

Participants: Caregivers listing albuterol as one of their child’s medications.

Setting: Two urban, university-affiliated pediatric emergency departments.

Interventions: Caregivers were asked about their knowledge of the medication, the child’s dose, frequency, duration of use, and where it was prescribed. In a mock scenario, they measured and demonstrated medication delivery to their child. Common measuring devices and formulations were offered.

Results: Forty-one caregivers were enrolled. Thirty-six (88%) were high school educated and 39 (95%) had a primary care provider. Twenty-six (63%) were out of medication, 7 (17%) stated an incorrect dose, 18 (44%) reported an incorrect frequency, and 10 (24%) stated an inadequate duration of use. Formulations chosen were liquid (n = 15, 37%), nebulizers (n = 15, 37%), and inhalers (n = 11, 27%). Metered dosing (metered-dosing inhaler or premixed solution) were chosen by 22 caregivers (54%), calibrated measuring tools (droppers, syringes) by 15 (37%), and noncalibrated delivery devices (teaspoon) by 4 (10%). An improper dose was measured by 9 (22%), and the dose intended was inaccurately measured by 7 (17%). All caregivers using a teaspoon inaccurately measured their intended dose of the liquid formulation.

Conclusions: Metered dosing and calibrated measuring devices aided in the accurate delivery of this prescription medication. However, considerable concern exists with the use of noncalibrated measuring devices (teaspoons), improper frequency, and duration of use. Refilling of medication was also a concern since 63% were out of albuterol. Caregiver education on use, delivery, and refilling of medications must be stressed and assessed at all emergency department and primary care visits. In addition, metered dosing and the use of calibrated measuring devices should be encouraged.


ASTHMA CONTINUES to be a leading cause of morbidity and even mortality among children in the United States. This is especially true among poor and inner-city families. In addition, it has been shown that the overall quality of care has a direct impact on patient outcomes, as would be expected. β-Adrenergic agents remain one of the first-line therapies for acute asthma exacerbations and are often used in the long-term care of children with asthma. They are the most commonly prescribed and used medication for asthma, especially by children in the inner cities. Parental knowledge and delivery of these and other medications to children is of vital importance since in most cases the caregivers are empowered with the monitoring and delivery of care. This is especially true given the significant health impact on children with chronic illnesses such as asthma if care regimens are not properly followed or understood by the child's caregiver. In a previous study it was shown that caregivers experienced considerable difficulty with the delivery of over-the-counter medications (OTCs) to
SUBJECTS AND METHODS

Eligible for participation in the study were caregivers presenting to 1 of 2 inner-city pediatric emergency care centers who noted at the time of triage that one of their child’s medications was albuterol. Families were eligible if their child was between 0 and 18 years of age. The study consisted of a prospective convenience sample of patients presenting on a representative mix of days, evenings, and weekends from September 1997 through November 1997. The combined annual emergency department census for the 2 inner-city Atlanta, Ga, children’s hospitals is more than 70,000. A questionnaire was developed and verbally administered to each caregiver by the primary investigator. The first portion of the questionnaire included 20 questions about demographic characteristics, medical history, parental level of education, and access to care. The second portion consisted of 12 questions asking the caregivers about their child’s use of albuterol. These questions included specifics about the type of formulation, when it was used, where it was prescribed, and medication delivery devices. Parents were asked to respond for the formulation they most commonly used for their child.

Following the questionnaire, the caregivers were given a mock scenario in which they were asked to determine the appropriate dose of albuterol for their child. They were all informed that no medication would actually be given to their child during this scenario and that this was strictly for demonstration purposes. They were also instructed that their child would receive routine care for their presenting complaint regardless of participation and that no care would be delayed by involvement in the study. Caregivers were asked to select the correct dose, schedule, and frequency of administration based on recall from previous albuterol use. A correct dose was considered the following: (1) oral, 0.1 mg/kg per dose 3 times daily; 2- to 4-mg/dose maximum; (2) aerosol, 1 to 2 puffs every 4 to 8 hours; or (3) nebulized, 0.05 to 0.15 mg/kg per dose every 4 to 8 hours, 2.5 to 5 mg maximum. Appropriate dosing was considered if these parameters were within ±20%. All children had been weighed previously at triage. This information as well as any other information available was given to the families if they requested it. The caregivers were given their choice from all common formulations (liquid, inhalers, nebulizer solution, premixed nebulizer solution) as well as all common measuring devices: (1) noncalibrated devices such as teaspoons and tablespoons; (2) calibrated devices such as calibrated tubes, syringes, measuring cups, droppers; and (3) premixed calibrated devices such as premixed nebulizer solution and inhalers with or without spacers. Because noncalibrated teaspoons may frequently vary from 4 mL to 6 mL, those offered to the participants included a plastic teaspoon and a metal teaspoon (from a typical household set), both of which were 5 mL when filled. No further prompting was performed unless requested by the caregiver. For children whom the caregivers reported routinely self-administered their medications, the child was asked to demonstrate the medication delivery under caregiver supervision. The investigator, for accuracy, then determined the actual dose measured by the caregiver. Accuracy was considered as administered doses within ±20% of the dose that the caregivers stated they intended to give. Alternatively, for inhalers, proper shaking, dosing, and mouth coordination were considered when determining accuracy (placebo inhalers were used). All data were stored and analyzed using an Epi Info database (Epi6.0). The Fisher exact test was used for categorical data. Risk ratios are reported with 95% confidence intervals. The Human Investigations Committee of Emory University approved the study.

RESULTS

During the study period, 42 families who met eligibility criteria were approached for enrollment. Forty-one (98%) of the 42 caregivers consented to participate. The remaining family would not comment on their reason for declining participation. All families that agreed to participate completed both the questionnaire and the mock dosing scenario.

Thirty-nine (95%) of the 41 children presented to the emergency department with respiratory-related illnesses. The mean ± SD age of the patients was 6.3 ± 4.1 years and that of the caregivers was 33.0 ± 8.5 years. Thirty-seven (90%) of the caregivers were one of the child’s parents. Twenty-nine (71%) of the caregivers were African American and 9 (22%) were white, which is consistent with the overall emergency department demographics. Forty (97%) spoke English as a first language; however, all were proficient enough in English to complete the study without language concerns. Thirty-six (88%) of the caregivers reported at least completing high school and 39 (95%) were able to identify a primary care physician or clinic as a source of medical care for their child.

Twenty-six (63%) of the caregivers were reportsedly out of medication or had none available to them.
Twenty-two (54%) reported that their primary care provider filled their last prescription for albuterol, 18 (44%) reported getting the medication from an emergency care center, and 1 (2%) was unsure. However, among those out of albuterol at the time of the study, there was no significant difference based on reported source of the medication. Nine (41%) of 22 who obtained their albuterol from a primary care provider and 6 (33%) of 18 who obtained it from an emergency care center were out of medication ($P = .66$).

During the questionnaire portion, 23 caregivers (56%) reported that their child had required hospitalization for asthma in the past. Nine (23%) reported that the child always used albuterol, 29 (74%) started its use at the very beginning of a respiratory tract illness, and the remaining child (2%) started it sometime into the illness. When asked what they routinely base their child’s dose upon, 33 (80%) reported “just knowing it,” 6 (15%) “rely on the doctor;,” and 2 (5%) “rely on the bottle.” In addition, only 7 (17%) reported that they read the bottle or prescription labels each time to base their dosing. Seven caregivers (17%) stated an incorrect dose, 18 (44%) an incorrect frequency of dosing, and 10 (24%) an inadequate duration of use.

Formulations chosen by the families for the mock scenario were liquid by 15 (37%), nebulizers by 15 (37%), and metered-dosing inhalers by 11 (27%). Metered-dosing (premixed nebulizer solutions or metered-dosing inhaler) were chosen by 22 (54%), calibrated measuring tools (dippers, syringes, measuring cups) by 15 (37%), and noncalibrated delivery devices (nonstandardized teaspoon) by 4 (10%). Twelve (29%) of the mock demonstrations were performed by the patient in conjunction with the caregiver (11 inhalers and 1 nebulizer) while the caregivers dosed the medication alone in 29 (71%) of the cases. Six (21%) of 29 doses measured by the caregivers and 1 (8%) of 12 measured by the patients were done incorrectly. The risk ratio of an improper dose being measured by the caregiver compared with when it was measured by the child was 2.26 (95% confidence interval, 0.35-14.8). However, there was a significant difference of measuring device used by the child or the caregiver with all liquids being measured by calibrated measuring devices by the families seemed to aid in the delivery of albuterol to their child. This is further evidenced by the fact that the older children who self-administered their medication for asthma in the past. The majority of families (83%) were able to state the proper dose, and 78% were able to actually deliver a proper dose to the child. This is compared with only 30% of families being able to properly state and deliver the common OTC (acetaminophen) to their child. Several notable differences exist between the 2 types of medications. First, because it is a prescription medication, albuterol requires physician and pharmacist interaction in the initial recommendation and counseling on dosing and delivery. In contrast, OTCs require no medical supervision in their use and delivery other than required package labeling by the Food and Drug Administration. In addition, the fact that albuterol is used for a chronic illness may have aided in the caregivers’ knowledge and delivery of these medications. Most strikingly, the availability of metered dosing and the use of standardized measuring devices by the families seemed to aid in the delivery of albuterol to their child. This is further evidenced by the fact that the older children who self-administered their medications did considerably better in their delivery of their intended dose when calibrated measuring devices were used. This is in contrast to much poorer results that occurred when a noncalibrated device (teaspoon) was used.

Caregivers seem to do much better with the delivery of this commonly prescribed asthma medication (albuterol), as demonstrated by the present study, compared with the historical controls’ ability to dose and deliver the common OTC (acetaminophen) to their child. These studies occurred at the same institution in similar patient populations. The majority of families (83%) were able to state the proper dose, and 78% were able to actually deliver a proper dose to the child. This is compared with only 30% of families being able to properly state and deliver the common OTC to their child. Several notable differences exist between the 2 types of medications. First, because it is a prescription medication, albuterol requires physician and pharmacist interaction in the initial recommendation and counseling on dosing and delivery. In contrast, OTCs require no medical supervision in their use and delivery other than required package labeling by the Food and Drug Administration. In addition, the fact that albuterol is used for a chronic illness may have aided in the caregivers’ knowledge and delivery of these medications. Most strikingly, the availability of metered dosing and the use of standardized measuring devices by the families seemed to aid in the delivery of albuterol to their child. This is further evidenced by the fact that the older children who self-administered their medications did considerably better in their delivery of their intended dose when calibrated measuring devices were used. This is in contrast to much poorer results that occurred when a noncalibrated device (teaspoon) was used.

While metered dosing, and potentially physician and pharmacist counseling of families, may have assisted the caregivers in performing better with the dosing of this prescription medication compared with the common OTC, several concerning trends occurred. Most of the albuterol was administered with premixed or metered dosing but caregivers who used noncalibrated measuring devices (teaspoons) performed poorly in their ability to properly deliver the intended dose to their child. In addition, access to medication remained a significant problem.

### Measuring Device vs Accuracy of Measured Dose

<table>
<thead>
<tr>
<th>Device</th>
<th>No. of Times Chosen</th>
<th>No. Accurate</th>
<th>No. Inaccurate</th>
<th>% Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaspoon</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Calibrated device</td>
<td>11</td>
<td>9</td>
<td>2</td>
<td>82</td>
</tr>
<tr>
<td>Inhaler</td>
<td>11</td>
<td>10</td>
<td>1</td>
<td>91</td>
</tr>
<tr>
<td>Nebulizer</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

*Of the 15 caregivers who chose the liquid formulation, 2 (18%) of 11 using a calibrated device compared with 4 of 4 choosing to use a noncalibrated teaspoon inaccurately measured their intended dose ($P = .03$).*
Whereas OTCs can be readily obtained by caregivers, the nature of the albuterol and the fact that it is used for a chronic illness requires prescription availability. However, nearly 2 of 3 caregivers report being out of their medication at the time of the emergency department encounter. This occurred even though the vast majority of patients identified a primary care provider or clinic.

A potential limitation of the study is that prescription medications have the dose written on the label or bottle. The families in this investigation were asked to dose the medication for their child based on recall of a proper dose. However, only 17% reported that they read the label at home and 80% reported dosing it at home based on “just knowing the proper dose.” Also, variation in physician prescribing has been reported and some individuals stating an incorrect dose may reflect proper recall of a nonstandard amount prescribed by their physician. Given the dosing ranges considered “correct” this should not have been a frequent occurrence. In addition, this is a convenience sample of patients who used the emergency care center and may not be generalizable to the broader pediatric population.

In conclusion, metered dosing and calibrated measuring devices appear to aid in the accurate delivery of this common prescription medication. This is compared with much poorer results shown with OTCs in a previous study. Considerable concern still exists with the use of noncalibrated measuring devices, improper frequency, and duration of dosing. Refilling of medications was also a concern, as 63% were out of albuterol. Therefore, caregiver education on the use, delivery, and refilling of these medications must be stressed at all emergency department and primary care encounters. In addition, whenever possible, metered dosing and calibrated measuring systems should be used preferentially over noncalibrated measuring devices.

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REFERENCES