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Blow-By Revisited

Respiratory care has changed substantially since I began my career as an "inhalation therapist." Intermittent positive-pressure breathing with a handful of medications was the predominant treatment. Today, respiratory therapists (RTs) utilize a wide range of drugs and aerosol devices supported by evidence-based research. What has not changed is our primary choice of interfaces: mouthpiece or mask. Disposables aside, there is little difference between a 1970 and 2008 era mouthpiece or mask.

One "interface" between the nebulizer and the patient has undergone dramatic changes: the RT. RT education has transitioned from "on-the-job oxygen orderlies" to associate and bachelor of science degree programs, with a few graduate-level schools. For my purpose, it is the RT who chooses the appropriate interface for an infant. Unfortunately, infants are not familiar with the current literature, they don't know that a mouthpiece is the best interface, nor do they care that a "well fitting" mask is the next best. Infants come with a wide variety of temperaments; a few, with a modicum of care, will let you put a mask on their face and will even tolerate it for the time it takes to deliver the medication. However, for a variety of reasons, a substantial number will not tolerate a mask on their face. Some will let you hold it 2 cm from their face but will not let you put it on their face.[1] Fortunately, RTs are familiar with the literature that supports an alternative delivery method: blow-by.[2-8]

The delivery and measurement of drug deposition in an infant lung model or in vivo is as much art as science, as reflected by the wide range of results in the literature. Estimates for blow-by range from negligible to greater than 100% of a mask-delivered dose,[5] the wide range due to differences in nebulizers, blow-by technique, distance from the patient, and measurement methods. The results of the research support the use of blow-by via T-piece or corrugated tubing held half an inch (1.27 cm) or less from the face, as a technique in those infants for whom a mask is not practical.[2-5,7]

Delivery of aerosolized medication to pediatric patients will continue to be a challenge that requires further research into the best techniques, interfaces, and the variables that the RT can control at the bedside. It is critical that RTs and physicians maintain familiarity with the current literature on treatment techniques and medications. However, for a specific patient, research can only provide guidance as to the appropriate technique. It is the role of the RT to evaluate the efficacy of the treatment regimen: Is the patient's work of breathing reduced? Are there fewer retractions? Is the respiratory rate lower? Are breath sounds improved? It is the RT at the bedside making a post-

treatment assessment who is best able to evaluate the appropriateness of the delivery technique and who, after consultation with the physician, changes the medication, delivery device, or in some cases recommends the discontinuation of inappropriate or ineffective therapy.

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The author responds:

I am delighted that Mr Baty has commented on my editorial regarding using the blow-by technique to deliver aerosol medication.[1] As he points out, there have been great changes in the practice of respiratory care in the 25 years since I began my career as an academic pediatric pulmonologist and aerosol scientist. There have been advances in nebulizer technology and improvements in the interface between the child and the nebulizer. I agree with his contention that the RT should choose the appropriate interface supported by evidence-based research, especially because the clinical assessment of bronchodilator response is inaccurate in young children. The published peer-reviewed data clearly demonstrate that blow-by delivery of aerosol is inferior to using a mouthpiece or a face mask sealed on the child's face. Mr Baty claims that there is a literature supporting blow-by aerosol therapy, and he gives several references for this claim. Let's see what these papers cited by Mr Baty really say.

Three of these papers were written by my friend, Dr David Geller. Dave is a pediatric pulmonologist and a superb aerosol scientist. However, 2 of these papers are review articles that contain no data. The review published in RESPIRATORY CARE indicates that studies of blow-by must be validated by clinical trials.[2] In the review with Thorsson,[3] Thorsson and Geller write that, "To avoid crying, some caregivers will move the mask away from the face and give 'blow-by' treatments. However, a poor face mask seal will result in 40–85% declines in inhaled dose with both metered-dose-inhaler/spacer devices and nebulizers."[3] This hardly supports the use of blow-by as an alternative technique. Dr Geller also presented unpublished data in an abstract that compared fine-particle dose from a T-piece nebulizer, using an in vitro model with a close-fitting face mask, blow-by with a mask, and blow-by with an extension tubing.[4] The blow-by tubing was aimed directly at a filter, and the dose captured on that filter was measured. It is not surprising that when blowing drug aerosol at a filter with a gap of less than 1 inch, there was a similar amount of medication deposited as when the filter was placed on a mask. This surely does not represent a realistic clinical scenario.

Similar to this, Nikander and colleagues evaluated a front-loading face mask at a gap of less than 2 inches from a face model with a fixed, open mouth 22 mm in diameter.[5] A filter was placed behind this open mouth, and a breathing simulator provided flow. The authors found that "in the evaluation of the blow-by technique with this bench model, the inhaled mass was clearly affected by the increase in distance between the face and the face mask." Although there was adequate deposition at very close range, when the drug was aimed directly at the open mouth, the drug mass significantly decreased as the mask was brought even a short distance away. Clinically, these studies would be like asking an infant to keep his mouth wide open so that a tube can continuously deliver aerosol into the mouth from a distance of less than 1 inch while the child and the tubing are held absolutely still. Although this sounds silly, such are the limitations of in vitro studies.

An interesting finding of the Nikander study, supported by Dr Restrepo's work,[6,7] is that a front-loading face mask is more likely to entrain aerosol than is a mask where the tubing is at the bottom of the mask. The fish-face mask described by Restrepo has the following modifications:

1. The mask is front-loaded so that the aerosol can stay within the mask rather than being blown out of the top.

2. The mask size is larger and has an extended face cover.

3. The side holes are much smaller than that of a standard mask, which reduces the area of potential aerosol loss to one eighth that of the standard mask.

Restrepo et al showed that, with less than a 1 inch gap, blow-by delivery reduces aerosol available to the patient by 58%, compared with a sealed face mask. This newly designed face mask *only* reduced the amount of medication available by 38% at a distance of 2 cm.[7] However, even under these optimal bench conditions, using the new mask, only a mean of 2.26% of the nominal (nebulized loading) dose was deposited on the filter! They concluded that the best way to deliver aerosol medication to an infant is with a mask held sealed against the face.

Mr Baty also cites an abstract presented a decade ago at the 44th International Respiratory Congress of the American Association for Respiratory Care, where Dickerson and colleagues studied aerosol deposition using T-adapter blow-by aimed toward a manikin head with open mouth.[8] They measured aerosol concentration in the respiratory range and showed that blow-by at a distance of 4 cm delivered significantly less than the sealed mask. They concluded that, "The results support the use of aerosol face masks as a recommended interface for infants." Thus it appears that a careful reading of each of these references condemns the use of blow-by as an alternative technique.

Most interesting was Mr Baty's remark that, "for a variety of reasons a substantial