Data-mining of medication records to improve asthma management

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ABSTRACT

Objectives: To use community pharmacy medication records to identify patients whose asthma may not be well managed and then implement and evaluate a multidisciplinary educational intervention to improve asthma management.

Design, setting and participants: We used a multisite controlled study design. Forty-two pharmacies throughout Tasmania ran a software application that "data-mined" medication records, generating a list of patients who had received three or more canisters of inhaled short-acting β_2-agonists in the preceding 6 months. The patients identified were allocated to an intervention or control group. Pre-intervention data were collected for the period May to November 2006 and post-intervention data for the period December 2006 to May 2007.

Intervention: Intervention patients were contacted by the community pharmacist via mail, and were sent educational material and a letter encouraging them to see their general practitioner for an asthma management review. Pharmacists were blinded to the control patients' identities until the end of the post-intervention period.

Main outcome measure: Dispensing ratio of preventer medication (inhaled corticosteroids [ICSs]) to reliever medication (inhaled short-acting β_2-agonists).

Results: Thirty-five pharmacies completed the study, providing 702 intervention and 849 control patients. The intervention resulted in a threefold increase in the preventer-to-reliever ratio in the intervention group compared with the control group ($P < 0.01$) and a higher proportion of patients in the intervention group using ICS therapy than in the control group ($P < 0.01$).

Conclusions: Community pharmacy medication records can be effectively used to identify patients with suboptimal asthma management, who can then be referred to their GP for review. The intervention should be trialled on a national scale to determine the effects on clinical, social, emotional and economic outcomes for people in the Australian community, with a longer follow-up to determine sustainability of the improvements noted.

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Asthma is responsible for substantial morbidity and mortality in Australia and is recognised as a National Health Priority Area. But despite the existence of national initiatives that aim to improve asthma care,[1,2] a recent national health survey highlighted major evidence-to-practice gaps, including the underuse of inhaled corticosteroids (ICSs) (preventer medication) and over-reliance on inhaled short-acting β_2-agonists (reliever medication).[3]

Pharmacists frequently see patients with asthma in the community, many of whom may be poorly managed. While the provision of comprehensive pharmaceutical care by community pharmacists has the potential to improve asthma management, the uptake into practice is poor, and the need for further research using strategies that are pragmatic in busy community pharmacies has been identified.[4]

The aim of our study was to use community pharmacy medication records to identify patients whose asthma management may be suboptimal and then to implement and evaluate a multidisciplinary educational intervention that would refer such patients to a general practitioner for review. To our knowledge, such an approach has not previously been used in Australia.

METHODS

Data-mining application

We developed a "data-mining" software application that seamlessly extracts data from the market-leading pharmacy dispensing software system in Australia (FRED Dispense [PCA NU Systems, Melbourne]). (PCA NU Systems was informed of our project.) About 50% of community pharmacies in Australia use this dispensing system.

Community pharmacies throughout Tasmania were sent a letter informing them about the project and inviting them to participate if they were currently using the FRED dispensing system.

Education sessions for participating pharmacists were held in major regions of the state. These sessions provided an overview of asthma management in Australia, an outline of the project's objectives and methods, and a demonstration of the data-mining software.

The data-mining application was installed in the participating pharmacies. Using a prespecified algorithm, the program identified patients who had received three or more relievers (inhaled short-acting β_2-agonists) in the preceding 6 months. This indicated that they may have been using, on average, three or more inhalations per day of reliever medication, which exceeds the level recommended in current guidelines for optimal asthma control.[5]

Patients receiving regular preventer medications (ICSs) were also identified if they fulfilled the aforementioned criteria, as they may have been receiving a dose of ICS that was too low or may have been using their ICS incorrectly — in either case, they may have needed a review of their asthma therapy.

Specific exclusions were written into the program algorithm to ensure that the patients selected for our study were likely to be people with poorly managed asthma who were under the care of a GP. The application excluded patients receiving:

- inhaled anticholinergic therapy (tiotropium or ipratropium) or methylxanthines, indicating the likely presence of chronic obstructive pulmonary disease (COPD); or
- leukotriene-receptor antagonists, indicating the probable presence of severe asthma, meaning the patient was likely to be under the care of a respiratory specialist.

The program was developed in a style that was familiar to community pharmacists so that it would not have a significant impact on their workflow.

Intervention and control groups

At each participating pharmacy, the data-mining software ranked the list of identified patients in order of greatest to least number of reliever canisters dispensed in the preced-

1 Reasons for patient exclusion*

Exclusion reason	Overall ($n = 384$)	Intervention ($n = 274$)	Control ($n = 110$)†
Patient under 18 years of age‡	117 (30.5%)	78 (28.5%)	39 (35.5%)
No reason given by pharmacist	82 (21.4%)	80 (29.2%)	2 (1.8%)
Patient too confused‡	31 (8.1%)	15 (5.5%)	16 (14.5%)
May cause undue distress to patient‡	30 (7.8%)	25 (9.1%)	5 (4.5%)
Patient has chronic obstructive pulmonary disease‡	25 (6.5%)	6 (2.2%)	19 (17.3%)
Patient not a regular patient	24 (6.3%)	14 (5.1%)	10 (9.1%)
Patient a nursing home resident‡	21 (5.5%)	10 (3.6%)	11 (10.0%)
Insufficient asthma-related dispensing history	15 (3.9%)	15 (5.5%)	0
Patient declined to participate	5 (1.3%)	5 (1.8%)	0
Patient prefers no further contact	4 (1.0%)	4 (1.5%)	0
Letter returned to sender	4 (1.0%)	4 (1.5%)	0
Patient deceased‡	4 (1.0%)	0	4 (3.6%)
Other	22 (5.7%)	18 (6.6%)	4 (3.6%)

* Figures represent number (%) of excluded patients. † Control patients' data were not viewed by the community pharmacist until 6 months after the intervention. ‡ Predefined exclusion criteria. ◆

ing 6 months. The patient receiving the greatest number of relievers was randomly assigned to the intervention or control group, with subsequent patients being alternately assigned to the control or intervention group.

The initial exclusion and group allocation process was concealed from the pharmacist and occurred automatically upon running the application, with only the resulting list of intervention patients available for viewing. To ensure an even geographical spread of intervention and control patients, the allocation process was repeated in each pharmacy.

Participating pharmacists examined the information for the intervention patients only and used their professional judgement, based on their knowledge of each patient, to decide whether it would be appropriate to send the patient an educational letter. The pharmacist was encouraged to include all patients unless they met the predefined exclusion criteria (Box 1).

Pharmacists were blinded to the control patients' identities until the end of the 6-month post-intervention period. In this way, it was intended that control patients would receive no intervention other than the pharmacist's usual care until after the data collection was complete. The concealed identification algorithm for patient identification and group allocation ensured that knowledge of intervention patients' identities did not give away the control patients' identities.

The intervention

The application generated a standard personalised letter to send to each intervention patient. The contents of the letter indicated that, based on the record of medication that had been dispensed recently, the pharmacist was concerned that the patient's asthma may not be ideally controlled and that it would be advisable for the patient to visit his or her GP for an asthma management review.

Intervention patients were sent an asthma intervention pack containing the following information:

- a computer-generated personalised letter;
- a standard (non-personalised) letter about the project;
- supporting educational material provided by the Asthma Foundation Tasmania (*Asthma: the basic facts*);[6]
- computer-generated asthma control,[7] quality-of-life,[8] and asthma knowledge questionnaires,[9] to be self-completed;
- a computer-generated letter (and medication history) to give to their GP; and
- a computer-generated satisfaction/perception questionnaire to give to their GP.

The intervention packs were mailed to patients at the end of November 2006. Six months after the intervention, the control patients' identities were revealed, and pharmacists examined their dispensing data to determined whether they were eligible to be included in the study (ie, did not meet any of the exclusion criteria). For ethical reasons, all included control patients who had received three or more relievers in the post-intervention period were sent an intervention pack at this stage, similar to that sent to intervention patients 6 months earlier.

Data collection

Our article focuses on changes in dispensed asthma medication between the 6-month pre-intervention period (May to November 2006) and the 6-month post-intervention period (December 2006 to May 2007). The de-identified dispensing data from the intervention and control groups were sent to the project team for analysis before and after the intervention. Because of potential seasonal changes between the pre-intervention and post-intervention periods, the more relevant analyses were *between* the intervention and control groups rather than *within* each group.

The preventer-to-reliever ratio

The asthma medications included in our analyses were inhaled short-acting β_2-agonists (relievers) and ICSs (preventers). Before performing statistical analyses, we converted the dispensed quantities of asthma medication to a standard equivalent dose:

- Salbutamol (reliever) equivalence: salbutamol 100 μg = terbutaline 250 μg;[10] and
- Beclomethasone-HFA (preventer) equivalence: beclomethasone-HFA 100 μg = fluticasone 100 μg = budesonide 200 μg = ciclesonide 80 μg.[11-13]

The preventer-to-reliever (P : R) ratio was calculated for each patient as the average beclomethasone-HFA-equivalent usage per day divided by the average salbutamol-equivalent usage per day. In accordance with other studies that have used the ratio,[14-17] long-acting β_2-agonists were not included as preventers in the ratio because they are not appropriate as single-preventer medication therapy.[18]

Statistical analysis

All variables were collated and entered into a statistical software package, Statview 5.01 (Abacus Concepts Inc, Berkeley, Calif, USA). Pre- and post-intervention comparisons were conducted using the Wilcoxon signed-rank test, and control group data were compared with intervention group data using the Mann–Whitney test. Proportional data were analysed using the χ^2 test. A significance level of $P < 0.05$ was used for all statistical procedures.

Ethics approval and patient consent

Our study was approved by the Human Research Ethics Committee (Tasmania) Network. Patients involved in our study were not required to give informed consent, as there was no contact with or disclosure of their identities to the researchers.

RESULTS

The data-mining application identified 2449 patients (1233 intervention patients and 1216 control patients) from 42 pharmacies. Thirty-five pharmacies completed the project, providing 1935 patients. Of these patients, 384 were excluded by the pharmacist (an exclusion rate of 19.8%), leaving a total of 1551 patients for analysis (702 intervention patients and 849 control patients). Of the seven pharmacies that did not complete the project, three had computer software problems and four did not send any intervention packs.

No significant differences were observed between the intervention and control groups in the pre-intervention period in terms of the P : R ratio, asthma medication profile, or daily usage of ICSs. However, a significant difference in the daily usage of relievers was observed ($U = 324\,673.0$, $Z = 3.0$, $P < 0.01$), with the intervention patients showing a greater range of daily reliever usage.

Outcome measures for the intervention and control groups are shown in Box 2. The median P : R ratio in the intervention group increased significantly, from 0.1 in the pre-intervention period to 0.3 in the post-intervention period (Wilcoxon $T = 21\,237.5$, $Z = 5.6$), while the median ratio in the control group remained the same (0.1 v 0.1; Wilcoxon $T = 34\,262.5$, $Z = 0.6$). Comparing the intervention group with the control group in the post-intervention period, the median P : R ratio was three times higher in the intervention group (0.3 v 0.1; $U = 149\,690.5$, $Z = 2.9$). While the use of relievers and preventers dropped significantly in both groups, a higher proportion of intervention patients than control patients were using ICS therapy in the post-intervention period (49.4% v 42.6%; $\chi^2 = 7.1$, df = 1).

The median daily usage of relievers fell significantly in both the intervention group (from 655.7 μg to 418.8 μg; Wilcoxon $T = 42\,405.0$, $Z = 15.0$) and the control group (from 655.7 μg to 414.5 μg; Wilcoxon $T = 80\,119.5$, $Z = 13.9$). There was no significant difference between the two groups in the post-intervention period ($U = 288\,658.0$, $Z = 1.1$).

Similarly, the median daily usage of ICSs fell significantly in both the intervention group (from 109.3 μg to 0.0 μg; Wilcoxon $T = 38\,076.5$, $Z = 3.8$) and the control group (from 65.6 μg to 0.0 μg; Wilcoxon $T = 42\,140.0$, $Z = 5.7$). However, there was a significant difference between the two groups in the post-intervention period ($U = 276\,154.5$, $Z = 2.5$), with the control group showing a higher maximum daily usage, although the median usage was the same in each group.

DISCUSSION

The intervention we describe significantly raised the P : R ratio of asthma medications dispensed, with a significantly higher proportion of intervention patients than control patients using ICS therapy by the end of the study.

It has been suggested that the P : R ratio, which can be used as a surrogate measure of the quality of prescribing for asthma, is an important factor in the outcome of asthma care.[14,16] An increased P : R ratio has been associated with reductions in asthma symptoms,[16] in rescue courses of oral prednisolone,[14] in hospital admissions[15] and in urgent GP visits.[17]

There have been other studies examining asthma management that have used the number of canisters[19,20] or defined daily doses[14,15] as a measure of ICS use. The limitation of using the number of canisters is that it does not account for the number of doses per canister or differing drug potencies. Using defined daily doses does not adequately represent the widely accepted dose equivalence. A particular strength of our study is the fact that the ICS potencies and doses per canister were taken into account, ensuring a more accurate representation of ICS use.

The intervention and control groups displayed a statistically significant difference in daily usage of reliever medication in the pre-intervention period. However, this particular parameter was not used individually as a primary outcome measure, so it is unlikely that the pre-intervention difference adversely affected the results reported here.

There are potential limitations to our study. It was assumed that the dispensed

2 Outcome measures before and after intervention*

Outcome measure†	Before intervention‡	After intervention‡	Wilcoxon *P* value
Preventer-to-reliever ratio			
Intervention	0.1 (0.0–4.5)	0.3 (0.0–4.5)	< 0.001
Control	0.1 (0.0–6.0)	0.1 (0.0–10.5)	0.5
Mann–Whitney *P* value	0.2	< 0.01	
Asthma medication profile			
Intervention			
ICS ± LABA ± reliever	387 (55.1%)	347 (49.4%)	< 0.001§
No ICS therapy	315 (44.9%)	355 (50.6%)	
Control			
ICS ± LABA ± reliever	443 (52.2%)	362 (42.6%)	< 0.001§
No ICS therapy	406 (47.8%)	487 (57.4%)	
χ^2 *P* value	0.2	< 0.01	
Relievers (daily usage in μg)			
Intervention	655.7 (109.3–5245.9)	418.8 (0.0–5054.9)	< 0.001
Control	655.7 (218.6–3497.3)	414.5 (0.0–4505.5)	< 0.001
Mann–Whitney *P* value	< 0.01	0.3	
Preventers (daily usage in μg)			
Intervention	109.3 (0.0–1967.2)	0.0 (0.0–2142.9)	< 0.001
Control	65.6 (0.0–2131.1)	0.0 (0.0–2199.0)	< 0.001
Mann–Whitney *P* value	0.1	< 0.05	

ICS = inhaled corticosteroid. LABA = long-acting β_2-agonist. * Total numbers of patients were 702 (intervention group) and 849 (control group). † Preventer medication: ICSs; reliever medication: short-acting β_2-agonists. ‡ Values represent median (range) or number of patients (%). § χ^2 *P* value. ◆

quantity of reliever medication equated with actual medication consumption, but factors such as storing relievers in different sites and misplacing medication could complicate the picture. These factors may have resulted in reduced measurement precision of medication usage, but are unlikely to have introduced systematic bias, as they existed both before and after the intervention and in both intervention and control groups. It is also possible that non-prescription supply of relievers, which is not always recorded in the dispensing software, resulted in underestimation of reliever medication usage. Underestimation may also have arisen from the assumption that asthma medications were not being dispensed at other pharmacies. However, the same level of underestimation would have applied to both groups and in both the pre- and post-intervention periods.

It can be seen from Box 1 that there was some discrepancy between intervention and control group exclusions, with more intervention patients excluded (especially without reason) than controls. It is conceivable that some pharmacists only included patients in the study if, in the pharmacist's opinion, they were likely to benefit from an intervention. Indeed, this could be an explanation for the significant difference in reliever usage between the groups in the pre-intervention period. When the time came to exclude control patients, at the end of the 6-month post-intervention period, pharmacists tended to adhere more tightly to the project's protocols, and fewer patients were excluded without reason.

While the results show an increased P : R ratio after the intervention, other factors may have influenced this change. The pre-intervention period was May to November, including the winter season, while the post-intervention period was December to May, including the summer season. Asthma control is often poorer in winter months.[21,22] It is also possible that safety net entitlements under the Pharmaceutical Benefits Scheme (PBS) may have influenced the dispensing of asthma medications, as it has been shown that rates of purchase of all PBS drugs are higher at the end of each calendar year, when the number of people covered by the PBS safety net is greatest.[23] However, such factors would have applied to both intervention and control groups.

Seasonal variations in asthma control and dispensing patterns are a likely explanation for the significant reduction in reliever and ICS usage in both the intervention and control groups in the post-intervention period. We recognise the limitation of having 6-month pre- and post-intervention periods, but this stipulation was required by the funding body. Changes in the control group may have also reflected a change in pharmacists' behaviour towards *all* asthmatic patients presenting to the pharmacy, due to a heightened awareness of asthma management issues arising from participation in the project. Knowledge of the intervention patients' identities may have also affected the pharmacists' behaviour towards such patients. Furthermore, the outcomes described were achieved in 6 months, and it is not yet known whether they are sustainable in the longer term, or what further intervention would be required to sustain them.

Our study demonstrates that community pharmacists are ideally placed to screen for patients who may have suboptimal asthma control, with the potential to address critical issues in asthma management in the community. The intervention we describe required minimal time and training on the part of the pharmacist, yet answered the societal need for improved asthma management. We recommend that the intervention be trialled on a larger scale and for a longer time to determine the effects on clinical, social, emotional and economic outcomes. Our results indicate that the program has the potential to produce significant improvements in asthma management, resulting in improved health outcomes for patients, and ultimately, a reduced burden on the Australian health system.

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COMPETING INTERESTS

E Haydn Walters has had unrestricted research finance of $90 000 from GlaxoSmithKline in the past 2 years for asthma epidemiology research (in-depth survey of asthma control and therapeutics in the community, as part of a 40-year follow-up study).

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