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POSITION PAPER

Position paper on aerosol therapy in childhood: a statement proposed by the SIMRI Asthma Committee and approved by the SIMRI Advocacy Council and Executive Committee

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KEY WORDS

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IMPACT STATEMENT

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ABSTRACT

Aerosol therapy represents a cornerstone in the management of respiratory diseases in pediatric patients. By enabling the direct delivery of medications to the airways, this modality ensures a rapid onset of action while minimizing systemic side effects. It is particularly valuable in the treatment of conditions commonly affecting children, such as recurrent wheezing, asthma, and croup, as well as orphan or complex diseases including cystic fibrosis, primary ciliary dyskinesia (PCD), and post-infectious bronchiectasis.

In pediatric practice, aerosol therapy offers several advantages, including improved therapeutic efficacy at lower doses and superior tolerability compared with systemic administration. However, the clinical effectiveness of this intervention is contingent upon multiple factors, such as the patient's age and degree of cooperation, respiratory pattern, and the appropriate selection and correct utilization of inhalation devices. Consequently, comprehensive education for both caregivers and healthcare professionals is essential to optimize therapeutic delivery and clinical outcomes. Overall, aerosol therapy is a safe, effective, and widely used strategy in pediatric respiratory management, contributing significantly to symptom control and quality of life in both acute and chronic conditions.

This statement summarizes current evidence and presents the official recommendations of the Italian Pediatric Respiratory Society (Società Italiana per le Malattie Respiratorie Infantili – SIMRI) to guide best practices for aerosol therapy throughout childhood.

INTRODUCTION

Aerosol therapy constitutes a cornerstone of pediatric respiratory medicine, providing an efficient route for the targeted delivery of pharmacological agents to the airways while limiting systemic exposure. It plays a pivotal role in the management of conditions such as recurrent wheezing, asthma, croup, cystic fibrosis (CF), and other obstructive airway diseases in the pediatric population. However, despite decades of clinical application, the practice of aerosol therapy in childhood remains highly variable. Discrepancies in device selection, inhalation techniques, and clinical protocols continue to impact therapeutic outcomes across different age groups and healthcare settings (1).

Pediatric patients exhibit unique physiological and developmental characteristics that influence aerosol delivery and lung deposition. Compared with adults, children possess smaller airway calibers, higher respiratory rates, and variable inspiratory flow patterns, all of which affect the distribution and deposition efficiency of inhaled particles (2). In infants and preschool-aged children, limited cooperation and suboptimal inhalation coordination often

necessitate caregiver intervention and the use of dedicated interfaces, such as valved holding chambers (VHCs) with face masks (3). Consequently, age-specific strategies are essential to ensure optimal drug delivery, treatment adherence, and therapeutic efficacy (4).

Technological advancements have broadened the range of delivery systems available for pediatric aerosol therapy (5). These include pressurized metered-dose inhalers (pMDIs), dry powder inhalers (DPIs), and various nebulizer platforms. Each device has distinct aerosol-generation mechanisms, output rates, and performance profiles that dictate its suitability for specific patient cohorts and clinical scenarios. Nevertheless, current evidence documents frequent inconsistencies in device utilization, cleaning, and maintenance, which may lead to suboptimal drug deposition and an increased risk of infection (1).

Education and practical training remain fundamental determinants of successful aerosol therapy. Research consistently demonstrates that the implementation of correct techniques and regular reinforcement can significantly enhance pulmonary deposition, symptom control, and overall disease management (6, 7). However, a substantial proportion of healthcare professionals responsible for prescribing inhalation devices may lack adequate training in device-specific administration techniques (8).

Structured and consistent educational programs are equally vital for caregivers. Regular competency assessments, practical demonstrations, and feedback sessions are instrumental in maintaining correct inhalation practices, thereby mitigating the long-term variability observed in clinical outcomes and maximizing treatment efficacy.

Despite the existence of various national and international guidelines, a single, universally accepted protocol for aerosol therapy across all pediatric age groups remains elusive. Disparities in recommendations concerning device selection, pharmacological agents, and delivery techniques contribute to clinical uncertainty and heterogeneous care (9). This lack of harmonization underscores the imperative for an updated, evidence-based consensus that integrates contemporary research findings with practical, age-appropriate guidance.

The objective of this position paper is to establish a scientifically grounded and clinically coherent framework for the use of aerosol therapy in childhood. By synthesizing current evidence on aerosol delivery systems, pharmacological principles, and patient-specific determinants of response, this document seeks to define unified standards to enhance the effectiveness, safety, and appropriateness of treatment. The standardization of pediatric aerosol therapy practices is expected to improve individual clinical outcomes, facilitate equitable access to high-quality respiratory care, and promote cost-effective management strategies on an international scale.

METHODOLOGY

Panel composition and scope

This position paper was commissioned by the Italian Pediatric Respiratory Society (Società Italiana per le Malattie Respiratorie Infantili – SIMRI). A panel of experts, comprising pediatric

pulmonologists and researchers with extensive clinical and academic expertise, was convened during the XXIX SIMRI National Congress (Verona, September 2025). The primary objective was to establish evidence-based recommendations to standardize aerosol therapy practices in the pediatric population, thereby addressing the current lack of national guidelines and the heterogeneity of clinical approaches within Italy.

Literature search strategy and evidence selection

The panel identified three core thematic areas: 1) pathophysiology of pulmonary deposition; 2) device characteristics and common technical mistakes; and 3) disease-specific pharmacological applications and patient-related factors. A comprehensive, non-systematic literature review was performed by pairs of experts for each thematic area. Electronic searches were conducted across PubMed, EMBASE, the Cochrane Database of Systematic Reviews, and Web of Science for articles published between January 2005 and December 2025. Search strings included combinations of the terms "aerosol therapy", "nebulizer", "pMDI", "spacer", "dry powder inhaler", and "pediatrics", with filters applied for English and Italian languages. Priority was given to meta-analyses, systematic reviews, and international guidelines (*e.g.*, GINA, GOLD, ERS).

Consensus process and development of recommendations

Following the literature review, a series of preliminary statements was drafted. In January 2026, a consensus-building process was facilitated through structured teleconferences. Any discrepancies were resolved through collegial discussion until a 100% consensus was achieved for each recommendation. The strength of each recommendation was graded based on a simplified Evidence-Based Medicine (EBM) framework, categorized as follows:

- Grade A: supported by high-quality evidence (meta-analyses or randomized controlled trials).
- Grade B: supported by moderate-quality evidence (observational studies or non-randomized trials).
- Grade C: expert opinion (based on panel consensus in the absence of high-level evidence).

Review and approval

The final draft underwent a two-stage internal peer-review process, conducted by the SIMRI Executive Committee and the SIMRI Advocacy Committee in March 2026. The final manuscript received formal approval on March 26, 2026.

THREE THEMATIC AREAS

Pathophysiology of pulmonary deposition

An ‘‘aerosol” is defined as a system composed of liquid droplets or solid particles small enough to remain suspended in the air (10).

In the context of aerosol therapy, these particles serve as carriers for pharmacological agents delivered locally to the respiratory tract, with the primary objective of targeting bronchial and pulmonary diseases. This route of administration facilitates targeted drug delivery, ensures a rapid onset of action, enhances therapeutic efficacy, and reduces systemic adverse effects due to localized deposition and lower systemic absorption.

However, the overall effectiveness of aerosol therapy is contingent upon several determinants, including: 1) the physical and chemical characteristics of the aerosolized drug; 2) patient-specific respiratory parameters (such as inspiratory flow, inspiratory volume, end-inspiratory breath-holding, and coordination between inhalation and drug delivery); 3) the anatomical features of the airways, including mucociliary clearance, airway geometry, and pathological conditions; and 4) the adequacy of the administration technique (10).

Drug delivery by inhalation is primarily achieved via nasal or oral routes, with oral inhalation providing superior efficiency for particles around 5 µm in diameter (11).

The therapeutic outcome depends not only on the pharmacological properties of the drug but also on the proportion and location of particle deposition within the airways. The principal factors influencing deposition include: 1) aerosol properties such as size, shape, density, electrical charge, and hygroscopicity; 2) inhalation dynamics, including inspiratory flow rate, tidal volume, and breath-holding; and 3) physiological conditions such as mucociliary clearance and airway geometry, which vary with age, sex, and disease state (12-14).

Three predominant mechanisms govern particle deposition within the respiratory tract: 1) inertial impaction; 2) gravitational sedimentation; and 3) Brownian diffusion (15, 16).

Inertial impaction occurs predominantly for particles ≥ 5 µm that are unable to follow airflow changes at high velocity, resulting in deposition within the oropharyngeal and upper bronchial regions. This phenomenon provides the rationale for using VHCs or spacers with pMDIs, which allow for the deceleration of the aerosol plume. It should be noted that aerosol particles and droplets acquire an electrostatic charge through contact or friction for solids, and through spraying for liquids when the device is activated. In addition, most spacers are manufactured from plastic materials and can accumulate electrostatic charge on their surface during use. The resulting effect is a reduction of available drug aerosol for inhalation and a shorter aerosol half-life within the spacer (17). Although measures exist to reduce electrostatic charge, the development and use of antistatic devices is highly advantageous.

Gravitational sedimentation affects particles between 0.5 µm and 5 µm that reach the distal bronchi and alveoli, where reduced airflow allows deposition under the influence of gravity. The efficiency of this process increases with particle size and residence time and is enhanced by an end-inspiratory breath-hold. This principle underlines the use of pMDIs and DPIs. With pMDIs, the generation of a fine aerosol independent of inspiratory effort, combined with slow

and deep inhalation followed by breath-holding, maximizes the time for sedimentation of fine particles in the peripheral lung. In DPIs, gravitational sedimentation plays a less significant role during the initial aerosolization phase, as rapid and forceful inhalation promotes the impaction of particles in the oropharynx. However, it becomes important for the deposition of respirable particles (2-5 μm), particularly during the breath-holding phase after inhalation (18).

Brownian diffusion dominates for particles < 0.5 μm and results from random molecular collisions that drive particles to deposit diffusively along bronchiolar and alveolar surfaces (15).

A key determinant of particle behavior is the aerodynamic diameter (19). In this regard, the mass median aerodynamic diameter (MMAD) in aerosol therapy is defined as the aerodynamic diameter at which 50% of the total mass of aerosol particles consists of particles smaller than this diameter, and 50% consists of particles larger than this diameter (20). By combining geometric diameter and density, the MMAD represents a crucial parameter determining the inhalability of a particle. Particles with lower density exhibit smaller aerodynamic diameters and can therefore penetrate deeply into the lung regions (21). Consequently, the selection of MMAD should be tailored to the disease, target site, and therapeutic goal. Particles with an MMAD of 1-3 μm achieve optimal deposition in both central and peripheral airways, while particles with an MMAD of 3-5 μm are more suitable for targeting central airways, and those with an MMAD < 1 μm may reach the alveoli and are therefore useful for systemic drug delivery. Accordingly, larger MMADs are utilized with traditional nebulizers to treat the upper airways, whereas medium-to-small MMADs, such as those produced by pMDIs, are preferred for the lower airways (20).

Despite technological advances in inhaler design, only approximately 20% of the delivered dose typically reaches the lungs, while the remaining fraction deposits in the oropharyngeal cavity and is swallowed (22). The fraction absorbed systemically may induce extrapulmonary side effects; however, these effects are often mitigated by extensive first-pass hepatic metabolism, as observed with inhaled corticosteroids (22).

Device characteristics and common mistakes

Technological advancements in aerosol delivery systems have progressively enhanced the efficiency, precision, and clinical applicability of inhaled therapies in pediatric respiratory care (23). Currently, most guidelines recommend pMDI as the first-line topical treatment for lower airways diseases in childhood (**Table 1**). These portable, multi-dose, manually operated devices generate aerosolized medication using a high-pressure propellant that forces a mixture through an atomizing nozzle, independently of the patient's inspiratory effort. pMDIs are characterized by reproducibility of the delivered dose but should be used with a spacer or valved holding chamber to increase the fraction of the dose reaching the lungs, since the particles are released at very high speed (approximately 130 km/h) and may otherwise impact the pharyngeal walls (24).

DPIs do not require spacers and are therefore often preferred by adolescents. However, their clinical effectiveness may be limited by high aerosol deposition in the upper airways due to the relatively large aerodynamic diameter of emitted particles; consequently, rinsing the mouth after the inhalation is recommended (25, 26) (**Table 1**).

Soft mist inhalers deliver medication as a fine mist form, allowing a reduction in drug deposition in the upper airways. However, these devices are currently available only for tiotropium with or without olodaterol, and their use in children remains limited (27).

As for traditional nebulizers, which may also be used to treat upper airways conditions, jet nebulizers are the most widely used (**Table 1**).

These devices nebulize both solutions and suspensions through the Venturi effect. Ultrasonic nebulizers, in contrast, aerosolize only solutions via vibration of piezoelectric crystals. Although relatively quiet and efficient, they are unsuitable for many inhaled medications that are formulated as suspensions. Mesh nebulizers, employing a vibrating mesh containing thousands of microscopic openings, provide improved efficiency and are widely used for aerosolized antibiotics, however, they remain costly (28) (**Table 1**).

Breath-actuated nebulizers are aerosol delivery devices designed to release medication only during inhalation, rather than continuously generating aerosol. This mechanism reduces drug waste and limits dispersion of medication into the surrounding environment: however, these devices are not widely available worldwide.

Considering the differences between aerosol therapy devices, physicians should select the most appropriate device for each patient. Moreover, inhaled treatments are effective only when medications reach the intended target site; therefore, families and patients should receive adequate training in the correct use of these devices. Unfortunately, poor inhaler technique is common among children and adolescents. Younger children may be unable to inhale deeply or hold their breath for several seconds without exhaling. In addition, some parents administer aerosol therapy when their children are sleeping or crying, despite the fact that both situations markedly reduce the dose of medication reaching the lower airways (29) (**Table 2**).

It is also important to remember that many mistakes are commonly made while using aerosol therapy devices: as an example, most pMDIs contain suspensions and need to be shacked just before every single actuation, but many patients forget to do so (30). Moreover, even if spacers with a facemask reduce the dose at the target, they should be used for pMDIs in younger children who cannot use a mouthpiece, and a good seal of the mask on the face should be warranted (31) (**Table 2**).

Notably, DPIs can be used without a spacer, but require the patient to prepare the dose and exhale completely before inspiration, which should be deep and forceful enough to produce a turbulent flow capable of disaggregating the drug when meeting the resistance of the device's

internal structure, thus producing an aerosol (**Table 1**). Therefore, most children are unable to use such devices.

Another significant mistake is failing to maintain proper hygiene and cleanliness of the devices used. This can lead to bacterial colonization of the airways, such as *Pseudomonas aeruginosa*, a germ that is difficult to eradicate (31) (**Table 2**).

The environmental impact of inhaler devices has become a significant consideration in respiratory medicine. pMDIs utilize hydrofluoroalkane (HFA) propellants, which are potent greenhouse gases. In contrast, DPIs have a significantly lower carbon footprint (32).

However, in pediatric populations – particularly infants and young children – clinical efficacy must remain the priority. Since many children under the age of 6 cannot achieve the inspiratory flow required for DPIs, pMDIs with spacers remain the first-line recommendation for this age group. We advocate for a "clinically-led" approach where the most sustainable device is chosen only if it is appropriate for the child's age, coordination, and clinical status.

Disease-specific pharmacological applications and patient-related factors

Aerosol therapy in children encompasses a broad range of pharmacological agents selected according to the underlying respiratory conditions and individual patient needs. It is indicated in numerous pediatric respiratory disorders (**Table 3**).

Among its primary applications is the management of asthma, particularly during acute exacerbations, in which inhaled short-acting β2-agonists (SABA), such as salbutamol constitutes the cornerstone of rapid bronchodilation (33, 34) and are therefore considered as the first-line therapy for acute asthma attacks. When administered in combination with anticholinergic bronchodilators, most notably ipratropium bromide, SABA demonstrate enhanced efficacy, especially in mild to moderate or moderate to severe asthma attacks, reducing symptom burden and hospital admission rates (33). For maintenance therapy in children older than 4 years of age, long-acting β2-agonists (LABA) may be delivered via inhalation in combination with inhaled corticosteroids (ICS), such as fluticasone and budesonide. ICS represent the most effective maintenance therapy for persistent asthma in children owing to their potent anti-inflammatory activity on airway mucosa. In case of poor control despite optimized ICS-LABA therapy, the addition of a long-acting muscarinic antagonist (LAMA), such as tiotropium bromide**,** may provide further improvement in symptoms and lung function in children older than 6 years.

Additionally, aerosol therapy plays a role in recurrent wheezing: the clinical response to inhaled salbutamol therapy at home during the acute episode together with the response to a therapeutic trial of ICS, constitutes one of the three diagnostic criteria used to support early asthma diagnosis in children under 6 years of age (33).

In bronchiolitis, the use of aerosolized hypertonic saline has been investigated for its potential to reduce the duration of hospitalization; however, the most recent guideline updates conclude that current evidence does not support its routine use (35). In contrast, aerosol therapy remains a cornerstone of treatment for croup. Nebulized budesonide, used as a second line after systemic corticosteroids or as an alternative when the latter are not available or are difficult to administer, and nebulized epinephrine, a non-selective adrenergic agonist with potent vasoconstrictive activity, provide rapid but temporary relief from upper airway obstruction and represent well-established approach for moderate to severe cases (36, 37).

Nebulized epinephrine is often used in the management of acute laryngospasm or post-extubation stridor, to reduce airway edema (38).

Aerosolized hypertonic saline (3-7%) is widely used in conditions associated with impaired mucociliary clearance (39). In CF, it is often combined with dornase alfa, a recombinant DNase that decreases mucus viscosity by cleaving extracellular DNA from neutrophils. Dornase alfa remains a mainstay of airway-clearance therapy, consistently demonstrating improvements in lung function and reductions in exacerbation frequency (40, 41). Inhaled antibiotics, such as tobramycin, aztreonam lysine, and colistin, are central to the management of chronic *Pseudomonas aeruginosa* infection in CF, allowing the delivery of high local concentrations while minimizing systemic toxicity. Although primarily indicated for CF, these agents may also be considered for selected multidrug-resistant respiratory infections in non-CF patients under specialized supervision (40, 41). Similar therapeutic principles apply to children with PCD and in those with post-infectious bronchiectasis, in whom aerosolized mucolytics and saline solutions support airway clearance. In conditions shared by CF and PCD, namely bronchiectasis and chronic *Pseudomonas aeruginosa* colonization, emerging evidence, largely derived from adult trials, supports the use of inhaled antibiotics (42).

Regarding preterm infants with a history of bronchodysplasia, there are no robust data on the chronic use of bronchodilators, nor on the efficacy of other aerosol therapy modalities for airway clearance in this population (43). Overall, the selection of aerosolized medication is informed by disease mechanism, guidelines-based recommendations, and patient-specific factors such as age, coordination abilities, and comorbidities. In certain infectious conditions such as bacterial pneumonia, aerosolized antibiotics are not considered first-line treatments, but may be used selectively for infections caused by multidrug-resistant pathogens under specialist supervision (44).

Finally, aerosol therapy is routinely used for airway humidification and secretion management in children with tracheostomies or neuromuscular diseases associated with ineffective cough, thereby supporting airway hygiene and reducing respiratory morbidity (22).

Study limitations

This position paper has several limitations that should be acknowledged. First, while the literature review was comprehensive and covered major international databases, it was not conducted as a formal systematic review (PRISMA). Therefore, selection bias cannot be entirely excluded. Second, many recommendations are based on a consensus of experts (Grade C evidence) or extrapolated from international guidelines, due to the relative scarcity of high-quality randomized controlled trials specifically conducted on the Italian pediatric population. In **Table 4**, we report only recommendations with level A or B. Lastly, while we provide a standardized framework, the choice of aerosol device remains highly dependent on individual patient adherence and local availability of medications.

SIMRI RECOMMENDATIONS (Table 4)

Aerosol therapy represents a fundamental component in the management of selected pediatric respiratory diseases; however, its use must be grounded in evidence-based indications and delivered using appropriate techniques to ensure clinical effectiveness. Current recommendations consistently support the use of aerosol therapy primarily for conditions characterized by lower airway obstruction, most notably asthma and recurrent wheezing, while discouraging its routine use in upper respiratory tract infections or uncomplicated viral illness, for which no meaningful clinical benefit has been demonstrated, with the exception of croup (36, 37). In infants and young children with bronchiolitis, both international and national intersociety recommendations, including those endorsed by the Italian Pediatric Respiratory Society (SIMRI/IPRS), strongly advise against the routine use of nebulized bronchodilators, corticosteroids, or other aerosolized medications. These interventions have not demonstrated improvements in clinically relevant outcomes and may contribute to unnecessary healthcare costs and caregiver burden (45, 46). Supportive care therefore remains the standard management in this population (12). For asthma management, aerosol therapy is recommended as the preferred route for the administration of bronchodilators and ICS, owing to its rapid onset of action and favorable safety profile. pMDIs used in combination with VHCs or spacers are recommended as first-line delivery systems in children of all ages, including preschoolers, as they provide drug deposition comparable to or superior to nebulizers while reducing treatment time and systemic exposure (33, 47). Nebulizers should be reserved for severe exacerbations or for children who are unable to effectively use an pMDI with spacer. The choice of interface is critical for effective aerosol delivery. A well-fitting face mask is recommended in infants and toddlers, whereas a mouthpiece is preferred in older children to minimize drug loss and facial deposition. The use of “blow-by” techniques is strongly discouraged, as it results in negligible pulmonary drug deposition (47). DPIs are generally not recommended in children under 5-6 years of age because of inadequate inspiratory flow generation. However, DPIs are less polluting; therefore, we prefer HFA pMDIs with a lower environmental impact (32). Regarding pharmacological agents, intersociety consensus documents involving SIMRI/IPRS support the use of ICS as maintenance therapy in children with persistent asthma and selected wheezing phenotypes, with dosing tailored to age and disease severity (48). In children with croup, the use of budesonide, particularly when delivered via jet nebulizers rather than ultrasonic

nebulizers, is recommended as a second line to the administration of systemic steroids or as an alternative in case of unavailability of the first (37). Conversely, the routine use of nebulized saline or mucolytics lacks robust evidence of clinical efficacy and should not be considered standard care outside specific well-defined indications (47, 48).

CONCLUSIONS

The selection of an appropriate aerosol delivery device is a critical determinant of therapeutic effectiveness in pediatric respiratory care. When used correctly, all major aerosol delivery devices demonstrate comparable efficacy; however, their real-world performance varies substantially according to patient- and context-specific factors (**Table 1** and **Table 2**). Device choice should therefore be individualized, taking into account the child's age, physical and cognitive abilities, coordination skills, availability of the prescribed medication in specific formulations, ease of use of the aerosol therapy device, the required administration time and the environmental setting in which the therapy is delivered.

Across all guidelines, structured caregiver and patient education is emphasized as an essential component of effective aerosol therapy. Proper instruction on device assembly and use, regular reassessment of inhalation technique, and systematic monitoring of adherence are essential to optimizing drug delivery, minimizing treatment failure and ensuring sustained clinical benefit

(33).

COMPLIANCE WITH ETHICAL STANDARDS

Conflicts of interest

The authors declare no conflicts of interest.

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Author contributions

GFen, SLG: conceptualization. GFen, MEDC, GFer, RN, FP, SLG: writing – original draft, writing – review & editing. The members of SIMRI Advocacy Council and Executive Committee contributed to drafting the paper based on their expertise on the subject. All authors discussed and approved the final recommendations. All authors read, critically reviewed and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Ethical approval

Human studies and subjects

N/A.

Data sharing and data accessibility

N/A.

Publication ethics

Plagiarism

Authors declare no potentially overlapping publications with the content of this manuscript and all original studies are cited as appropriate.

Data falsification and fabrication

All the data corresponds to the real.

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Table 1. *Main technical characteristics of delivery devices.*

Device type	Mechanism	Target Age group	Key technical feature
pMDI + Spacer	Pressurized metered-doseinhaler	All ages (gold standard < 5 years)	Portable, high lung deposition, no coordination needed with spacer
DPI	Patient's inspiratory flow	Children > 5-6 years	No propellants; required high peak inspiratory flow
Jet nebulizer	Compressed air/oxygen	Neonates / Severe distress	Can deliver high doses: commonly used for upper airway treatment; noisy and requires a power source
Vibrating mesh	High-frequency vibration	Chronic patients/ Neonates	Silent, minimal residual volume, preserves drug integrity

Table 2. *Common mistakes in pediatric aerosol therapy.*

Type of Mistake	Description	Clinical impact
The "Crying and/or sleeping child"	Administering aerosol therapy while the child is crying and/or is sleeping	Massive reduction in lung deposition (most drug remains in the throat)

Failure to shake the pMDI	Administering aerosol therapy with pMDI containing drugs in suspension without shaking the pMDI well before every single actuation	Variability in delivered dose
Poor mask seal	Gap between the mask and the child's face	Up to 50-80% of the medication is lost to the environment
"Blow-by" technique	Holding the mask / tube near the face without contact	Ineffective delivery; negligible drug reaches the lower airways
Inadequate cleaning	Failing to wash / dry the nebulizer kit after use	Risk of bacterial colonization and respiratory infections (*e.g.*, Pseudomonas)
Nasal breathing	Using a mask for older children who should use a mouthpiece	The nose acts as a filter, trapping most of the drug before it reaches the lungs

Table 3. *Examples of indications and pharmacological inhaled treatments.*

Condition / disease	**Main drug class**	**Specific examples**	**Therapeutic goal**
Asthma / wheezing	Inhaled corticosteroids (ICS)	Fluticasone, Budesonide	Reduce airway inflammation
Acute exacerbations	Short-Acting Beta-Agonists (SABA)	Salbutamol (Albuterol)	Rapid bronchodilation
Croup	Sympathomimetics	Nebulized Epinephrine	Reduce subglottic edema
	Inhaled corticosteroids	Nebulized Budesonide	reduce airways inflammation

Cystic fibrosis / PCD/post-infectious bronchiectasis	Mucolytics / antibiotics	Dornase alfa / tobramycin	Clear mucus and treat infection

Table 4. *SIMRI recommendations in pediatric aerosol therapy.*

	SIMRI Recommendations	**LoE***
1	Target lower airway obstruction, such as asthma or recurrent wheezing, rather than routine upper respiratory infections (except for croup).	A
2	Avoid routine aerosol use for bronchiolitis, as bronchodilators and corticosteroids do not improve clinical outcomes in these cases.	A
3	Prioritize pMDIs with spacers/holding chambers for all ages when treating the lower airways, as they are as effective as nebulizers but faster and with fewer side effects.	A
4	Reserve nebulizers for severe exacerbations, for children who cannot effectively use a pMDI with a spacer, or when treating croup.	B
5	Ensure a well-fitting face mask for infants and toddlers to maximize drug delivery and minimize ocular/skin deposition.	B
6	Transition to a mouthpiece in older children (usually > 5 years) to minimize drug loss and deposition on the face.	B
7	Strictly avoid the "blow-by" technique, as it results in negligible medication reaching the lungs.	A
8	Avoid DPIs (Dry Powder Inhalers) under age 5–6, as young children often lack the inspiratory flow required to use them effectively.	B
9	Do not use saline or mucolytics routinely, as there is a lack of robust evidence regarding their clinical efficacy, with the exception of specific conditions such as CF and PCD.	A

10	Provide regular education and reassessment of the inhalation technique to caregivers and patients to ensure therapeutic success.	A

*LoE (Level of Evidence): A: High-quality evidence (RCTs/Meta-analyses); B: Moderate-quality evidence; C: Expert Opinion/Consensus.