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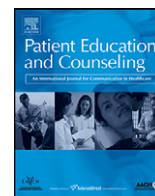


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# Asthma disease management—Australian pharmacists' interventions improve patients' asthma knowledge and this is sustained

Bandana Saini<sup>a</sup>, Kate LeMay<sup>a</sup>, Lynne Emmerton<sup>b</sup>, Ines Krass<sup>a</sup>, Lorraine Smith<sup>a</sup>,  
Sinthia Bosnic-Anticevich<sup>a</sup>, Kay Stewart<sup>c</sup>, Deborah Burton<sup>d</sup>, Carol Armour<sup>a,e,\*</sup>

<sup>a</sup> Faculty of Pharmacy, The University of Sydney, Sydney, Australia

<sup>b</sup> School of Pharmacy, The University of Queensland, Brisbane, Australia

<sup>c</sup> Department of Pharmacy Practice, Monash University, Melbourne, Australia

<sup>d</sup> School of Biomedical Sciences, Charles Sturt University, Wagga Wagga, Australia

<sup>e</sup> Woolcock Institute of Medical Research and Faculty of Medicine, The University of Sydney, Sydney, Australia

## ARTICLE INFO

### Article history:

Received 15 December 2010

Received in revised form 28 April 2011

Accepted 2 May 2011

### Keywords:

Asthma

Knowledge

Self-management

Pharmacist

## ABSTRACT

**Objective:** To assess any improvements in knowledge of asthma patients after a tailored education program delivered by pharmacists and measure the sustainability of any improvements. To ascertain patients' perceptions about any changes in their knowledge.

**Methods:** Ninety-six specially trained pharmacists recruited patients based on their risk of poor asthma control. A tailored intervention was delivered to patients based on individual needs and goals, and was conducted at three or four time points over six months. Asthma knowledge was assessed at the beginning and end of the service, and six and 12 months after it had ended. Patients' perceptions of the impact of the service on their knowledge were explored qualitatively in interviews.

**Results:** The 96 pharmacists recruited 570 patients, 398 (70%) finished. Asthma knowledge significantly improved as a result of the service ( $7.65 \pm 2.36$ ,  $n = 561$ , to  $8.78 \pm 2.14$ ,  $n = 393$ ). This improvement was retained for at least 12 months after the service. Patients reported how the knowledge and skills gained had led to a change in the way they managed their asthma.

**Conclusion:** Improvements in knowledge are achievable and sustainable if pharmacists used targeted educational interventions.

**Practice implications:** Pharmacist educational interventions are an efficient way to improve asthma knowledge in the community.

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## 1. Introduction

Self-management has been a key concept for improving patient care in chronic illness for over a decade. One of the issues with patient self-management in chronic disease is improving patient understanding of how to control and monitor his/her condition. Asthma is a disease in which knowledge of the underlying inflammation, the episodic nature of symptoms, trigger factors for exacerbations, as well as the benefits and risks of medications, can help to improve self-care and adherence to disease-controlling drugs. Taken by itself, knowledge about asthma may not have a direct impact on the practical skills of disease management, but it contributes to patients' ability to adapt to the disease [1]. It has been shown that in patients with asthma, knowledge of the disease

and adherence to treatment are associated with better control, better adherence and improved quality of life [2–4]. Thus, enhancing patients' asthma knowledge is an important preliminary step to achieving better outcomes in the longer term. For this reason, education and counseling are components of many structured asthma programs, and asthma management guidelines are designed to improve patient knowledge as a prerequisite step to improved health outcomes [5].

Despite this emphasis in guidelines on enhancing patients' asthma knowledge, research repeatedly indicates that patients' asthma knowledge is suboptimal [6–8]. It has also been established that in higher-risk groups, such as those with poor control, asthma knowledge and awareness are lower than in the general population with asthma [9]. Similarly, in people with non-adherent asthma behaviors, low levels of asthma knowledge are independently associated with poorer quality of life [10]. Therefore, education and care programs must be able to effectively enhance patients' knowledge of the condition, particularly those in higher-risk groups.

\* Corresponding author at: Woolcock Institute of Medical Research, PO Box M77, Missenden Rd, NSW, 2050, Australia. Tel.: +61 2 9114 0040; fax: +61 2 9114 0014.

E-mail address: [carol.armour@sydney.edu.au](mailto:carol.armour@sydney.edu.au) (C. Armour).

The way in which patient education is conducted is also important. If learning deficits are not identified and appropriately addressed by the health care professional (HCP), learning will not occur. Gaps have been reported between patient information needs and the delivered healthcare [11–14]. From the patient's perspective, dissatisfaction with the lack of individualization of asthma information provided has been reported [15]. In tailoring asthma education, there is a need to take into account the age, individual needs, health beliefs, socioeconomic-cultural context, preferences and prior experience of the patient [16–24].

The design and delivery of 'optimal' asthma education programs involves more than transmission of knowledge. These programs are multifaceted and should focus on actual individual patient needs. They must address knowledge, skills and attitudes as well as encourage regular medical reviews and written asthma action plans [25]. Structured education programs that include ongoing support and monitoring/feedback have achieved greater improvements in patient self-care and quality of life as well as health outcomes than those that do not [26–30]. Despite what is known about key elements of asthma education, education opportunities are not fully utilized by HCPs. Further, there is evidence that many HCPs are unaware of their patients' level of understanding of asthma management and their medication taking behavior. Hence there is a need to improve asthma education and diversify the access to such education. Every HCP involved in asthma management should take the opportunity to reinforce key messages about the disease and its treatment.

In primary care, when it comes to delivering asthma education, pharmacists are in a unique position both in regards to the nature and frequency of intervention delivery. Pharmacists are usually the last HCP to see the person with asthma before the patient decides to use, or not use, the prescribed medication. Pharmacists also see the patient more frequently than other HCPs, as patients collect repeat prescriptions. This provides the pharmacist with further opportunities to monitor the patient. It has been demonstrated that community pharmacies are suitable venues to identify patients in need of asthma education, i.e. those with poorly controlled asthma and those with poor medication adherence identifiable through pharmacy records [31,32].

It has also been shown that, as a result of pharmacists delivering structured programs focusing on a partnership with the patient, improved health outcomes for people with asthma can be achieved. Pharmacist interventions have been shown to improve asthma control, asthma knowledge and self-care in disease management [26,33,34]. Different approaches to asthma education delivery have now been tested in pharmacies, e.g. group education, individualized education and outreach education [34–36]. In most cases, asthma care programs have been delivered across a period of six months to a year, with very few reporting ongoing patient monitoring beyond the period of program delivery [37,38]. Moreover, many studies of pharmacy-based asthma care programs do not report on the 'frequency' of the education/care sessions [37]. This is possibly an important determinant, as it can affect patient retention of new knowledge [39].

In Australia, a pharmacy asthma care program, based on several research pilot studies, was tested in a randomized control trial with very positive clinical, humanistic and economic outcomes [26,40]. This program explored the outcomes from either three or four patient consultations over six months and the consultations included tailored patient education. To design sustainable pharmacy-based programs, research should offer direction about the frequency and duration of time over which such services may be offered, and what can be achieved. Sustained positive outcomes and the drive to keep delivering or attending such services may rely on such services comprising both clinical and humanistic perspectives [41,42].

Thus, the research questions are:

- (a) can pharmacists deliver improvements in asthma knowledge if they tailor the education program to the patient's needs, and if improvements are achieved how sustainable are they? and
- (b) what are patients' views about any changes in their asthma knowledge?

## 2. Methods

This study reports on the asthma knowledge scores from patients enrolled in a six-month intensive asthma service delivered between January and November 2009. Key features of this pharmacy asthma service were founded in the literature and previous research [26]. Patients attended either three or four visits at their pharmacy over a six-month period, and educational needs were assessed by the pharmacists, so that the educational interventions delivered were targeted to individual needs (Fig. 1).

A subset of patients received a follow-up visit six months after the end of the intensive service, while the remainder received mailed questionnaires. All patients who completed the six-month follow-up visit or questionnaires were also mailed questionnaires 12 months after the end of the service (Fig. 1).

The study protocol was approved by the Human Ethics Committees of The University of Sydney (NSW), Charles Sturt University (NSW), The University of Queensland (Qld) and Monash University (Vic). All pharmacists and patients provided written informed consent.

### 2.1. Pharmacist recruitment

Pharmacist recruitment occurred by invitation through a web interface established by a pharmacy body (The Pharmacy Guild of Australia). The pharmacies chosen to participate were proportionally sampled from regional and metropolitan areas in four states/territories in Australia: New South Wales, Queensland, Victoria and the Australian Capital Territory. Recruited pharmacists were specially trained in advanced asthma care; this training was accredited by the Australian Association of Consultant Pharmacy. The training was held over two days, and incorporated pathophysiology and treatment of asthma, recruitment and motivation of patients, lung function testing, and how to use the supplied service protocol effectively. Pharmacists were also offered the opportunity to call the research team if they were in doubt at any stage.

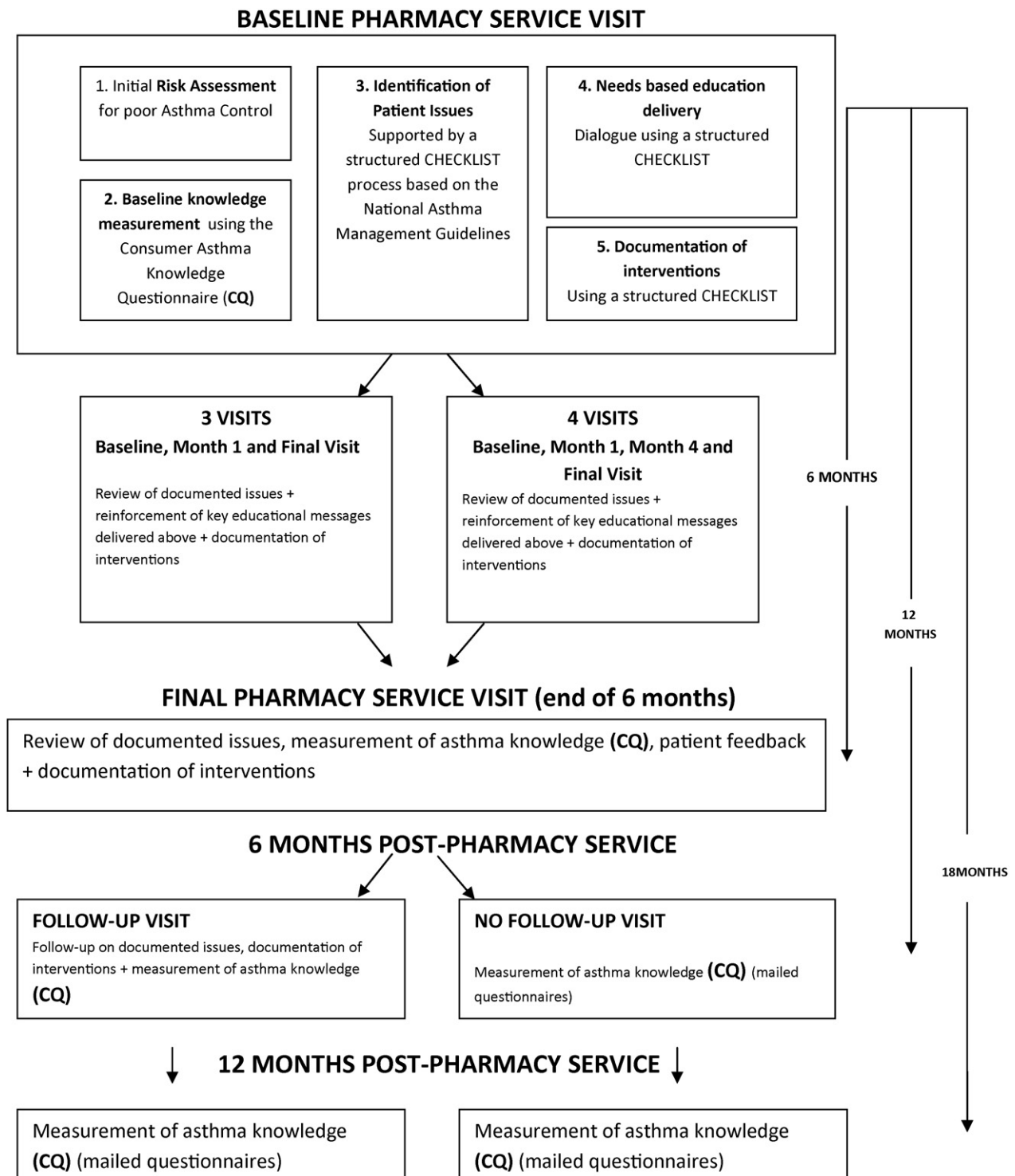
### 2.2. Patient recruitment

Patients aged  $\geq 18$  years were recruited through their regular community pharmacy based on their risk of poor asthma control, using a previously developed brief risk-assessment tool [26,43]. The tool asks questions about recent asthma symptoms and whether a physician asthma review has occurred in the previous six months. Patients were excluded if they had a terminal illness, if they did not speak English well enough to communicate with the pharmacist and complete the study questionnaires independently, were enrolled in another study, or if they did not self-administer their medicines/inhalers.

### 2.3. Data collection

#### 2.3.1. Patient data

The Consumer Asthma Knowledge Questionnaire (CQ), a previously validated tool using Australian populations, was used [44] (Table 1). This is a 12-item questionnaire comprising a series of true/false questions. A higher score indicates better asthma knowledge. The CQ was used at four time points (baseline, end of



the six-month service, and six and 12 months after the service), to explore the change in, and sustainability of, patients' asthma knowledge. At all time points the CQ was completed by the patient with no assistance from the pharmacist.

In addition, to explore patients' perceptions of the impact of the service on their knowledge of asthma, face-to-face focus groups and individual telephone interviews using a semi-structured interview guide, were conducted with patients at three time points (after the initial visit in the intensive six

month service, the end of the six-month service and six months after the service had been completed). Patients who had experienced the full service were selected by the pharmacists so we could contact them, they had to be willing to give an interview; and both urban and rural participants were included. The interviews proceeded until data saturation occurred. The interview guide covered many aspects of the service provision, we have only selected the comments that relate to asthma knowledge for the discussion.

**Table 1**

Asthma knowledge questionnaire and the number of patients completing each question correctly at baseline and at the end of the six-month service.

Question	Baseline (out of 570)	Final visit (out of 398)	p value for difference in proportion correct <sup>a</sup>
You can become addicted to asthma medications if you use them all the time (false)	367 (64%)	297 (75%)	0.002
A written asthma action plan can prevent hospitalizations due to asthma (true)	424 (74%)	340 (85%)	<0.001
When you know that you are going to be exposed to something that triggers your asthma, you should take the recommended medication just before exposure (true)	434 (76%)	338 (85%)	<0.001
When you know that you are going to be exposed to something that triggers your asthma, you should wait until you develop symptoms before taking medication (false)	430 (75%)	341 (86%)	<0.001
Side effects are less likely with inhaled medications than with tablets (true)	242 (42%)	226 (57%)	<0.001
With asthma preventer medications, it does not matter if some doses are missed or if you go on or off (false)	406 (71%)	314 (79%)	0.006
If you get a cold or flu, you should increase your asthma medications (true)	298 (52%)	256 (64%)	<0.001
Some medications can trigger asthma attacks (true)	355 (62%)	284 (71%)	<0.001
You should use "preventer medication" when you have an asthma attack (false)	308 (54%)	229 (57%)	0.016
Going from a cold to a hot environment can trigger asthma, but going from a hot to a cold environment does not trigger asthma (false)	370 (65%)	290 (73%)	0.014
Parents should give "reliever medication" to a child as soon as they recognize the first sign of asthma (true)	358 (63%)	294 (74%)	<0.001
Blue puffer (Ventolin), Brown puffer (Flixotide) and Green puffer (Serevent) are called "preventer medications", so they should be used everyday even though you are well (false)	302 (53%)	220 (55%)	0.791

<sup>a</sup> Using McNemar's test.

### 2.3.2. Pharmacist interventions

Pharmacists recorded the interventions they performed as part of the service delivery. They used a service-specific checklist which listed all the possible interventions that could be delivered within the service. The 14 possible interventions focused on knowledge improvement and are listed in Table 2. The interventions delivered were at the discretion of the pharmacist, based on individual patient's needs and goals.

### 2.4. Sample size calculation

In a previous study, the change in CQ scores over six months was  $1.11 \pm 0.61$  [26]. We assumed that the improvement in knowledge in our sample at six and 12 months post-service delivery would be retained and the same as that achieved at six months by Armour et al. [26]. Using a confidence level of 5% plus a power of 90%, it was estimated that a minimum sample of 81 patients was required in each of the three and four visit groups. In our previous study patient retention at six months was 86% [26]; as our data collection was planned to occur 12 months beyond the service, we assumed a

retention rate of 30%. Hence we targeted 270 patients ( $81/270 = 30\%$ ) in each group (three visit or four visit), with a total target of 540.

### 2.5. Data analysis

The Wilcoxon signed-ranks test was used to measure changes in knowledge scores within groups between the four time points. The Friedmans test was used to compare scores between groups of patients. The proportions of knowledge-related interventions delivered at baseline and at end of the six-month service were checked for significant differences using Pearson's Chi-Square test. The level of significance for all tests was set at  $p < 0.05$ .

Since two items in the CQ could now be considered redundant (Item 9 and 12 in light of new therapies such as the SMART regimen [45] and the warnings about use of long acting beta agonists alone [46]), the CQ score was recalculated out of 10 (instead of 12) and the score out of 10 compared with the original CQ scores using linear regression and reliability analyses.

The focus groups and interviews were manually transcribed and themes arising were documented using manual inductive

**Table 2**

Interventions related to improving asthma knowledge provided by the pharmacists at the start and end of the intensive six-month asthma service.

<sup>a</sup> Checklist of potential interventions	Baseline (n = 570)	Final visit (n = 398)
Misunderstanding of disease process – counsel on the episodic nature of asthma and appropriate management	466	261
Explore health beliefs about asthma control	452	243
Counsel patient on trigger factors	524	335
Provide trigger factor information, such as quit smoking information	418	253
Clarify inaccurate perceptions about asthma and treatment	457	256
Counsel on benefits of taking preventer medication	482	282
Counsel on safe use of reliever	460	256
Explain consequences of not taking medications	435	239
Provide Self Care Facts card <sup>b</sup>	344	116
Discuss medications as triggers	413	216
Counsel on side effect minimization (e.g. rinse, gargle after inhaler use)	409	234
Counsel on need and use of written asthma action plan	433	205
Counsel on the need to recognize poorly controlled asthma and what to do if it gets worse	419	224
Provide information on asthma attack management	409	196

<sup>a</sup> These suggested interventions were provided in a table in the patient file and pharmacists ticked them off if they were provided. Provide information = give written information, counsel = talk to the patient and explore their level of understanding.

<sup>b</sup> Self Care Facts cards are produced by the Pharmaceutical Society of Australia and provide general information about medical conditions and self-management. The pharmacists had these provided as a resource for the asthma service.

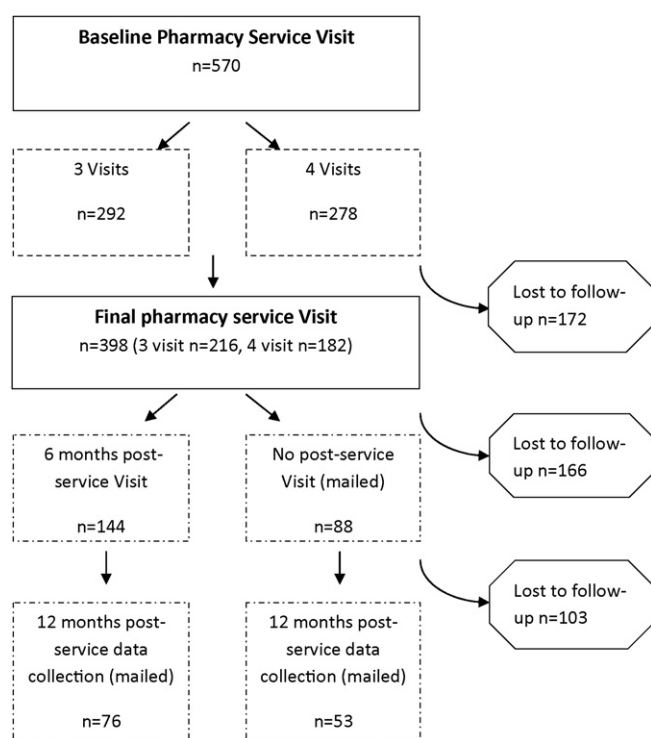


Fig. 2. Patient retention through the pharmacy asthma service.

coding. The transcripts were analyzed by three investigators and quotations selected to illustrate the themes, including themes related to patient's knowledge.

### 3. Results

#### 3.1. Patients

A total of 570 patients were recruited from 96 pharmacies, of which 398 finished the intensive six-month service and 129 were selected for follow-up to the 12 months post-service time point (Fig. 2). Any variation in the number of patients reported at any time point is due to missing data for that variable.

Using the risk-assessment tool, pharmacists identified patients with poor asthma control [26] in need of educational interventions. That is, 77% had poor control and 23% had good/fair control. The majority of patients recruited were from urban areas ( $n = 402$ ,

Table 3

Characteristics of the pharmacists providing the asthma service. Data available for 94/96 pharmacists.

Characteristic	n (%)
Gender	
Female	40 (43%)
Age	
18–35	38 (40%)
36–45	22 (23%)
≥46	36 (37%)
Years in practice	
1–5	23 (24%)
6–10	13 (14%)
11–15	10 (11%)
≥16	48 (51%)
Position in pharmacy	
Sole proprietor	27 (29%)
Partner/proprietor	24 (26%)
Salaried pharmacist	41 (43%)
Other	2 (2%)

70%); this is representative of the Australian population. The mean age for the recruited cohort was 50.6 years ( $\pm 16.8$ ) and there was a higher proportion of female (62%) than male (38%) patients.

Details of the pharmacists who provided the service are available in Table 3. The larger proportion of pharmacists were male, owned the pharmacy and had been in practice 16 or more years.

#### 3.2. Pharmacists' interventions

At the baseline visit, pharmacists collectively performed 8075 interventions with the patients, 6121 (76%) of which were related to improving asthma knowledge (Table 2). At the final visit of the six-month intensive service, 5142 interventions were provided, 3316 (64%) of which were related to improving asthma knowledge (Table 2). The total number of knowledge-related interventions delivered per patient decreased across the six months from baseline to the end of the service ( $10.8 \pm 3.0$  to  $8.3 \pm 4.4$ ,  $p < 0.001$ ), indicating that individual patients' need for knowledge was decreasing over the period of the intervention. However, there were still a significant number of interventions being performed at the end of the six-month service; the 3316 interventions were delivered to 393 patients, averaging eight or nine per patient. At baseline, the most frequently delivered interventions were to counsel patients about asthma triggers, highlight the role of preventer medications and clarify patient misunderstanding of the disease process. Counseling about triggers and benefits of preventer medications were the most frequent interventions delivered by pharmacists.

#### 3.3. Asthma knowledge

For all questions, the proportion of patients who answered correctly improved from baseline to the final measurement. Higher improvements in proportions answering correctly were seen in questions relating to medication use in situations where trigger exposure was likely, about the fact that side effects were minimized using inhaled route drug administration, or that medications were not addictive. Overall, the patients' CQ scores significantly improved over the duration of the six-month service ( $p < 0.001$ ) in both groups of patients (three visits and four visits), and there was no difference between the groups ( $p = 0.30$ ) (Table 4). There was some difference in the proportion of patients who were able to improve their knowledge for each question. This reflects the difficulty of some questions. Two questions had very little improvement as a result of the knowledge intervention and these had been flagged as information that is now not current for asthma education. It would be best to remove these questions in future. This increased asthma knowledge was maintained in both groups of patients who did and did not have a follow-up visit with their pharmacist six months after the service concluded (Table 5). There was no significant difference in scores 12 months after the completion of the service between the patients who did and did not have a follow-up visit ( $p = 0.80$ , Table 5). Although six months after the completion of the service, the group receiving follow-up had a statistically significant higher CQ score ( $p = 0.02$ , Table 5) the lack of such difference at 12 months after the service between

Table 4

Asthma knowledge at baseline and the end of the six-month asthma service.

Group	n	V1 Mean $\pm$ S.D.	FV Mean $\pm$ S.D.	V1 vs. FV p value
3-visit	212	7.51 $\pm$ 2.39	8.60 $\pm$ 2.25	<0.001
4-visit	179	7.80 $\pm$ 2.33	8.98 $\pm$ 1.99	<0.001

FV = final visit (at end of the six-month service), S.D. = standard deviation, n = number of patients,  $p < 0.001$  (Wilcoxon signed-ranks test).



**Table 5**

Asthma knowledge at end of the six-month asthma service vs. six and 12 months post-service.

Group	End of service	Six months post-service	12 months post-service
	Mean $\pm$ S.D. (n)	Mean $\pm$ S.D. (n)	Mean $\pm$ S.D. (n)
Follow-up	8.97 $\pm$ 2.12 (143)	8.94 $\pm$ 2.15 (141)	8.74 $\pm$ 2.21 (58)
Non-follow-up	8.50 $\pm$ 2.20 (86)	8.33 $\pm$ 2.12 (79)	8.54 $\pm$ 2.39 (50)

No significant change in knowledge scores within groups (Wilcoxon signed-ranks test). S.D. = standard deviation, n = number of patients.

groups clearly indicates that while a follow-up visit after six months can slow the rate of knowledge decline, there is no actual difference 12 months after the service.

Since the number of patients completing the asthma knowledge questionnaire 12 months after the service was only a small proportion of those who commenced we calculated the knowledge scores at each time point for those patients who completed the questionnaire at all visits and follow-up ( $n = 100$ ). For this group, the baseline mean score was  $7.7 \pm 2.6$  and this significantly increased to  $8.8 \pm 2.0$  at the end of the six-month service (final visit). This was maintained at six and 12 months after the service ( $9.0 \pm 2.0$ ,  $8.7 \pm 2.1$  respectively).

### 3.4. Patients' qualitative feedback

A total of 37 patients provided feedback about the service either through focus groups ( $n = 21$ ) or as individual interviews ( $n = 16$ ). Patients were aware that the service had focused on improving their knowledge and skills. They reported being impressed with the service, and how it had led to a change in the way they managed their asthma.

*"How to use your medication properly, overall the education I got. I think I'm definitely managing my asthma better than I've ever managed it and that's due to the education I got."* Patient 1

A number of patients reported on the aspects of value and how the change in knowledge had manifested in terms of asthma management, treatment and disease understanding. In terms of the disease, they reported what kind of information they received and what this information had meant to them.

*"I found it very informative. I didn't know a lot about asthma really, to be honest. I'm a bit ignorant of it, although I've had it all my life. Had it in childhood, grew out of it, then I got it back at about 42. But it's been in the family and I've been around asthma all my life. I didn't really know exactly what it was, but now I have an understanding of the illness and how it affects people."* Patient 2

*"Well, it's kind of the first time that anyone ever explained to me what asthma was all about. It's kind of, I mean having suffered, having it for many years you usually get told to 'take this and go away'."* Patient 3

In terms of medications, patients reported on specific aspects of medication use particularly with respect to understanding the importance of taking their inhaled anti-inflammatory medication. They also discussed how their fears of the reported side effects of such medications had been dispelled.

*"I think knowing how important it is to take your preventer. Knowing about the tubes and stuff like that and knowing that if you don't take it, eventually it's harder to get rid of it."* Patient 4

*"I've realized that I have to use the medication, whereas I wasn't sure about side effects, so I wasn't keen to have it every day, twice a*

*day. But now I understand a little bit about it, I'm not so worried about the 'steroid' part of it, which is one thing I wasn't sure on."* Patient 4

Patients also compared the type of information they had received from the pharmacist to what they had received before.

*"I think when you've been an asthmatic a long time, previous doctors assume that you've got all the ins and outs and doctors don't volunteer enough information. I got more information and a better education and better management skills out of the program and X up at the chemist."* Patient 1

## 4. Discussion and conclusion

### 4.1. Discussion

This study has demonstrated that pharmacists' interventions can lead to a sustained increase in asthma knowledge. As knowledge improved, there was a decrease in knowledge-related interventions delivered by pharmacists. Further, patients recognized and appreciated their increased knowledge. This study is the first large-scale research to provide meaningful insight about the role and structure of pharmacy asthma services in making sustained improvements in patient asthma knowledge.

The maximum gains in asthma knowledge occurred between baseline and the end of the six-month asthma service. The three visits over six months were as effective as the four visits in terms of improvement in knowledge. The delivery of an additional follow-up visit six months after the service did not alter knowledge scores. These results provide important answers for resource allocation when designing pharmacy-based asthma services, in that an intensive service can result in retention of knowledge for at least 12 months. This is the first study to describe retention of knowledge from a pharmacy-based asthma service with an educational component. Given the large body of evidence supporting the pharmacist's role in improving asthma outcomes in patients [37], the sustained increase in knowledge is not surprising. Our results suggest that pharmacy-based services are very efficient in terms of improvements and retention of asthma knowledge.

Asthma knowledge was gained by a group of patients who were identified as being at risk of poorly controlled asthma. As poorly controlled asthma is associated with lower levels of knowledge [9], it may be that the significant increase in mean knowledge scores over the six-month intervention resulted from a lower-than-usual knowledge score at baseline. However, these are the patients who should be targeted for educational interventions, given the evidence supporting the benefits.

In our study, asthma knowledge scores were measured at the end of the six-month service; in other studies using group education formats in pharmacies, even greater increases were measured at earlier time points after education, e.g. at three months [35]. We do not have a measure at three months or even immediately after education was delivered, it could be that the patients' asthma knowledge gain was even higher at these time points. However, this instrument is specific to knowledge gains, as in another pharmacy study in Australia where patient education was not the focus, i.e. patients with possible uncontrolled asthma were identified, provided written information and a doctor referral, no significant change was observed in the asthma knowledge score [32,47]. Our instrument can thus be used in the community setting to assess effectiveness of education programs.

In our study, pharmacists were specially trained to tailor educational interventions based on the patient's identified need(s). This cohort of patients demonstrated particular needs, which

continued to be evident even at service completion, for example needing information about triggers, and not understanding the benefit of sustained preventer medication use. These could represent areas for future focus in pharmacist delivered asthma education, although of course such needs could be different in different settings. In similar studies in other healthcare professions, for example in general practitioners, it has been shown that tailored education is more effective at reducing the information needs of the patient, as compared to usual care [48].

This study also addressed the need for resource allocation in asthma education delivery and design. Previous pharmacy studies utilized a six-month structure with varied numbers of education sessions [26]. It appears that six months may be a reasonable time period for the duration of an educational program. For example, in other settings when self-management programs have been shortened, the gains in knowledge and self-management skills seem to recede faster, e.g. at three months [49]. In longer programs, e.g. 12-month programs, asthma knowledge has been shown to remain at improved levels for a year [25]. In our study, the improved asthma knowledge was sustained for 12 months after the six-month intensive service. One group of patients received an extra follow-up visit six months after the service, but this did not affect their knowledge scores. Follow-up and collation of such data can provide accurate and key answers to those involved in planning and policy making about models of healthcare design and delivery for people with asthma.

As outlined, asthma knowledge is a preliminary step towards improving asthma outcomes. However, education programs and improved knowledge do not always result in better health outcomes for the patient [50]. Despite expressed need for more education, asthma patients do not always use the knowledge provided by their HCP [51]. Often the messages delivered are not those received, and even when there is concordance between the deliverer and the receiver, the change in knowledge may be divorced from actual asthma behavior change, i.e. 'to know is not necessarily to do' [52]. This highlights the importance of asthma education delivery that is effective not only in improving knowledge in patients but also helping them translate this acquired knowledge to actual behaviors. Our finding of patients' reports that their knowledge and skills had changed is good evidence that the service had achieved its aims.

#### 4.1.1. Limitations

The intervention in community pharmacy was a complex one involving counseling and goal setting as well as assessment and monitoring of many aspects of asthma. Thus it is difficult to relate improvement in knowledge of the patients to any specific interventions. Although we have measured an improvement in knowledge and patients reported that they understand more about their disease and medications, we have no direct measurement that this has been translated into behavior.

We do have a direct measurement of knowledge gain, but whether that can be directly linked to the counseling provided by the pharmacist or their improved skills in managing their asthma and seeking further information cannot be discerned.

#### 4.2. Conclusion

Patients' knowledge of the asthma and medications used to treat asthma can be improved by pharmacists' interventions. We have also shown that this improved knowledge is maintained at six and 12 months after the service concluded. This shows that improvements in knowledge are able to be maintained in primary care with targeted interventions focused on issues relating to disease and medications. Patients were also aware of,

grateful for and satisfied with, the improved asthma knowledge they gained from participating in this community pharmacy-based asthma service.

#### 4.3. Practice implications

With appropriate training pharmacists can deliver asthma interventions at the primary care level which are sustainable and result in significant improvements in patient knowledge and positive perceptions by patients. Three asthma visits delivered by pharmacists over a six-month service individualized to patient needs can produce these significant improvements. This level of intensity and duration of service provides effects that last for at least 12 months, suggesting that it is a very efficient way to improve asthma knowledge in the community.

#### Role of funding

The Pharmacy Asthma Management Service was funded by the Australian Government Department of Health and Ageing as part of the Fourth Community Pharmacy Agreement. The funding body had no involvement in the study design, collection, analysis and interpretation of data or writing of the report.

#### Acknowledgements

We would like to thank Jaya Soma, Phillipa Yabsley, Julie Cooke and Victoria Jarvis, who contributed as Project Officers, and all of the pharmacists who participated in this study.

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