The Effects of Regular Peak Flow Meter Utilisation on Asthma Self-Management

By: Julia Knobloch

Submitted for the degree of Bachelor of Pharmacy (Honours)

11th November 2013

Pharmacy Discipline

School of Psychological and Clinical Sciences

Charles Darwin University
The Effects of Regular PFM Utilisation on Asthma Self-Management

**Author:** *Julia Knobloch*

Student s198154  
Charles Darwin University  
1/15 Athanasiou Road  
Coconut Gove, NT 0810  
E: s198154@students.cdu.edu.au  
M: 0404 282 705

**Primary Supervisor:** *Dr. Kwang Choon Yee (PhD, BPharm (Hons))*

Pharmacy Lecturer  
School of Psychological and Clinical Sciences  
Charles Darwin University

**Secondary Supervisor:** *Mary-Jessimine Bushell (BPharm (Hons))*

Pharmacy Lecturer  
School of Psychological and Clinical Sciences  
Charles Darwin University
Statement of Authorship

I, Julia Knobloch, hereby declare that the work herein, now submitted as a thesis for the degree of Bachelor of Pharmacy with Honours of the Charles Darwin University is the result of my own investigations, and all references to ideas and work of other researchers have been specifically acknowledged. I hereby certify that the work embodied in this thesis has not already been accepted in substance for any degree, and is not being currently submitted in candidature for any other degree.

An abstract of this study has been accepted for publication at Australasian Pharmaceutical Science Association (APSA) conference 2013, Dunedin, NZ.

________________________________________

Julia Knobloch
Acknowledgements

First of all, I would like to express my sincere gratitude to my supervisors, Dr. Kwang Choon Yee and Mrs. Mary-Jessimine Bushell, for their guidance throughout the development for this thesis, as well as for their continuous support, advice, encouragement and endless hours spent to accomplish this research and to achieve more than I would have thought.

Additionally, I would like to thank Prof. Patrick Ball for his support as a unit co-ordinator and contact person during this time. I would also like to thank Ms. Elizabeth Lycett for organising and helping me with the financial aspects of this research. My sincere thank also goes to Bernadette Royal, who supported me with technical matters, particularly in regards to the referencing program.

I would like to extent my appreciation to the School of Pharmacy, Charles Darwin University, for offering and supporting me in this honours research project, as well as providing me with essential technical appliances.

I would like to express my sincerest thank to all participants of this study, who helped me realising my research. I hope every person gained a better understanding of his or her condition and enjoyed to have been part of this project.

Great appreciation goes to the staff from the Asthma Foundation NT for their remarkable support. I would like to thank them for their cooperation and all their active support in advertising and promoting this project, as well as for supplying educational information for this study and giving me the opportunity to purchase the peak flow meters at a member price.

I would like to thank all participating organisations for agreeing to take part in and supporting this study, as without them it would not have been possible. I would like to thank Leigh Moore and the Pharmaceutical Society of Australia for their friendly cooperation and supply of Self-Care Cards to aid in the provision of educational information in this study. I also would like to thank the Australian Red Cross and pharmacies for enabling advertisement for this project, which include Amcal in
Northlakes; Amcal Max in Casuarina and Nightcliff; Barden’s Amcal Pharmacy at the CBD Plaza; Chemist Warehouse in Casuarina, Darwin and Ludmilla; Chemist King in Palmerston; Better Health Pharmacy in the Mitchell Centre and Hibiscus Shopping Centre; Harrison’s Pharmacies in the Casuarina Shopping Centre; Northpharm Pharmacy; Stuart Park Pharmacy; United Discount Pharmacy in Palmerston; and Value Plus Discount Pharmacies in Casuarina and Palmerston. I greatly appreciate it.

Finally, I would like to express my appreciation and thank to Daniel Huey, who carefully reviewed my work, politely suggested ideas for improvement, and assisted me with my vocabulary. Additionally, I would like to thank him for supporting me throughout the thesis development and being there for me as a boyfriend and friend.
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## Acronyms

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<th>Description</th>
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<tbody>
<tr>
<td>AAP</td>
<td>Asthma Action Plan</td>
</tr>
<tr>
<td>BSL</td>
<td>Blood Sugar Level</td>
</tr>
<tr>
<td>CDU</td>
<td>Charles Darwin University</td>
</tr>
<tr>
<td>COPD</td>
<td>Chronic Obstructive Pulmonary Disease</td>
</tr>
<tr>
<td>DMed</td>
<td>Daily Medications</td>
</tr>
<tr>
<td>FEV₁</td>
<td>Forced Expiratory Volume in 1 second</td>
</tr>
<tr>
<td>FVC</td>
<td>Forced vital capacity</td>
</tr>
<tr>
<td>GP</td>
<td>General Practitioner</td>
</tr>
<tr>
<td>ICS</td>
<td>Inhaled Corticosteroid</td>
</tr>
<tr>
<td>ISMWUT</td>
<td>Independent-Samples Mann-Whitney U Test</td>
</tr>
<tr>
<td>LABA</td>
<td>Long-Acting β₂-Agonist</td>
</tr>
<tr>
<td>LTRA</td>
<td>Leukotriene Receptor Antagonist</td>
</tr>
<tr>
<td>MDI</td>
<td>Metered-Dose Inhaler</td>
</tr>
<tr>
<td>NT</td>
<td>Northern Territory</td>
</tr>
<tr>
<td>p</td>
<td>p-value</td>
</tr>
<tr>
<td>PEF</td>
<td>Peak Expiratory Flow</td>
</tr>
<tr>
<td>PEFR</td>
<td>Peak Expiratory Flow Rate</td>
</tr>
<tr>
<td>PFM</td>
<td>Peak Flow Meter</td>
</tr>
<tr>
<td>PFT</td>
<td>Pulmonary Function Test</td>
</tr>
<tr>
<td>PSA</td>
<td>Pharmaceutical Society of Australia</td>
</tr>
<tr>
<td>QOL</td>
<td>Quality Of Life</td>
</tr>
<tr>
<td>SABA</td>
<td>Short-Acting β₂-Agonist</td>
</tr>
<tr>
<td>SD</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Th</td>
<td>T-Helper Cells</td>
</tr>
<tr>
<td>Treg</td>
<td>T-regulatory cells</td>
</tr>
<tr>
<td>VQ</td>
<td>Validated Questionnaires</td>
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Abstract

Introduction:

Asthma is a common chronic disease in Australia with suboptimal self-care. The peak flow meter (PFM) is a simple device available at pharmacies that measures a specific part of lung function, but is largely underutilised by people with asthma. When used properly, the peak expiratory flow (PEF) can provide useful information to people with asthma for their disease management.

Objectives:

The project aims to identify if the introduction of a PFM with appropriate education can improve engagement in asthma self-management in a sample of the Darwin population.

Method:

The study was designed as a crossover before-and-after randomised controlled intervention pilot study, conducted in four separate steps. Participants were adults previously diagnosed with asthma who did not use a PFM as part of their asthma management. Participants in the intervention group were provided with a PFM and asthma education, whereas the control group only received asthma education. The study then evaluated participants’ awareness and asthma control using validated questionnaires and formative feedback.

Results:

Twelve subjects (5=intervention and 7=control) completed the study. The effect of PFM utilisation on asthma knowledge and asthma control determined by validated questionnaires was not statistically significant either between the groups ($p=1.000$ and $p=0.103$, respectively) or the crossover ($p=0.226$ and $p=0.889$, respectively). However, the majority of subject’s feedback was positive, indicated by an increased awareness and better quantification of asthma control by all subjects.
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Conclusion:

The study did not find great improvement in asthma control as a result of PFM utilisation. However, the findings are limited by a small sample size and limitations associated with the questionnaires. In addition, the long-term benefit of asthma control is not assessed and follow-up assessments are recommended for future studies. The findings suggest that participants are more aware of their asthma control after this pharmacist-based intervention. Integration of PFM education and monitoring into pharmacy practice may expand current pharmacist services in a multidisciplinary approach to optimise asthma control, and potentially improve asthma self-management.
1 Introduction

1.1 Asthma – A Chronic Condition

Asthma is a chronic inflammatory disease of the airways with complex and not fully understood pathogenesis.\textsuperscript{1-3} People with asthma can exhibit a wide range of symptoms, from mild to severe disabling symptoms.\textsuperscript{1,2,4,5} The characteristic symptoms of asthma include repeated and variable symptoms such as cough, wheezing, breathlessness, increased mucous secretion, and bronchoconstriction.\textsuperscript{1-6} People with asthma can experience acute asthma exacerbations if exposed to triggering factors, regardless of the severity of the baseline disease status.\textsuperscript{1,7} Several definitions exist to describe an asthma exacerbation, including loss of asthma control, need for systemic corticosteroids,\textsuperscript{8} decrease in expiratory capacity and peak flows,\textsuperscript{5,8} or hospitalisations.\textsuperscript{8}

According to the data from the World Health Organisation, there were just under 250 million people (3.45%) worldwide who had asthma in 2011,\textsuperscript{9,10} although Australia appears to have a much higher prevalence than most other countries\textsuperscript{11,12} and a higher prevalence in children than in adults.\textsuperscript{9} In 2011-12, approximately 10.2% (2.3 million) of Australians had asthma\textsuperscript{13}, this number appears to have slightly decreased in children and remains stable in adults.\textsuperscript{11,12} There are currently no consistent statistics about the prevalence of asthma in the Northern Territory (NT), as previous national surveys failed to provide reliable estimates, either due to too small sample size,\textsuperscript{14} incomplete sampling (urban population only),\textsuperscript{15} or omission of the NT from the report.\textsuperscript{16} The latest data (1995) indicates the prevalence of asthma in the NT being similar or slightly above the national average.\textsuperscript{15} Furthermore, Indigenous Australians are found to have the highest prevalence of asthma compared to any other Australian population.\textsuperscript{11,12} Asthma-related mortality appears to decrease compared to previous decades with the latest (2011) figures indicating 378 deaths, particularly of elderly people.\textsuperscript{12}

Currently there is no cure for asthma,\textsuperscript{6,17} but long-term management of asthma and its complications has significantly improved due to advanced treatment options and implementation of evidence based consensus management guidelines since the
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1990s. These guidelines underline asthma self-management as a vital factor in the achievement of effective asthma control, including home monitoring utilising a peak flow meter (PFM). A relatively small proportion of asthma patients are involved in self-management, which reflects on the large proportion of patients with suboptimal asthma control and underlines the need for patients to be more engaged in self-management.

1.2 Pathophysiology and Aetiology

Asthma symptoms such as inflammation, hypersensitive response and airway obstruction are associated with an immune system dysregulation. Environmental exposures and genetic features are found to contribute to the development of asthma, where differences in immunoglobulin (Ig), T-cells and cytokines responses create different phenotypes.

Studies investigating asthma inheritance identified a large number of genes that are linked to asthma aetiology with variable results, where gene-environment interactions (e.g. ADAM33 polymorphism, air pollution, smoking habits, and viruses) seem to play a critical role. This is suggested to be the responsible factor that has increased the prevalence of asthma.

The pathophysiology of asthma is often described in two different components: cellular and physiological pathophysiology.

1.2.1 Cellular pathophysiology

T-lymphocyte cells – including CD4+ and CD8+ – are responsible for recognising foreign elements and produce cytokines as part of their immune response.

Subgroups of CD4+ T-lymphocytes (T-Helper cells: Th1 and Th2) are found to produce different types of cytokines. Excess Th1 cytokines are found to cause uncontrolled tissue damage, while Th2 cytokines stimulate IgE and eosinophilic responses promoting asthma, and counteract Th1 responses. Asthma is found to be associated with dysregulation between these two types of cytokines, often known as Th1/Th2 paradigm. In addition, new studies have identified that T-
regulatory cells (Treg) play a vital role in controlling the Th1/Th2 response, whereby increased amounts of Treg cells are observed in people with asthma.\textsuperscript{32,35}

Allergens activate antigen-presenting cells triggering the CD4+ response.\textsuperscript{1,3} This causes B-cells to produce antigen-specific IgE and proinflammatory cytokines and chemokines,\textsuperscript{1,3,35} which further activate eosinophils, neutrophils and alveolar macrophages.\textsuperscript{1,35} Association of IgE to mast cells and basophils triggers the release of inflammatory mediators\textsuperscript{1,3,5,28} including histamine, prostaglandins, leukotrienes, tryptase,\textsuperscript{1} and TNF-α,\textsuperscript{2} causing bronchoconstriction.\textsuperscript{1,5} Whereas release of histamine, leukotrienes and bradykinin\textsuperscript{1} intensify microvascular permeability that causes oedema.\textsuperscript{1,3} Subsequent degranulation of mast cells and basophils promote ongoing CD4+ response, contributing to reversible bronchoconstriction and inflammation.\textsuperscript{1,2}

1.2.2 Physical pathophysiology

The cellular reaction of asthma interferes with physiological function of normal breathing mechanism due to inflammation, airway hyperresponsiveness and bronchoconstriction.\textsuperscript{17,36} In people with asthma, inhaled triggers cause reversible airway narrowing, reduced lung ventilation, reduced alveolar oxygen tension, increased carbon dioxide tension,\textsuperscript{5,37} diffuse airway smooth muscle (ASM) contractions and bronchoconstriction,\textsuperscript{5,17,37} airway obstruction, reduced airflow to functional cells,\textsuperscript{5,17} and trapping of gases.\textsuperscript{5,37} These potentially lead to hypoxemia, respiratory acidosis, and respiratory arrest.\textsuperscript{5,37} Additionally, further obstruction may be caused by airway oedema and mucus hypersecretion, hindering breathing.\textsuperscript{1,17} This is associated with the clinical symptoms of wheezing, chest tightness and cough, potentially leading to an asthma exacerbation.\textsuperscript{17}

1.2.3 Model of acute asthma exacerbation

The pathophysiology can be described in a two-phase reaction model.\textsuperscript{1,26,27} The ‘early phase’ is the acute phase in an asthma exacerbation, potentially leading to the ‘late phase’, predominated by inflammatory responses.\textsuperscript{1,26,27}

The ‘early phase’ is characterised by immediate – but reversible – local airway inflammation\textsuperscript{27} initiated by inhaled allergens that are taken up by antigen-presenting cells.\textsuperscript{2,3,27} Consequent mast cell response causes early stage
bronchoconstriction,\(^2\) whereas degranulation of basophils triggers bronchoconstriction and allergic inflammation lasting for approximately one hour.\(^1,2\) Airway cells activated during the ‘early phase’ potentially initiate the ‘late phase’, occurring four to six hours after exposure to triggering factors.\(^1,27\) Inflammatory cytokines, especially Th2 cytokines, are released into the lungs, causing chronic and more intense airway inflammation,\(^1,3,27\) mucus secretion,\(^1,27\) as well as some bronchoconstriction.\(^1\) Mucous gland numbers are increased in asthma, contributing to increased mucous secretion and airway obstruction.\(^1,25,28\) As inflammation is the predominant factor, inhaled bronchodilator medications often have limited efficacy in relieving symptoms\(^27\) and systemic corticosteroids should be administered.\(^38\)

This model applies to most cases, but does not apply to all phenotypes. Uncommon phenotypes include asthma characterised by airway remodelling,\(^1\) which may reduce the responsiveness of patients to therapeutic treatment.\(^1,25\)

### 1.3 Clinical Presentation and Diagnosis

Asthma significantly reduces the Quality of Life (QOL) of patients and their families if not treated or poorly managed.\(^28,36\) In current practice, asthma is identified by clinical history taking\(^36,38,21,5\) and physical examination, whereas pulmonary function tests (PFTs) are employed to confirm diagnosis.\(^5,25,37,38\) However, there is no ‘gold standard’ for asthma diagnosis and recommended tools and techniques are based on agreed opinion among physicians.\(^28,38\)

Presenting symptoms include cough, wheeze, breathlessness, and chest tightness.\(^36,38\) Variability in symptoms and severity, classified by frequency, nocturnal awakening, and exercise limitations, indicate asthma.\(^36,38\) Symptoms may vary significantly among individuals.\(^36-38\)

Additional tests may be carried out to identify triggers\(^5,37,38\) and/or exclude potential diagnoses such as chronic obstructive pulmonary disease (COPD), allergic rhinitis and gastro-oesophageal reflux disease.\(^5,25,36-38\) Other tests such as challenge testing may also be used to help diagnosing asthma.\(^7,37,38\)
After diagnosis, severity will be classified and the management plan adjusted accordingly.\textsuperscript{5,25,38} Classifications include intermittent, or persistent mild, moderate or severe asthma, which is initially based on type and frequency of symptoms, exacerbation profile and PFT.\textsuperscript{25,38} Ongoing reassessment of classification is based on medication used, patients’ symptom profile and spirometry.\textsuperscript{7,25,38}

1.3.1 Pulmonary function tests (PFT)

Objective support for confirming the diagnosis of asthma is provided by spirometry.\textsuperscript{25,36,37} The outcome of these tests is largely influenced by individual variations, such as breathing effort.\textsuperscript{37}

Spirometry can identify airflow obstructions by measuring lung capacity and airflow,\textsuperscript{36,38} which helps to quantify obstruction severity.\textsuperscript{37} Spirometry is applied for diagnosing asthma, assessing severity and control, and for monitoring treatment response.\textsuperscript{38} It is done before and after short-acting bronchodilator use,\textsuperscript{25,37,38} measuring \(\text{FEV}_1\), \(\text{FVC}\) and \(\text{FEV}_1/\text{FVC}\) ratio.\textsuperscript{25,37} \(\text{FEV}_1\) refers to the Forced Expiratory Volume in the first second,\textsuperscript{25,39} and the Forced Vital Capacity (FVC) refers to maximum expiration volume after a maximum inspiration.\textsuperscript{25,39,40} Decreased \(\text{FEV}_1\), \(\text{FEV}_1/\text{FVC}\) and/or FVC values before bronchodilator use,\textsuperscript{25,37} and improvement of more than 12% in \(\text{FEV}_1\) or 10% of predicted \(\text{FEV}_1\) after bronchodilator use, are used to determine reversible airway obstruction in asthma.\textsuperscript{25,37,38} Tests should be repeated once or twice a year in order to monitor disease progression.\textsuperscript{37}

The peak expiratory flow (PEF) values can be measured with a PFM, which is recommended for monitoring of asthma severity\textsuperscript{37} and to guide therapy at home.\textsuperscript{25,37,38} It does not replace spirometry for diagnosing asthma, however it is useful for identification of triggering factors in occupational asthma through frequent monitoring.\textsuperscript{25,38}

In asthma, airway obstruction can cause wheezing,\textsuperscript{27,41} where audible wheezing indicates that the PEF declined by approximately 50% to 60%.\textsuperscript{41} PEF depends on upon lung size, as the size of the lungs describes pulmonary capacity.\textsuperscript{42} Thus, during bronchoconstriction-triggered cough the bronchi narrow, decreasing lung size and both \(\text{FEV}_1\)\textsuperscript{42} and PEF results, which can be observed by spirometry and PFM use
respectively.\textsuperscript{42,43} However, diurnal variability should be taken into consideration, as these can influence measurements.\textsuperscript{42,44}

### 1.4 Current Treatment and Management of Asthma

Currently, there is no cure for asthma.\textsuperscript{5,17} Treatment focuses on eliminating symptoms and improving QOL.\textsuperscript{4,17} Mild and moderate asthma can be well controlled when complying with treatment recommendations.\textsuperscript{17,45} Treatment should be a stepwise approached by initially focusing on acute management, and then shifting the emphasis to long-term treatment and individualised self-care management.\textsuperscript{4,36} Competent health care professionals should support this approach by addressing self-management, symptom control, inhaler technique, and adherence.\textsuperscript{36} Asthma control is considered good if the person experiences minimal symptoms during daytime and night-time, has a minimal requirement for reliever medication, no exacerbations, no restriction of physical activity, and normal lung function.\textsuperscript{25,38}

#### 1.4.1 Non-pharmacological treatment

Effective asthma management to achieve optimal disease control includes appropriate use of medications and active self-care management.\textsuperscript{25,38} This will be further discussed in Section “1.5 Asthma Self-Management”.

#### 1.4.2 Pharmacological treatment

Pharmacological (drug) treatment aims to reach and maintain optimal lung function\textsuperscript{38} and control asthma symptoms at the lowest effective dose, with the least potential of adverse effects.\textsuperscript{4,38,45} The medication regimen is usually determined by the severity, pattern and level of asthma control, and the risk-and-benefit profile needs to be also considered.\textsuperscript{38}

There are two main groups of asthma medications, classified as relievers and preventers (Table 1):\textsuperscript{7,25,38}
Table 1: Indications and mechanisms of action of medications used in the treatment of asthma.

<table>
<thead>
<tr>
<th>Therapeutic agent</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relievers:</strong></td>
<td>Relievers cause direct bronchodilation to relieve difficulties breathing and are essential for relief of acute asthma symptoms.(^7,38)</td>
</tr>
</tbody>
</table>
| **Rapid-acting \(\beta_2\)-agonists:** | • Rapid-acting \(\beta_2\)-agonist members:  
  - Short-acting \(\beta_2\)-agonist (SABA): Salbutamol, Terbutaline\(^{46,47}\)  
  - Rapid-acting-LABA (LABA: long-acting \(\beta_2\)-agonist): Eformoterol\(^{46,47}\)  
  • Indication: Mild intermittent asthma,\(^{36,38,46}\) immediate relief of acute asthma symptoms, and protection from exercise-induced asthma.\(^{38,47}\) Eformoterol is a LABA with a rapid onset of action\(^{38,47}\) (not used in severe asthma attacks).\(^{38}\) |
| **Short-acting anticholinergics:** | • Indication: Second line therapy for acute relief of asthma exacerbation as slower onset of action (30-60 min).\(^{38,47}\) |
| **Ipratropium**\(^4,38,46,47\) | |
| **Preventers:**   | Preventers are medications that are taken daily to prevent asthma symptoms and exacerbations,\(^7,38\) mainly due to their anti-inflammatory effects and/or prolonged bronchodilation.\(^{36,38,46,47}\) |
| **Inhaled Corticosteroids (ICS):** | • Indication: Continuous therapy\(^{36,46}\) to achieve and maintain asthma control in all patients that experience more than mild intermittent asthma.\(^{38}\) |
| Beclometasone,\(^{36,38,46,47}\)  
Ciclesonide,\(^{38,46,47}\)  
Budesonide and Fluticasone\(^{36,38,46,47}\) | |
| **LABA:** | • Indication: Symptom controllers (LABAs) prevent bronchoconstriction\(^{38}\) and are used as adjunct therapy to ICS.\(^{38,47}\) |
| Eformoterol and Salmeterol\(^{46,47}\) | |
| **Leukotriene Receptor Antagonist (LTRA): e.g. Montelukast**\(^{38,46-48}\) | • Indication: Add-on therapy to prevent asthma symptoms\(^{38,48}\) in patients with persistent poor asthma control,\(^{36}\) or aspirin- or exercise-induced asthma, however drug response of patients varies.\(^{36,38,48}\) |
| **Others:** | Cromones,\(^{38}\) Omalizumab,\(^{38}\) Theophylline,\(^{36,38,46}\) Oral corticosteroids,\(^{38}\) Zileuton,\(^{48}\) Long-acting anticholinergics (tiotropium),\(^4\) and Mepolizumab.\(^{49}\) |
The management of intermittent asthma involves a reliever medication for short-term use.\textsuperscript{36,38,50} All people with symptomatic asthma should be prescribed a reliever therapy\textsuperscript{38,50} in the form of a SABA or Symbicort, which contains eformoterol that acts as a maintenance and reliever medication.\textsuperscript{38,46} Currently, the benefit of using a preventer medication in mild intermittent asthma remains controversial.\textsuperscript{38,51,52} Though, it is recommended for people who experience asthma symptoms more than three times a week.\textsuperscript{38,50}

The management of persistent asthma includes a regular and continuous therapy with a preventer medication along with as-required SABA therapy (Figure 1).\textsuperscript{36,38} Preventer medication use should be initiated with low dose ICS to control asthma according to asthma severity and pattern and titrated subsequently.\textsuperscript{4,36,38,47,53} Prevention of airway remodelling and irreversible lung function impairment may be achieved with early ICS therapy in people with persistent symptoms.\textsuperscript{38,54} LTRAs are an alternative if ICS is not suitable.\textsuperscript{28,38,50} Nevertheless ICS therapy has proven better efficacy in improving lung function than treatment with LTRA, theophylline\textsuperscript{28,38} or cromone.\textsuperscript{38}

If a person experiences moderate persistent asthma despite low dose ICS, additional therapy with LABA should be considered (Figure 1).\textsuperscript{36,38,50,54} Combination therapy, including LABA and ICS, has been found to improve symptom control, and decreases the need for ICS.\textsuperscript{4,38,54} It is recommended to withdraw LABA from the combination treatment once symptoms are controlled for at least three weeks with SABA and daily ICS therapy.\textsuperscript{7,38} The frequency of SABA use can reflect on asthma control, indicating that the combination treatment achieves better asthma control than ICS alone if SABA use exceeds more than three times a week.\textsuperscript{7,38}

The management of severe persistent asthma comprises further steps including increasing ICS dose, trial of additional add-on therapies such as LTRAs and theophylline (Figure 1),\textsuperscript{36,38,50,54} and re-evaluation of the diagnosis.\textsuperscript{38,54} Theophylline and cromones are not frequently used due to decreased efficacy or increased adverse effects compared to ICS, LABA or LTRA.\textsuperscript{38,50,38,54} In the UK, persistent asthma with poor control despite regular treatment is treated by further increasing
the ICS dose, or by the addition of a fourth drug such as LTRAs or theophylline (Figure 1).\textsuperscript{4,36,50} If there is no improvement in asthma control, daily low-dose oral steroids may be considered in conjunction with high-dose ICS or other treatments to minimise steroid use (Figure 1).\textsuperscript{4,36,50} Regular long-term use of oral corticosteroids may be required, increasing the risk of systemic adverse effects, which should be monitored by a specialist.\textsuperscript{4,36,50}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Recommended pharmacological management plan for the treatment of asthma. The figure demonstrates the recommended add-on therapy procedure with increasing asthma severity.\textsuperscript{36,38,50}}
\end{figure}
The Effects of Regular PFM Utilisation on Asthma Self-Management

Asthma treatment for children differs from adult treatments.\(^38,51\) In addition, the use of medications currently available might not be able to achieve ideal asthma control for a small population of asthma patients.\(^17,45\) The development of new medications that may be used by non-responding asthma patients include new anti-inflammatories and agents neutralising IgE.\(^17\)

1.5 Asthma Self-Management

Asthma self-management is one of the most important parts in current asthma treatment.\(^1,6,38\) It gives patients freedom to adjust their therapy according to the individual’s need, which has been shown to improve asthma control and overall health outcomes, and to reduce morbidity and mortality.\(^1,22,25,38,55\) Additionally, it reduces the frequency of unplanned doctor visits,\(^1,38,55\) hospital admissions\(^19,36,55,56\) and expenses,\(^6,25\) and increases the confidence to manage changes in therapy according to asthma symptoms.\(^38,55\)

Components of asthma self-management include lifestyle modifications\(^36,37\), ability of the patient to self-assess asthma symptoms, asthma action plan (AAP) use, PFM use,\(^1,20,25,36,55\) appropriate education, and regular reviews by the doctor.\(^20,38,55\) The doctor’s reviews should integrate three steps, which include assessment of asthma control (e.g. by PFTs and symptom record\(^38\)), identifying reasons for poor control (e.g. by assessment of adherence and adverse effects, review of inhaler technique, AAP and triggering factors\(^38\)), and appropriate therapy adjustments.\(^36,38\) Investigation of patients’ ideas, concerns, expectations, as well as education about self-management ensures continuous asthma control.\(^25,36\) In addition, education of lifestyle modifications to achieve asthma control include avoidance or control of triggering factors\(^25,36,37\) such as allergens, cold temperatures,\(^37\) stress\(^36\), and smoking cessation.\(^36,37\) Some triggers can be easily controlled by using synthetic fibre pillows, frequent washing of linens, dehumidifying damp rooms to decrease mould, and house cleaning.\(^37\) Limited evidence shows improved asthma control by diet and exercise modifications, including specific management in exercise-induced asthma.\(^38\)
An important tool in assessing and controlling asthma is a diary for recording symptoms, PEF results, and medication details. The diary and use of an AAP enable patients and their doctors to identify poor control and make appropriate therapy adjustments.

Ideal management of asthma also includes optimal treatment of other co-morbidities, such as depression, anxiety, and allergies.

1.5.1 Education and patient health literacy

Asthma education includes active training on correct medication use and delivery devices, disease knowledge, and cooperation with health care professionals to effectively manage asthma.

Poor asthma control mostly occurs due to incorrect diagnosis, poor technique, lack of adherence, and poor response to therapy. Thus, education provided by trained health-care professionals addressing these factors can improve asthma care and avoid up to 75% of hospitalisations and up to 90% of deaths. However, studies show that employment of self-management education is poor, mostly due to time and resource constraints. This highlights the importance of integrating asthma education into a multidiscipline approach to optimise asthma control, such as regular assessment of inhaler technique by a pharmacist. Disease education ensures a better understanding of the basics of the condition, different roles of the medications, correct medication and inhaler use, and the effect of treatment onto their disease. This contributes to raising awareness of asthma, better decision-making for self-management, and better understanding on how to effectively manage asthma including the importance of reviews.

The frequency of doctor reviews will depend on severity of asthma. Generally, they are recommended every 6-12 months, emphasised by studies indicating patients with inadequate reviews are generally more likely to suffer from severe asthma or asthma attacks.
The Effects of Regular PFM Utilisation on Asthma Self-Management

1.5.2 Asthma Action Plan (AAP)

The AAP is an individually designed self-management tool used to provide guidance for people with asthma to identify change in asthma status and required self-adjustment to their treatment. Some studies have demonstrated that patients with greater involvement in asthma self-management are more likely to utilise AAPs, associated with better health outcome and patient satisfaction. The AAP (Appendix A) is a paper-based guide for indicators of worsening of asthma symptoms (including increased symptom frequency or severity, increased SABA use, failure of SABA therapy, decline in PEF, and increase in PEF variability). It also includes instructions for responding to recognised symptoms (including dose adjustment, contacting a doctor, or seeking emergency care), according to disease severity and patient’s preference. An AAP may include PEF readings and/or a symptom diary as indicators for the disease state, where the two indicators are considered equally effective.

There are two versions of AAPs available, depending whether eformoterol is part of the treatment, as it has a different onset of action. Hence an AAP specifically designed for this regimen has been developed (Appendix B).

Only one in four asthma patients possess an AAP. The lack of AAP use has been associated with a decrease in patients’ engagement in their disease and asthma self-management.

1.5.3 Monitoring Peak Expiratory Flow (PEF)

The PEF, also known as peak expiratory flow rate (PEFR), refers to the maximum rate of airflow during exhalation. As people with suboptimal asthma control have exaggerated diurnal changes in airway size, daily PEF measurements can observe these significant variation (≥20%). Therefore, measurement of PEF by a PFM can be used to assess daily asthma control.

1.5.4 Drug delivery devices

In current practice, most of the medications used in asthma control are delivered by various inhaler devices, designed to deliver an accurate dose of the drug directly to the site of action. Therefore, inappropriate inhaler techniques can significantly
reduce the amount of drug being delivered, resulting in suboptimal asthma control.\textsuperscript{36,60} These medications are usually delivered by pressurised metered-dose inhalers (MDIs), breath-triggering devices, or dry powder inhalers.\textsuperscript{7,36,38} Aiding delivery devices, such as mask and spacer, can also be utilised.\textsuperscript{36} The optimal device used depends on patients’ preferences and requirements, and the drug used, thus the choice of device should be individualised.\textsuperscript{36,38} Some people may have difficulties using a specific device, causing inadequate drug delivery; therefore appropriate education on how to use and maintain care of drug delivery devices is fundamental.\textsuperscript{36,38,47}

MDIs are transportable and quick to use,\textsuperscript{36} although some people have a poor hand-breath co-ordination, inadequate inspiratory force,\textsuperscript{7,36,38} or inhale the drug too fast, resulting in drug loss.\textsuperscript{36} This can be overcome with the use of a breath-activated device, a spacer,\textsuperscript{5,38,47} and/or training to improve inhalation.\textsuperscript{36,38}

\subsection*{1.6 Self-care problems}

Asthma symptoms may significantly affect work and school performance depending on the patient’s self-care management in asthma.\textsuperscript{13} Approximately 18\% of asthma patients require days off school or work due to asthma complications (Figure 2).\textsuperscript{13} Any absence indicates poor asthma control,\textsuperscript{38} which significantly reduces QOL of patients and their families,\textsuperscript{36} demonstrating the necessity of better asthma management.\textsuperscript{36,38}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure2.png}
\caption{Percentage of people who had to take time off work, school or study caused by their health condition in last 12 months, 2011-12\textsuperscript{13}}
\end{figure}
The Effects of Regular PFM Utilisation on Asthma Self-Management

Generally, people with chronic conditions such as arthritis, asthma, cancer, diabetes, cardiovascular, renal and mental diseases, as well as osteoporosis are more likely to consult health care professionals (Figure 3). Approximately 57% of asthma patients in Australia have consulted a General Practitioner (GP) in 2011-12, and patients with other chronic diseases indicate similar results. However, the number of asthma patients being consulted by other health care professionals is relatively low. Asthma patients (6%) have the lowest level of specialist consultation compared to patients with other chronic conditions (ranging from 15% to 75%).

An Australian survey has found that 34% of asthma patients experience problems performing daily activities at least once a month, and 26.5% of patients mentioned worsening of their asthma in 2011-12. Among these patients, 31.3% were admitted to hospital at least once within the 12-month period. These findings highlight the importance of AAP utilisation, as only 24% of asthma patients surveyed are found to own an active AAP. Additionally, specialists' consultations may increase AAP utilisation and consequent asthma control.
A cross-sectional analysis by Patel and colleagues, exploring the relationship between utilisation of AAP and socioeconomic status, identified that the higher proportion of patients with AAPs belongs to a population of higher household incomes.\textsuperscript{23} Also, patients whose asthma is being managed by specialists are the most likely to utilise APPs.\textsuperscript{23} The AAP is preferred for asthma self-management, especially for patients with difficulties obeying treatment recommendation and patients with multiple co-morbidities.\textsuperscript{23} However, there is no data from controlled studies showing that utilisation of an AAP as a sole strategy can improve health outcomes.\textsuperscript{20,23,64}

Poor asthma self-care is often due to the patient’s belief about the chronicity of their asthma.\textsuperscript{65} A prospective, longitudinal, observational cohort study showed that 53\% of people hospitalised due to their asthma, perceive asthma as an acute disease, i.e. if they have no symptoms, they have no asthma.\textsuperscript{65} Consequently, this belief contributes to non-compliance with preventer medications, overuse of reliever medications and poor asthma control.\textsuperscript{65} Further factors contributing to poor compliance include patient stopping or reducing their preventer medication without consulting their doctor as experiencing less symptoms,\textsuperscript{66} forgetfulness, misguided concerns about steroid use and adverse effects of medications.\textsuperscript{67} Poor asthma control can also be contributed by clinical factors such as co-morbidities (e.g. allergic rhinitis)\textsuperscript{68,69} and genetic characteristics, as well as patient behaviour reflecting on patients who fail to see a doctor.\textsuperscript{68} This is often related to poor communication between patient and health care professional, as well as poor health education.\textsuperscript{67} To overcome the self-care problem, health care professionals are encouraged to focus on more individualised asthma education,\textsuperscript{65,67,69} and regular disease monitoring.\textsuperscript{69}
1.7 Peak Flow Meter (PFM)

1.7.1 How to use the PFM

The PFM is a simple and robust monitoring device enabling reproducible PEF readings. A health care professional should assess and adjust the patient’s PFM technique where necessary during first time use. Further education on the interpretation of PEF measurements and the importance of monitoring variability should be provided. Additionally, it is necessary to continuously review patients’ technique and personal best value to ensure appropriate use, preferably at a yearly interval due to physical growth or disease progression.

In order to measure the PEF accurately, patients need to perform an appropriate technique. For optimal results, the pointer of the PFM needs to be reset to the end of the slot, the patient should be standing or sitting erect, have a nose clip, and the ability to breathe in fully with the lips around the mouthpiece. Patients are required to exhale as fast as possible into the PFM using maximum expiration force following maximum inhalation, as the maximum speed occurs during the first second of the exhalation. The PEF can be determined by reading the location of the pointer on the PFM. At least three tests should be completed and the largest value should be reported for accurate reading. Important considerations include difficulty exhaling or requiring more time, and people who may not exhale forcefully due other concerns such as incontinence or chest pain.

Normal predicted values of the PEF may vary depending on the individual, with men having a larger PEF. Generally, PEF increases until the age of 20 in women and 25 in men, and decreases later on. Other variables of PEF measurements include weight and height, for example increased height causes an increase in PEF due to increased total volume of tissues. Additionally, different ethnic populations may exhibit small differences in average PEF, for example African American and people from Hispanic backgrounds have a 10% lower
predicted PEF.\textsuperscript{44,70} Therefore adjustments for variables must be made,\textsuperscript{39\hspace{1em}} or the individual’s baseline value needs to be established.\textsuperscript{7,38,44,70}

1.7.2 PEF monitoring with a PFM

Measurements of PEF are best compared against the individual’s best value (baseline) instead of a pre-existing scale of the general population\textsuperscript{22,25,38,44,70} for evaluation of asthma in relation to lung capacity and variability.\textsuperscript{1\hspace{1em}} This is because individuals’ PEF depends on their effort and muscular strength,\textsuperscript{7,44} with a high variability observed in different users, their ability to use it,\textsuperscript{38,44} and the PFM itself.\textsuperscript{38,40,44} The baseline PEF is established by daily measurements for one to three weeks while receiving optimal treatment.\textsuperscript{1,7\hspace{1em}} Measurements should be performed at the same time each day due to diurnal variations,\textsuperscript{7,42,44} preferably in the morning after waking prior to bronchodilator use.\textsuperscript{1,7\hspace{1em}} Other studies show similar approaches to baseline establishment.\textsuperscript{7,70,73} Monitoring PEF is found most useful in moderate to severe asthma, asthma that is difficult to control, patients with a history of severe exacerbations, and patients having poor perception of their airflow limitations,\textsuperscript{7,25,38,44} but less valuable in mild asthma.\textsuperscript{38\hspace{1em}} A person with poor perception should measure the PEF every morning and evening before and after bronchodilator use, and if asthma symptoms are experienced, whereas a person with well controlled asthma may only measure the PEF if expecting or experiencing asthma symptoms.\textsuperscript{70}

Guidelines evaluate the performance by different zones,\textsuperscript{1,38,63,70} where slight differences are seen in different countries.\textsuperscript{1,63,70\hspace{1em}} In Australia, a PEF of 76-100\%\textsuperscript{38\hspace{1em}} of personal baseline (green zone) indicates a normal PEF range and acceptable therapy.\textsuperscript{1,38,44,63,70\hspace{1em}} A PEF of 50-75\% (yellow zone) indicates moderate asthma control\textsuperscript{38\hspace{1em}} or an imminent exacerbation and requirement of administration of a SABA.\textsuperscript{1,44,63,70\hspace{1em}} A PEF less than 50\% (red zone) signals a medical emergency in which the patient should administer a SABA immediately and seek medical attention.\textsuperscript{1,38,44,63,70\hspace{1em}} Additionally, PEF measurements can be used to identify patients with high-risk asthma that require close monitoring, indicated by decreased PEF measurements in the morning (less than 60\% of personal baseline) or by diurnal variations of more than 25\%.\textsuperscript{38\hspace{1em}}
1.7.3 Benefits of the PFM

Patients above the age of five are able to use PFMs appropriately to produce reliable results. Most studies revealed that PEF monitoring is beneficial in asthma management if combined with symptom dairies and patient education.

1.7.3.1 Cost-effectiveness of the PFM

Some studies observed a lack of PFM and AAP possession among low-income populations, however PFMs are relatively inexpensive and proven cost-effective and therefore should be promoted by health care professionals. As a large population of Australians have asthma, the cost-effectiveness of the PFM has significant potential to improve asthma care and self-management. PFMs appear to raise awareness of asthma in patients and improve the ability to control their asthma, potentially decreasing expenses, but clinical data is still limited.

1.7.3.2 Detection of asthma symptoms

Generally, airway narrowing occurs before asthma symptoms are experienced, which can be indicated by a declining PEF. The PFM is a portable device, which makes daily use and symptom monitoring very convenient and can improve patients’ compliance. It aids in identifying triggers for asthma exacerbation and improves patients’ ability to recognise airflow limitations and early exacerbation.

1.7.3.3 Long-term monitoring of PEF

Repeated measuring of PEF in asthma patients can help identify patterns in lung function and specific features of the patient’s asthma. For example, a decline of PEF during weekdays and improvement on weekends suggests occupational asthma, whereas isolated declines in PEF indicates contact with certain allergens or triggering factors. Generally, a decline in PEF and increasing variability of PEF predict worsening of asthma, conversely, improvement of disease control is usually associated with increases in PEF and decreases in variability. Long-term PEF monitoring potentially aids in identifying changes in asthma that require modification of the therapy and treatment plan, including the AAP.
1.7.4 Limitations of the PFM

1.7.4.1 Intra-patient variability of PEF
A major limitation is the large amount of variables that interfere with the measurements of the PFM. Patient-related factors can cause variable results leading to inaccuracy, including using submaximal effort in exhalation, inappropriate sealing of mouthpiece causing air leakage, incomplete inhalation or exhalation, hesitation when initiating exhalation, cough, glottis closure, tongue obstructing the mouthpiece, vocalisation during exhalation, incorrect posture, and poor cooperation by patients.

1.7.4.2 Conditions affecting PEF readings
Health factors that can influence PEF include COPD and smoking, which can lower the measurements. However, PEF can be used as part of COPD monitoring and management, despite some limitations. Alternative devices may be used for patients with COPD to produce more reliable measurements. Nevertheless, COPD can be a limiting factor in PEF monitoring in asthma due to its influences to the results.

1.7.4.3 Correlation between PEF and FEV\textsubscript{1}
The FEV\textsubscript{1} measured by spirometry is the gold standard used to measure lung function in patients with asthma, but the PEF is found to correlate well with FEV\textsubscript{1} among patients with asthma. However, this correlation diminishes with decreasing air flow and spirometry is preferred in patients with severe airflow limitations, especially as some small changes in FEV\textsubscript{1} in patients with severe disease are not detected by PEF measurements. Comparison of PEF to FEV\textsubscript{1} values using spirometry should be performed regularly, e.g. once a year, or if any concerns are raised about PEF measurements. In addition, inaccurate techniques or untrained health care technicians can cause variability in spirometry measurements.
The Effects of Regular PFM Utilisation on Asthma Self-Management

1.7.5 Effects of PEF on the outcome of asthma self-management

The optimal role of PEF monitoring in managing asthma is still unclear, yet daily PEF monitoring has theoretical benefits by providing data that can be used to aid in therapeutic decision.\textsuperscript{70} There is a shortage of PFM utilisation in current practice, which may be due to the lack of data to support PEF measurements as an indicator for improving asthma self-management.\textsuperscript{64} Thus, further studies are needed to clarify the role of PEF monitoring in improving asthma control.

1.7.5.1 Adherence to asthma management

Adherence is a major factor in the treatment of asthma.\textsuperscript{36,47,80} A report by Kaufmann has found that people tend to under-utilise more than over-utilise asthma medications due to various reasons.\textsuperscript{36,53} It has been observed that nocturnal symptoms as well as increased hospital admissions due to exacerbations\textsuperscript{80} are highly associated with poor adherence.\textsuperscript{47,80} Recent studies observed that implementing asthma self-management, especially individually designed educational interventions, are useful in improving compliance and asthma control.\textsuperscript{19,56} It was also observed that PEF monitoring can improve patients’ awareness of asthma deterioration.\textsuperscript{56} Health care professionals and patients should discuss individual needs by understanding, recognising and responding to patients’ perspectives, as poor-controlled asthma is often associated with a misunderstanding of the disease and under-estimation of benefits of regular therapy.\textsuperscript{36,47}

Studies have found that short-term monitoring of PEF is often associated with better compliance,\textsuperscript{19,70} however long-term recording of PEF is found to be more problematic,\textsuperscript{70} where the compliance gradually decreases after weeks or months, associated with worsening of asthma.\textsuperscript{44,70,80} This behavioural pattern was mostly observed in younger patients due to a lack of concern about prophylactic aspects of PEF monitoring in asthma management,\textsuperscript{44,80} but utilisation of electronic PFMFs appears to improve in some minority groups.\textsuperscript{44}
1.7.5.2 Improvement seen by asthma self-management education including PFM use

Asthma self-management and education has shown to effectively reduce emergency department presentation and hospital admissions,\textsuperscript{19,36,55,56} morbidity, mortality,\textsuperscript{36} absence from work due to symptoms,\textsuperscript{19,55,74} nocturnal asthma symptoms and indirect expenses, as well as improving QOL.\textsuperscript{19,55} Individualised asthma education promotes more compliance with ICS use, reduces night-time awakening, reduces emergency SABA use, and improves perceived control of asthma.\textsuperscript{56} Furthermore, standard asthma education was associated with decreasing adherence over time,\textsuperscript{56} whereas personalised asthma education had a more pronounced effect on adherence, reflected by a 60% higher adherence rate, but only had a minimal effect on lung function.\textsuperscript{25,56} According to Janson et al, individualised self-management education, comprising even minimal amounts of time and resources, is significant enough to be integrated into clinical practice.\textsuperscript{56}

1.7.5.3 Indicator for asthma exacerbation

Currently, there is no single tool that can predict the risk of an asthma exacerbation. It usually depends on individual patients’ disease phenotypes and susceptible triggering factors.\textsuperscript{81} Other determining factors of future exacerbations include demographics, genetics, physiological environment, access to care, treatment plan, adherence, as well as symptom and exacerbation history.\textsuperscript{81}

In current practice, the severity of asthma exacerbations cannot solely rely on PEF measurements as studies have shown inconsistent findings.\textsuperscript{25,44,70,81,82} However, utilisation of PEF with a dual approach (PEF and symptom recording) is found to assist patients to observe the relationship between triggering factors and worsening of asthma control.\textsuperscript{70,81} Furthermore, additional records of medications used are found to improve patients’ awareness of asthma control and improves self-management.\textsuperscript{6,81} Medication use and PEF records are also a good indication of compliance.\textsuperscript{70} Additionally, it was seen that electronic diaries used to report PEF values are much more reliable than paper-based diaries, but both are still subject to the ability of the patient to record the data.\textsuperscript{81}
The Effects of Regular PFM Utilisation on Asthma Self-Management

2 Intentions and Justifications of the Study

2.1 Aim of Study

The project aims to identify if the introduction of a PFM with appropriate education can improve asthma self-management among a sample of adults of the Darwin population. In current practice, the PFM is not commonly utilised by people with asthma for their disease management.\textsuperscript{6,24,64}

Hypothesis:

Adults with asthma using a peak flow meter regularly will improve their involvement in asthma self-management and their confidence in managing asthma.

2.2 Objectives

This study is designed to address the following research questions:

1. Does daily use of the peak flow meter help in asthma self-management?
2. Does regular use of the peak flow meter increase people’s confidence in asthma self-management?
3. Does the peak flow meter aid people with asthma in recognising breathing difficulties earlier and enable people to follow appropriate directions given by their doctor?

The introduction provided the basis and added validation to this study’s design, where the primary objective is to assess the hypothesis above and was conducted with the following objectives:

- **Conduct a guided survey:** A survey was created to assess asthma management, severity, knowledge and control as well as guide a meeting with people with asthma in a sensitive and respectful manner to gain asthma-related information of people.
• **Provide individualised asthma education**: Listen to people with asthma and understand their concept of the disease to identify their asthma characteristics to provide individualised asthma education in order to improve their self-management.

• **Provide education on PFM use**: Educate people with asthma on the purpose and appropriate utilisation of PFM, and evaluate if PFM use improves the patient’s ability to recognise breathing difficulties early and follow appropriate directions given by their doctors.

• **Compare the outcome of intervention**: Comparison and analysis of completed questionnaires to assess achievement of the primary objective.

### 2.3 Significance and Justification of the Study

Asthma is more prevalent in Australia compared to other countries,\(^{11,12}\) and was associated with 378 deaths in 2011.\(^{12}\) Irrespective of asthma classification, any person with asthma can experience an acute asthma exacerbation, especially after exposure to triggering factors or due to suboptimal therapy.\(^1\) Unfortunately, there was no proven treatment providing cure at the point of writing.\(^{17}\) However, developed management plans, which include self-care with an AAP and a PFM to optimise asthma control,\(^{38}\) enable an asthma symptom-free life.\(^{17}\) Studies observed poor implementation of self-management,\(^{36,59}\) that suggested the need for improvement and better engagement by health care providers.

UK statistics have found that poor asthma control is often due to a lack in asthma self-management or education, where a significant number of hospitalisations and deaths are preventable if self-management is improved.\(^{36,57,58}\) In Australia, a recent survey has found that asthma patients rarely seek specialist’s consultations and relatively high numbers of people with asthma experience difficulties in performing daily duties and hospital admissions due to asthma symptoms (for details refer to Section “1.6 Self-care problems”),\(^{13}\) where poor asthma control can have a substantial effect on QOL of patients as well as their families.\(^{36}\) These findings
underline the importance of patient education, appropriate self-care management where an AAP and a PFM to help patients recognise worsening of asthma. If participants continue using the PFM on a long-term basis, it can help identify patterns in lung function and specific features in asthma. This helps doctors as well as patients to identify triggering factors, and aids doctors in assessing responsiveness of treatment modifications, changes in asthma symptoms, and quantifying results.

Most studies indicate that PEF monitoring is beneficial if integrated into a suitable asthma management plan. The recording of results can show patients the relationship between asthma symptoms and their lung function. Improving awareness and understanding may result in better self-management of asthma and better control of asthma symptoms as well as reducing expenses for the patient.

Self-management education (including PFM and AAP use) has shown to improve adherence to asthma medications and improved perception of symptom control in up to 60% of the population. A longitudinal study has found that people who do not notice asthma symptoms may have marked deterioration in asthma if PEF is not monitored. Implementation of PEF monitoring into society will potentially lead to lower exacerbation and hospitalisation rates, consequently it may lower government expenses on asthma symptoms and exacerbations.

Similarly, diabetes mellitus is a prevalent chronic disease characterised by high blood sugar levels (BSL), which can be associated with severe complications if not controlled and therefore requires frequent BSL monitoring to optimise diabetic control. It has been observed that integrating BSL monitoring into diabetes self-management education improves diabetic control and health outcomes. Some type II diabetes patients have difficulties perceiving changes in BSL. Thus, frequent BSL monitoring enables patients to identify potential influencing factors, and achieve levels in target ranges, therefore reducing the risk of complications. Generally, diabetes patients are frequently consulted by other health care professionals (39.7%), and report relatively low absence from work or school (9.6%). In comparison, asthma patients are not seen very often by other health professionals.
care professionals (9.6%)\textsuperscript{13} and frequently require additional sick days off work or school due to asthma symptoms (18.4%),\textsuperscript{13} indicating poor asthma control.\textsuperscript{38}

Therefore, the concept of measuring BSL to control diabetes may be employed to asthma management by using a PFM more frequently to monitor PEF, identify triggers and establish individual PEF ranges in order to prevent worsening of asthma. Patients may become more aware about the symptoms and control of asthma, potentially contributing to better asthma control and less time off work or school.

A reason for very low PFM utilisation in asthma self-management may be contributed by the lack of supporting data.\textsuperscript{64} This underlines the need for further studies assessing the effect of PFM utilisation in asthma self-management.
3 Methodology

3.1 Study design

The study was designed as a before-and-after controlled intervention study. This study utilised convenience-sampling methods, where participants were adults who have been previously diagnosed with asthma (details refer to Section “3.3 Inclusion and exclusion criteria”). The participants were provided with a PFM and adequate education about the use of a PFM for their asthma management. The study then evaluated participants’ asthma knowledge and asthma control as well as awareness of their own asthma symptoms, before and after the intervention occurring at four separate steps using validated questionnaires (VQ) (Appendix C) (Figure 4).

The participants had four scheduled meetings with the principal researcher(s), which took place at a time and location convenient to the participant and researcher, e.g. at the Charles Darwin University (CDU) or a local café/restaurant. During the meetings, participants were required to complete three questionnaires at 4-week intervals (+/-1 week), which were composed from a validated Asthma Control Test and a validated asthma knowledge test. Each meeting took approximately 30 minutes and each questionnaire took 10-15 minutes to complete. The subject was randomly assigned into a control group or interventional group using a free computer program (www.randomization.com).

**Step 1:** The first meeting involved a guided survey and all participants were provided individualised asthma education (Appendix D). The first questionnaire included part 1 (guided survey, incorporating the Asthma Control Questionnaire by Wheatbelt GP Network⁸⁸) to gather the subject’s baseline information and part 2 (the two VQs) to assess the subject’s asthma control and asthma knowledge.

**Step 2:** The second meeting involved the completion of the second survey by all participants. The second survey included only part 2 of this questionnaire (the two VQs) to assess any improvement in asthma knowledge and/or asthma control as the outcome from asthma education from Step 1. Participants allocated into the
interventional group were provided with a PFM, a diary to record their measurements, and education on how to use the device. The participants were encouraged to measure their PEF every morning and whenever they felt that they may be experiencing airflow limitation. The participants allocated into the control group were not given any information about the PFM, however both groups’ asthma management as well as any improvement in their engagement in self-management were reviewed and discussed.

**Step 3:** At the third meeting, all participants were asked to complete a third survey. The third survey included only part 2 of the questionnaire (the two VQs) as in the second meeting to assess asthma knowledge and asthma control. Participants in the control group will now be provided with a PFM, a diary to record PEF measurements, and education on how to use the device (as per intervention group in Step 2). Both groups’ engagement and any improvement in asthma self-management were assessed and noted.

**Step 4:** At the final meeting, all participants were asked to complete a fourth survey, including only part 2 of the questionnaire (the two VQs). Both groups’ engagement and any improvement in asthma self-management were assessed and noted.
3.1.1 Questionnaire design

The questionnaire includes two sections, which are composed of adapted questionnaires as well as originally designed questionnaires.

Part 1: This section is composed of a originally designed questionnaire and adapted from an asthma severity questionnaire from Wheatbelt GP Network. This part of the questionnaire is designed to collect information of the subject’s baseline information. The questions aimed to gather demographic information, including the subject’s age, gender, smoking status, and pulmonary-related disease status. Further information collected included participants’ medication use, asthma treatment, compliance, and perception of asthma symptoms and care. The adapted asthma severity questionnaire comprised of ten questions ranking the subjects’ answer between 1-7, where a total score of 70 can be achieved.

Part 2: This section of the questionnaire is composed of only two VQs, including asthma knowledge test from NIH MedlinePlus and Asthma Control Test from Asthma UK (Appendix C). This part of the questionnaire is designed to collect information of the subject’s baseline asthma knowledge and asthma control as well as differences after the intervention. The asthma knowledge questionnaire comprises five TRUE-or-FALSE questions and one multiple-choice question, whereas the Asthma Control Test comprises five questions ranking their answer between 1-5.

3.1.2 Asthma education

All subjects were provided with educational information in the first meeting. The information and disease education session was designed to provide a similar asthma self-awareness level prior to the introduction of the PFM. The education also acted as a longitudinal control in order to exclude any improvement of asthma self-management due to asthma education during the introduction of the PFM. Information was obtained through standardised material provided by the Asthma Foundation, the Pharmaceutical Society of Australia (PSA), evidence based researched information (e.g. journal articles, Asthma Management Handbook 2006), and education delivered during the university course Bachelor of Pharmacy at CDU. The written information was composed from material provided by the
Asthma Foundation (including Asthma Australia and Asthma Foundation NT) and PSA (Table 2).

**Table 2: List of written educational material offered to all subjects.**

<table>
<thead>
<tr>
<th>Provider</th>
<th>Name of Brochure</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSA</td>
<td>Self-Care Card 0073, 2011: Asthma</td>
</tr>
<tr>
<td>PSA</td>
<td>Self-Care Card 0074, 2011: Asthma Medicines</td>
</tr>
<tr>
<td>Asthma Australia</td>
<td>Asthma Medications &amp; Devices</td>
</tr>
<tr>
<td>Asthma Australia</td>
<td>Asthma Basic Facts</td>
</tr>
<tr>
<td>Asthma Australia</td>
<td>Asthma: 10 Things to Ask &amp; Tell your Doctor</td>
</tr>
<tr>
<td>Asthma Australia</td>
<td>Asthma &amp; Pregnancy</td>
</tr>
<tr>
<td>Asthma Australia</td>
<td>Asthma &amp; Seniors</td>
</tr>
<tr>
<td>Asthma Foundation NT</td>
<td>Asthma in the Home</td>
</tr>
<tr>
<td>Asthma Foundation NT</td>
<td>Personal Spacer: Use &amp; Care</td>
</tr>
<tr>
<td>Asthma Foundation NT</td>
<td>Nebuliser: Use &amp; Care</td>
</tr>
<tr>
<td>Asthma Foundation NT</td>
<td>Helping People Breathe Better</td>
</tr>
</tbody>
</table>

Information provided included an explanation of asthma symptoms, aetiology and pathophysiology, relevant information about medications (e.g. relievers, preventers and symptom controllers) and asthma devices (including information about inhaler techniques and maintenance, benefits of certain devices, etc.). Further information was given about the perception of asthma symptoms, triggers, instructions on how to manage an asthma attack, and when to consult a doctor. Asthma management information comprised the treatment goals and self-management information on medication storage, breathing exercises, regular doctor reviews, AAP use, lifestyle modifications, exercise as well as diet and other medication that may influence asthma control. Further information was provided if requested such as on exercise-induced asthma, asthma-related diet and other considerations (Appendix D; Appendix E). The information was provided in accordance to individual’s treatment and needs. In addition, the subject inhaler technique was assessed, any questions were answered and educational information listed in Table 2 was offered.
3.1.3 PFM provision and education

In the second or third meeting the subject received a PFM depending on the group allocation. Information was provided about the purpose of PFM use, its potential effect on asthma self-management, its influencing factors, and instructions on how to establish a baseline value, the Australian guidelines to PEF measurements, and identification of high-risk asthma. Written information (Appendix F) was provided to review information and ensure optimal use. The device was provided to the subject free of charge after the researcher explained how to use the device. Subjects were asked to demonstrate the correct technique of the using the PFM in the presence of the researcher to ensure optimal use. The subjects were then asked to measure their PEF once in the morning before reliever use and whenever they expected to experience or experienced any asthma symptoms.

3.2 Subject recruitment and sample size

Participating pharmacies, the Australian Red Cross and the Asthma Foundation were invited to take part in this study through personal visits, which was followed by a written invitation per email and written confirmation by the organisation. Participating organisations displayed project flyers (Appendix G) to recruit subjects. The flyers contained the contact details of the researchers in order for potential participants to contact the researchers and express interest in participating in the project. Additionally, the primary researcher actively promoted the study by talking to potential participants and engaging with people that voiced interest for the project.

After making initial contact, potential participants who met the selection criteria were provided with an information package that contained a copy of the information sheet (plain language statement, Appendix H) and a copy of the consent form (Appendix I). Informed consent was obtained when the participant had signed the consent form and returned it to the principal researcher during the first meeting.

This study is designed as a pilot study and we anticipate that a sample size of 30-40 subjects will be sufficient to provide data that can guide future studies.
3.3 Inclusion and exclusion criteria

Inclusion criteria:

1. Subjects must be 18 years old or over.
2. Subjects must be previously diagnosed with asthma by a doctor.
3. Subjects must be able to provide written informed consent.
4. Subjects must be able to understand information given and able to complete the survey.

Exclusion criteria:

1. Subjects using a PFM for their asthma self-management, prior to the intervention.
2. Subjects unable to understand and comprehend the information provided.
3. Subjects unable to comply with the meeting requirements of this study.
4. Subjects refusing to participate in the study.

3.4 Equipment and budget

The budget provided by the CDU covers the expenses required for this project for up to AUD$1000. Equipment required for each participant was a PFM (Breath-Alert™ – Peak Flow Meter by Allersearch distributed in Australia by Richard Thomson Pty Ltd and manufactured by Medical Developments International Limited with the batch number 0F9Z91). The device had a standard range of 50 – 800 L/min, which is considered suitable for older children and adults. Other equipment required included a diary for peak flow recording (included with the PFM), educational information about asthma, and inhaler and spacer devices for educational demonstration. The PFM, the diary and the educational information can be kept by the subject as an incentive for taking part in this study. These materials are valued at AUD$27 (Table 3), and are of insignificant value to have any potential adverse impact on the outcome of the study.
Table 3: Resources required for project.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak flow meter</td>
<td>1 PFM: AUD$27.00</td>
</tr>
<tr>
<td></td>
<td>AUD$27 x 12 = AUD$324.00</td>
</tr>
<tr>
<td>Spacer for demonstration purposes</td>
<td>AUD$19.00</td>
</tr>
<tr>
<td>Travelling costs (car fuel)</td>
<td>AUD$ TBD</td>
</tr>
<tr>
<td>Applied First Aid Course (required for meetings with asthma patients)</td>
<td>AUD$160.00</td>
</tr>
<tr>
<td>Educational information and devices</td>
<td>In kind support by the Asthma Foundation, CDU and the PSA.</td>
</tr>
<tr>
<td>Computer, Printing, Internet and Phone</td>
<td>AUD$100.00</td>
</tr>
<tr>
<td>Total</td>
<td><strong>AUD$603.00</strong></td>
</tr>
</tbody>
</table>

3.5 Data analysis

The study evaluated the outcome of the intervention by comparing results of the two VQs. The difference of VQ scores between Step 1 and Step 2 served to examine the effect of asthma education alone, acting as a longitudinal control. The influence of the PFM on the patient’s asthma self-management was assessed by the third survey through the differences between the control and the intervention. The fourth survey was used to examine the effect of PFM use in the control group.

3.6 Procedure for data processing

The initial data from the guided survey and the data from all questionnaires were collected in person by the principal researcher during the four scheduled meetings.

The data were analysed using the SPSS statistical program (IBM™, IBM Australia Ltd). Comparison of demographics between control and intervention group was performed by the Chi-square test, whereas comparison of results from VQs was performed using the student t-test 2-tailed and the Independent-Samples Mann-Whitney U Test (ISMWUT). A p-value \( p \) of less than 0.05 is considered statistically
significant. Basic descriptive data and graph generation was performed using the Microsoft Excel™ program. All members of the investigating team (Julia Knobloch, Dr. Kwang Choon Yee and Mary-Jessimine Bushell) have access to the data.

3.7 Confidentiality

The researcher met the subjects individually after the recruitment. The subjects are not anonymous to the researcher, but the data collected was coded with a unique study number. All information gathered during educational meetings and in the questionnaires, as well as all other paper work was stored in the CDU building (yellow 3.1.13) until the study was completed. All documents were filed and locked up in a storage room, kept in the secure building of the CDU (room yellow 3.1.13). The electronic copy was stored within the CDU computer (in a password protected computer and as a password protected file) and only the principal researcher and the supervisors were having access to these copies. After completion of the study, the information was transferred to a CD-ROM for storage with the hard copy material. All electronic copies were removed and deleted from the computer, using an appropriate computer program. Only members of the investigating team – Julia Knobloch, Dr. Kwang Choon Yee, and Mary-Jessimine Bushell, will have access to collected data. Any identifiable information or re-identifiable information was not included in the final report “The Effects of Regular Peak Flow Meter Utilisation on Asthma Self-Management” or in publications generated from this study.

This study was approved by the Charles Darwin University Human Research and Ethics Committee (EC00154) in June 2013, reference number: H13072 Knobloch (Appendix J: Provisional approval; Appendix K: Final approval).
4 Results

4.1 Recruitment

Thirteen subjects were recruited for the study during the nine weeks recruitment period, and all subjects took part in the first meeting. One subject was excluded after the first meeting according to the exclusion criteria number one. All other subject completed all four meetings in an average of 27-day intervals (Standard Deviation (SD)=8.20 days). Respectively, the mean time intervals between meeting one and two, two and three, as well as three and four were 26.0, 25.9 and 27.5 days, and there was no statistically significant difference in time intervals between the meetings for the intervention group and control group (26.20 and 26.67 days, respectively).

All but two subjects followed the instructions regarding the use of the PFM. One subject of each group was not fully compliant with the instructions of PFM utilisation, which only used the PFM for one to two weeks.

4.2 Demographics

The baseline demographic data of all subjects is shown in tables 4-7, and there was no statistically significant difference between subjects from the intervention group and control group.

4.2.1 Non-asthma-related demographics

The ages of subjects ranged from 20 to 71 years. There were slightly more female than male subjects. All but two subjects were identified as non-smokers, of which both subjects belonged to the control group. Both subjects had a smoking history of over a year but successfully quit smoking more than three years ago, therefore both subjects were considered as ex-smokers. The majority of subjects were not currently diagnosed with any other health condition that would considerably interfere with their respiratory function, except for one subject in the intervention group who was previously diagnosed with bronchiectasis (Table 4).
Table 4: Subjects’ non-asthma-related demographics collected from surveys.

<table>
<thead>
<tr>
<th></th>
<th>Intervention (N=5)</th>
<th>Control (N=7)</th>
<th>Total (N=12)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>35.6</td>
<td>39.0</td>
<td>37.6</td>
<td>0.364</td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
<td>0.921</td>
</tr>
<tr>
<td>Male</td>
<td>2(40.0%)</td>
<td>3(42.9%)</td>
<td>5(41.7%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>3(60.0%)</td>
<td>4(57.1%)</td>
<td>7(58.3%)</td>
<td></td>
</tr>
<tr>
<td>Smoking history:</td>
<td></td>
<td></td>
<td></td>
<td>0.190</td>
</tr>
<tr>
<td>Never smoked</td>
<td>5(100.0%)</td>
<td>5(71.4%)</td>
<td>10(83.3%)</td>
<td></td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>0(0.0%)</td>
<td>2(28.6%)</td>
<td>2(16.7%)</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>Medical conditions affecting breathing</td>
<td>1(20.0%)</td>
<td>0(0.0%)</td>
<td>1(8.3%)</td>
<td>0.217</td>
</tr>
</tbody>
</table>

*p-value was analysed by SPSS statistical program using the Pearson Chi-Square Test.

4.2.2 Asthma health management demographics

The information regarding daily regular medications (DMed), collected from all subjects, referred to any medications taken by the subject including medications for asthma, blood pressure, depression and medications used to treat other medical condition. Medications that were only taken when required (prn) were excluded. There was no statistical significance between the two groups regarding the number of DMeds taken (Table 5).

Additionally, there was no statistical significance between subjects in the control group and intervention group in regards to the use of an AAP and/or spacer to aid asthma management. Most subjects were either using both tools or none of the listed tools as seen in Table 5.

Furthermore, subjects were answering three questions by ranking their perception on a scale from 1-5 (Table 5), of which none showed any statistically significant difference between the intervention group and control group. The first question investigated their perception of having an asthma symptom-free life, where 1
indicated to never be able to live a symptom-free life, and 5 indicated the ability to live a symptom-free life. Approximately 50% of subjects reported to never being able to live an asthma symptom-free life. The second question inquired the subject’s ability to predict an asthma attack, where 1 referred to never being able to predict an asthma attack, and 5 referred to the ability to predict an asthma attack every time. Subjects from the intervention group reported either not be able to predict an asthma attack or able to predict an attack every time, whereas answers from the control group were more evenly distributed. The third question inquired the subject’s satisfaction with the treatment and care they received from their health care professionals. Subjects reporting 1 were not satisfied, whereas subjects reporting 5 were completely satisfied, where 50% of all subjects reported to be completely satisfied, particularly subjects from the control group.
### Table 5: Subject asthma-related demographics collected from surveys.

<table>
<thead>
<tr>
<th></th>
<th>Intervention (N=5)</th>
<th>Control (N=7)</th>
<th>Total (N=12)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DMeds (mean):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMed = 0</td>
<td>3(60.0%)</td>
<td>1(14.3%)</td>
<td>4(33.3%)</td>
<td>0.144</td>
</tr>
<tr>
<td>DMed = 1</td>
<td>0(0.0%)</td>
<td>3(42.9%)</td>
<td>3(25.0%)</td>
<td></td>
</tr>
<tr>
<td>DMed = 2</td>
<td>0(0.0%)</td>
<td>2(28.6%)</td>
<td>2(16.7%)</td>
<td></td>
</tr>
<tr>
<td>DMed = 3</td>
<td>1(20.0%)</td>
<td>0(0.0%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>DMed = 4</td>
<td>1(20.0%)</td>
<td>1(14.3%)</td>
<td>2(16.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Asthma tools used:</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.640</td>
</tr>
<tr>
<td>AAP only</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>Spacer only</td>
<td>0(0.0%)</td>
<td>1(14.3%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>AAP &amp; Spacer</td>
<td>2(40.0%)</td>
<td>3(42.9%)</td>
<td>5(41.7%)</td>
<td></td>
</tr>
<tr>
<td>No AAP or Spacer</td>
<td>3(60.0%)</td>
<td>3(42.9%)</td>
<td>6(50.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>“Do you think you can live an asthma symptom free life?”</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.0</td>
<td>2.7</td>
<td>2.4</td>
<td>0.438</td>
</tr>
<tr>
<td>1 (Never)</td>
<td>3(60.0%)</td>
<td>3(42.9%)</td>
<td>6(50.0%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0(0.0%)</td>
<td>1(14.3%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1(20.0%)</td>
<td>0(0.0%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1(20.0%)</td>
<td>1(14.3%)</td>
<td>2(16.7%)</td>
<td></td>
</tr>
<tr>
<td>5 (Yes)</td>
<td>0(0.0%)</td>
<td>2(28.6%)</td>
<td>2(16.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>“How well can you predict an asthma attack?”</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.164</td>
</tr>
<tr>
<td>Mean</td>
<td>3.0</td>
<td>4.3</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>1 (Never)</td>
<td>1(20.0%)</td>
<td>0(0.0%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2(40.0%)</td>
<td>0(0.0%)</td>
<td>2(16.7%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0(0.0%)</td>
<td>2(28.6%)</td>
<td>2(16.7%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0(0.0%)</td>
<td>1(14.3%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>5 (Every time)</td>
<td>2(40.0%)</td>
<td>4(57.1%)</td>
<td>6(50.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>“Are you satisfied with the treatment and care you receive currently?”</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.139</td>
</tr>
<tr>
<td>Mean</td>
<td>3.0</td>
<td>4.6</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>1 (Not satisfied)</td>
<td>1(20.0%)</td>
<td>0(0.0%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3(60.0%)</td>
<td>1(14.3%)</td>
<td>4(33.3%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0(0.0%)</td>
<td>1(14.3%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>5 (Completely satisfied)</td>
<td>1(20.0%)</td>
<td>5(71.4%)</td>
<td>6(50.0%)</td>
<td></td>
</tr>
</tbody>
</table>
4.2.3 Asthma medication use and asthma health literacy

The demographic results of preventer medication use and asthma health literacy were reflecting on written and verbal information provided by subjects.

All subjects used salbutamol as their reliever medication, of which eight subjects used a preventer medication (Table 6). Two different types of preventer medications were taken by the subjects, which were the combination product of fluticasone with salmeterol (Seretide®), and beclomethasone.

Among the subjects having used preventer medications, only 50% of subjects had full compliance on preventer medication in the week prior to first meeting according to subject’s recollection (Table 6), with no statistically significant difference between the groups.

The number of missed doses, asthma severity and asthma control assessed if the utilisation of asthma medication was in accordance with the Asthma Management Handbook 2006. Results (Table 6) show that the difference between intervention group and control group was not statistically significant, although the control group appeared to utilise their asthma medications more frequently in accordance with the guidelines.

The subject’s asthma health literacy prior to this study was assessed subjectively by the researcher according to subjects’ asthma knowledge and ability to understand the educational information provided during the first meeting. The level of asthma health literacy was divided into three categories: Well-educated, some education and no prior education. Well-educated subjects were defined as subjects that knew approximately >80% of the information provided (Appendix D) and easily understood new information. Subjects who had some education were identified where approximately 50% of the information was new for them and new information was easily understood, demonstrating limited health literacy. Subjects who had no prior education perceived approximately >80% of the information provided as new and/or had difficulties understanding the information provided, subsequently demonstrating poor health literacy. The results were mixed, showing that most subjects were either well-educated or had no prior education (Table 7).
### Table 6: Subjects’ preventer medication use information collected during first interview.

<table>
<thead>
<tr>
<th></th>
<th>Intervention (N=5)</th>
<th>Control (N=7)</th>
<th>Total (N=12)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asthma medication use</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.219</td>
</tr>
<tr>
<td>Reliever</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salbutamol</td>
<td>5(100.0%)</td>
<td>7(100.0%)</td>
<td>12(100.0%)</td>
<td></td>
</tr>
<tr>
<td>No reliever</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>Preventer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluticasone with Salmeterol</td>
<td>2(40.0%)</td>
<td>5(71.4%)</td>
<td>7(58.3%)</td>
<td></td>
</tr>
<tr>
<td>Beclomethasone</td>
<td>0(0.0%)</td>
<td>1(14.3%)</td>
<td>1(8.3%)</td>
<td></td>
</tr>
<tr>
<td>No preventer</td>
<td>3(60.0%)</td>
<td>1(14.3%)</td>
<td>4(33.3%)</td>
<td></td>
</tr>
<tr>
<td><strong>Utilisation of asthma medication in accordance to Asthma Management Handbook 2006</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.276</td>
</tr>
<tr>
<td>In line with recommendations</td>
<td>2(40%)</td>
<td>5(71.5%)</td>
<td>7(58.3%)</td>
<td></td>
</tr>
<tr>
<td>Underprescribing of medication</td>
<td>3(60%)</td>
<td>2(28.6%)</td>
<td>5(41.7%)</td>
<td></td>
</tr>
<tr>
<td>Overprescribing of medication</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Compliance</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.721</td>
</tr>
<tr>
<td>Missed doses in past week (mean)</td>
<td>0.5 (N=2)</td>
<td>2.4 (N=6)</td>
<td>1.5 (N=8)</td>
<td></td>
</tr>
<tr>
<td>Nil</td>
<td>1(50.0%)</td>
<td>3(50.0%)</td>
<td>4(50.0%)</td>
<td></td>
</tr>
<tr>
<td>&lt; 10%</td>
<td>1(50.0%)</td>
<td>1(16.7%)</td>
<td>2(25.0%)</td>
<td></td>
</tr>
<tr>
<td>10 – 50%</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>0(0.0%)</td>
<td>1(16.7%)</td>
<td>1(12.5%)</td>
<td></td>
</tr>
<tr>
<td>All doses</td>
<td>0(0.0%)</td>
<td>1(16.7%)</td>
<td>1(12.5%)</td>
<td></td>
</tr>
</tbody>
</table>
Table 7: Subjects' asthma education demographics collected during first interview.

<table>
<thead>
<tr>
<th></th>
<th>Intervention (N=5)</th>
<th>Control (N=7)</th>
<th>Total (N=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
</tr>
<tr>
<td><strong>Level of asthma health literacy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well-educated</td>
<td>2(40.0%)</td>
<td>3(42.9%)</td>
<td>5(41.7%)</td>
</tr>
<tr>
<td>Some education</td>
<td>0(0.0%)</td>
<td>2(28.6%)</td>
<td>2(16.7%)</td>
</tr>
<tr>
<td>No prior education</td>
<td>3(60.0%)</td>
<td>2(28.6%)</td>
<td>5(41.7%)</td>
</tr>
<tr>
<td><strong>Source of asthma education</strong>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmacist</td>
<td>1(20.0%)</td>
<td>1(14.3%)</td>
<td>2(16.7%)</td>
</tr>
<tr>
<td>Doctor</td>
<td>3(60%)</td>
<td>6(85.7%)</td>
<td>9(75.0%)</td>
</tr>
<tr>
<td>Asthma Foundation</td>
<td>2(40%)</td>
<td>4(57.1%)</td>
<td>6(50%)</td>
</tr>
<tr>
<td>Friends</td>
<td>1(20%)</td>
<td>0(0.0%)</td>
<td>1(8.3%)</td>
</tr>
<tr>
<td>Self-educated (Internet)</td>
<td>2(40%)</td>
<td>1(14.3%)</td>
<td>3(25.0%)</td>
</tr>
</tbody>
</table>

*Subjects were able to choose more than one option.

4.3 Effects in asthma knowledge and asthma control after the intervention

The differences of asthma knowledge and asthma control results between the control group and the intervention group were analysed, and the statistical results are described in this Section. Given the small sample size and that parametric distribution could not be confirmed, the results were analysed using the student t-test and the ISMWU test. This was valid for the results of the asthma knowledge and asthma control, which showed no statistically significant difference between the intervention group and the control group (p>0.05).

There was no difference between the two groups, but we also did not observe any statistically significant difference after the introduction of the PFM, regardless of the location of subject (p>0.05).

4.3.1 Effect of PFM use on asthma knowledge between intervention and control group

The mean values of the asthma knowledge scores in each meeting for each group are represented in Figure 5. There was no statistically significant difference between the intervention group and control group in regards to their baseline asthma knowledge. The score in both groups appeared to decrease after the educational intervention and remained relatively stable in subsequent meetings.
Given the small sample size, nonparametric analyses were performed, which also showed no statistically significant difference between the two groups. In addition, the median scores in the intervention group were at the maximum throughout the three meetings, whereas there were slight changes in median score in the control group.

Change in asthma knowledge score was also assessed in all subjects before and after PFM utilisation (meeting two and three in the intervention group, and meeting three and four in the control group). PFM utilisation showed not to be statistically significant (t-test $p=0.226$; ISMWUT $P=0.210$).

The following paragraphs examine the results of the difference in scores from the asthma knowledge test. The longitudinal control showed no statistical significance in score of asthma knowledge test and was consistent between intervention group and control group (t-test $P=0.826$; ISMWUT $P=0.711$).

There was no change observed in asthma knowledge scores in subsequent meetings, where only two cases had a change in their score, which showed no statistical significance (Figure 6).
Figure 6: Difference of asthma knowledge scores: (A) between meeting two and meeting three where PFM was introduced in the intervention group (t-test $p=1.0$; ISMWUT $p=1.0$) and (B) between meeting three and meeting four where PFM was introduced in the control group (t-test $p=0.815$; ISMWUT $p=0.802$).

The differences between asthma knowledge score during the meetings were similar in both groups (Figure 7). The calculated median for the difference of asthma knowledge scores equalled zero for all differences of scores between the meetings in both groups.

Figure 7: Mean difference of asthma knowledge score of each group between subsequent meetings with error bars indicating 2 SD.
4.3.2 Effect of PFM use on asthma control between the intervention group and control group

The mean values of the asthma control scores in each meeting for each group are represented in Figure 8. Although there was no statistical significance, it appeared that the mean score was initially lower in the intervention group, and slightly decreased over subsequent meetings, whereas the mean asthma control score of the control group showed a higher variability. Median results of asthma control scores in both groups were very similar to the mean values.

![Figure 8: Mean asthma control scores of intervention group and control groups during meetings conducted with error bars indicating 2 SD.](image)

Change in score of the Asthma Control Test was also assessed in all subjects before and after PFM utilisation (meeting two and three in the intervention group, and meeting three and four in the control group) (Table 8). PFM utilisation showed not to be statistically significant (t-test p=0.889; ISMWUT P=0.804).

<table>
<thead>
<tr>
<th></th>
<th>Before introduction of PFM Mean (SD)</th>
<th>After introduction of PFM Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention (N=5)</strong></td>
<td>18.4 (4.0)</td>
<td>18.0 (5.1)</td>
</tr>
<tr>
<td><strong>Control (N=7)</strong></td>
<td>22.3 (2.3)</td>
<td>21.6 (2.8)</td>
</tr>
<tr>
<td><strong>Total (N=12)</strong></td>
<td>20.7 (3.6)</td>
<td>20.1 (4.1)</td>
</tr>
</tbody>
</table>
The differences of scores from the Asthma Control Test between the meetings were further examined. The results of the longitudinal control showed not to be statistically significant between the intervention group and control group (t-test $p=0.373$; ISMWUT $p=0.415$).

There was no change observed in asthma control scores in subsequent meetings, where more subjects from the control group than intervention group appeared to have an increased asthma control score after meeting three, which showed no statistical significance (Figure 9).

![Figure 9: Difference of asthma control scores: (A) between meeting two and meeting three where PFM was introduced in the intervention group (t-test $P=0.103$; ISMWUT $P=0.104$) and (B) between meeting three and meeting four where PFM was introduced in the control group (t-test $P=0.962$; ISMWUT $P=0.566$).](image)

The difference of score in the Asthma Control Test was slightly decreased after PFM provision in the intervention group if analysed using parametric analysis (Figure 10) but the result was opposite when analysed using nonparametric analysis expressed by median score. However, neither analysis showed any statistical significance in PFM-associated change of asthma score.
The Effects of Regular PFM Utilisation on Asthma Self-Management

4.4 Awareness in asthma self-management and asthma symptoms

Subjects’ perceived awareness of asthma was assessed using questions instead of a quantified scale. Every subject was asked if the information provided in the previous meeting improved his/her awareness about asthma, and what information provided would have increased his/her awareness. Awareness was defined as being more conscious about basic pathophysiology and knowledge of asthma, their triggers, asthma symptoms and their management plan. Additionally, subjects were asked if they were more engaged in their asthma management and if the information provided and/or their active involvement had an effect on their asthma.

4.4.1 Effects of educational intervention

The effects of educational intervention were found to be associated with subject’s baseline asthma health literacy. Most subjects were categorised as no prior education, reported to be more aware about their asthma and more engaged after the educational intervention, e.g. by visiting a doctor, purchasing a spacer, having a better compliance with their preventer medication (Table 9). Three subjects in this category mentioned that their asthma control had improved a lot due to the education provided.

Figure 10: Mean difference of asthma control scores of each group during subsequent meetings with error bars indicating 2 SD.
Table 9: Effect on asthma management after educational intervention.

<table>
<thead>
<tr>
<th>Effect of Education</th>
<th>Number of Subjects with no prior education (N=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visiting the doctor</td>
<td>2*</td>
</tr>
<tr>
<td>Purchasing a spacer (N=5)</td>
<td>2</td>
</tr>
<tr>
<td>Improving compliance (N=2)</td>
<td>2</td>
</tr>
<tr>
<td>Initiation of preventer medication (N=3)</td>
<td>2*</td>
</tr>
</tbody>
</table>

*Asthma education may not have been the primary reason why one of the subjects visited the doctor and started the preventer medication.

4.4.2 Effects of PFM initiation

The introduction of the PFM was found to increase all subjects’ awareness about their asthma and asthma symptoms, including subjects with mild asthma (Table 10). This included subjects being more aware of early asthma symptoms, which reaffirmed the requirement of reliever medication due to a sudden reduction in PEF (e.g. PEF<450L/min as identified by one of the subjects).

It was found that PFMs were also useful as a measure for asthma and to better understand asthma, particularly for subjects with a lower level of asthma health literacy. Some subjects reported better engagement in their asthma treatment, identification of asthma patterns and triggers, and improved compliance with preventer medication use. One subject stated that PFM use

“...reminds me that there is always something I did not do or did not pay attention to, which affects my asthma management, ...and I think it would increase my asthma control if I use it for longer.”

The majority of subjects agreed that it helped them quantifying their asthma and improved communication with their doctors, as they could provide data presenting their asthma control. Particularly, graph generation in the diary showing PEF results helped subjects in quantifying their asthma, confirmed their asthma status, and enabled earlier identification and treatment of worsening of asthma. Subjects, who reported worsening of their asthma, triggered by a change in season, increasing
humidity, respiratory infections or encountering stressful situations, identified a decrease in their PEF while experiencing asthma symptoms. One subject stated that

“...if the PEF is high I feel better and it is a good guide when the PEF goes down as an indication that my asthma gets worse and medication is needed.”

Table 10: Summary of the effect of PFM utilisation on subjects’ asthma.

<table>
<thead>
<tr>
<th>Effect after 4 weeks of PFM utilisation</th>
<th>Number of Subjects (N=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved awareness</td>
<td>12</td>
</tr>
<tr>
<td>Better quantification</td>
<td>12</td>
</tr>
<tr>
<td>Relationship of PEF with symptoms</td>
<td>11</td>
</tr>
<tr>
<td>Better perception of asthma symptoms</td>
<td>9</td>
</tr>
<tr>
<td>Better engagement due to education</td>
<td>6</td>
</tr>
<tr>
<td>Better engagement due to PFM</td>
<td>5</td>
</tr>
<tr>
<td>Better compliance to preventer medication</td>
<td>4</td>
</tr>
<tr>
<td>More confidence in controlling asthma</td>
<td>3</td>
</tr>
<tr>
<td>Earlier detection of asthma symptoms</td>
<td>2</td>
</tr>
<tr>
<td>Earlier initiation of treatment adjustments</td>
<td>1</td>
</tr>
<tr>
<td>Better control</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effect after 8 weeks of PFM utilisation</th>
<th>Number of Subjects (N=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable awareness</td>
<td>2</td>
</tr>
<tr>
<td>Further improved awareness</td>
<td>1</td>
</tr>
<tr>
<td>Better asthma control</td>
<td>1</td>
</tr>
</tbody>
</table>

However, not all subjects perceived the relationship between asthma symptoms and PEF results, where one subject reported a lack of association between the two. In addition, this study observed an issue with compliance to regular PFM utilisation. Although not all subjects followed the full instructions of PFM use, all subjects reported improvement in awareness and better communication to their doctors. The
majority (91.67%) also stated they identified a relationship between PEF reading and asthma symptoms, including the two subjects who only used the PFM for a very short period of time.

4.4.3 Eight weeks versus four weeks monitoring of PEF monitoring

The fourth meeting assessed asthma management in subjects allocated into the intervention group after approximately eight weeks, comprising five subjects. One subject reported having much better asthma control, due to a more suitable environment as well as regular PFM utilisation. Subjects with stable asthma reported no further increase in awareness of asthma control, as most of them were able to establish their baseline relatively quickly and knew when the PEF declines according to the subject’s symptoms.
4.5 Additional feedback of participants

Miscellaneous feedback from subjects is presented in Table 11.

Table 11: Additional feedback of subjects towards asthma self-management.

<table>
<thead>
<tr>
<th>Category</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement in asthma due to children</td>
<td>Most subjects who had children agreed that once their child was diagnosed with asthma, the parent showed more involvement in their own asthma management. (N=3)</td>
</tr>
<tr>
<td>PFM use for poor perceivers</td>
<td>PFM use helped subject (poor perceivers of asthma symptoms) in judging the severity of asthma, as PFM use often overcame under- or overestimation of asthma symptoms, thus increasing confidence in adjusting asthma treatment according to the AAP. (N=1)</td>
</tr>
<tr>
<td>Plan for long-term PFM use</td>
<td>Regular PEF measurements should be continued until the patient understands their asthma better and can interpret PEF values for their asthma self-management. Once baseline is established, it may be sufficient to only utilise the PFM if asthma worsens, comparing readings to the established baseline. (N=1)</td>
</tr>
<tr>
<td>Diet in asthma control</td>
<td>An increase of daily vitamin C intake was related to experiencing less asthma symptoms and better asthma control. However, an increased magnesium intake showed no further improvement of the subject’s asthma. (N=1)</td>
</tr>
<tr>
<td>Mobile applications for PEF records</td>
<td>There are mobile phone applications available to monitor BSL, which makes it easier for diabetics to record BSL results and gaining a better overview of their management. This concept could be applied to monitor PEF results to improve recording. (N=1)</td>
</tr>
</tbody>
</table>
5 Discussion

The study aimed to identify if PFM utilisation has an effect on asthma self-management. This part discusses the findings, and how the results and subjects’ feedback can be implemented to asthma management plans to improve asthma self-care.

5.1 Effect on asthma knowledge and control

This study shows that there is no statistical significance between the two groups of subjects in improving asthma knowledge or improving asthma control as a result of short-term PFM use.

Results show no significant change in asthma knowledge score, however subjects appear to have fluctuations in their asthma knowledge. These fluctuations may be improved by regular reviews, where the introduction of PFM utilisation may contribute to better outcomes. As the time intervals between the meetings may be sufficient for subjects to forget or become less aware about their asthma, their knowledge score may decline. However, as demonstrated in Figure 5 the initiation of PFM utilisation appears to maintain subjects’ knowledge or may even increase knowledge. This may be explained by subjects being more aware of their asthma during PFM utilisation and being reminded of their disease and of identification of triggers, supported by similar findings in a study by Reddel.91 Studies show that educational interventions including PEF monitoring can increase asthma knowledge,92 however no studies were found that support or investigate the effect of PFM use alone on asthma knowledge.

The study did not observe statistically significant effects on asthma control from PFM use, which can be attributed by the limitations of this study including a small sample size, factors triggering asthma and the restricted time frame for the completion of the study. The small subject number contributed significantly to the findings in asthma control, whereas the qualitative feedback is very positive, generating valuable data. Moreover, our study was conducted during the change of seasons in
The Effects of Regular PFM Utilisation on Asthma Self-Management

Darwin (June-October) where most of our subjects were exposed to known environmental factors that triggered their asthma. Similar results were observed in other studies. These factors included infection of influenza, cold temperatures, increased humidity and smoke from controlled bush fires. Most subjects believed that these factors have the largest effect on their asthma control during the study period, worsening their asthma. However, regular PFM utilisation showing a decrease in PEF and a relationship to asthma symptoms during worse asthma control helped subjects to be more aware about their asthma and asthma symptoms. A study by Janson et al observes similar results, particularly if the PEF declines prior to symptoms being noticed. For example, one subject was suffering from a lung infection while daily recording of PEF provided the ability to recognise the worsening of asthma and requirement for medication earlier. In addition, one subject with a previous respiratory condition and difficult to control asthma reported to have better asthma control contributed by PFM use after eight weeks. Regular PEF readings made the subject more aware about the subject’s lung function and asthma treatment. This contributed to better compliance and more confidence in treatment adjustments, which the subject perceived as improved asthma control reflected by increased PEF results. These observations are in line with other studies that show PFM utilisation is most beneficial in people with sub-optimal control. Thus, regardless of the influence of PFM use on asthma control, PEF recording was associated with an increased engagement in subjects’ disease management. This can potentially have a positive impact for asthma control on a long-term basis.

Compliance is an important factor in asthma management, including compliance to lifestyle adjustments, PEF monitoring and preventer medications, to achieve better asthma control. It was observed that PFM utilisation contributes to better compliance with preventer medications, which is consistent with the results of other studies. Some subjects attributed the improvement in compliance mainly due to the PFM acting as a reminder for them to use preventer medication and adherence to self-management including trigger avoidance. This benefit leads to more appropriate disease management and can potentially result in better asthma control.
5.2 Asthma awareness

This study found that PFM utilisation increased awareness of asthma and asthma symptoms during the short-term of approximately four weeks, according to the feedback from all subjects, which is in line with findings from a study by Janson et al.\textsuperscript{56} This was best seen in subjects who experienced deterioration in their asthma control with a simultaneous decrease in PEF. Most subjects reported to recognise the relationship between change in PEF readings and asthma symptoms with regular PEF measurements. Subsequently, subjects experienced increased awareness that helped the quantification of asthma, leading to an improved understanding of the condition. Personalised baseline values and PEF measurements enabled subjects to discover their individual values as indicators for their management. PFM utilisation was reported to help in reaffirming the worsening of asthma, and increased confidence in assessing and confirming medication adjustment requirements according to PEF results and asthma symptoms. Thus, subjects identified PEF results as a valuable measure for asthma, which helped in identifying triggers and developing personalised asthma management plans. Similar outcomes are observed in a study by Johns et al,\textsuperscript{39} which indicates that PFM utilisation helped patients to improve perception of symptoms and subsequently become more aware of the relationship between asthma severity and medical requirements. In addition, observations of this study are similar to findings from other studies, which suggest that regular PFM utilisation aids in early detection of airflow limitations.\textsuperscript{36,70} This can contribute to earlier consultation with a doctor, earlier and more suitable adjustments in asthma medication, and treatment of any causative condition, as observed in this study.

In addition, subjects with lower asthma health literacy prior to the educational and PFM intervention were associated with greater improvement in awareness of their condition, as well as with increased engagement in asthma self-management. These findings were evidenced by subjects purchasing a spacer to help with MDI use and improved compliance with preventer medication. Similar findings are reported in other studies.\textsuperscript{19,36,56}
Generally, studies indicate that PFM utilisation is valuable for moderate to severe asthma.\textsuperscript{7,25,38,44} However, this study observed increased awareness of asthma patterns among individuals with mild asthma, as well as those with a more severe disease status. Subjects with stable asthma or mild asthma may not require reliever medication when observing slight decreases in PEF, but the PFM was found to serve as a reminder of their disease and provide benefit by maintaining their awareness.

However, PFM utilisation for a longer time (including eight weeks as in this study) may cause difficulties in adherence, as it was observed that not all subjects were able to adhere to the instructions of PFM utilisation for this study. The relationship between PFM utilisation and increased asthma awareness still existed during this short time, but the benefit may not have continued after PFM utilisation was discontinued. Results showing adherence problems with long-term PFM utilisation are in line with findings by Bailey et al,\textsuperscript{70} while Pettersson et al observed high rates of adherence maintained for over one year.\textsuperscript{92} Regardless of long-term use, short-term utilisation was generally associated with better compliance.\textsuperscript{70,92} Thus, it may be considered to establish the individual’s baseline for a few weeks, with encouragement of continuous PFM utilisation. Additionally, patients that appear to have adherence difficulties should be recommended to resume regular PFM utilisation whenever they experience or expect to experience airflow limitations. The PEF results can then be compared to the established baseline, followed by regular reviews, which can contribute to better awareness of asthma symptoms and management as well as improve self-motivation. For any chronic disease, self-motivation is an essential factor for effective management.\textsuperscript{96-98} We designed this intervention so that self-motivation is required to achieve the ideal outcome in asthma management. Ultimately, the improved compliance potentially leads to better awareness and asthma control in the long-term.
5.3 Effect on communication with health care professionals

Increased awareness and better quantification of asthma as a result of the intervention has been observed to contribute towards better communication with health care professionals. We observed that subjects appeared to have increased enthusiasm and a better understanding of their disease. Most subject-provided feedback suggested that they are more prepared to discuss their asthma with their doctors, especially as regular PEF monitoring generated an important parameter to quantify their asthma history. Accordingly, PEF records acted as valuable measure of their asthma and for discussion points with their doctors. PEF records can also be presented to doctors and other health care professionals, to aid in evaluating patient’s asthma status and progression.\textsuperscript{39,82}

The study by Tharmrin et al has suggested that individual’s PEF records can be beneficial during hospital admissions, and potentially contribute to risk assessments of an exacerbation.\textsuperscript{82} A subject from this study has reported that during an asthma exacerbation that required hospital admission, the subject presented their PEF diary showing recent asthma history. This provision of PEF data was reported to be associated with more efficient treatment by doctors and nursing staff compared to not presenting the PEF diary.

In addition, the study also observed that after the educational intervention, some subjects visited their GPs to discuss their asthma management, which subsequently resulted in initiation of preventer medication use. However, underutilisation of preventer medication and the concern about ICS use has long been the reason for suboptimal asthma management.\textsuperscript{67} Such incidence was observed in a subject of this study, where the subject was told by their GP to only use reliever medications despite suboptimal control of asthma (according to current Australian guidelines\textsuperscript{38}), due to the fear of adverse effects of ICS. The presentation of PEF recording may better indicate the severity of the patient’s asthma, resulting in improved treatment decisions by the doctor. Thus, asthma control is not only subject to the patient’s management plan, education and compliance, but also decision making by health care professionals. Presentation of patient’s PEF results may ultimately improve
The Effects of Regular PFM Utilisation on Asthma Self-Management

communication with health care professionals and result in faster and more efficient decision-making.

5.4 Pharmacy intervention and Future Directions: Introduction of PFM utilisation
In current practice, pharmacists often educate and reassess the technique of using various inhaler devices among patients with asthma. However, despite the availability of PFMs in many community pharmacies, most pharmacists are playing a limited role in actively engaging patients in asthma education, asthma self-management or multidiscipline care for patients with asthma. Results of this study indicated that subjects did not often source their educational information from the pharmacist (Table 7).

Subjects’ feedback from this study suggested that implementation of PFM utilisation increases awareness of asthma control, which may subsequently improve asthma self-management and disease outcome. Given the characteristics and accessibility of community pharmacy, a service providing comprehensive asthma education, PFM utilisation, and ongoing monitoring should be integrated into pharmacy practice. It is speculated that such a service will be particularly beneficial for individuals who do not visit their doctor regularly. Not dissimilar to the management of diabetes mellitus, blood pressure monitoring, and cardiovascular disease monitoring, a multidisciplinary approach to optimise asthma control is desired to potentially improve asthma self-management.

However, the extent of the clinical benefit and value for such service provision cannot yet be determined by the outcome of this study.

Our findings provide a base for future studies, where limitations of this study and subjects’ feedback can be utilised for further studies to provide stronger evidence supporting integration of PFM utilisation into asthma self-management. Only then we can suggest it to be incorporated into advanced services provided by pharmacists. Services of this nature could be in line with other service incentive programs such as clinical interventions, MedsCheck, or Home Meudication Reviews. The intervention
should include asthma education, PEF monitoring as well as device and medication assessments, recognising that some pharmacists may need to take advanced training before such services can be provided effectively. Furthermore, services may be incorporated into partnerships with various organisations (e.g. Asthma Foundation) or with government funded initiatives (e.g. Community Pharmacy Agreement). Specific services may be funded by the agreement, supporting pharmacists in providing this service to the community. As this intervention may ensure patients receive a high quality of care, such a service would qualify for funding under programs such as the ‘Pharmacy Practice Incentive and Accreditation’ program. Since funding under the agreement only applies to evidence-based professional pharmacy programs and services, further studies should be conducted to fulfil the requirement. This study generates a base as a pilot study, however it does not show sufficient evidence to support PFM utilisation.

In future, other advanced technologies may be introduced to aid in self-management. As an example, mobile phone applications are successfully utilised to monitor BSL with very positive research results and good reviews by users. Currently for asthma, a few PEF monitoring applications are available, and only a limited amount of studies have been done, which found that the quality of this advanced technology requires improvement. However, it can make it easier to record PEF results, give an improved overview of asthma control, improve compliance and the ability to follow treatment plans. If such technology can be further advanced to incorporate an interactive asthma action plan with PEF recording, it may improve asthma control significantly.

This research project can provide further evidence for PFM education and PEF monitoring to be integrated into pharmacy practice, possibly contributing to evidence required for program funding.
5.5 Limitations

A few limitations have been identified which would have a significant influence on the outcome of this study. Although designed as a pilot study, the number of subjects recruited is below the anticipated sample size of about 35 subjects. The relatively small number of subjects was insufficient to provide significant results, rendering the study less powerful. As the research was conducted as a pilot study, findings serve as a guide for further research in examining effects of the PFM.

The study was conducted over the dry season in Darwin and some participants’ asthma was triggered by the change of seasons. As a result, subject’s asthma control and PEF readings were influenced by environmental factors as identified previously.

Due to the restricted time frame to complete this study, the effect on asthma self-management was only assessed for a short-term of eight weeks, and could not provide information about the long-term effects. A follow-up survey, conducted for a minimum of 12 months would be desirable. Such a study may also provide additional insight into the long-term effects of this intervention, including influences by changing seasons.

The asthma knowledge scores obtained from the asthma knowledge test showed no statistically significant difference, though subjects’ feedback suggested differently. This may be due to a limitation of the test, including the simplicity and suitability of questions. Most subjects achieved the highest score in the initial survey, thus improvement cannot be observed and questions should be adjusted accordingly to the study. Furthermore, some subjects were suspected of guessing the answer, where their score generated was in part dependent on chance. Thus, this test is not considered sensitive enough for a study that provides comprehensive education. In future studies, an originally designed asthma knowledge questionnaire would be recommended, focusing on the educational information provided. The questionnaire should be designed with questions containing more comprehensive details of asthma knowledge, such as information regarding the relationship between exercise and asthma, and PEF readings. However, such a questionnaire should avoid individualised questions that may not affect every subject. In addition, the asthma
control test is designed for doctor consultations and rapid self-assessment, however we found it was not suitable for the design of our study. Thus, improved questionnaires are recommended for further studies, where both questionnaires should be validated prior to the study to ensure suitability and quality of use.
6 Conclusion

Asthma is a common chronic disease in Australia characterised by symptoms restricting lung function, potentially leading to an acute exacerbation of asthma. Currently there is no cure available, therefore management focuses on pharmacological treatment and asthma self-management, where appropriate management can facilitate a symptom-free life for some patients. Components of self-management include PFM utilisation, which is poorly implemented due a lack of supporting data, although it has been found to benefit if integrated into a suitable asthma self-management plan. The results from this study indicate that short-term utilisation of the PFM did not statistically significantly influence asthma knowledge and asthma control measured by the adopted VQs. Four weeks appears to be an insufficient timeframe to assess improvement in asthma control. Additionally, asthma control was variable in many subjects due to environmental factors that triggered asthma symptoms and worsened asthma control. Provided asthma education contributed to a better awareness of asthma control, particularly in subjects who had no prior education.

Similarly, PFM utilisation during poor asthma control was associated with an increased awareness of asthma and earlier detection of asthma symptoms. Thus, the short period of four weeks was sufficient to improve awareness of asthma, as well as improve subjects’ ability to quantify their asthma. This enabled subjects to gain a better understanding of their asthma self-management, and was associated with improved compliance in some subjects. Long-term use of the PFM has the potential to improve asthma control, however more studies need to be conducted in this area.

The ideal role of PEF monitoring in asthma management is unclear, nevertheless daily PEF monitoring has been observed to be beneficial by generating data that can be used to assist in therapeutic decisions. Regular PFM utilisation increases awareness and quantification of asthma, making patients more confident in their management. Health care professionals play an important role in providing asthma education, and pharmacists are in a great position to provide asthma-related services, including promotion of PFM education and PEF monitoring. The ability to
provide and potentially receive funding towards these services requires further study to seek evidence supporting the integration of PFM utilisation into asthma self-management. This study provides information on important limitations that need to be considered and valuable feedback from subjects that can be used as a base for future studies.

Asthma symptoms and triggers vary largely among patients, thus treatment needs to be individualised to achieve optimal asthma control. This study demonstrated that comprehensive and individualised asthma education could have a positive effect on a person’s engagement in their asthma self-management, and potentially leads to better long-term asthma control.
The Effects of Regular PFM Utilisation on Asthma Self-Management

7 References


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8 Appendices

Appendix A: Asthma Action Plans

My Asthma Action Plan

When my asthma is WELL CONTROLLED
- No regular wheezing, cough or chest tightness at night times, or waking up during the day.
- Able to take part in normal physical activity without wheeze, cough or chest tightness.
- Need reliever medication less than three times a week (except if it is used before exercise).  
- Peak Flow® above

What should I do?
Continue my usual treatment as follows. Preventer.

Combination Medicine
- See my doctor to talk about my asthma getting worse
- See my doctor for advice

Always carry my reliever puffer

What should I start doing?
If I think I have an asthma attack, I should:
- Call an ambulance immediately and follow the action plan below, and:
- Take my inhaler press on my reliever puffer
- See my doctor immediately after an attack.

What should I do if?
- If I have an acute attack, CALL AN AMBULANCE IMMEDIATELY (111) and follow the action plan below, and:
- Take my inhaler press on my reliever puffer
- See my doctor immediately after an attack.

What happens in asthma?
Asthma inflames the airways. During an asthma attack, the air passages (tubes of the lungs) become inflamed, swollen and narrowed. Thick mucus may be produced and breathing becomes difficult. The tubes to coughing, wheezing and shortness of breath.

Asthma Triggers
Common asthma triggers are dust mite, pollen, animal fur, mold, tobacco smoke, and cold air. It is unusual but some foods may trigger asthma attacks.

Exercise is a common asthma trigger but can be well managed with pre-exercise medication and warm-up activities.

My known asthma triggers are:

Before exercise I need to warm up properly and take the following asthma medication:

Useful telephone numbers
- Asthma Foundation: 1800 000 120 for information and advice about asthma management
- My pharmacy:

How your symptoms controller helps
Symptoms controller helps people who still get symptoms even when they take regular preventer medications. If you need a symptom controller, it should be taken with your preventer medication. It should not be taken instead of a preventer.

Like your reliever medicine, your symptom controller helps widen the airways. But while your reliever works for around 6–8 hours, symptom controllers work for up to 12 hours at a time. However, they are not good for quick relief of symptoms so they should not be used for asthma first aid.

Symptom controllers are: Foradila and Dose (both brands of theophylline), and Seroflo (bromosuxim).

There are combination medications that combine a symptom controller and a preventer in one pill:
Combination medications are: Gemilide (theophylline and salmeterol) and Symbicort (budesonide and formoterol).

Your GP can advise you on the availability under the Pharmaceutical Benefits Scheme of the drugs mentioned above.

Julia Knobloch, CDU 2013

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# ASTHMA ACTION PLAN

**Name:** ………………………………………. **Date:** ………… **Best Peak Flow**…………………

*Not recommended for children under 12 years*

## WHEN WELL

**Asthma under control (almost no symptoms)**

<table>
<thead>
<tr>
<th>Drug Type</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventer</td>
<td></td>
</tr>
<tr>
<td>Reliever</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drug Type</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom controller (if prescribed)</td>
<td></td>
</tr>
<tr>
<td>Combination medication (if prescribed)</td>
<td></td>
</tr>
</tbody>
</table>

## WHEN NOT WELL

**Asthma getting worse (waking from sleep, first sign of a cold, using more reliever)**

<table>
<thead>
<tr>
<th>Drug Type</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventer</td>
<td></td>
</tr>
<tr>
<td>Reliever</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drug Type</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue symptom controller</td>
<td></td>
</tr>
<tr>
<td>Continue combination medication</td>
<td></td>
</tr>
</tbody>
</table>

Continue on this increased dosage for ………………… before returning to the dose you take when well.

## IF SYMPTOMS GET WORSE

**Asthma is severe (difficulty with normal activity, feel that asthma is out of control)**

- **Start prednisolone/prednisone and contact doctor**
  - Dose …………………
- **Extra steps to take:** ………………………………………………………………………………………
- **When your symptoms get better, return to the dose you take when well.**

## DANGER SIGNS

**(symptoms get worse very quickly, need reliever more than 1 hourly)**

<table>
<thead>
<tr>
<th>Drug Type</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue reliever</td>
<td></td>
</tr>
</tbody>
</table>

Dial 000 for ambulance

## Peak flow levels

- **Peak flow above**
- **Peak flow between** and
- **Peak flow below**

Doctor’s stamp and/or contact details: 
Pharmacist’s stamp and/or contact details:

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WHEN WELL

You will
- be free of regular night-time wheeze or cough or chest tightness
- have no regular wheeze or cough or chest tightness on waking or during the day
- be able to take part in normal physical activity without getting asthma symptoms
- need reliever medication less than 3 times a week (except if it is used before exercise)

WHEN NOT WELL

You will
- have increasing night-time wheeze or cough or chest tightness
- have symptoms regularly in the morning when you wake up
- have a need for extra doses of reliever medication
- have symptoms which interfere with exercise

(You may experience one or more of these)

IF SYMPTOMS GET WORSE, THIS IS AN ACUTE ATTACK

You will
- have one or more of the following: wheeze, cough, chest tightness or shortness of breath
- need to use your reliever medication at least once every 3 hours or more often

DANGER SIGNS

- Your symptoms get worse very quickly
- Wheeze or chest tightness or shortness of breath continue after using reliever medication or return within minutes of taking reliever medication
- Severe shortness of breath, inability to speak comfortably, blueness of lips

IMMEDIATE ACTION IS NEEDED: CALL AN AMBULANCE

Take this Asthma Action Plan with you when you visit your doctor.

To order more Asthma Action Plans, please visit the National Asthma Council Australia website: www.NationalAsthma.org.au

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The Effects of Regular PFM Utilisation on Asthma Self-Management

Appendix B: Symbicort® Asthma Action Plan

My Symbicort® Asthma Action Plan

Name: ____________________________

Date: ____________________________

GP: ____________________________

Usual best PEF: ___________ L/min

GP phone: ____________________________

Normal mode

- MY SYMBICORT ASTHMA TREATMENT IS:
  - Symbicort 100/6 µg OR
  - Symbicort 200/6 µg

- MY REGULAR TREATMENT EVERY DAY:
  - Take __ inhalation(s) in the morning
  - and __ inhalation(s) in the evening, every day

- RELIEVER:
  - Use Symbicort 1 inhalation whenever needed for relief of my asthma symptoms
  - I should always carry my Symbicort Turbuhaler

- MY ASTHMA IS STABLE IF:
  - I can take part in normal physical activity without asthma symptoms
  - AND
  - I do not wake up at night or in the morning because of asthma

OTHER INSTRUCTIONS: ____________________________

Asthma flare-up

- IF OVER A PERIOD OF 2–3 DAYS:
  - My asthma symptoms are getting worse OR not improving OR
  - I am using more than 6 Symbicort reliever inhalations a day,
  - I should:
    - Continue to use my regular everyday treatment
    - PLUS 1 inhalation Symbicort whenever needed to relieve symptoms
    - Start a course of prednisolone
    - Contact my doctor

- COURSE OF PREDNISOLONE TABLETS:
  - Take 2 x 25 mg or mg prednisolone tablets per day for __ days OR

- IF I NEED MORE THAN 12 SYMBICORT INHALATIONS (TOTAL) IN ANY DAY,
  - I must see my doctor or go to hospital the same day

Asthma emergency

- SIGNS OF AN ASTHMA EMERGENCY:
  - Symptoms getting worse quickly
  - Extreme difficulty breathing or speaking
  - Little or no improvement from Symbicort reliever inhalations

- IF I HAVE ANY OF THE ABOVE DANGER SIGNS, I SHOULD DIAL 000 FOR AN AMBULANCE AND SAY I AM HAVING A SEVERE ASTHMA ATTACK.

- WHILE I AM WAITING FOR THE AMBULANCE TO ARRIVE, START MY ASTHMA FIRST AID PLAN:
  - Sit upright and stay calm
  - Take 1 inhalation of Symbicort. Wait 1–3 minutes. If there is no improvement take another inhalation of Symbicort (up to a maximum of 6 inhalations)
  - If only Ventolin® is available, take 4 puffs as often as needed until help arrives
  - Start a course of prednisolone tablets (as directed) while waiting for the ambulance
  - Even if my symptoms appear to settle quickly, I should see my doctor immediately after a serious asthma attack
Appendix C: Survey

Peak Flow Meter: A tool for asthma self-management

Part 1: Guided survey

Basic Information - Demographics

1. How old are you as of the 1st January 2013?   
   __________

2. What is your gender?
   ☐ Female
   ☐ Male

3. Do you smoke?
   ☐ Never smoked
   ☐ Ex-smoker
      How long have you been smoking?   __________
   ☐ Currently smoking
      How much on average per day?   __________
      How long have you been smoking?   __________

4. Do you have any other medical conditions that affect your breathing (e.g. COPD, bronchitis)?

________________________________________________________________________
________________________________________________________________________

5. How many medications are you taking a day?   __________

Information about your asthma

1. Do you use an Asthma Action Plan?
   ☐ Yes ☐ No

2. Do you use a spacer (with or without a mask)?
   ☐ Yes ☐ No

3. Do you use a Peak Flow Meter?
   ☐ Yes ☐ No

4. What medication are you using for your asthma?

   Reliever
   ☐ Salbutamol (Airomir, Asmol, Ventolin, Butamol)
   ☐ Terbutaline (Bricanyl)
   ☐ Eformeterol (Oxis, Foradile) → Also as preventer
      ☐ with Budesonide (Symbicort)
   ☐ Ipratropium (Atrovent, Ipratrin, Ipravent)
The Effects of Regular PFM Utilisation on Asthma Self-Management

Preventer
- Salmeterol (Serevent)
- Beclomethasone (Qvar)
- Budesonide (Pulmicort)
- Ciclesonide (Alvesco)
- Fluticasone (Flixotide)
  - with Salmeterol (Seretide)

Others
- Cromoglycate (Intal, Cromese)
- Nedocromil (Tilade)
- Montelukast (Singulair)
- Omalizumab (Xolair)

5. How many doses of the preventer medication have you missed over the past week? _____ doses

6. Do you think you can live an asthma symptom free life?
   
<table>
<thead>
<tr>
<th>1 – Never</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 - Yes</th>
</tr>
</thead>
</table>

7. How well can you predict an asthma attack?

<table>
<thead>
<tr>
<th>1 – Never</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 – Every time</th>
</tr>
</thead>
</table>

8. Are you satisfied with the treatment and care you receive currently?

<table>
<thead>
<tr>
<th>1 – Not satisfied</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 – Completely satisfied</th>
</tr>
</thead>
</table>

9. Where do you usually receive your information and knowledge about asthma?
   - My doctor
   - My pharmacist
   - Friends
   - Internet
   - Other: ________________________
10. How severe is your asthma?

**Q. A:** On average, during the past week, how often were you woken up by your asthma during the night?

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly ever</th>
<th>A few times</th>
<th>Several times</th>
<th>Many times</th>
<th>A great many times</th>
<th>Unable to sleep because of asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
</tbody>
</table>

**Q. B:** On average, during the past week, how bad were your asthma symptoms when you woke up in the morning?

<table>
<thead>
<tr>
<th>No symptoms</th>
<th>Very mild symptoms</th>
<th>Mild symptoms</th>
<th>Moderate symptoms</th>
<th>Quite severe symptoms</th>
<th>Severe symptoms</th>
<th>Very severe symptoms</th>
</tr>
</thead>
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</tbody>
</table>

**Q. C:** In general, during the past week, how limited were you in your activities because of your asthma?

<table>
<thead>
<tr>
<th>Not limited at all</th>
<th>Very slightly limited</th>
<th>Slightly limited</th>
<th>Moderately limited</th>
<th>Very limited</th>
<th>Extremely limited</th>
<th>Totally limited</th>
</tr>
</thead>
<tbody>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Q. D:** In general, during the past week, how much shortness of breath did you experience because of your asthma?

<table>
<thead>
<tr>
<th>None</th>
<th>Very little</th>
<th>Little</th>
<th>Moderate amount</th>
<th>Quite a lot</th>
<th>A great deal</th>
<th>Very great deal</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

**Q. E:** In general, during the past week, how often did you feel frustrated as a result of your asthma?

<table>
<thead>
<tr>
<th>None</th>
<th>Very little</th>
<th>Little</th>
<th>Moderate amount</th>
<th>Quite a lot</th>
<th>A great deal</th>
<th>Very great deal</th>
</tr>
</thead>
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</tbody>
</table>

**Q. F:** In general, during the past week, how often were you bothered by coughing?

<table>
<thead>
<tr>
<th>None</th>
<th>Very little</th>
<th>Little</th>
<th>Moderate amount</th>
<th>Quite a lot</th>
<th>A great deal</th>
<th>Very great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
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</tbody>
</table>

**Q. G:** In general, during the past week, how often did you feel afraid of not having your asthma medication available?

<table>
<thead>
<tr>
<th>None</th>
<th>Very little</th>
<th>Little</th>
<th>Moderate amount</th>
<th>Quite a lot</th>
<th>A great deal</th>
<th>Very great deal</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

**Q. H:** In general, during the past week, how much time did you wheeze?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Hardly any of the time</th>
<th>A little of the time</th>
<th>Some of the time</th>
<th>Lot of the time</th>
<th>Most of the time</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
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</tr>
</tbody>
</table>

**Q. I:** In general, during the past week, how much of the time did you experience a feeling of chest tightness or chest heaviness?

<table>
<thead>
<tr>
<th>None of the time</th>
<th>Hardly any of the time</th>
<th>A little of the time</th>
<th>Some of the time</th>
<th>Lot of the time</th>
<th>Most of the time</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
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</tbody>
</table>

**Q. J:** In general, during the past week, how many puffs of short-acting bronchodilator (e.g. Ventolin) have you used each day?

<table>
<thead>
<tr>
<th>None</th>
<th>1-2 puffs most days</th>
<th>3-4 puffs most days</th>
<th>5-8 puffs most days</th>
<th>9-12 puffs most days</th>
<th>13-16 puffs most days</th>
<th>More than 16 puffs most days</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
</tr>
</tbody>
</table>
Part 2: Participant Survey

Participant: ____________________

Asthma knowledge

1. Asthma is caused by an inflammation of the inner lining of the bronchi of the lungs.
   - True
   - False

2. Which of the following can make asthma worse?
   - Household dust mites
   - Pollen and outdoor mold
   - Secondhand smoke
   - All of the above

3. Dust mites can be eliminated simply by washing sheets in warm water.
   - True
   - False

4. A peak flow meter records how many asthma attacks you have had.
   - True
   - False

5. Treating chronic asthma usually involves taking medication.
   - True
   - False

6. Until more is known, asthma patients can do little to help themselves.
   - True
   - False
**Asthma control**

**Q. 1:** During the past 4 weeks, how often did your asthma prevent you from getting as much done at work, school or home?

- All of the time
- Most of the time
- Some of the times
- A little of the time
- None of the time

**Q. 2:** During the past 4 weeks, how often have you had shortness of breath?

- More than once a day
- Once a day
- 3-6 times a week
- 1-2 times a week
- Not at all

**Q. 3:** During the past 4 weeks, how often did your asthma symptoms (wheezing, coughing, chest tightness, shortness of breath) wake you up at night or early in the morning?

- 4 or more times a week
- 2-3 nights a week
- Once a week
- Once or twice
- Not at all

**Q. 4:** During the past 4 weeks, how often have you used your reliever inhaler (usually blue; to relief symptoms)?

- 3 or more times a day
- 1-2 times a day
- 2-3 times a week
- Once a week or less
- Not at all

**Q. 5:** How would you rate your asthma control during the past 4 weeks?

- Not controlled
- Poorly controlled
- Somewhat controlled
- Well controlled
- Completely controlled

Thank you for your participation.

You’re contribution is very much appreciated.

If you have any further questions please contact:

Julia Knobloch (primary investigator): s198154@students.cdu.edu.au

Dr. Kwang Choon Yee (supervisor): KwangChoon.Yee@cdu.edu.au

Disclaimer:

This questionnaire is composed by a validated source:

1. Asthma Knowledge Test by NIH MedlinePlus.
2. Asthma Control Test by Asthma UK.
Appendix D: First Meeting Procedure

Meeting Procedure

1. Survey
   o Part 1
   o Part 2

2. What is asthma?
   o Causes (what, who)
   o Pathophysiology
   o Symptoms (early and late)

3. Medications
   o Relievers
   o Preventers
   o Symptom controller
   o Combination
   o Others (Ipratropium, Montelukast, Cromones, Theophylline, Predisolone)

4. Devices
   o Inhalers:
     • Devices (MDI, Accuhaler, Turbohaler, Autohaler)
     • Inhaler technique
     • Maintenance
   o Spacer:
     • Benefits
     • Technique
     • Maintenance
   o Nebuliser
     • Benefits
     • Technique
     • Maintenance

5. Symptoms
   o How do you notice symptoms? (mild, moderate, severe)
   o When? How often? Triggers?
   o Attack:
     • Management plan (4x4x4)
     • Medications
   o When to see the doctor?

6. Management
   o Aim of treatment
   o Medication (use, storage, expiry)
   o Regular doctor visits (review management, medications, techniques)
   o Asthma Action Plan
   o Breathing exercises
• Lifestyle: (AF: In Home)
  • Identify and avoid triggers (colds, pollen, exercise, dust, temperature, emotions...)
    • Diary
    • Tips for the home
  • Asthma First Aid (reliever, friends are informed)
  • Exercise
  • Weight maintenance (BMI)
  • Diet
  • Check other medications

7. Exercise-induced
  • Medication management (when, SABA, preventers)
  • Maintain fitness (increases threshold)

8. Breastfeeding and Pregnancy
  • Breastfeeding: Inhalers are safe
  • Pregnancy
    • Prepare for worsening of asthma
    • Possible complications
    • Medications and categories
    • Management and reviews

9. Seniors
  • Facts and statistics
    • What is normal with aging?
    • Prevalence of asthma (can start at any age) and related deaths
  • Management
    • Trigger are often meds, smoke, exercise
    • Vaccinations (influenza, pneumococcal)
    • Review medications/device techniques/AAP frequently (aging = dynamic change)
    • Monitor for other lung diseases

10. Programs
  • National
  • Local
Appendix E: Asthma-related Diet

**Asthma-related diet**

There is inconclusive data about the relationship between diet and asthma.

Diet that may improve asthma control:

1. Generally, a healthy diet including fruits and vegetables (unclear which ones) improves asthma control.
2. Some studies found that asthma rates were lower in people eating more:
   a. Vitamin C: major antioxidant in airways
   b. Vitamin E: reduces incidence of attacks
   c. Vitamin D and antioxidants: reduce severity and risk of attacks
   d. Vitamin A: protective effect, especially against exercise-induced asthma
   e. Beta-carotene: protects against exercise-induced asthma
   f. Magnesium: has a bronchodilator effect (supported by good evidence and data) and is also used to treat/prevent muscle cramps. Additionally, it had been observed that asthma patients often have a deficiency in magnesium and antioxidants. Therefore supplements may be beneficial in improving asthma control.
   g. Omega-3 fatty acids (salmon, tuna, sardines, some plant sources e.g. flaxseed)
3. Also, beverages containing caffeine have been shown to cause slight bronchodilation.

Diet that may worsens asthma control:

1. There are specific foods that trigger asthma, which include milk, eggs, shellfish, fish, citrus, peanuts, soya. However, not all asthma patients react to these triggers.
2. Some preservatives may trigger asthma, such as sulphites, as they release sulfur oxide that irritates the lungs. It may be found in some processed foods, dried fruits, canned vegetables and wine.
3. A high sodium diet potentially increases airway responsiveness, however this claim is supported by only low evidence.
4. Trans fats and omega-6 acids may increase the risk of an asthma attack and contribute to the worsening of other diseases (e.g. heart disease), whereas full fat cream/butter reduces the risk in children.
5. Echinacea is used to prevent and treat cold and influenza, however it may cause bronchoconstriction in some asthma patients.
6. In the USA, there is an increasing prevalence of asthma, which may be linked to a poor diet by eating fewer fruits and vegetables and an increased diet of processed food.
7. Food causing reflux can worsen asthma control. In order to prevent reflux it is recommended to eat smaller meals, to consume less alcohol and caffeine, to avoid food triggers (e.g. spicy or fatty meals), and to avoid eating before lying down.
Appendix F: Peak Flow Meter Information Sheet

Peak Flow Meter

Technique:
- Pointer of the PFM needs to be reset to the end of the slot
- Person should be standing or sitting erect
- Optional: Nose clip
- Breath in fully with lips sealed around the mouthpiece
- Exhale as fast as possible into the PFM using maximal force (max force occurs during the first seconds of expiration)
- Read: Location of the pointer on the PFM
- Repeat 3 times and report the largest value

It is recommended to review technique and baseline once a year, due to disease progression and growth (children)

Normal values vary depending on the person:
- Men have larger PEF
- PEF increases until the age of 20 (females) and 25 (males), and decreases after
- Weight
- Increasing height increases PEF, as it increases the total volume of tissues
- African Americans and Hispanics have a 10% lower PEF

Establish baseline:
- PEF measurements are best compared to your best value (baseline)
  → Because of the variables in different users, their ability to use it, and the device itself
- Baseline is established by daily measurements in the morning before using Ventolin (for 1-3 weeks) with optimal treatment
  → At the same time each day due to variations throughout the day

Guidelines in Australia:
- Green zone:
  o PEF: 76-100%
  o Normal PEF & acceptable therapy
- Yellow zone:
  o PEF: 50-75%
  o Moderate asthma control or imminent attack & reliever use
- Red zone:
  o PEF: < 50%
  o Medical emergency & reliever use (4x4x4)

High-risk asthma patients:
- Morning dips of PEF of less than 60%
- Diurnal variations of more than 25%
  → Require close monitoring
The Effects of Regular PFM Utilisation on Asthma Self-Management

Appendix G: Project Flyer

CHARLES DARWIN UNIVERSITY

Pharmacy discipline, School of Psychological and Clinical Sciences
Charles Darwin University

Peak Flow Meter: A tool for asthma self-management

Hello,

I am looking for adults with asthma who would like to participate in a research project.

I am Julia Knobloch, a Pharmacy Honours Student at Charles Darwin University, and I am conducting a research project about the use of a peak flow meter in the management of asthma.

The study will involve people with asthma who are not using a peak flow meter for their asthma self-management. The peak flow meter is a device that measures maximal speed you can exhale in one forced breath, which helps you identify any limitations to your breathing.

If you are interested in taking part of this study, please contact:

Primary Researcher: Miss Julia Knobloch, email: s198154@students.cdu.edu.au

Or Primary Supervisor: Dr Kwang Choon Yee, email: KwangChoon.Yee@cdu.edu.au; phone (office hours): (08) 8946 6566
What the study involves:

You are invited to complete three questionnaire surveys, that include questions about your asthma, and three meetings with the principle researcher which will take place at a time and location convenient to you, e.g. at the Charles Darwin University. In these meetings we will talk about your asthma, and the primary investigator will provide you with a peak flow meter and diary to record your measurements, and teach you how to use them. The surveys should take about 5 to 10 minutes to complete.

These surveys are completely confidential and identifiable information will only be used to compare your results. Only researchers directly involved in the study will have access to this information.

Your participation in this study is entirely voluntary and you can withdraw anytime.

The study has been approved by the Charles Darwin University Ethics Committee. If you have any concerns of an ethical nature of complaints about the manner in which the study is being conducted you can contact:

Ethics Administrator Officer, CDU, Human Research Ethic Committee & Animal Ethics Committee; phone: (08) 8946 6923 or email: cdu-ethics@cdu.edu.au

Disclaimer:

These pictures are sourced from:

2. Blue Cross Blue Shield of Kansas via the URL <http://www.bcbsks.com/behealthy/DiseaseMgmt/Asthma/peakFlow.htm>
The Effects of Regular PFM Utilisation on Asthma Self-Management

Appendix H: Plain Language Statement

PLAIN LANGUAGE STATEMENT

RESEARCH PROJECT: Peak Flow Meter: A tool for asthma self-management.

CHIEF RESEARCHER: Julia Knobloch, Bachelor of Pharmacy (Honours) Student, Charles Darwin University, Australia.

SUPERVISOR: Dr Kwang Choon Yee, BPharm (Hons) PhD, Pharmacy Lecturer, School of Psychological and Clinical Sciences, Charles Darwin University, Australia.

SECONDARY SUPERVISOR: Mrs Mary-Jessimine Bushell (Hons) BPharm, Pharmacy Lecturer, School of Psychological and Clinical Sciences, Charles Darwin University, Australia.

PURPOSE OF THE STUDY: The objective of this study is to investigate whether the use of a peak flow meter improves self-management among a sample of patients diagnosed with asthma.

BENEFITS OF THE STUDY: The results of this study may provide information for health professionals when managing asthma. It may help health professionals to provide better health care advice on asthma self-care management in the future, as well as improving the provision of health information. The study will promote the use of a peak flow meter in a sample population as recommended with Asthma Management Plans. This study may direct future studies in this area.

You will be given information about asthma, as well as information about the effects and benefits of optimal treatment to your asthma control. In the study you will be given a peak flow meter, and we will explain to you how to use it.

This study may or may not have a direct benefit to you personally. However, you may benefit from knowing more about your asthma and how to improve your asthma control.

WHAT WOULD BE EXPECTED OF YOU?: If you do decide to participate in this project you will be asked to meet three times with the researcher, complete three questionnaires (4 weeks in between), listen to asthma education, and use a peak flow meter.

Meetings with the primary researcher will take place at a time and public location convenient to you (e.g. at the Charles Darwin University). The first meeting will take place in June. The second meeting will occur 4 weeks after your first meeting, and the third meeting will be scheduled 4 weeks after your second meeting.

During the first meeting, the researcher will ask you a few questions about your health and your asthma (e.g. your age, are you a smoker), the researcher will then give you information of how to look after your asthma. Participants will then be divided into two groups. The researcher will give you a peak flow meter and teach you how to use it during the second or third meeting, depending on your allocated group for this study.

You will be asked to complete a short questionnaire during all three meetings. Each questionnaire will take approximately 5 to 10 minutes to complete.

RISKS: There are no anticipated risks associated with participating in this project. If you have concerns with the conduct of the study please contact the Executive Officer of the CDU Human Research Ethics Committee toll free on 1800 466 215, or email cdu-ethics@cdu.edu.au to have your concerns raised with the appropriate officers within the University.
CONFIDENTIALITY: The data you provide will be kept confidential, and no identifying information will be accessible to anyone other than the researchers of this project. Only group data will be analysed and reported.

PARTICIPATION: Your participation in this project is entirely voluntary and you are free to decline to take part in any of the questionnaires or any other part of this research. You will also have the opportunity to withdraw from the project at any stage during the study, by simply disposing the survey in a waste bin and/or cancelling the meeting with the principle researcher, Julia Knobloch. Any information gathered previously will be removed and properly disposed once you indicate your withdrawal to the researcher.

RESULTS OF THE STUDY: In December 2013, you will have the opportunity to review a summary of the project’s results, by contacting the principle researcher, Julia Knobloch by email: s198154@students.cdu.edu.au. Alternatively the summary of the result will be made available on the Charles Darwin University Pharmacy Honours website in December 2013 <Note: portal link will be inserted after being created>.

PERSON TO CONTACT: If you require further clarifications or have questions about this project, please do not hesitate to contact the principle researcher, Julia Knobloch by email: s198154@students.cdu.edu.au or (primary supervisor) by email: KwangChoon.Yee@cdu.edu.au or by telephone: 8946 6566.
If you have concerns regarding this study at any stage, please contact the Executive Officer of the CDU Human Research Ethics Committee toll free on 1800 466 215, or email cdu-ethics@cdu.edu.au. The executive officer will be able to notify the appropriate person with the University about your concerns.

ETHICAL GUIDELINES: This project will be executed in accordance with the Australian Code for the Responsible Conduct of Research, as defined by the National Health and Medical Research Council of Australia.

Thank you for dedicating some of your time to reading this statement, and considering its contents.

This copy of the plain language statement is for you to keep.
Appendix I: Consent Form

Consent Form

_Peak Flow Meter: A tool in asthma self-management_

Declaration:

- I have read and understood the plain language statement.
- I am 18 years of age or older.
- I voluntarily agree to take part in this study.
- I agree that research data gathered for the study may be published provided that I cannot be identified as a subject.

I accept the above declarations: ☐ ☐

Signature: ............................................................ Date: ..............................................

Name: ........................................................................

Peak Flow Meter Study 2013
28 May 2013

Ms Julia Knobloch
1/15 Athanasiou Rd
Coconut Grove NT 0810

S198154@students.cdu.edu.au

Re: Peak Flow Meter: a tool for asthma self-management

Dear Julia,

Thank you for your responses to the issues raised previously by the Faculty Human Ethics Committee (FHEC). These responses are accepted. The Committee will now recommend to the Human Ethics Research Committee (HREC) that approval be given to your application for ethics clearance. This recommendation will be considered for ratification at the next full meeting of the CDU HREC. In the meantime, however, you have provisional approval to commence your research project.

The Committee prefers to use email wherever possible, however if there is a problem with this, please advise the Chair. Best wishes with your project.

Yours sincerely,

Dr Bev Turnbull
Chair
Faculty Human Ethics Committee
Faculty of Engineering, Health, Science and Environment

Cc. Dr Kwang Choon Yee
The Effects of Regular PFM Utilisation on Asthma Self-Management

Appendix K: Formal Approval from Ethics Committee

10 July 2013

Ms Julia Knobloch
1/15 Athanasiou Rd
Coconut Grove
NT 0810

Dear Ms Julia Knobloch,

RE: H13072 Knobloch, Peak Flow Meter: a tool for asthma self-management

RATIFICATION OF FACULTY ETHICS COMMITTEE/ HREC CHAIR'S DECISION

At Human Research Ethics Committee meeting 4/13, held on 20th June 2013, the Committee was advised that your application for ethics clearance had been approved by the HREC Chair.

The Committee ratified this EHSE FEC approval.

A notice of clearance has already been issued.

You are reminded that the expiry date of ethics approval for your project is 20th June 2014.

It is the responsibility of the researcher to ensure that ethics approval is renewed prior to the expiry date. If renewal is necessary, you will need to submit a progress report including a statement of compliance with ethical requirements, and detailing any proposed or actual changes to the project, which may affect its ethical acceptability.

Renewal/Final Report forms are available from the Web at:

Should any significant alterations to your project be contemplated, or if any matters arise which may conceivably affect the continued ethical acceptability of the project, you are required to immediately notify the Human Research Ethics Committee.

Yours sincerely

[Signature]

Professor Sharon Bell
Chair, Human Research Ethics Committee

Cc, Supervisor: Kwang Yee@cdu.edu.au

OFFICE OF RESEARCH AND INNOVATION
T: +61 8 8946 6923 | F: +61 8 8946 7066 | E: cdu-ethics@cdu.edu.au