

# Wearing a noseclip improves nebulised aerosol delivery<sup>1</sup>

Roland Meier, Graham L. Hall, Felix H. Sennhauser, Johannes H. Wildhaber

Swiss Paediatric Respiratory Physiology Research Group, Department of Respiratory Medicine, University Children's Hospital, Zürich

## Summary

**Objective:** The efficiency of nebulised aerosol delivery is limited due to drug retained within the nebuliser, and due to a poor ratio between inspiratory drug delivery and expiratory drug loss. Several technical approaches have improved the ratio between inspiratory aerosol delivery and expiratory aerosol loss. In our pilot study we aimed to investigate if wearing a noseclip during inhalation therapy improves the inspiratory versus expiratory ratio and hence, improves nebulised aerosol delivery.

**Methods:** Drug delivery was measured in thirteen subjects (7 males; age range 23–36 years) inhaling in random order nebulised aerosol through

a mouthpiece once while wearing a noseclip and once without.

**Results:** Wearing a noseclip leads to an increase of 113% (SEM 23.5) in drug delivery and improves the inspiratory versus expiratory ratio (ratio 2.07 versus 0.75).

**Conclusions:** We have shown that aerosol delivery is increased due to an improved inspiratory versus expiratory ratio when wearing a noseclip.

**Key words:** inhalation therapy; noseclip; aerosol deposition; nebuliser

## Introduction

Nebulised aerosols are widely used in the treatment of various respiratory disorders [1]. However, there are problems with nebuliser therapy limiting the effective aerosol delivery to the patient. These are mainly the high dose of drug retained within the nebuliser, and the poor ratio between drug delivery during inspiration and drug loss during expiration. This inefficiency has a great clinical and economic impact, especially when using expensive drug formulations, such as DNase. There have been several approaches to improve the ratio between inspiratory delivery and expiratory loss. One possibility is to use an interrupter

during expiration and hence, minimise drug loss during expiration. However, this technique is only suitable for co-operative patients and is therefore limited to certain age and patient groups. Based on the knowledge of air entrainment during nebulised aerosol therapy, breath enhanced nebulisers which increase inspiratory drug delivery were invented [2]. Another possibility of increasing the ratio would be to reduce air entrainment through the nose during nebulised inhalation with a mouthpiece and thus, enhance drug delivery. The use of a noseclip is a controversial topic, however, its effect on aerosol delivery is unknown.

## Methods

In our pilot study we investigated drug delivery in thirteen subjects (7 males; age range 23–36 years) familiar to inhalation therapy, with FEV<sub>1</sub> and FVC >80%. The subjects inhaled for two minutes, in random order, nebulised (Pari Master compressor with Pari LC-star; Pari, Germany) salbutamol (Ventolin®; Glaxo Wellcome, Great Britain) through a mouthpiece, once while wearing a noseclip and once without. Breathing patterns were measured with a pneumotachograph (Brasco; Pari, Germany) in-

serted in the mouthpiece and analysed with a breathing monitor (Brasco; Pari, Germany). Salbutamol deposition was measured spectrophotometrically on low resistance inspiratory and expiratory filters inserted in the system, and in the nebuliser. The resulting values were then expressed as a percentage of the total nominal dose (2000 µg). The study was approved by the local Ethics Committee. Statistical analysis was carried out using a paired t-test (significance level of 95%; p <0.05).

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## Results

Inspiratory volume was (mean  $\pm$  SEM) 1115  $\pm$  95 mL when wearing a noseclip which is higher ( $p < 0.0001$ ) than 456  $\pm$  76 mL without the noseclip (table 1). Accordingly, deposition (mean  $\pm$  SEM) on the inspiratory filter and thus drug delivery was 17% (335  $\pm$  62  $\mu$ g) which is higher ( $p = 0.006$ ) than

8.6% (171  $\pm$  27  $\mu$ g) without the noseclip (figure 1). In addition, deposition (mean  $\pm$  SEM) on the expiratory filter and hence, expiratory drug loss was 9.4% (188  $\pm$  43  $\mu$ g) when wearing a noseclip which is significantly ( $p < 0.001$ ) lower as compared to 14.7% (294  $\pm$  53  $\mu$ g) without the noseclip.

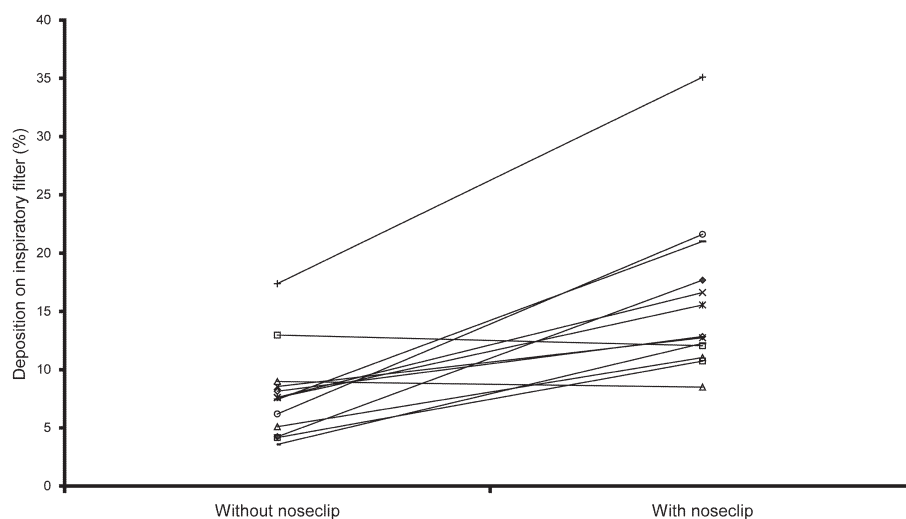
**Table 1**

Individual and group mean data for inspiratory volumes and inspiratory and expiratory depositions, and ratio of inspiratory drug delivery and expiratory drug loss both without (+NC) and with (-NC) a noseclip.

Patient	Inspiratory volume			Inspiratory deposition			Expiratory deposition			Ratio	
	- NC (mL)	+ NC (mL)	%	- NC ( $\mu$ g)	+ NC ( $\mu$ g)	%	- NC ( $\mu$ g)	+ NC ( $\mu$ g)	%	- NC	+ NC
1	240.7	779.8	224.0	112.8	341.3	202.5	484.8	188.2	-61.2	0.23	1.81
2	731.3	966.4	32.1	84.1	206.1	145.0	344.8	196.5	-43.0	0.24	1.05
3	459.3	1075.5	134.2	93.7	255.1	172.3	230.0	184.6	-19.8	0.41	1.38
4	349.4	1521.1	335.4	152.3	267.1	75.4	198.9	136.7	-31.3	0.77	1.95
5	112.74	957.5	749.3	132.0	252.8	91.5	325.7	194.2	-40.4	0.41	1.30
6	202.3	858.2	324.2	123.6	354.4	186.8	303.0	77.0	-74.6	0.41	4.61
7	804.4	1089.4	35.4	395.1	542.2	37.2	213.3	129.6	-39.3	1.85	4.18
8	308.8	688.7	123.0	62.6	209.7	235.0	233.6	173.8	-25.6	0.27	1.21
9	349.0	1183.0	238.9	317.3	1009.8	218.2	844.7	690.5	-18.3	0.38	1.46
10	252.1	1278.2	406.9	164.3	262.3	59.7	188.2	139.1	-26.1	0.87	1.89
11	1006.6	1034.2	2.7	264.7	238.4	-9.9	149.9	111.6	-25.5	1.77	2.14
12	579.7	1068.7	84.4	167.8	163.1	-2.9	175.0	127.2	-27.3	0.96	1.28
13	536.1	2001.1	273.3	155.9	246.8	58.3	129.6	92.5	-28.6	1.20	2.67
Mean	456.3	1115.5	228.0	171.2	334.5	113.0	294.0	187.8	-35.5	0.75	2.07
SEM	76.2	94.7	56.2	27.0	62.1	23.5	53.1	43.3	16.5	0.16	0.31

**Figure 1**

Drug deposited on the inspiratory filter expressed as a percentage of the total dose when inhaling without and with a noseclip.



## Discussion

In conclusion, wearing a noseclip during inhalation therapy leads to an increase of 113% (SEM 23.5) in inspiratory drug delivery and hence, to an improved ratio of inspiratory drug delivery and expiratory drug loss (ratio 2.07 versus 0.75). This may have major implications on nebulised aerosol delivery in general and on nebulised aerosol therapy with expensive drugs in particular. The mechanism of this finding remains unclear. However, the most likely explanation for this finding is that air entrainment through the nose may occur during inhalation with a mouthpiece. An-

other explanation would be that obstructing the nose may simply increase the inspiratory drive by a reflex mechanism.

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*Correspondence:*

*Johannes H. Wildhaber, MD, PhD  
Department of Respiratory Medicine  
University Children's Hospital  
Steinwiesstrasse 75  
CH-8032 Zürich  
E-mail: johannes.wildhaber@kispi.unizh.ch*

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