Practical considerations of nebulized corticosteroid in children with acute asthmatic exacerbation: A consensus

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Abstract

Background: Acute asthmatic exacerbation in children causes economic burdens both directly and indirectly. The GINA guideline does mention the use of inhaled or oral corticosteroids in the treatment of asthmatic exacerbation, it provides little practical guidance on the use of nebulized corticosteroid.

Objective: To review and recommend the practical considerations in the use of nebulized corticosteroid in children with acute asthmatic exacerbation.

Methods: This consensus was developed by a group of expert pediatricians in respiratory and allergy fields in Thailand. The recommendations were made based on a review of published studies and clinical opinions. The eligible studies were confined to those published in English, and randomized controlled trials and meta-analyses involving nebulized corticosteroids in asthmatic exacerbation in children aged between 1-18 years.

Results: There were 13 randomized controlled-trial studies published from 1998 to 2017. Nine of the 13 studies compared nebulized with systemic corticosteroid conducted in moderate to severe exacerbation, while the remaining four compared nebulized corticosteroid with placebo conducted in mild to severe exacerbation. The admission rate was significantly lower in severe exacerbation (one study) and pooled four mild to severe exacerbation studies comparing with placebo (p 0.022). Other clinical parameters were significantly improved with nebulized corticosteroid such as clinical scores, systemic corticosteroid/bronchodilator use, or shorter ER stays. Only one study used fluticasone, while the other 12 studies conducted by budesonide (92.31%).

Conclusion: Nebulized corticosteroid may offer an effective therapeutic option for the management of acute exacerbation of asthma in all severities. Nebulized budesonide is the preferred corticosteroid.

Key words: budesonide, admission, bronchodilator, randomized-controlled trial, meta-analysis

Introduction

The prevalence of asthma in Thai children was 7.8-15% and 8.7-13.9% in 6- and 13-year-old children, respectively.1,2 A study conducted on 6-12 year-old Thai students with asthma showed that 46.7% of them were controlled, 43.4% were partially controlled and 10% were uncontrolled.3 Acute asthmatic exacerbation is still a problem in Thailand. A survey conducted in 400 Thai patients with asthma; 9.5% had aged between 12 and 17 years showed that 36% had exacerbations in the
previous year, 17% had been hospitalized and 35% had an unscheduled emergency visit to a healthcare facility.\(^4\) A study on the annual cost of treatment children with asthma in Chiang Mai and Lamphun showed that the average total cost per person was 258 USD, of which 216 USD was direct and 41 USD was indirect.\(^5\) Similar finding from a study in Ramathibodi Hospital showed that the annual direct costs for asthmatic children aged less than 20-year-old in Thailand was estimated to be 278 USD, of which those patients with at least one exacerbation and without any exacerbation costing 463.6 USD and 241.6 USD respectively.\(^6\)

The 2018 update of the Global Strategy for Asthma Management and Prevention recommends systemic or high-dose inhaled corticosteroid for asthma exacerbation.\(^7\) Inhaled corticosteroid can be delivered via a pressurized metered-dose inhaler [pMDI], with or without a spacer, a dry powder inhaler [DPI], or a nebulizer. Any types of inhaled corticosteroid should be administered within one hour of presentation to the hospital. Although pMDI with a spacer is commonly used to deliver corticosteroid in children with asthma, nebulized corticosteroid offers an effective option for patients who may be unwilling or unable to use a pMDI.\(^8\) This is especially relevant in children with an acute asthmatic exacerbation who may be challenged to perform the precision technique with an inhaler.

While the GINA guideline does mention the use of inhaled or oral corticosteroids in the treatment of asthmatic exacerbation, it provides little practical guidance on the use of nebulized corticosteroid. This consensus aims to review and recommend the practical considerations in the use of nebulized corticosteroid in children with acute asthmatic exacerbation.

**Methods**

This consensus was developed by a group of expert pediatricians in respiratory and allergy fields in Thailand. A series of meetings was held in Bangkok to discuss the role of nebulized corticosteroid in acute asthmatic exacerbation in children. The recommendations were made based on a review of published studies and clinical opinions. The eligible studies were confined to those published in English, and randomized controlled trials and meta-analyses involving nebulized corticosteroids in asthmatic exacerbation in children aged between 1-18 years.

**Recommendations**

An overview of the treatment algorithm is captured in figure 1. It is adapted from the Thai asthma guideline.\(^9\)

**Severity of Asthmatic Exacerbations**

- Nebulized high-dose corticosteroid is recommended in the treatment of all severities [mild, moderate and severe] of asthmatic exacerbation in children at least 1 year old [Figure 1] by the below evidence.
- The severity of asthmatic exacerbation should first be established based on the existence of retraction, degree of difficulty in speaking, SpO\(_2\), pulse rate and peak expiratory flow rate, as stipulated in the Thai Asthma guideline.\(^9\)

There were 13 randomized controlled-trial studies published from 1998 to 2017.\(^10\)-\(^22\) Of those, two studies conducted in hospital setting, while the other 10 studies conducted at the emergency room [ER] and one study conducted at an asthma clinic. Nine of the 13 studies compared nebulized with systemic corticosteroid [Table 1],\(^10\),\(^16\)\(^-\)^\(^18\) while the remaining four compared nebulized corticosteroid with placebo [Table 2].\(^19\)-\(^22\)

Studies on moderate to severe asthma exacerbation. Of the nine systemic corticosteroid-controlled studies compared with nebulized budesonide,\(^10\)-\(^18\) five studies evaluated the admission rate as the main outcome. There were 200 patients with moderate asthma attack in all studies with age ranged between 1-18 years. All the studies used nebulized budesonide mostly 3 times daily with total dose between 800 microgram and 3 mg. Nebulized budesonide had better clinical outcomes over systemic corticosteroid without suppression of pituitary adrenal axis.\(^17\) Combination of admission rate by the three studies, the admission rate was slightly lower but not different between nebulized budesonide [149/660 patients; 22.58%] versus systemic corticosteroid [171/649 patients or 26.35%; p 0.123].\(^10\),\(^11\),\(^14\)

In one study from Saudi Arabia 30.9% of the patients in the study had severe asthma exacerbation.\(^13\) Treatment with nebulized budesonide vs placebo was compared. The results showed a significant improvement in group with nebulized budesonide in several parameters including clinical scores,\(^11\),\(^12\),\(^13\),\(^18\) peak flow,\(^12\),\(^15\) fewer use of bronchodilator,\(^17\) the reduction in intravenous corticosteroid use,\(^11\) and shorter length of emergency room stays.\(^15\) The admission rate in severe case with baseline clinical score of over or equal to 13 was significantly lower in nebulized budesonide group than placebo group [p 0.03].\(^15\) There were two studies comparing groups receiving nebulized budesonide versus systemic corticosteroids which showed a better asthma score and a lower use of bronchodilator in the nebulized budesonide group.\(^16\),\(^17\)

Studies on mild to severe asthma exacerbation. In the four placebo-controlled studies, which was done in the hospital setting, there were 384 patients with mild to severe asthmatic exacerbation with age ranging from 2 to 15 years.\(^18\)-\(^22\) Three studies used nebulized budesonide with daily dose range between 2-11 mg, while another study used 1.5 mg of fluticasone. Two studies from Mexico and China found positive results using nebulized corticosteroids over placebo in clinical score, admission rate, systemic corticosteroid need, and complete remission rate. Even though clinical outcomes in Milani and Sekerel studies were not statistical significant,\(^19\),\(^20\) analysis as a meta-analysis by Chen et al, showed statistical significance.\(^22\) The admission rate,\(^19\),\(^22\) and systemic corticosteroid need were both statistically different between the nebulized budesonide and placebo arms.\(^20\),\(^22\) The admission rate was significantly higher in placebo [11/69; 15.9%] than nebulized budesonide group [3/76; 3.9%; p 0.022]. Systemic corticosteroid need, an indicator of treatment failure, was also significantly higher in placebo group [32/88; 36.4%] than nebulized budesonide group [12/92; 13.0%; p < 0.001].
Assessment of exacerbation severity
Conduct a brief history, physical examination $\text{SpO}_2\pm$ Peak expiratory flow rate
Assessment A: Airway B: Breathing C: Circulation

If respiratory failure
Prepare intubation and admit PICU
While waiting give: SABA and $\text{O}_2$

Mild - Moderate (Non-severe)
- No retraction, speak in sentences
- $\text{SpO}_2 \geq 92\%$ (room air), Pulse rate 100-120/min or PEF rate > 50% predicted
Start treatment
- $\text{O}_2$, keep $\text{SpO}_2 > 95\%$
- SABA, repeat every 20 min, up to 3 doses for the first hour
- Consider Ipratropium bromide
- Systemic corticosteroid OR high dose ICS* ($0.5-1 \text{ mg budesonide} / 1 \text{ mg fluticasone}$), repeat every 20 min, up to 3 doses for the first hour

Re-assessment at 1 hour
Partly/uncontrolled

Severe / High risk
- Retraction, speak in words, restless
- $\text{SpO}_2 < 92\%$ (room air), Pulse rate > 120/min or PEF rate < 50% predicted
Start treatment
- $\text{O}_2$, keep $\text{SpO}_2 > 95\%$
- SABA and Ipratropium bromide repeat every 20 min, up to 3 doses for the first hour
- Systemic corticosteroid AND high dose ICS* ($0.5-1 \text{ mg budesonide} / 1 \text{ mg fluticasone}$), repeat every 20 min, up to 3 doses for the first hour
- Consider β2-agonist SC/IM if have poor air entry
- Consider Magnesium sulfate (aged ≥ 6 years old)

Admit/Transfer to high level care

Controlled
Good air entry, no retraction
$\text{SpO}_2 > 95\%$ (room air)
(peak expiratory flow > 60% predicted)

Acute treatment continuation
- Systemic corticosteroid 3-5 days OR home nebulised corticosteroid, twice daily for 3-5 days
- Maintenance treatment
- Controller and reliever medications, as clinically indicated

* ICS delivered via a nebulizer. In the absence of a nebulizer, ICS could be delivered via a pMDI with a spacer.
* Total daily dose for budesonide / fluticasone should not exceed 2 mg

Adapted from Thai Pediatric Asthma Guideline 2015-2016

Figure 1. Management of pediatric asthma exacerbation in hospital
### Table 1. Studies comparing nebulized corticosteroids with systemic corticosteroids in children with asthma exacerbation at hospital setting.

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<td>RCT, double blinded</td>
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<td>RCT, double blinded</td>
<td>RCT, double blinded</td>
<td>RCT</td>
<td>RCT</td>
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<tr>
<td>Numbers of patients</td>
<td>42</td>
<td>80</td>
<td>26</td>
<td>169</td>
<td>100</td>
<td>906</td>
<td>66</td>
<td>40</td>
</tr>
<tr>
<td>Setting</td>
<td>Moderate-severe</td>
<td>Moderate-severe</td>
<td>Moderate; PIS 3-6</td>
<td>Moderate to severe</td>
<td>PIS 7-13</td>
<td>Moderate to severe</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Site</td>
<td>ER</td>
<td>ER</td>
<td>ER</td>
<td>ER</td>
<td>ER</td>
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<td>ER</td>
<td>ER</td>
</tr>
<tr>
<td>Age</td>
<td>6 months-18 years (median 3.5-4.4 years)</td>
<td>2-12 years</td>
<td>5-15 years</td>
<td>2-18 years; mean 6.2-6.3 years</td>
<td>6 months-6 years</td>
<td>2-12 years</td>
<td>5-15 years</td>
<td>&lt; 5 years</td>
</tr>
<tr>
<td>Treatment</td>
<td>Oral prednisolone 1 mg/kg Nebulized salbutamol q 30 minutes x 3 doses, then q 1 hr x 4 hours 4 ml of nebulized budesonide</td>
<td>Oxygen Nebulized salbutamol Nebulized budesonide 800 microgram Oral prednisolone</td>
<td>3 doses of nebulized salbutamol Single dose of IM methylprednisolone 1 mg nebulized budesonide</td>
<td>Albuterol, ipratropium bromide, systemic corticosteroid 2 doses of albuterol with budesonide then one ipratropium bromide</td>
<td>3 doses of budesonide 1 mg/2 ml with salbutamol 0.15 mg/kg/dose (maximum 5 mg) at 0, 20, 40 min 1 dose of 1M methylprednisolone 1 mg/kg, ipratropium bromide, salbutamol at 80, 120, 180 minutes</td>
<td>3 doses of 500 microgram of budesonide Salbutamol Oral prednisolone 2 mg/kg</td>
<td>Oral prednisolone 1 mg/kg Nebulized salbutamol plus ipratropium bromide q 20 minutes x 3 doses than q 1 hour x 2 doses 2 mg of nebulized budesonide (4 ml) after first dose of bronchodilator</td>
<td>3 times of Procatenol 0.3 ml Budesonide suspension 0.5 mg/2 ml</td>
</tr>
<tr>
<td>Dose of nebulized corticosteroid</td>
<td>2 mg budesonide x 1</td>
<td>800 microgram budesonide (800 microgram x 1)</td>
<td>1 mg of budesonide</td>
<td>2 mg budesonide</td>
<td>3 mg budesonide (1 mg x 3)</td>
<td>2 mg budesonide</td>
<td>1.5 mg budesonide (0.5 mg x 3)</td>
<td>1.5 mg of budesonide initially (800 microgram x 3)</td>
</tr>
<tr>
<td>Control</td>
<td>Oral prednisolone 1 mg/kg Nebulized salbutamol q 30 minutes x 3 doses, then q 1 hr x 4 hours 4 ml of nebulized normal saline</td>
<td>Oxygen Nebulized salbutamol Nebulized placebo Oral prednisolone</td>
<td>3 doses of nebulized salbutamol Single dose of IM methylprednisolone 1 mg nebulized normal saline</td>
<td>Albuterol, ipratropium bromide, systemic corticosteroid 2 doses of albuterol with normal saline then one ipratropium bromide</td>
<td>Normal saline 2 ml, salbutamol 3 doses at same interval 1 dose of 1M methylprednisolone 1 mg/kg, ipratropium bromide, salbutamol at 80, 120, 180 minutes</td>
<td>3 doses of normal saline Salbutamol Oral prednisolone 2 mg/kg</td>
<td>Oral prednisolone 1 mg/kg Nebulized salbutamol plus ipratropium bromide q 20 minutes x 3 doses than q 1 hour x 2 doses 4 ml of normal saline after first dose of bronchodilator</td>
<td>3 times of Procatenol 0.3 ml Cromoglycate 2 ml iv methylprednisolone 1 mg/kg/d</td>
</tr>
</tbody>
</table>

Note. RCT: randomized controlled trial, ER: emergency room, PIS: pulmonary index score, outcomes showed numbers in treatment group vs control group respectively.
Nebulization Regimen

- Nebulized corticosteroid should be administered within the first hour of presentation to the hospital and could be administered concurrently in a mixture with or sequentially after a nebulized dose of short-acting bronchodilator.
- Each dose of nebulized solution of corticosteroid and short-acting bronchodilator, delivered in a mixture or separately, could be repeated every 20 minutes, up to three doses for the first hour.
- As part of an acute treatment, two nebulized doses are recommended within the first hour, any subsequent dose is determined by clinical outcome.
- The recommended nebulization dose for corticosteroid is 0.5-1 mg for budesonide and 1 mg for fluticasone per dose with a total daily dose of 2 mg in acute exacerbation of asthma in children.
- The volume of nebulized agents should be between 2.5 and 4 ml and can be nebulized within 15 minutes.

A meta-analysis found that using inhaled corticosteroid within one hour reduced hospitalizations by 56% even without systemic corticosteroid treatment. Most published studies use nebulized corticosteroid in 3 doses regimen, with a total dose of 2-3 mg of budesonide. These safety findings are also found in several studies. In addition, nebulized corticosteroids have faster action than systemic corticosteroids [1-2 hours versus 4 hours]. They improve pulmonary score faster than systemic corticosteroids. They also have more local effects on airways to reduce airway swelling and airway spasms. Both effects are from local pharmacology of nebulized corticosteroids including reduction of sputum eosinophils and reduction of adenosine 5'-monophosphate from topical nongenomic vasoconstriction.

For economic concern, the absolute cost of high-dose nebulized corticosteroid is higher than oral prednisolone in acute asthma exacerbation, the total cost –
Table 2. Studies comparing nebulized corticosteroids with placebo in children with asthma exacerbation at hospital setting.

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<tr>
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<tr>
<td>Design</td>
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<td>RCT, double blinded</td>
<td>RCT, double blinded</td>
<td>RCT, double blinded</td>
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<tr>
<td>Numbers of patients</td>
<td>49</td>
<td>67</td>
<td>150</td>
<td>118</td>
</tr>
<tr>
<td>Setting</td>
<td>Moderate</td>
<td>Mild to moderate</td>
<td>Moderate</td>
<td>Moderate to severe</td>
</tr>
<tr>
<td>Site</td>
<td>Clinic</td>
<td>ER</td>
<td>Mean 9.8-10 years</td>
<td>Mean 7.9-8.2 years</td>
</tr>
<tr>
<td>Age</td>
<td>2-7 years</td>
<td>6-15 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>3 ml of salbutamol</td>
<td>3 doses of nebulized</td>
<td>3 doses of salbutamol 30</td>
<td>4 ml of mixture of</td>
</tr>
<tr>
<td></td>
<td>4 ml of budesonide (2 mg)</td>
<td>budesonide (1 mg/dose) at ER</td>
<td>microgram/kg plus fluticasone</td>
<td>salbutamol 1 mg/kg</td>
</tr>
<tr>
<td>Dose of nebulized corticosteroid</td>
<td>2 mg budesonide</td>
<td>3mg at ER, total of 11mg of budesonide</td>
<td>1.5 mg of fluticasone</td>
<td>3 mg of budesonide</td>
</tr>
<tr>
<td>Control</td>
<td>3 ml of salbutamol</td>
<td>Same regimen but use normal saline</td>
<td>3 doses of salbutamol 30 microgram/kg q 15 minutes</td>
<td>4 ml of mixture of salbutamol, ipratropium and 0.05% budesonide 2 ml q 20 minutes x 3 doses</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Admission 0/17 vs 1/15 (p 0.469)</td>
<td>Systemic corticosteroid need</td>
<td>Treatment group had better clinical score at 2 hours (p &lt; 0.05)</td>
<td>Admission 3/59 vs 10/54 (p 0.037)</td>
</tr>
<tr>
<td>Clinical score at 1-2 hours 6.2 (2.2) vs 5.64 (2.4)</td>
<td>Systemic corticosteroid need</td>
<td>Complete resolution at 2 hours 10/59 vs 25/54 (p 0.011)</td>
<td></td>
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</tbody>
</table>

Note. RCT: randomized controlled trial, * another group received inhaled placebo with oral prednisolone 1 mg/kg, ** another group received 3 doses of salbutamol plus 2 doses of fluticasone 500 microgram/dose, outcomes showed numbers in treatment group vs control group respectively.

Table 3. Pharmacological properties of budesonide and fluticasone

<table>
<thead>
<tr>
<th>ICS</th>
<th>Budesonide</th>
<th>Fluticasone</th>
</tr>
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<tbody>
<tr>
<td>Mean Absorption Time</td>
<td>1 hour</td>
<td>7 hours</td>
</tr>
<tr>
<td>Tmax</td>
<td>15.5 mins</td>
<td>50.8 mins</td>
</tr>
<tr>
<td>Half life</td>
<td>2.8 hours and low systemic potency</td>
<td>14.4 hours and high systemic potency</td>
</tr>
<tr>
<td>Water solubility (µg/ml)</td>
<td>16</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Dissolution time</td>
<td>6 mins</td>
<td>&gt; 8 hours</td>
</tr>
<tr>
<td>Residence time in airway/lung tissue</td>
<td>Similar or longer</td>
<td>Shorter</td>
</tr>
<tr>
<td>Volume distribution</td>
<td>Low (183 L)</td>
<td>High (318 L)</td>
</tr>
<tr>
<td>Pneumonia risk</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Note. ICS: Inhale Corticosteroid

including savings from shortened the hospital stay – of nebulized corticosteroid may be lower than oral prednisolone. The study showed that hospital length of stay was shorter by 36 hours and the cost of treatment with budesonide was lower by 130 USD compared with placebo.14

Post-Nebulization Monitoring
- The clinical status of the patient should be evaluated at the end of each nebulized corticosteroid dose to determine whether any subsequent doses are needed.
- If three nebulized doses are required, the need for more intensive treatment and monitoring in the hospital is recommended.
- If the clinical status of the patient is improved at the end of the first hour of initiating nebulization, the patient should continue home nebulized corticosteroid for 3-5 days18 if available or start systemic corticosteroid at home for 3-5 days.
- If the clinical status of the patient is not improved at the end of the first hour of initiating nebulization, the patient should be hospitalized, and be initiated or maintained on systemic corticosteroid as part of the inpatient treatment.

For those with clinical responses with nebulized corticosteroid, defined by improvement of clinical score such as asthma index or pulmonary index score, short-term corticosteroids
are needed. If available, home nebulized budesonide is justified with a dose of 1 mg twice a day for 3-5 days. An alternative treatment is oral prednisolone 0.5-1 mg/kg/day for 3-5 days. Note that those with clinical responses may have a risk of ER revisit and hospitalization rate of 4.18% [16/383] and 0.78% [3/383], respectively. Choice of Corticosteroid

- Nebulized budesonide is the preferred corticosteroid.
- Nebulized fluticasone is an alternative if budesonide is not available.

First, pharmacological properties of budesonide are better than fluticasone [Table 4]. Budesonide has faster absorption time [1 hr vs 7 hr], more water solubility [16 vs 0.1 microgram/ml], and longer deposit in airways or lung tissues than fluticasone. Second, budesonide has lower pneumonia risk which is relatively constant across all doses, while fluticasone increases risks of pneumonia as a dose-dependent fashion. Finally, budesonide has lower systemic side effects than fluticasone. These findings may indicate that nebulized budesonide has faster clinical improvement and fewer side effects than nebulized fluticasone.

Home Nebulization

- Home nebulization may be considered only for a short period as a continuation of the acute treatment in a healthcare facility after demonstrable improvement in the clinical status of the patient who first presented with acute asthmatic exacerbation.
- Home nebulized corticosteroid should be administered twice a day as maintenance for 3-5 days after clinical improvement following acute treatment of acute asthmatic exacerbation.
- The use and care of a nebulizer should be based on the recommendations from the American Association for Respiratory Care.

There is no randomized controlled trial comparing nebulized corticosteroids and inhaled corticosteroids to treat home asthma exacerbations in children. Currently, there are some evidence of inhaled corticosteroids at home for treat and prevent asthma exacerbations as follows:

A meta-analysis study compared an increasing and stable dose of inhaled corticosteroids to treat asthma exacerbations at home in patients with mild to moderate asthma. The study included three studies with 422 children and five studies with 1,247 adults. The primary outcome of this study was treatment failure identified by a need of rescue systemic corticosteroids. A sub-group analysis in children showed that increasing dose of inhaled corticosteroids at home was not better than stable dose of inhaled corticosteroids [odds ratio of 0.93; 95% confidence interval of 0.61, 1.41] for the primary outcome.

Another study in children compared a quintupled dose of fluticasone [220 microgram/inhalation; twice a day] for seven days versus low-dose fluticasone [44 microgram/inhalation; twice a day]. This study was a randomized, double-blind study conducted in 17 sites in the US with 254 mild to moderate children with history of one exacerbation in the past years. The average age of all patients was 8.0 [SD 1.9] years. The study found that severe asthma exacerbations/year were comparable between both groups [0.48 vs 0.37 in quintupled dose and low-dose; p value 0.30]. Other outcomes were also not statistically different between both groups such as the time to the first exacerbation or the rate of treatment failure. A study conducted in Turkey using a 4-, 8-, and 8-day of inhaled corticosteroid plus azithromycin at home to treat asthma exacerbation also found good response rate at 84%, 83%, and 94% of the three regimens. The inhaled corticosteroids in this study were budesonide and fluticasone.

The role of inhaled corticosteroid at home in children with mild to moderate asthma to treat asthma exacerbations are still controversial. The home regimen, types, or duration of inhaled corticosteroid use are still limited. For nebulized corticosteroid, there is no clinical data to show efficacy on treatment and prevention of asthma exacerbation at home. One study from Turkey evaluated nebulized budesonide versus placebo at home after the ER visit. The 1 mg of budesonide or placebo was given twice a day for four days. The FEV1 improvement in both groups for both short term [at ER] and long term [day sixth] were not statistical different. The home nebulized budesonide group had a trend of fewer patients who required systemic corticosteroid than placebo group [2/33 vs 7/34; p value 0.073]. No major side effects of nebulized budesonide were reported in a 72-hour study. Two out of 17 patients [11.76%] had coughing, while one out of 15 patients [6.67%] in placebo group did. Nebulized corticosteroid treatment at home needs more attention on care, use, and side effects.

Conclusions

Nebulized corticosteroid may offer an effective therapeutic option for the management of acute exacerbation of asthma in all severities. It may be used within the first hour of presentation of acute treatment. Nebulized budesonide is the preferred corticosteroid. Home nebulization if available may be used for a short period as a continuation of the acute treatment in a healthcare facility only after demonstrable improvement in the clinical status of the patient who first presented with acute asthmatic exacerbation.

Acknowledgement

The development of this manuscript was supported by an unrestricted educational grant from AstraZeneca (Thailand) Ltd. All authors have read and approved the final manuscript and take full responsibility for the accuracy of its content.

References