ABSTRACT

Asthma action plan (AAP) is an essential component of asthma education and self-management. AAPs provide patients with instructions on how to recognize loss of asthma control and the appropriate treatment steps. The use of AAP improves asthma-related quality of life and reduces the risk of asthma exacerbation. Despite its benefits, utilization of AAP is disappointingly low both locally and worldwide. This review highlights the importance of AAP as part of an asthma care plan and provides practical information on the prescription of AAPs. We conclude by identifying possible barriers to AAP implementation and how these may be overcome.

Keywords: AAP; Peak Expiratory Flow; Yellow Zone; Inhaled Corticosteroids; SMART;
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INTRODUCTION

Asthma is a common chronic condition in Singapore, seen in both primary and tertiary care. It contributes to 0.9% of the total disease burden locally and results in an estimated 4,400 disability-adjusted life-years lost. We observed a higher than expected incidence of fatal asthma at 2 per million population between 2006 to 2010, which was postulated to be due to high-risk health seeking behaviours and insufficient patient education amongst asthma patients. In addition to asthma education and care provisions by healthcare providers, asthma self-management by patients is an important part of an effective overall asthma care plan.

The 4 core components of asthma self-management include:
1) Skills training for effective inhaler use;
2) Adherence to clinician management strategy;
3) Asthma information;
4) Self-monitoring of asthma symptoms or peak flow, with written asthma action plan (AAP) to recognize and respond to worsening asthma.

This narrative review will be focusing on the “what”, “why” and “how” of using an asthma action plan in adult patients with asthma.

What is an asthma action plan?

The written AAP is a clinician-prescribed plan which varies asthma therapy according to symptom severity and/or peak flow rate (Figure 1). It consists of 3 coloured zones:

1) The green zone indicates asthma therapy for baseline medications when asthma control is good;
2) The yellow zone provides clinician-directed instructions for intensified therapy during acute loss of control;
3) The red zone describes severe symptoms that require prompt medical attention.

This figurative plan guides patients on individualised escalation of therapy during worsening of asthma symptoms with the aim of preventing severe exacerbations, use of systemic corticosteroids, and the need for urgent healthcare attention.

International guidelines including the Global Initiative for Asthma (GINA) guideline 2018 recommend that all patients with asthma should be provided with an AAP. The local asthma clinical practice guideline published in 2008 by the Ministry of Health, Singapore, also recommends provision of AAP to all patients with asthma. It further recommends that healthcare providers use provision of AAP as a clinical quality indicator or care in asthma care. A freely available template for personalised AAP is provided in Annex A of the clinical practice guidelines which deviates from most AAP templates with the addition of an orange zone between the yellow and red zone that provides guidance on initiation of oral prednisolone.

Why use an AAP? - Evidence for Efficacy

A Cochrane review comprising 36 randomised controlled trials involving 6090 participants compared the effectiveness of adult self-management education programmes versus usual care on health outcomes. In the trials reviewed, 33 studies examined self-monitoring of symptoms and/or peak expiratory flow, 24 trials included regular physician review, and 18 trials provided a written AAP as part of self-management. Active interventions with asthma self-management strategies halved the risks of hospitalisations (risk ratio 0.58 [95% confidence interval 0.43-0.77]), reduced emergency room visits, unscheduled doctor visits, days off work or school, nocturnal asthma symptoms and quality of life. The authors concluded that asthma self-management strategies incorporating an AAP have the potential to improve patient’s quality of life and reduce total asthma burden of care.

There is also some evidence that AAP may protect against fatal asthma exacerbations. In a retrospective case-control study of asthma mortalities in Australia, patients provided with a written AAP had a lower risk of asthma death (odds ratio 0.29 [95% confidence interval 0.09-0.93]) 5. To further illustrate this...
A systematic review by Gatheral et al evaluated the effectiveness of personalised AAPs when used alone or in combination with education 7. The authors were unable to draw firm conclusions due to variable study methods and outcomes measured, but they did not find clear evidence of benefit when personalised AAP was used alone. This suggests that the use of AAP may only be beneficial when coupled with other components of asthma self-education.

How to personalise an AAP

The Green Zone

The aim of the green zone is to remind patients of their daily preventer therapies and their personal best peak expiratory flow. Guidance on the use of asthma preventer therapies may be found in the GINA 2018 document 3.

A comprehensive list of asthma symptoms to prompt the use of reliever therapies should also be provided. These should include the occurrence of wheezing, chest tightness, breathlessness or persistent cough. The choice of reliever therapies is inhaled salbutamol or budesonide/formoterol inhaler, should the patient be on single maintenance and reliever therapy (SMART) using budesonide/formoterol inhaler.

The Yellow Zone

The yellow zone describes symptoms of, and actions to take during, loss of asthma control. In addition to symptoms described in the green zone, the yellow zone should include the presence of nocturnal symptoms and symptom interference of daily activities. If peak expiratory flow monitoring is used, a decrease in 20% of best peak expiratory flow should alert the patient or caregiver to a loss of asthma control.

Written action plans based on symptom self-monitoring alone perform as well as those incorporating peak expiratory flow self-monitoring 4. The exception to this may be patients with poor symptom and bronchoconstriction perception in whom peak expiratory flow monitoring is preferred 5. Peak expiratory flow limits for early detection of asthma exacerbations have been suggested 10. In one study, a combination of increased symptoms with peak expiratory flow of less than 80% of personal best predicted exacerbations within the next five days with a sensitivity of 100% and specificity of 87%; a decrease in peak flow to 60% of personal best predicted an exacerbation the next day with a sensitivity of 78% and specificity of 99%. It is therefore reasonable to commence systemic corticosteroid therapy when peak expiratory flow is less than 60% of personal best in the AAP.

Various treatment escalation measures have been proposed for loss of asthma control in the yellow zone of the AAP. The GINA 2018 guideline recommends at least doubling the maintenance dose of inhaled corticosteroids (ICS) for a period of 7 to 14 days in the yellow zone. However, studies that investigated the effects of doubling the dose of inhaled corticosteroids did not show a reduction in need for oral corticosteroids and unscheduled physician visits 11,12. Quadrupling the dose of ICS or increasing it to an equivalent of beclomethasone dipropionate 2000mcg per day may be a more effective strategy to decrease the risk of progression to an exacerbation 13.

Quadrupling ICS therapy, while attractive, presents difficulty for patients who are already on a high dose of maintenance ICS. There is limited evidence that quadrupling ICS beyond a dose equivalence of 2000mcg of beclomethasone dipropionate is efficacious in AAPs. In these patients, initiation of a short-course of oral prednisolone may be appropriate in place of quadrupling ICS therapy.

For patients who are on combination inhalers containing both ICS and long-acting beta-agonists (LABA), the intensification of therapy in the yellow zone depends on the ICS/LABA formulation. For patients on ICS/formoterol the number of inhalations can be increased to a maximum dose of formoterol at 72 mcg per day. However, the maximum permissible doses of other forms of LABA in non-ICS/formoterol preparations are less clear, with a theoretical increased risk of cardiac events when exceeded. An alternative to circumvent this problem (other than temporarily exceeding regulatory limits or commencing oral corticosteroids), would be the provision of an additional ICS-only inhaler in addition to the maintenance non-ICS/formoterol inhaler, for use only when action points in the yellow zone are activated. Practical considerations are the cost of an additional inhaler that would be used infrequently and drug expiration before complete utilisation.

Provision of standby prednisolone is recommended for patients who are on maintenance high-dose ICS, previous near-fatal asthma exacerbations, peak expiratory flow less than 60% of personal best, or no improvement after 2 to 3 days of increased ICS therapy. The dose recommendation is oral prednisolone at 1mg per kg per day, for a duration of 5 days. A reminder for the patient to visit the doctor for early review of asthma control and medications should conclude the instructions in the yellow zone.

Reliever inhaler therapy use is similar to that in the green zone. Salbutamol may be used up to a maximum of 800mcg per day and budesonide/formoterol inhaler may be used up to a maximum of 72 mcg of formoterol per day.

The Red Zone

The red zone educates patients on the recognition of an asthma exacerbation. The symptoms described in the red zone should include use of reliever therapy more frequent than every 4 hours, difficulty in walking or talking, increase in breathlessness, wheezing or chest tightness. Salbutamol inhaler should be administered twice every 5 minutes up to a maximum of 10 inhalations, ideally via a space device, while seeking immediate medical attention. Patients should be advised to start...
rescue oral prednisolone if they have been prescribed.

**Special considerations for AAP implementation**

The most common form of AAP is the individualised written plan provided by the healthcare professional during a clinic consultation for asthma care. However, one study found that 70% of AAPs required at least a 6th grade education for comprehension. The ideal written AAP should therefore be optimised for readability and adapted to the patient or caregiver’s primary language of choice and level of literacy. A group of researchers in Toronto attempted to improve usability of AAPs by involving physicians, asthma educators and patients on an online collaboration to create a usable asthma action plan with visual design optimisation. Participants in the study were able to compile elements of an ideal AAP to developed one with optimised visual design features. Similar models of AAP development may be considered in specific populations to improve adherence.

Patients with poor literacy have worse asthma outcomes due to low socioeconomic status as well as poor access to healthcare. Health information delivery to this group of patients should be easily understood, such as in the form of a pictorial asthma action plan. Implementing AAP using the telephone is also an acceptable strategy to patients and has the potential to improve asthma control.

The elderly represents another vulnerable asthma population due to poor symptom perception, cognitive and memory impairment. Sensory disturbances due to visual and hearing loss may hamper asthma education and explanation on use of AAP. A randomised controlled study showed that telephone administration of asthma-specific questionnaire and encouraging the elderly to discuss asthma care at the next clinic consultation increased use of peak flow meters and AAPs.

On the other end of the spectrum, smartphone app-based asthma self-management platforms have the potential to replace written AAP in technologically-savvy populations. App-based asthma management are not easily misplaced or discarded, the user can be prompted to monitor peak expiratory flow rate and notifications may be sent to the healthcare provider if yellow or red zones action points are activated. A 2013 Cochrane review of smartphone and tablet self-management apps for asthma included 2 randomised controlled trials with 408 participants. One study showed no effect on asthma-related outcomes while the other study demonstrated higher asthma-related quality of life, improved peak expiratory flow rate and reduced emergency room visits (OR 0.20, 95% CI 0.04-0.99). Patient groups that require close monitoring or are at higher risk of non-compliance may benefit from this strategy. Adolescents who used smartphone AAPs had significant improvement in asthma control test scores and improvement in asthma attack prevention self-efficacy scores. Two antenatal clinics in Australia using telehealth for asthma found that participants who had telehealth intervention had better asthma control and asthma-related quality of life. These examples suggest that while the written AAP is most familiar to physicians, smartphone app-based asthma management is feasible and likely to be non-inferior.

**Barriers to AAP implementation and suggestions to overcome them**

The self-management model of care for asthma is an attractive one as asthma is a chronic disease with variable periods of worsening symptoms and is rapidly responsive to escalation of therapy. Despite that, only about a quarter of patients with asthma in the developed world have a personalised AAP. Local data suggests that implementation rates are similar. Chai et al conducted a cross-sectional survey of patients with asthma seeking care at a tertiary centre in 2004; only 17.0% reported receiving a written asthma action plan.

Some of the barriers to delivery of AAPs cited are a lack of clinician consultation time and paucity of physician experience in creating personalised AAPs. A qualitative study of factors that influence local primary care physicians’ prescription of written AAPs found that physician’s training and familiarity with AAP, perceived effectiveness, language barriers and availability of a nurse to administer AAP influenced their prescription of AAPs.

Interventions that have been suggested to increase AAP use include:

1) Structured asthma education and interval telephone reinforcements for patients;
2) Internet-based asthma management tool for patients and physicians with decision support systems;
3) Education seminars for physicians aimed at encouraging prescription of AAPs;
4) Pre-discharge asthma education by specialist nurse during hospitalisations.

Other novel approaches that have been described are a pharmacy-based asthma service that improved AAP ownership from 19% to 56%; integration of AAPs into electronic health records of healthcare systems with provision of evidence-based guidelines, which has allowed accurate tracking of implementation and outcome indices.

**Future Challenges**

A more widespread adoption of AAP requires an increase in provider implementation and patient utilisation. To improve provider implementation, there is a need to introduce education programmes that allow clinicians to confidently prescribe AAPs. Thereafter, scheduled healthcare systems reviews of implementation rates, as part of quality improvement initiatives for asthma care should also be in place.

To facilitate patient utilisation, formatting of AAPs should take into consideration the patient’s preferred language, literacy level and mode of delivery. Utilisation of AAP can be encouraged with electronic notifications, phone reminders and physician
reinforcement at clinic reviews. Challenges to AAP use are unique to individual healthcare systems and communities, these require targeted strategies for AAPs to be successfully integrated in asthma care.

REFERENCES
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LEARNING POINTS

- Personalised asthma action plan is an essential and effective component of asthma self-management, in preventing exacerbations.
- Inhaled corticosteroid dose should be quadruple (or at least double) of the maintenance dose, in the yellow zone, during acute worsening of symptoms.
- Personalising the format and delivery of the asthma action plan would improve patient utilisation.

Table 1: Adjusting Preventer Inhaler Therapy for AAP Yellow Zone

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<td>ICS/LABA combination inhaler (non-formoterol preparations)</td>
<td>Increase to higher dose formulation of ICS/LABA, for 7-14 days or Add separate ICS inhaler to a maximum BDP 2000mcg per day, for 7-14 days.</td>
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<td>ICS/Formoterol combination inhaler (SMART)</td>
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For all patients who do not respond to first-line therapy over 2 to 3 days, on high dose maintenance ICS, or if peak expiratory flow is less than 60% of personal best, to commence oral prednisolone at 1mg/kg/day for 5 days.


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**ASTHMA ACTION PLAN FOR ADULTS**


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