Lack of efficacy of humidification in the treatment of croup: Why do physicians persist in using an unproven modality?

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ABSTRACT

Background: Humidification is a time-honoured therapy for childhood croup (acute laryngotracheobronchitis). Despite a paucity of evidence supporting its use, many physicians, nurses and parents still apply this treatment. Our objective was to summarize available evidence and assess the rationale for the ongoing use of humidity to treat childhood croup.

Methods: Searches of both MEDLINE and the Cochrane Database were conducted for English-language original or review literature on the treatment of croup with humidity, for the years 1966–1999.

Results: Only 2 published studies have attempted to evaluate humidification therapy for croup, and none has been published since 1984. There is no published evidence to support the commonly held empirical view that humidity helps alleviate the symptoms of childhood croup, and no understanding of which factors of moisture or temperature affect patient outcomes. Risks may include scalding and unnecessary discomfort.

Interpretation: There is no strong evidence supporting the use of humidity in the treatment of croup. Although such treatment is still widely used, it is not without risk, and further trials are required to address its efficacy.

RÉSUMÉ

Contexte : L'humidification est un traitement contre le croup (laryngotrachéobronchite aiguë) chez l'enfant consacré par l'usage. Malgré le manque de preuves appuyant l'efficacité de ce traitement, de nombreux médecins, infirmières et parents y ont recours. Nos objectifs étaient de résumer les preuves disponibles et d'évaluer le raisonnement justifiant l'utilisation de l'humidité pour traiter le croup chez l'enfant.

Méthodes : Des recherches de MEDLINE et de la banque de données Cochrane furent menées afin de trouver des articles originaux ou des revues de littérature sur le recours à l'humidité pour le traitement du croup pour la période entre 1966 et 1999.

Résultats : Seulement deux études publiées ont tenté d'évaluer le traitement par humidification pour le croup et aucune étude n'a été publiée depuis 1984. Aucun article publié ne présente de données probantes appuyant la notion empirique largement répandue selon laquelle l'humidité contribue à soulager les symptômes du croup chez l'enfant, ni quels sont les facteurs d'humidité ou de température qui influencent le devenir des patients. Le recours à l'humidification comporte des risques d'ébouillanter l'enfant et peut provoquer un inconfort inutile.

Interprétation : Il n'existe aucune donnée probante qui appuie le recours à l'humidité lors du traitement du croup. Bien qu'un tel traitement soit encore largement répandu, il n'est pas sans risques et des essais additionnels s'imposent afin d'en vérifier l'efficacité.

Key words: croup, treatment, humidification, mist, particle size, laryngotracheobronchitis

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Introduction

Croup is primarily a childhood syndrome defined by the triad of hoarseness, a dry, distinctive barking cough, and inspiratory stridor, and is accompanied by respiratory distress of varying degree. The most common type of croup is acute viral laryngotracheobronchitis, which usually runs a self-limited course but may cause laryngeal obstruction. Parainfluenza viruses types 1, 2 and 3 account for almost 75% of cases and the recognized increase in incidence during winter months. Other, less common causative agents include respiratory syncytial virus, adenovirus, influenza A and, rarely, *Mycoplasma pneumoniae*. Croup incidence peaks during the second year of life, with a mean age of 18 months, and is more common in boys than girls.[1]

After viral infection of the nasopharynx, infection spreads downward to the larynx and trachea. Inflammation and edema lead to tracheal wall swelling, which impairs vocal cord mobility and reduces the surface area of the child's trachea. Narrowing of the subglottic trachea and accumulation of secretions lead to inspiratory stridor and the characteristic barking cough.[1]

Moisture in various forms has been used as croup therapy since the 19th century observation that steam produced by tea kettles and hot baths seemed to alleviate symptoms. The first devices used in hospital were "croup kettles." These were gradually replaced by devices that produced cool steam; this reduced the risk of scalding and incorporated the observation that cold night air also alleviated symptoms.[2] Croup tents were then developed and, currently in the hospital setting, cool mist is delivered through a hose directed toward the child's face. Parents are also often instructed to run hot water into the bathtub and take a child into the moisture-filled washroom for a period of time. Warm steam, cool mist, and a brief exposure to cool night air have all been commonly recommended in the therapy of croup.[1,3]

Our objective was to review and synthesize the available evidence on the treatment of childhood croup with warm or cool mist or humidity, and to assess the rationale for current practice of this treatment. Searches of both MEDLINE and the Cochrane Database were conducted for English-language literature on the treatment of croup with humidity for the years 1966–1999.

Postulated benefits of humidification therapy

Temperature and comfort

A 1983 letter by Richard Henry[4] is cited in much of the literature addressing croup and its treatment. Henry stated that, in the absence of evidence that moisture alters the course of illness, a clinical judgement must be made, and that placing a child in a warm, moist environment is at least harmless. Any improvement may be due to the warmth, the moisture, or the comfort of being held in a parent's arms. Although Henry provided no references to support this clinical opinion, his letter is still cited in recent pediatric respirology literature.[5]

Thinning of secretions

Aerosolized water may thin respiratory epithelial secretions, thereby facilitating clearance via the mucociliary escalator. Purulent mucus has been shown in vitro to gain water significantly after 3 hours of exposure to 100% humidity with no significant decrease in viscosity. However, with only 1 hour's exposure to both 100% humidity and nebulized water, a greater water gain, accompanied by a significant decrease in viscosity, was noted.[6] In addition, since laryngeal mucous membranes are not ciliated, thinning of accumulated secretions may aid in their upward removal from the level of the vocal cords.[7]

Improvement in local airway characteristics

Air turbulence through the narrow subglottic space may cause drying and inflammation of mucous membranes in croup.[7] Aerosolized water may soothe inflamed mucosa and prevent drying and crusting,[4] increasing tracheal surface area.

Effects on respiratory patterns

Microaerosol inhalations have been shown to change breathing patterns reflexively in kittens through nasal and supraglottic laryngeal mucosal mechanoreceptors, possibly improving respiratory flow rates.[8] Hot steam has been shown to improve nasal patency in adults suffering from the common cold, improving symptoms.[9]

Oxygen delivery

Humidity is usually administered in additional oxygen, which may benefit the child.

None of these speculative benefits to the respiratory tract has been supported by clinical data.

Risks of humidification therapy

Presentations of children to emergency departments with both acute viral croup and severe scalds from boiling water after attempts at home humidification have been documented.[10] Inhaled moisture may aggravate bronchospasm in children prone to wheezing,[1] and excessive moisture

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may cause hyponatremia.[11] Humidifiers may become contaminated with pathogenic bacteria such as *Pseudomonas aeruginosa*[12] or their water reservoirs colonized by fungi.[13] Subjecting a child to facemasks, hoses, hoods, or cold or hot moisture may cause more discomfort to a child than simply allowing him or her to sit quietly and unencumbered in a parent's arms.

Relevance of water particle size and deposition

Even if it is assumed that there is a beneficial effect from steam or humidity in the treatment of croup, it is still unclear as to which anatomical area the water particles should be directed. Water particles greater than 10 μm in diameter may serve only to coat the mouth, nasopharynx and oropharynx, and will probably not reach further into the respiratory tract.[14] Particles between 5 and 10 μm in diameter represent a transition from mouth to airway deposition and would be important for delivery of moisture to the subglottic larynx.[14] In one study of particle deposition in the adult lung, a model of airway deposition according to particle size was developed. It was theorized that greater particle impaction in the child's smaller airway would necessitate the use of even smaller particles to reach the subglottic larynx.[15] Popular humidifiers or home shower steam may not create the appropriately sized water particles to reach the toddler's subglottic larynx. Several current disposable nebulizers do create particle sizes below 5 μm, as measured by laser diffraction.[16]

Animal and human studies

In the only animal study that investigated the effects of humidity, Wolfsdorf and Swift actually showed a detrimental effect for this treatment modality.[17] They passed various air mixtures over the vocal cords of 12 sedated dogs. Warm moist air (36°C) increased translaryngeal resistance, while cold dry, cold moist, and warm dry air all significantly decreased it. Upon gross examination of the upper airways, the dogs treated with moist air displayed edematous laryngeal mucosa and accumulated secretions, while those treated with dry air did not display these characteristics.

Only 2 published studies have attempted to evaluate humidification therapy for croup in humans. Bourchier and associates[18] studied 16 consecutive patients hospitalized for viral croup on a pediatric ward, randomly assigning them to receive humidification or control room air for 12 hours. A humidifier was connected directly to a plastic-covered cot for patients receiving humidity, while control patients were monitored in room air without such an enclosure. No significant difference in clinical croup scores was observed between the groups in this small, unblinded study. Moreover, the use of a humidifier would have delivered water particles of a size that would have impacted mostly in the nasopharynx rather than the larynx.

Lenney and Milner[19] studied the effect of α-adrenergic stimulants and nebulized water on total respiratory resistance in cases of viral croup in children. All children were given xylometazoline to ensure full nasal patency, then sedated with chloral hydrate. The 5 children treated with nebulized water showed no significant change in total respiratory resistance. The use of sedation in this study severely limits the relevance of this data to the typical emergency room presentation of the child with croup.

No studies of humidification in croup therapy have been published since 1984. Although 2 studies of racemic epinephrine noted improvement in croup scores in saline control groups,[20,21] the studies were not designed to evaluate the efficacy of humidification; indeed, the nebulized saline that constituted their ***placebo group*** is the ***treatment modality*** discussed in this article.

Discussion

There is no published evidence that humidification of inspired air or mist therapy is of any benefit in the treatment of croup. Indeed, there are published risks to such therapy.

It is arguable whether the published studies would have been able to demonstrate benefit, considering the limitations in their design and the small number of subjects. It may be premature to discard such a universally available, low cost, and traditionally accepted therapy without better designed assessments of its efficacy and risk. Even modern sources continue to recommend advising parents to fill a bathroom with steam by running a hot shower and to sit in the room with the child.[22,23]

Humidification in the emergency setting may be considered reasonable if it does not interfere with observation of patients or increase their agitation. Time spent on humidification might be better spent on other standard-of-care, evidence-based therapies such as nebulized epinephrine or steroids. Indeed, time spent on humidification may very well prolong emergency department stay, while not providing any treatment of demonstrable benefit.

Further evaluation of humidification in the treatment of croup, utilizing a water particle size that deposits in the subglottic region in children, would serve to clarify its role in the treatment of this common illness.

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