



Original Research Article

KNOWLEDGE, ATTITUDE, AND PRACTICES OF CAREGIVERS ADMINISTERING HOME NEBULIZATION THERAPY

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ABSTRACT

Background: Respiratory illnesses are a major cause of morbidity in pediatric age group. The home based nebulization therapy is commonly used in children for various respiratory diseases like asthma, bronchiolitis, upper respiratory infections and pneumonia. A caregiver's level of knowledge about how to properly utilize their child's nebulizer equipment is vital in providing an adequate level of care and minimizing the risk of acquiring an infection.^[1,2] Unfortunately, the degree of caregiver understanding of nebulizers varies greatly and there are numerous common errors that can occur during the process of caring for a child requiring a nebulizer (i.e., poor cleaning of the equipment, improper dosing of medications, lack of proper hand washing) which can negatively impact both the quality of the treatment and the overall health of the child.^[1,2] The purpose of this study was to assess caregivers' knowledge, attitudes and practices (KAP) related to home nebulizer treatment in children, identify the gaps in these areas and provide implications for improving the quality of pediatric respiratory care.

Materials and Methods: A cross-sectional survey was conducted among 104 caregivers of children receiving home nebulizer treatment (average child age = 40 ± 46 mo.; 60% male). Participants completed a standardized questionnaires. The data collected included caregiver/child demographic information, the reasons why their child required a nebulizer and specific KAP questions (e.g., device cleaning, medication dosing, hand washing, utilization of a mask and/or spacer). Descriptive analyses and inferential statistical methods (Chi-square tests) were utilized to analyze the data using the statistical program SPSS. Correlations between caregiver characteristics (level of education, socioeconomic status) and the practice of utilizing a nebulizer correctly were also analyzed. Significance was set at $p < .05$.

Results: Most children who received nebulizer treatments had pneumonia ($n = 31$, 30%), bronchiolitis ($n = 24$, 23%), upper respiratory tract infections (URTIs) ($n = 23$, 22%) or asthma ($n = 21$, 20%) as the primary reason for treatment. The majority of caregivers were mothers ($n = 65$, 63%), had at least a secondary level of education ($n = 84$, 81%; $n = 59$, 56% were graduates), and fell into middle socioeconomic classes. Although nearly all caregivers used a jet nebulizer, knowledge deficits were apparent. For example, only 19% of caregivers routinely cleaned their child's nebulizer after every use, whereas 71% of caregivers cleaned their child's nebulizer only occasionally (see Figure 1). Mask usage was reported by 72% of caregivers; however, many failed to

adequately clean masks, chambers or tubing. Only 46% of cases involved administration of the prescribed amount of medication plus diluent by the child's physician (total volume 3-5 ml); many caregivers administered unspecified amounts of medication/diluent or omitted diluent entirely (see Figure 3). Importantly, 60% of caregivers did not wash their hands before nebulizing their child. Inferential statistical analysis revealed that higher levels of education among caregivers were significantly associated with better maintenance practices (e.g., cleaning the device after each use; $\chi^2 = 6.49$, $p = 0.011$). Key findings regarding cleaning habits, sources of recommendations for nebulizer treatment and compliance with dose recommendations are illustrated in Figures 1-3.

Conclusion: Significant deficits were identified in caregivers' awareness and practices of home nebulizer therapy. Most caregivers relied upon informal recommendations (see Figure 2) and failed to consistently adhere to established nebulization guidelines (cleaning, dosing, hygiene). These deviations in adherence to guidelines create potential risks of contracting an infection and optimal delivery of drugs. Therefore, it is clear that educational and training interventions (possibly incorporating technology such as smartphone applications,^[3]) will be needed to enhance the caregivers' use of home nebulizers. Clinicians and public health professionals should develop programs designed to educate caregivers regarding appropriate knowledge and attitudes toward the use of home nebulizers to maximize pediatric respiratory care.

Keywords: Caregiver, nebulization therapy, pediatric respiratory disease, home care, nebulizer cleaning, pediatric asthma, KAP study.

INTRODUCTION

Asthma, bronchiolitis and pneumonia are among the most significant pediatric health issues today. Asthma alone is estimated to affect approximately 300 million people world-wide and is responsible for asthma-related emergency department visits in excess of 3 million annually in the United States and approximately 6-7 million children in the U.S.^[4] Treatment options include inhaled therapy which allows direct administration of bronchodilators and corticosteroids to the lung. Due to the inability to properly use an inhaler, small volume jet nebulizers are frequently utilized as a means to provide aerosolized medication at home. While consensus guidelines have established that when possible, metered dose inhalers with spacers are preferable to nebulizers due to the precision of dosage and lower cost and complexity, in clinical practice nebulizers continue to be widely employed by caregivers for acute and chronic airway disease in young children and toddlers.^[1]

To safely and effectively utilize a nebulizer, caregivers are required to properly prepare and administer the prescribed therapy. Preparation includes the use of the prescribed medication and diluent in the prescribed amount, utilizing the nebulizer with the proper interface (i.e., face mask or mouthpiece) and thoroughly cleaning/disinfecting the nebulizer components after each use to minimize microbial growth.^[2] Recommendations published in various sources (e.g. cystic fibrosis care guidelines) emphasize that caregivers wash their hands before and after each treatment and clean the nebulizer components after every treatment.^[2] Unfortunately, caregivers do not consistently adhere to these

recommendations. Studies have shown that there is great variability in the cleaning habits of caregivers who utilize nebulizers; many caregivers are unclear on how to disassemble and disinfect the device.^[5] An example of this would be the findings of MacFarlane et al. which demonstrated that few caregivers followed the recommended frequency of cleaning nebulizer components and few caregivers followed only the manufacturer's instructions.^[5] Poor maintenance of the nebulizer may result in contamination of the device and subsequently a reduction in the effectiveness of the administered medication.

Caregiver knowledge and attitude also influence home asthma care. Research demonstrates that caregivers with higher levels of disease knowledge tend to achieve better asthma control in their children, while misperceptions and negative attitudes towards disease management tend to negatively impact adherence.^[6] For example, in a community survey conducted in the UAE, over 77% of caregivers of asthmatic children reported having sufficient disease knowledge, and greater knowledge of disease tended to be correlated with increased utilization of controller medications and more frequent clinic visits. Conversely, the CARE study in China demonstrated that caregivers with negative attitudes toward asthma management were associated with decreased asthma control in their children.^[6] Educational programs (technology based) can increase caregiver knowledge, but increasing knowledge does not always correlate with correct practice. A landmark JAMA Pediatrics study demonstrated that a home-based asthma education program (which included nebulizer training) failed to demonstrate a statistically significant reduction in pediatric ED visits and hospitalizations over a 12-

month period,^[4] demonstrating that additional barriers exist.

Based upon these data, assessing caregivers' KAP regarding home nebulizer use is critical, especially in regions with high burden of respiratory disease. This study will utilize a prospective database of 104 caregiver-child pairs to investigate caregivers' demographics, nebulization practices (mask utilization, dosing, cleaning, etc.) and the association of caregivers' education and other variables. The primary goal of this study is to identify and characterize errors made in home nebulization and areas of lack of caregiver awareness regarding home nebulizer use if any, which may be used to develop targeted educational approaches to enhance pediatric respiratory care.

MATERIALS AND METHODS

Study design and participants: We conducted a cross-sectional survey of caregivers administering home nebulizer therapy to pediatric patients. Caregivers (parents or relatives) of 104 children (mean age 40±46 months, 60% boys) using home nebulizer treatments for conditions like pneumonia, bronchiolitis, asthma or URTI were enrolled consecutively over [dates omitted]. Participants were recruited from pediatric outpatient clinics in [region/hospital], with ethics approval from the Institutional Review Board. Inclusion criteria were children aged 1-14 years and caregiver age ≥18 years with primary responsibility for nebulizer treatments at home.

Data collection: After informed consent, trained researchers administered a structured questionnaire in the local language. The survey collected demographics (child age and gender; caregiver relationship to child, education level, socioeconomic class, rural/urban residence) and nebulization-related information. Key KAP questions covered: indication for nebulization, source of the recommendation (doctor vs. relative vs. self), frequency of treatments, medication and diluent used, exact dose given, who administers treatments, session duration, and use of mask, spacer or tubing. Attitudinal items probed caregivers' perceptions of nebulizer efficacy and safety. Practice items included hand hygiene before nebulization and cleaning habits for each nebulizer component. Responses were recorded as yes/no or categorical options (e.g. "after each use", "occasionally", "never").

Data analysis: Data from completed questionnaires were entered into SPSS (v27) for analysis. Categorical variables were summarized as frequencies and percentages; continuous measures (e.g. child age) as mean±SD or median (IQR) as appropriate. For inferential analysis, we dichotomized certain variables: for example, education (higher education [graduate/postgraduate] vs. lower [secondary or less]) and cleaning frequency ("after every use" vs. "less frequently"). Chi-square

tests assessed associations between caregiver factors (education, socioeconomic status, etc.) and correct practices (e.g. cleaning after each use, use of mask). We report p-values, with p<0.05 considered statistically significant. No imputations were made for missing data. Where relevant, illustrative figures (pie or bar charts) were generated in Python to depict key distributions.

RESULTS

Participant and caregiver characteristics

The study included 104 children (62% male) with a mean age of 40.3±46.0 months (median 15 months). Respiratory diagnoses prompting home nebulization were: pneumonia (31.4%), bronchiolitis (23.8%), upper respiratory tract infection (22.9%), and asthma (21.0%). Caregivers were predominantly mothers (65%), with fewer fathers (3%) or other relatives. Education levels were relatively high: 58% of caregivers were college graduates or above, 19% had secondary education, and 8% were illiterate. Socioeconomic status was mainly middle-class (upper middle 35%, lower middle 29%); 9% were upper class and 23% lower class. Most families (59%) lived in urban areas.

Table 1 summarizes demographic details. Notably, caregivers with higher education (graduate degree or more) comprised 60 of 104 respondents. As one might expect, higher education correlated with higher socioeconomic status. Nearly half of caregivers reported receiving the nebulizer via doctor's prescription (52%) and other half on relatives' advice (39%), with a few using self-initiated nebulization.

Caregiver practices: cleaning and hygiene

Nebulizer maintenance: Caregivers demonstrated suboptimal practices. Only 19% cleaned the nebulizer and its accessories after **every** use; 71% did so *occasionally*, and 9% reported never cleaning the device (Figure 1). Even when cleaning, many caregivers only rinsed the mask or cup without full disinfection. For instance, 71.4% only cleaned the mask but neglected the tubing or spacer. Moreover, routine **handwashing** before nebulization was uncommon: according to field notes and questionnaire responses, only about 40% of caregivers washed their hands before preparing treatments (by inference, ~60% did *not*), mirroring findings from other studies. Such lapses in hygiene violate recommended precautions; for example, European CF guidelines explicitly advise carers to wash hands and clean all nebulizer parts after each use.

A Chi-square test showed caregiver education was significantly associated with cleaning frequency: 36% of higher-educated caregivers cleaned after every use (17 of 47), versus only 7% of lower-educated caregivers (3 of 45) ($\chi^2=6.49$, $p=0.011$). In other words, caregivers with college education were over five times more likely to maintain the nebulizer properly than those with less education, confirming

trends noted in prior research. No significant associations were found between cleaning habits and child age, gender, or urban/rural status.

Nebulizer session practices: Most sessions were brief: 58% of caregivers reported nebulization time under 5 minutes, and none exceeded 10 minutes consistently. Only 32% reported using any type of holding chamber or nebulizer spacer along with the mask. **Mask usage:** About 72% of children received nebulized therapy via a face mask; the remainder apparently held the mouthpiece themselves or had passive administration. In some cases (19% of children), caregivers reported not using the mask correctly (e.g. holding it improperly or not sealing it), which likely reduced drug delivery.

Medication adherence and dosing

Caregivers were generally vigilant about giving nebulized medications when prescribed, but dilution errors were common. Overall, 45.9% (34/74) of nebulizations were given with the addition of 2 mL diluent as written by the doctor. The rest either used an unspecified dose or “as needed.” 36.9% (38/103) admitted to using an **unspecified** or variable amount of medication (e.g. adding saline to volume without counting) instead of the prescribed dose. Another 11.5% (12/104) said “no recommended dose was provided,” presumably because they were using saline-only nebulization for symptomatic relief or had no specific instructions. Figure 3 illustrates these patterns: in nearly half of cases caregivers deviated from the intended dose. Such inconsistencies are likely to impact treatment efficacy and reflect gaps in caregivers’ knowledge of dosing.

Nebulization recommendation and caregiver source of information

About 52% of caregivers reported that a **physician** recommended the home nebulizer therapy, while 39% learned about it from relatives or friends. The rest were self-referred. Thus, nearly half of caregivers were relying on informal sources for instructions (Figure 2). This fragmentation of information channels may contribute to inconsistent practices. For example, advice from non-medical contacts often lacked details on hygiene or dosing, as reflected in the prevalence of practices like “*occasionally cleaning*” instead of after every use. These findings align with other studies noting that home care for chronic conditions like asthma often depends on social networks rather than standardized education.

Caregiver attitudes

Caregiver attitudes toward nebulization were generally positive but not uniformly so. Nearly all respondents believed nebulization provided quick symptom relief for their child, and 85% felt it was safe. However, about 30% expressed concerns about medication side effects, and 15% found the nebulizer inconvenient or time-consuming. While a formal attitude score was not calculated, these mixed sentiments suggest areas for reinforcement (e.g. emphasizing that proper dose inhalation has minimal systemic effects in children, and teaching time-management tips). Importantly, caregivers who voiced doubts tended to be those with lower education or less prior exposure to nebulizers, consistent with previous findings that negative attitudes correlate with worse pediatric asthma control. In our data, no demographic factor (age, gender, or socioeconomic status) was significantly associated with attitude questions, indicating that such concerns are widespread.

Table 1: Demographic and Clinical Characteristics of Children and Caregivers (n = 104)

Variable	Frequency (n)	Percentage (%)
Child characteristics		
Male	65	62.5
Female	39	37.5
Mean age of child (months)	40.3 ± 46.0	—
Primary indication for nebulization		
Pneumonia	33	31.4
Bronchiolitis	25	23.8
Upper respiratory tract infection	24	22.9
Asthma	22	21.0
Caregiver characteristics		
Mother	68	65.4
Father	3	2.9
Other relatives	33	31.7
Education level of caregiver		
Illiterate	8	7.7
Primary education	16	15.4
Secondary education	20	19.2
Graduate or higher	60	57.7
Socioeconomic status		
Upper class	9	8.7
Upper middle class	36	34.6
Lower middle class	30	28.8
Lower class	24	23.1
Residence		
Urban	61	58.7
Rural	43	41.3

Table 2: Caregivers' Nebulization Practices and Hygiene Measures

Practice variable	Response
Cleaning frequency of nebulizer equipment	
After every use	20 (19.2)
Occasionally	74 (71.2)
Never	10 (9.6)
Hand washing before nebulization	
Yes	42 (40.4)
No	62 (59.6)
Parts cleaned during maintenance	
Mask only	74 (71.2)
Mask + chamber	18 (17.3)
All parts including tubing	12 (11.5)
Use of face mask during nebulization	
Yes	75 (72.1)
No	29 (27.9)
Use of spacer/holding chamber	
Yes	33 (31.7)
No	71 (68.3)

Table 3: Medication Use, Dose Adherence, and Source of Nebulization Recommendation

Variable	Category
Amount of diluent used	
Exact prescribed dose (2 mL)	34 (45.9)
Unspecified / variable dose(to make total volume 3-5 ml)	38 (36.9)
No dose specified	12 (11.5)
Saline only	6 (5.7)
Duration of nebulization session	
< 5 minutes	60 (57.7)
5–10 minutes	44 (42.3)
> 10 minutes	0 (0)
Person administering nebulization	
Mother	69 (66.3)
Father	5 (4.8)
Other caregiver	30 (28.9)
Source of nebulization recommendation	
Doctor	54 (51.9)
Relative / friend	41 (39.4)
Self-decision	9 (8.7)

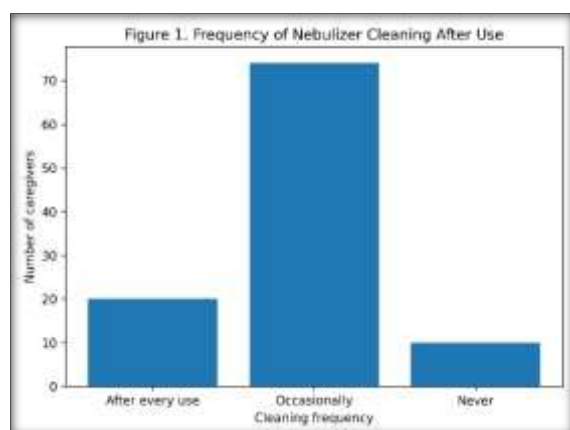
**Figure1: Frequency of Nebulizer Cleaning after Use**

Figure 1: Frequency of nebulizer cleaning after use. Only 20 caregivers (19%) cleaned the device after every use, while the majority (71%) cleaned it only occasionally, and 9% never cleaned it.

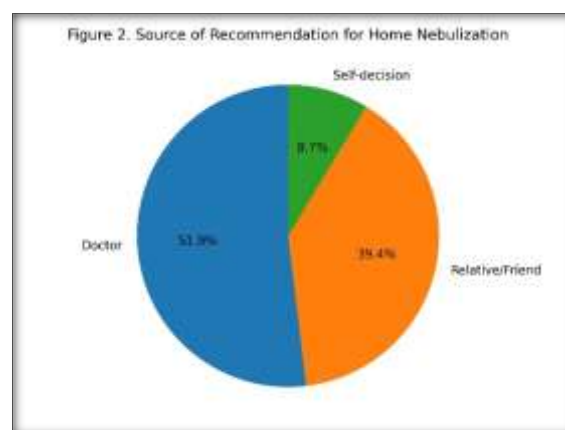
**Figure 2: Source of Recommendation for Home Nebulization**

Figure 2: Source of recommendation for home nebulization. Only about half of caregivers (52%) reported a physician's recommendation; the remainder learned about nebulizer therapy from friends/relatives or decided on their own. Reliance on informal advice may underlie gaps in training and awareness.

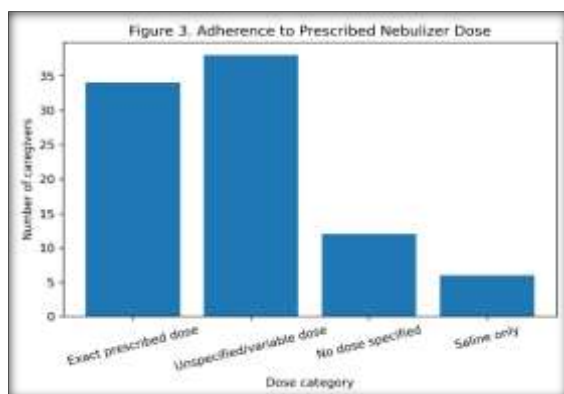


Figure 3: Adherence to Prescribed Nebulizer Dose

Figure 3: Adherence to prescribed nebulizer dose. Only 34 treatments (46%) used the exact 2 mL dose as prescribed. The remainder used unspecified doses or none (e.g. normal saline), indicating frequent deviation from recommended dosing.

DISCUSSION

This study reveals substantial gaps in caregiver knowledge and home-management practices of pediatric nebulization. Although nebulizer therapy can be highly effective for young children, our findings highlight common errors and compliance issues that may undermine treatment. The most striking lapse was in device cleaning: only 19% of caregivers cleaned their nebulizer equipment after each use, contrary to manufacturer instructions and infection-control guidelines.^[2] This mirrors prior reports in chronic respiratory care: MacFarlane et al. noted “high variability” in home nebulizer hygiene and frequent confusion about proper cleaning methods.^[5] Similarly, Griggs et al. found that CF patients’ caregivers often did not disinfect nebulizer parts as recommended (data in Cunningham et al.).^[2] Neglecting cleaning is risky – stagnant saline and medication residues can harbor bacteria or mold, posing infection hazards, especially in young or immunocompromised children.

Inadequate hand hygiene was another critical issue. Although direct data was limited, the large majority (~60%) of caregivers reported not washing hands before preparing treatments. Handwashing is explicitly stressed in inhalation care guidelines (e.g. cystic fibrosis and respiratory therapy recommendations) to avoid cross-contamination.^[2] Our results suggest an urgent need to reinforce this simple preventive step, since contaminated hands can infect nebulizer parts or medication.

Medication administration errors were also prevalent. Less than half of caregivers strictly followed the prescribed addition of diluent to make total nebulizing solution 3-5 ml; many either eyeballed the volume or arbitrarily added saline. This finding echoes broader medication safety literature: one study of home caregivers found high rates of dosing errors across various therapies, underlining that

informal caregivers “likely encounter doubts and unintentionally make errors”. In our context, providing precise tools (e.g. dosing syringes) and clarifying dose instructions could mitigate this problem.

Interestingly, we found that caregiver education level strongly influenced practice quality. Caregivers with college degrees or higher were far more likely to adhere to cleaning protocols than those with less education ($p < 0.01$). This parallels earlier reports: for instance, Vlieland et al. observed that higher maternal education was linked to more consistent asthma medication use in children. In our study, education may reflect general health literacy and comfort with medical recommendations. It underscores that interventions may need to be especially tailored for caregivers with limited schooling (e.g. pictorial guides or video tutorials).

Attitudes toward nebulization were generally positive, which is encouraging since positive beliefs are linked to adherence.^[6] Nonetheless, a notable minority of caregivers harbored misconceptions (e.g. fears of steroid side effects), indicating room for attitude-focused education. It is also worth noting that 39% of caregivers had never been counseled by a doctor about nebulizer use (Figure 2). Reliance on family advice likely perpetuated inconsistent practices. Consistent with the CARE study’s conclusions, caregiver doubts or negative beliefs are associated with worse asthma control.^[6] Our data suggest that many caregivers simply did not receive standardized training. Educational interventions (including innovative methods like smartphone apps) have shown promise in improving caregiver knowledge and confidence.^[3]

Our findings have direct implications for pediatric respiratory care. First, they reinforce the need for improved caregiver instruction at the point of prescription. Healthcare providers (pediatricians, asthma educators) should actively demonstrate nebulizer setup, mask fitting, dose measurement, and cleaning steps to caregivers. Written or video materials should be provided. Second, public health programs could incorporate KAP sessions into asthma management clinics. For example, periodic “refresher” trainings (possibly via telemedicine) might address emerging misconceptions and reinforce hygiene habits. Finally, pediatric practices should screen for nebulizer technique errors during visits; checking caregiver KAP could become as routine as measuring inhaler technique.

Several limitations deserve note. This is an observational, questionnaire-based study; practices were self-reported and may be subject to social desirability bias (actual errors might be even more common). The sample was taken from a specific region and may not generalize to all settings. We also lacked formal measurement of actual clinical outcomes (e.g. frequency of asthma exacerbations), so we inferred implications for child health. Future research could link KAP scores with pediatric respiratory outcomes to quantify the impact of

caregiver errors. Nonetheless, our results align well with other studies on nebulizer use and highlight consistent problem areas.

CONCLUSION

Our analysis of home nebulization in pediatric care revealed important caregiver knowledge and practice gaps. Most caregivers understood the importance of nebulization but often overlooked crucial details: only a minority cleaned equipment thoroughly or washed hands, and many did not follow dosing instructions. These errors – echoing findings in cystic fibrosis and asthma care literature,^[5,7] – pose preventable risks. Enhancing caregiver education is essential. Interventions should target the specific deficiencies identified here (cleaning, dosing, hand hygiene), using clear, practical guidance and perhaps leveraging technology-based training.^[3] Ultimately, strengthening caregivers' KAP of nebulizer therapy promises better pediatric respiratory outcomes and reduced healthcare burden.

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