The Advantages of Low Flow Continuous Nebulization*

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Continuous Nebulizer Therapy (CNT) has been shown to be an effective means of treating severe reversible airway disease. Numerous studies comparing CNT to traditional medication aerosol treatments have shown that, for patients with severe reversible airway disease or impending respiratory failure, CNT is both more effective and labor efficient. There exists a number of different nebulizers which may be used to deliver CNT. Originally CNT was delivered by hand held nebulizers attached to an IV apparatus or by high flow, large volume nebulizers. Newer low flow continuous nebulizers (like the EZflow Continuous Nebulizer) provide an alternative and superior method of delivering CNT which is more labor effective and more appropriate for the typical CNT patient. In addition to being smaller, easier to set up, and allowing for connection directly onto an aerosol mask, low flow CNT nebulizers will also deliver more of the medication intended for a patient than traditional high flow, large volume CNT nebulizers.

Optimizing Nebulizer Flow to Inspiratory Requirements

Most patients presenting to the ER with asthma are children typically under the age of ten years and have peak inspiratory flows in the range of 12 L/min or less. Unless a patient's inspiratory flow exceeds the flowrate of the nebulizer, the patient is unable to inhale all the medication intended for them. When using a high flow nebulizer, this occurs only a small percentage of the inspiratory period (see Fig. 1). Low flow nebulizers have the advantage that almost for the entire duration of the inspiratory phase, the patient is out drawing the nebulizer, and thus receiving all the medication intended for them. Table 1 shows the percent of total available aerosol during inhalation

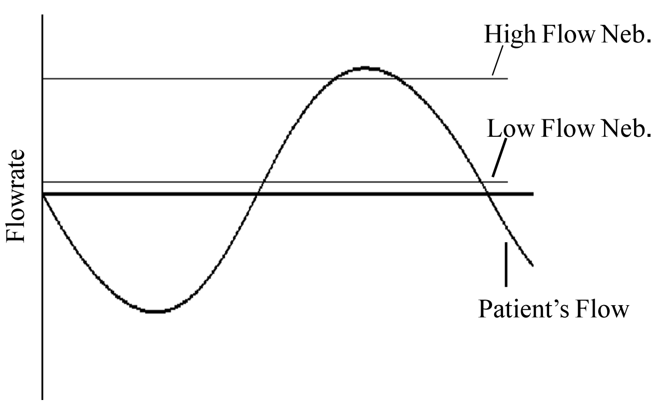

FIGURE 1. Plot of patient and nebulizer flow as a function of time.

Nebulizer Flow (L/min) \ Patient's Peak Flow (L/min)	6	8	10	12	16	20	24
2	89	92	94	95	96	97	97
3	84	88	90	92	94	95	96
4	78	84	87	89	92	94	95
6	64	75	80	84	88	90	92
8	48	64	73	78	84	87	89
10	38	51	64	71	79	84	87
13	29	39	49	59	72	78	82
15	25	34	42	51	67	75	79

TABLE 1: percent of total available aerosol inhaled by the patient

which is actually inhaled by the patient and is calculated based on the given peak flow of the patient and the assumption that the patient will breathe similar to a sine wave. Hess et al, in their study of nebulizer performance measured the waveforms of a number of spontaneously breathing patients and found that a sine wave was a good approximation to patient respiration. It is important to note that the results of Table 1 are totally independent of tidal volume and respiratory rate, and are dependant on peak inspiratory flow only.

Interpreting the Impact of Nebulizer Flow

Table 1 shows percent of aerosol which is available during inhalation which is actually inspired by the patient. A patient with a peak inspiratory flow of 10 L/min receiving a treatment from a nebulizer running at 3 L/min, like the EZflow, will receive 90% of the medication aerosolized during inhalation. The same patient receiving a treatment from a nebulizer running at 10 L/min will only receive 64% of the medication aerosolized during inhalation. Provided that both nebulizers were mixed to deliver the same prescription, say 10 mg/hour, the 3 L/min low flow nebulizer would actually deliver almost 50% more medication to the patient than the 10 L/min high flow nebulizer simply because much of the medication aerosolized during inhalation by the high flow nebulizer was allowed to escape into the surrounding ambient environment.

Conclusion and Discussion

A low flow continuous nebulizer, like the EZflow, ensures that patients receive the maximum amount of medication available to them and best optimizes aerosol delivery to the patient's inspiratory demands. For the asthma patient who arrives in the ER and receives a prescription of a specific amount of medication in mg/hour, a low flow continuous nebulizer will be able to deliver the most efficient treatment. This is in addition to other factors, such as nebulizer efficiency, which are also known to affect the amount of medication delivered to the patient.

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* From Piper Medical Products, Oct. 8, 1999, West Sacramento, CA 95691, 1-800-810-1116, www.pipermedical.com
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