Evaluation of the Effects of Isoprenaline and Salbutamol Aerosols on Airways Obstruction and Pulse Rates of Children with Asthma*

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Hambleton, G. and Shinebourne, E. (1970). Archives of Disease in Childhood, 45, 766. Evaluation of the effects of isoprenaline and salbutamol aerosols on the airways obstruction and pulse rates of children with asthma. Investigation of FEV$_{1.0}$ and pulse rates in 10 asthmatic children who were given inhalations of isoprenaline, salbutamol, and placebo separately showed that both drugs had a similar effect on airways obstruction. Salbutamol has a longer duration of action. Neither drug caused a tachycardia at the dosage used.

Administration of bronchodilators is an established treatment for airways obstruction in children with asthma. Drugs which may be given in this way include isoprenaline, atropine, adrenaline, and orciprenaline. Other than atropine all have sympathomimetic actions and cause β-adrenergic cardiac effects. Salbutamol is a new sympathomimetic agent which has been claimed to have a specific β-adrenergic bronchodilator action and minimal cardiac effects as judged by experiments on cats, dogs, guinea-pigs, and isolated tissues (Hartley et al., 1968; Cullum et al., 1969). These effects have been studied in adults (Kelman, Palmer, and Cross, 1969; Kennedy and Simpson, 1969; Choo-Kang, Simpson, and Grant, 1969; Riding, Chatterjee, and Dinda, 1969; Palmer and Diament, 1969; Warrell et al., 1970). The present study was designed to ascertain in children with asthma (i) whether salbutamol given as aerosol inhalation is an effective bronchodilator; (ii) whether it differs from isoprenaline in effectiveness or duration of action; (iii) whether it differs from isoprenaline in its effect on pulse rate.

The aerosol canisters and dosages used were essentially the same as those generally available, and the respiratory function apparatus used is also commercially available for clinical use.

Subjects and Methods

Ten children who attended out-patients regularly were selected; their ages ranged from 5 to 13 years. There were 6 girls and 4 boys, all of whom were considered on clinical grounds to be severe or moderately severe asthmatics. They attended on six separate occasions receiving a single inhalation each visit, taking placebo, salbutamol, and isoprenaline on two occasions each. They had no treatment for 24 hours before the experiments were carried out. The trial was double-blind, and the order in which the children received the various drugs was randomly decided. The aerosol canisters were lettered, the results were analysed, and the canisters decoded after the trial was completed.

Respiratory function tests. Measurements were made of forced expiratory volume in 1 second (FEV$_{1.0}$) and the forced vital capacity (FVC) using an Air-Shields Pulmonary Function Recorder. The children rested for 15 minutes and then the three resting values were taken at 15-minute intervals; the aerosol was then given and further measurements made at 5, 10, 60, and 120 minutes. On each occasion 3 values of FVC and FEV$_{1.0}$ were taken.

Each child received a single inhalation from the canister, the doses being as follows: salbutamol 100 μg., and isoprenaline 100 μg.

The placebo contained Arcton 11 and Arcton 12 with a small amount of oleic acid as a surfactant. The children were seated during the investigation and appeared able to co-operate easily.

The mean was obtained of three resting values and all subsequent measurements compared with this mean. For each timed measurement the best of three readings of FEV$_{1.0}$ was taken.
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From all children 60 mean resting values of FEV$_{1.0}$/FVC, and FEV$_{1.0}$/FVC ratio were obtained. For comparison of effects on airways obstruction only those occasions when the resting FEV$_{1.0}$/FVC ratios were abnormal are included in the statistical analysis. There were 22 such occasions, the ratios ranging from 34.0% to 67.9%. There were only two ratios over 65%—one of 67.9% and the other of 66.7%. These have been included together with those which were below 65% the conventional lower limit of normal. Of the 22 abnormal ratios the number of occasions on which the various drugs were subsequently given were:—isoprenaline 9, salbutamol 7, and placebo 6.

**Pulse rates.** These were measured by palpation of the radial artery for 30 seconds immediately before the respiratory function tests.

**Results**

**Airways obstruction.** Table I shows mean resting values of FEV$_{1.0}$/FVC ratio and there is no significant difference between the three groups (Student 't' test).

**TABLE I**

<table>
<thead>
<tr>
<th>Resting FEV$<em>{1.0}$/FVC Ratios† of Groups of Children Included in Analysis of Drug Effects on FEV$</em>{1.0}$</th>
<th>Drug Subsequently Given</th>
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</thead>
<tbody>
<tr>
<td>Mean Resting FEV$_{1.0}$/FVC Ratio (± 1 SD)</td>
<td>Isoprenaline (n = 9)</td>
</tr>
<tr>
<td><em>58.5 ± 10.2</em></td>
<td>Placebo (n = 6)</td>
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<tr>
<td><em>55.5 ± 9.5</em></td>
<td>Salbutamol (n = 7)</td>
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</tbody>
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†Selected as being less than 68.0%.

Table II shows the mean percentage changes in FEV$_{1.0}$ compared with resting values and placebo. Placebo had no significant effect. Isoprenaline significantly improved FEV$_{1.0}$ at 5 and 10 minutes, but was no different from placebo at 60 and 120 minutes. Salbutamol significantly improved FEV$_{1.0}$ at all times.

Table III compares the differences between salbutamol and isoprenaline. Isoprenaline and salbutamol were equally effective at 5 and 10 minutes; salbutamol was significantly better than isoprenaline at 60 and 120 minutes.

**TABLE III**

<table>
<thead>
<tr>
<th>Percentage Improvement in Mean Resting FEV$_{1.0}$ ± 1 SD</th>
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<tr>
<td>Time (min.)</td>
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<td>-------------</td>
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<tr>
<td>5</td>
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<tr>
<td>10</td>
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<td>60</td>
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<td>120</td>
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**Pulse rates.** All pulse rates of all children are reported.

Table IV shows mean changes from resting rates. Neither isoprenaline nor salbutamol caused any significant change, and tachycardia was not observed. With the placebo, pulse rates tended to fall and analysis shows this to be statistically significant at 10, 60, and 120 minutes (p < 0.05 each time) though the mean value of the fall was only 4.5 beats per minute.

**Discussion**

The results show that aerosol administration of 100 µg. salbutamol produced a useful improvement in reversible airways obstruction which was of the same order as isoprenaline 100 µg., whereas placebo had no significant effect. The duration of action of salbutamol was longer than that of isoprenaline, evidence of the effect being apparent at 2 hours, with little indication of decline. This is probably explained by the fact that salbutamol is absorbed from the gastro-intestinal tract (Warrell et al., 1970) in contrast to isoprenaline. Any portion of the
salbutamol which is not inhaled will usually be
swallowed and thus still be capable of exerting an
effect. In addition, salbutamol is relatively resis-
tant to metabolic breakdown or inactivation, signifi-
cant quantities being excreted unchanged in the
urine after inhalation (Kennedy and Simpson, 1969). The prolonged action of salbutamol has
been shown in adults, where effects up to 5 hours
have been observed (Riding et al., 1969; Choo-Kang
et al., 1969).

No tachycardia was observed with either salbuta-
mol or isoprenaline at this dosage, even at 5 minutes.
Studies in adults have shown the effect on pulse to
be evident at this time for isoprenaline (Choo-Kang
et al., 1969; Kelman et al., 1969). It is probable
that in the children reported here insufficient
quantities of either drug had been given to cause
tachycardia. There is no evidence in man that
bronchodilatation occurs with lower circulating
levels of isoprenaline than are required to produce
tachycardia, and the marked bronchodilatation
found in our patients is presumptive evidence of
adequate drug absorption. However, the response
to isoprenaline is known to be extremely variable
and what appears a more likely explanation is that,
in children, especially during attacks of broncho-
spasms, the heart rate is so labile that the naturally
occurring variations in rate are as great as those
occurring after a sympathomimetic agent. It is
thus reasonable to conclude that in children at doses
of 100 µg isoprenaline and salbutamol do not cause
tachycardia, but nevertheless produce clinically
useful improvement in airways obstruction.

Our conclusions are that salbutamol is to be
preferred to isoprenaline because of its longer
duration of action. In asthmatic children when
isoprenaline and salbutamol were administered in
the standard aerosol dosage, no tachycardia was
demonstrated.

We wish to thank Drs. B. D. R. Wilson and D. G.
Cottom for permission to investigate their patients.
The Pulmonary Function Recorder was kindly loaned
by Messrs. Air-Shields, Inc.; the pressurized aerosols
were prepared by Messrs. Allen and Hanburys, Ltd.,
Miss Angela Brinton gave assistance which is much
appreciated. Professor W. I. Cranston gave advice.

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