Episodic viral wheeze in preschool children: effect of topical nasal corticosteroid prophylaxis

M Silverman, M Wang, G Hunter, N Taub

Background: The effect of prophylactic nasal corticosteroids on wheezing episodes associated with colds was investigated in a 12 week parallel group, double blind, randomised controlled trial in preschool children.

Methods: Data were collected from 50 children aged 12–54 months with a history of at least three episodes of wheeze associated with colds over the previous winter, but few or no interval symptoms; 24 were given one dose of fluticasone aqueous nasal spray (50 µg) into each nostril twice daily and 26 received an indistinguishable placebo spray. Episodes of lower respiratory illness occurring within 2 days of the onset of a cold were identified from daily symptom diaries. The main outcome was nocturnal symptom score during the first 7 days of an episode.

Results: The groups were well balanced on entry except that the treatment group had a history of more prolonged episodes. During the trial there was no significant difference in the number of episodes in the treatment and control groups (27 and 37, respectively), in the severity of nocturnal symptoms (mean score 1.33 and 1.22, respectively, confidence interval of difference –0.24 to +0.47) or in daytime symptoms, activity or total scores during episodes. Compliance was estimated to be over 50% in 43 of the children.

Conclusions: Nasal corticosteroid treatment does not prevent acute wheezy episodes associated with upper respiratory infections (common colds) in preschool children.

Seasonal episodes of wheeze and cough are common in preschool children, are disruptive to families, and costly to the National Health Service each winter in the UK. Clinical observation confirmed by virological evidence collected in school children has shown that a variety of viral upper respiratory tract (URT) infections (common colds) can initiate almost all of these lower respiratory tract (LRT) events. Most young children who experience these episodes, formerly known by the apt description “wheezy bronchitis”, do not progress to atopic asthma.

Evidence for the extensive “cross talk” between the nose and lungs has recently been reviewed, but the precise mechanisms of the link between URT infection (common colds) and LRT symptoms have yet to be established. Although in experimental adult rhinovirus infections there is evidence of viral replication in the LRT, from what is known of rhinovirus biology it seems likely that the predominant site of viral activity is the nose. In an adult experimental model of viral wheeze due to human coronavirus there were marked differences in inflammation of the URT between wheezy and non-wheezy subjects, and very little evidence of viral replication in the LRT. If the LRT response to the common cold is at least partially mediated by indirect mechanisms rather than directly by infection of the LRT epithelium, it may be possible to ameliorate LRT symptoms in susceptible individuals by suppressing nasal inflammation. It is important to test this hypothesis, both because of potential advantages of direct URT treatment and because of the light it may shed on possible mechanisms in viral wheeze.

No experimental studies of this topic have been reported in adults or children. Certainly, prophylactic inhaled corticosteroids targeted at the lungs do not prevent acute episodes in children with pure viral episodic wheeze, although, conversely, systemic steroids (the usual treatment for severe wheezy episodes) might potentiate viral replication. Another example of the possible benefits of nasal corticosteroids on the relationship between the URT and LRT is their effects on bronchial hyperresponsiveness (BHR) during seasonal rhinitis. Whereas nasal corticosteroids ameliorate both direct and indirect BHR in non-asthmatic subjects with rhinitis, orally inhaled corticosteroids have no effect which suggests an indirect (URT dependent) mechanism for BHR, potentially amenable to nasal therapy. The evidence is, however, inconsistent. Conversely, inhaled corticosteroids can ameliorate nasal symptoms in asthmatics with seasonal rhinitis.

We set out to test the hypothesis that nasally administered fluticasone propionate in a dose shown previously to be safe and effective in children ameliorates the acute LRT symptoms associated with common colds in preschool children with a history of episodic viral wheeze in winter. We chose children without features of classical atopic asthma recruited from a primary care setting.

METHODS
Design of study
A 12 week double blind, randomised, parallel group design was used. Study numbers were assigned sequentially and drugs were prepacked in a block size of 4. Trial drugs were available in identical containers labelled only with the subject number. Decoding took place after all the data had been entered into the computer file.

Subjects
Children aged 12–54 months were selected for study from six suburban, small town, or rural general practices (i.e. from primary care). The initial letter from their general practitioner to all children in the appropriate age group who had been prescribed bronchodilators (but not inhaled steroids) over the
Table 1 Symptom categories

<table>
<thead>
<tr>
<th>Score</th>
<th>Night time symptoms (cough, wheeze or breathing difficulty)</th>
<th>Daytime or activity ratings (cough, wheeze, breathing difficulty or play limitation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>Slight; sleep not disturbed</td>
<td>Slight, no treatment given</td>
</tr>
<tr>
<td>2</td>
<td>Sleep disturbed once; no help required</td>
<td>Required treatment but no outside help</td>
</tr>
<tr>
<td>3</td>
<td>Sleep disturbed more than once or child needed help</td>
<td>Severe, required help from GP</td>
</tr>
<tr>
<td>4</td>
<td>Sleep very disturbed or GP called</td>
<td>Very severe, admitted to hospital</td>
</tr>
</tbody>
</table>

Analysis of data

Based on data collected in previous trials, it is reasonable to assume that there is some within-child correlation of these episodes. Statistical tests were interpreted at the 5% level of significance.

RESULTS

Of 77 children recruited to the trial, 44 completed the 12-week protocol and a further six completed at least the first 6 weeks of the protocol. These 50 children were said to have complied and analysis of their data forms the basis of this report. The remaining 27 children dropped out or were excluded for the following reasons: child refused trial treatment (n = 16), parents too busy or failed to complete or return diaries (n = 5), child developed intercurrent illness (n = 4), GP prescribed inhaled steroids (n = 2).

The characteristics of the treatment and control groups were similar at entry in most respects (table 2). By chance, the severity and duration of winter wheezy episodes recalled by their parents was more severe for the treatment group. The difference was statistically significant for duration (p < 0.05). Children had few symptoms between episodes because of the selection criteria.

It is clear from a compilation of all the data for acute episodes (fig 1) that the onset was well defined, the level of symptomatology in the previous week was low, and the duration was about 1 week with a “tail” lasting for a further few days. There was considerable variability in the profile of individual episodes.

Summary statistical analysis of the geometric means of night time, daytime, and activity scores for children showed

Table 2 Entry characteristics of children who completed the trial

<table>
<thead>
<tr>
<th></th>
<th>Placebo group (n=26)</th>
<th>Treatment group (n=24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/F</td>
<td>16/10</td>
<td>13/11</td>
</tr>
<tr>
<td>Age [months]</td>
<td>35.6 (8.5)</td>
<td>36.2 (10.0)</td>
</tr>
<tr>
<td>Recalled symptoms in previous winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No of episodes</td>
<td>3.5 (1.8)</td>
<td>4.2 (6.3)</td>
</tr>
<tr>
<td>Episode duration (days)</td>
<td>8.6 (6.0)</td>
<td>12.1 (6.3)*</td>
</tr>
<tr>
<td>Symptoms between episodes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days per month</td>
<td>5.0 (4.2)</td>
<td>6.2 (4.8)</td>
</tr>
<tr>
<td>Nights per month</td>
<td>8.3 (5.1)</td>
<td>9.1 (4.1)</td>
</tr>
<tr>
<td>Personal atopy†</td>
<td>9 (35%)</td>
<td>5 (21%)</td>
</tr>
<tr>
<td>Personal asthma</td>
<td>14 (54%)</td>
<td>13 (54%)</td>
</tr>
<tr>
<td>Maternal smoking</td>
<td>7 (27%)</td>
<td>9 (38%)</td>
</tr>
</tbody>
</table>

Values are number (%) or mean (SD).

*p < 0.05 (t test).
† Reported eczema or rhinitis excluding wheeze or “asthma” as a diagnosis.
no significant difference between active and placebo treat-
ments. The total number of episodes (placebo 37, active 27)
and the number of children with episodes (placebo 23; active
19) did not differ between the groups (table 3). There was no
significant difference between active and placebo treat-
ments The total number of episodes (placebo 37, active 27)
and the number of children with episodes (placebo 23; active
19) did not differ between the groups (table 3). There was no
evidence of a difference between groups in the number of epi-
sodes experienced by each child.

The main outcome of interest was night time symptom
score during episodes which, by definition, lasted for 7 days
on each occasion. Using multilevel modelling, neither night time
scores nor any other mean daily symptom scores during episodes
differed between the active and placebo groups. A secondary
analysis was carried out, adjusting for the total
duration of wheezy episodes experienced by each child
during the previous winter, and this produced no substantial changes
in the result.

The main complaint related to children’s intransigence with
nasal therapy. Treatment was withdrawn in one child because of
nausea (fluticasone group). Trial medication was returned
by the parents of 40 children at the end of the trial. Mean (SD)
compliance estimated by weighing the bottles was 99.9
(44.6)%. One child was given no medication and six others
received less than half of the intended number of doses. There
was no difference in compliance between active and placebo
groups.

**DISCUSSION**

This trial has shown no effect of prophylactic intranasal

corticosteroids (fluticasone propionate 50 µg per nostril twice
daily) on LRT symptoms associated with URT infections in

preschool children. Although underpowered for its original
objective of detecting a 40% reduction in nocturnal symptoms,
the chance of missing an effect of this size was negligible
(table 3).

It seems unlikely that any oversights or deficiencies in the
conduct of the trial could have led to a falsely negative result,
although compliance is always an issue. Our crude estimate of
overall mean compliance based on weighing medication
returned at the end of the trial was about 100%, with a wide scatter. In other circumstances once daily administration is
adequate, so there should be a good margin of effective dos-
ing.

The subjective technique used for recognition of episodes
might be criticised. It is certainly difficult to be sure about the
onset of an episode in the presence of variable day to day
symptoms. However, since episodes were identified blind
before decoding, there should have been no bias. We have
explored the development of a computer based algorithm for
discerning acute episodes automatically. Preliminary analysis
using a moving time average (window length 7 days, start of
episode when weekly average total symptom score increased
by 2, end of episode when score back to baseline) picked up 44
of 64 episodes (and one additional episode which had not
been identified by subjective scrutiny). The severity of com-
puter generated episodes was greater in the treatment group,
and this translated into a significant odds ratio (OR) of 15.4 (CI 1.2
to 198) for a more severe daytime outcome for the treatment
group, and a similar trend (OR 3.5; CI 0.5 to 25) for night time
scores. An automated scoring algorithm for this type of
research could be valuable but has yet to be perfected.

From a clinical viewpoint, the treatment was ineffective in
this group of preschool children with mainly episodic wheeze
and relatively few interval symptoms. Because we did not
record URT symptom severity (only its presence or absence),
we cannot judge whether nasal corticosteroids had an effect
on nasal inflammation as has previously been (transiently)
demonstrated in adults. There were no fewer colds in the
treatment group. It seems likely that corticosteroids in the
dose given here had little effect on inflammation in viral URT
infections, in comparison with their major role in nasal aller-
gic inflammation. Thus, we have not adequately tested the
hypothesis that LRT symptoms in children with viral episodic
wheeze are mediated to a significant degree by indirect
mechanisms emanating from the URT. This could only be
achieved with a drug which reduces the URT inflammatory
effects of the common cold.

Similar groups of preschool and older children with mainly
episodic symptoms given lung targeted preventer inhaled
corticosteroids during the winter months do not respond—
although high doses of inhaled steroids given at the time of an
episode may alleviate symptoms. This approach may be
worth exploring using high dose nasal corticosteroids during
episodes. In contrast, several studies of preventer inhaled ster-
oids in mixed pattern wheeze (equivalent to classical atopic
asthma) have shown effects both on interval symptoms and
episodes. It seems likely from the present data that any
effect on LRT symptoms in these studies was achieved by
direct anti-inflammatory effects on chronic asthmatic airway
inflammation rather than by an indirect nasal anti-

Episodic viral wheeze appears to be a condition independ-
ent of extrinsic allergy and not associated with chronic airway
inflammation or baseline BHR. This may partly explain the
difference between the beneficial effects of nasal cortico-
steroids in allergic airway diseases and the negative results
in our study.

Because the many viruses which are commonly implicated in
viral wheeze operate through a variety of different
adhesion mechanisms and induce different cytopathic
effects in different target zones of the respiratory tract, it may
be rewarding to seek a final common pathway leading to

---

**Figure 1** Mean values and 95% confidence intervals for symptoms
recorded from 7 days before until 14 days after the onset
of episodes. (A) Daytime and night time symptoms for both groups
combined. (B) Night time symptoms shown separately for active
(solid symbols) and control (open symbols) groups.

**Table 3** Analysis of episodes

<table>
<thead>
<tr>
<th></th>
<th>Placebo group</th>
<th>Treatment group</th>
<th>Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of episodes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total no</td>
<td>37</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Children affected</td>
<td>23</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Geometric mean daily symptom score during episodes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night time</td>
<td>1.22</td>
<td>1.33</td>
<td>0.11 (-0.24 to 0.47)</td>
</tr>
<tr>
<td>Daytime</td>
<td>1.03</td>
<td>1.17</td>
<td>0.14 (-0.16 to 0.45)</td>
</tr>
<tr>
<td>Activity</td>
<td>0.94</td>
<td>1.06</td>
<td>0.12 (-0.25 to 0.47)</td>
</tr>
</tbody>
</table>
wheeze rather than to explore virus specific mechanisms in detail. In this regard, the possibility that inflammation in the URT may be the vital common trigger factor leading to wheeze in individuals with susceptible airways still needs to be ruled out. Given the ethical constraints on research in young children, an adult model of viral episodic wheeze may promote better opportunities to explore this hypothesis.2,7

ACKNOWLEDGEMENTS

We thank Dr David Richards for facilitating a grant-in-aid from Glaxo Smith Kline and for the coded trial preparations. Glaxo Smith Kline played no part in the conduct or analysis of the trial or the preparation of the manuscript. We thank the general practitioners and practice managers of six Leicestershire practices (Melton Mowbray, Long Clawson, Uppingham, Highgate (Sileby), Winstanley Road and Evington) for their assistance. Mr Andrew Leary obtained the compliance data by painstakingly weighing the medication.

Authors’ affiliations
M Silverman, M Wang, Department of Child Health, Institute for Lung Health, Leicester University, Leicester, UK
G Hunter, N Taub, Department of Epidemiology, Institute for Lung Health, Leicester University

Conflict of interest: Professor Silverman has previously received research and travel grants from several pharmaceutical companies including GSK.

REFERENCES
16 Henriksen JM, Wenzel A. Effect of an intranasally administered corticosteroid (Budesonide) on nasal obstruction, mouth breathing, and asthma. Am Rev Respir Dis 1984;130:1014–8.
Episodic viral wheeze in preschool children: effect of topical nasal corticosteroid prophylaxis
M Silverman, M Wang, G Hunter and N Taub

Thorax 2003 58: 431-434
doi: 10.1136/thorax.58.5.431