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RESEARCH ARTICLE

Playful Adaptation of the Forced Expiratory Technique in Children: A Mechanism-Based Conceptual Framework for Airway Clearance

Lucas Oliveira Soares[1*] **Fernanda Ferrante Alves**[2]

[1] Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), São Paulo, Brazil
[2] Heart Institute (InCor), São Paulo, Brazil

Correspondence to: Lucas Oliveira Soares, Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), São Paulo, Brazil; Email: lucassoaresft@gmail.com

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Abstract: Objective: To propose and analyze a playful adaptation of the Forced Expiratory Technique (FET) in children based on a mechanism-oriented framework for airway clearance. **Methods**: This is a descriptive theoretical-conceptual study based on the development and analysis of a pediatric clinical protocol incorporating playful strategies into FET execution. The components of the technique were mapped to their underlying physiological mechanisms according to contemporary classifications of airway clearance techniques. **Results**: The proposed model suggests that the playful adaptation of FET is theoretically capable of activating key physiological mechanisms involved in airway clearance, including airflow modulation, increased lung volumes, and secretion mobilization. The integration of these components supports a multimodal physiological approach. **Conclusion**: The playful adaptation of FET may represent a feasible and physiologically grounded strategy to enhance adherence and facilitate the execution of therapeutic breathing patterns in pediatric patients.

Keywords: airway clearance techniques, forced expiratory technique, pediatric physiotherapy, play therapy, mucociliary clearance

1 Introduction

Airway clearance techniques (ACTs) are widely used in the management of respiratory conditions associated with secretion retention, contributing to improved ventilation and mucociliary clearance [1, 2]. Traditionally, these techniques have been classified based on their execution or the devices used. However, recent approaches propose classification based on predominant physiological mechanisms, such as airflow modulation and lung volume recruitment [1].

The Forced Expiratory Technique (FET) is recognized for its effectiveness in secretion mobilization, as it increases expiratory flow while minimizing the risk of airway collapse [3]. In pediatric populations, the application of these techniques is frequently limited by behavioral and developmental factors, often requiring the use of playful strategies to facilitate engagement and adherence [4, 5]. Despite their widespread use, such strategies are rarely described within a structured physiological framework.

This study proposes that playful strategies should not be considered merely as behavioral facilitators, but as functional tools capable of inducing specific physiological mechanisms relevant to airway clearance in children.

2 Methods

This study is a theoretical-conceptual descriptive analysis proposing a mechanism-based framework for a playful adaptation of the Forced Expiratory Technique (FET) in children aged 3 years and older. The protocol was developed based on clinical experience in pediatric emergency care settings and grounded in established physiological principles of airway clearance techniques described in the literature. The intervention consists of sequential breathing components mediated by playful commands designed to enhance understanding, engagement, and execution. These components include rapid breathing with an open mouth, deep inspiration, forced expiration (huffing), and cyclic repetition. Each component was analyzed according to its underlying physiological mechanism and categorized based on contemporary ACT classifications [1]. No human subjects were involved, and no ethical approval was required due to the theoretical-conceptual nature of this study.

3 Results

The proposed framework integrates physiological principles of airway clearance with developmentally appropriate playful strategies. The model suggests that playful commands can induce specific and reproducible breathing patterns aligned with defined physiological mechanisms. (see Table 1)

Table 1 Mechanism-based mapping of playful commands

Therapeutic Goal	Playful Command	Physiological Mechanism	ACT Classification
Loosen/Remove secretion	"Breathing like a tired puppy"	Turbulent flow, increased shear	Airflow modification
Recruit/Expand lung	"Take a deep breath" Smell the flower and blow out the candle	Increased lung volume, collateral ventilation	Increased lung volume
Mobilize secretion	Dragon's breath: "Make a loud 'raaa' sound with your mouth open." (huffing) "Blow out a breath on the mirror."	Increased expiratory flow	Airflow modification
Transport secretion	Repeated cycles	Flow + volume interaction	Combined strategy

Rapid breathing with an open mouth, often associated with playful instructions such as panting, is theorized to generate turbulent airflow, increasing shear forces and facilitating mucus detachment from bronchial walls [1, 6].

Deep inspiration, frequently guided by symbolic commands, is associated with increased lung volume, promoting alveolar recruitment and collateral ventilation, which may facilitate secretion mobilization in peripheral lung regions [2, 7].

Forced expiration with an open glottis (huffing), mediated by playful cues, is associated with increased expiratory flow and may support the movement of secretions toward central airways [5, 8].

Cyclic repetition of these components suggests an interaction between airflow modulation and lung volume recruitment, promoting alternating phases of secretion mobilization and lung expansion, conceptually similar to active breathing cycle strategies [2, 6]. (see Figure 1)

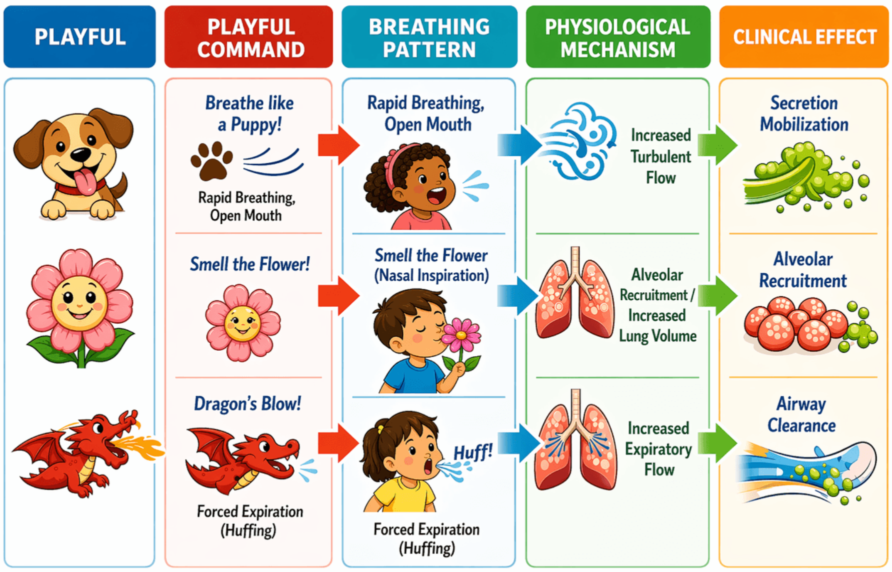

Figure 1 Conceptual model of integration between playful strategies and physiological mechanics in pediatric respiratory physiotherapy. Playful commands are used to induce specific protective patterns, which activate physiological mechanisms for clearing the airways, resulting in the mobilization of secretions, alveolar recruitment, and improvement of lung function. (Source: Developed by the authors with the aid of an artificial intelligence tool.)

The analysis demonstrated that the playful adaptation of the technique is capable of activating multiple physiological mechanisms relevant to airway clearance. Rapid breathing with an open mouth promotes turbulent flow, increasing shear forces on mucus and favoring its detachment from the bronchial walls [6]. Additionally, forced expiration (huffing) increases expiratory flow, contributing to the mobilization of secretions towards the central airways [1, 3, 6].

Deep inspiration, in turn, is associated with an increase in lung volume, promoting alveolar recruitment and collateral ventilation, mechanisms that favor the mobilization of secretions located in more peripheral regions of the lung [2, 7]. The cyclical execution of these components suggests a functional integration between the mechanisms of airflow modulation and lung volume increase, promoting alternation between recruitment and mobilization of secretions, in a manner similar to that observed in the active cycle of respiration [2, 6].

The approach used reframes play, not as a complement to therapy, but as a mechanism to provide physiologically targeted interventions in pediatric patients. Rapid open-mouth breathing promotes turbulent flow, increasing shear forces on mucus and favoring its detachment from the bronchial walls [6]. Additionally, forced expiration (huffing) increases expiratory flow, contributing to the mobilization of secretions towards the central airways [5] Deep inspiration, in turn, is associated with increased lung volume, promoting alveolar recruitment and collateral ventilation, mechanisms that favor the mobilization of secretions located in more peripheral regions of the lung [2, 7].

The cyclical execution of these components suggests a functional integration between the mechanisms of airflow modulation and lung volume increase, promoting alternation between recruitment and mobilization of secretions, similar to what is observed in the active cycle of respiration [2].

4 Discussion

Airway clearance techniques are grounded in well-established physiological mechanisms, including modulation of expiratory flow, lung volume expansion, and mucus mobilization through shear forces [1, 3, 6]. These mechanisms are central to reducing airway obstruction and improving respiratory function. The present framework suggests that a playful adaptation of FET can preserve these mechanisms by inducing breathing patterns that modulate airflow and promote secretion clearance. Rapid breathing may enhance airflow turbulence, while deep inspiration supports alveolar recruitment. Forced expiration optimizes expiratory flow and secretion transport [2, 5, 7].

In addition to physiological considerations, playful interventions have been shown to reduce anxiety, fear, and resistance in pediatric patients, while improving engagement and participation during therapy [8, 9]. Play also plays a role in motor learning, facilitating the acquisition and automation of complex motor patterns through repetition and engagement. This may enhance the execution of therapeutic breathing maneuvers in children [10].

This approach reframes play as a mechanism-driven therapeutic tool rather than a supportive adjunct, integrating physiological, behavioral, and motor learning dimensions. From a clinical perspective, this framework may support individualized interventions, particularly in children with low adherence or difficulty cooperating with conventional techniques. However, this study is limited by its theoretical nature and lack of clinical validation.

5 Conclusion

Play-based modification of the Forced Expiratory Technique offers a physiologically rational and clinically viable approach to pediatric airway clearance, with the potential to improve treatment adherence and optimize therapeutic outcomes. Critically, play can serve as a mechanism-driven therapeutic tool within pediatric respiratory physiotherapy, facilitating the establishment and automatization of effective breathing patterns while boosting treatment adherence and active patient engagement.

6 Limitations

This study is constrained by its conceptual-theoretical nature, lacking clinical validation and objective physiological quantification. In addition, inter-individual variability in implementation may compromise the reproducibility of the proposed technique.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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