

## Drug-Related Problems Detected in Australian Community Pharmacies: The PROMISe Trial

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**D**rug-related problems (DRPs) are defined as “undesirable events (either actual or potential) experienced by the patient and thought to be due to drug therapy,”<sup>1</sup> and can broadly be related to errors, adverse events, or adherence issues.<sup>2-4</sup> As in other countries, DRPs in Australia are a major burden on the health care system, with many resulting in admission to the hospital or visits to general practitioners (GPs) each year. In 2002, it was reported that more than 140,000 Australians were hospitalized each year as a result of DRPs, and approximately 50% of these DRPs were potentially preventable.<sup>5</sup> In 2008, Roughead et al. reviewed the available literature regarding drug-related hospital admissions in Australia, identifying 9 studies which found that 2-4% of all hospital admissions were drug-related and up to 75% of these were considered potentially preventable.<sup>4</sup> An Australian general practice study published in 2006 reported that 10.4% of patients visiting their GP had experienced a DRP within the last 6 months.<sup>6</sup>

These studies highlight the need for improved detection and prevention of DRPs within the community before hospital attendance or admission is necessary. Pharmacists are well-respected, highly trained, and accessible health professionals, making them ideally situated

**BACKGROUND:** Drug-related problems (DRPs) are a major burden on health care systems. Community pharmacists are ideally placed to detect, prevent, and resolve these DRPs.

**OBJECTIVE:** To determine the number and nature of DRPs detected and clinical interventions performed by Australian community pharmacists, using an electronic system.

**METHODS:** An electronic documentation system was designed and integrated into the existing dispensing software of 186 pharmacies to allow pharmacists to record details about the clinical interventions they performed to prevent or resolve DRPs. Participating pharmacies were randomly allocated to 3 groups: group 1 had documentation software, group 2 had documentation software plus a timed reminder to document interventions, and group 3 had documentation software, a timed reminder, and an electronic decision support prompt. Pharmacists classified DRPs, entered recommendations they made, and estimated the clinical significance of the intervention. An observational substudy that included pharmacies without any documentation software was completed to verify intervention rates.

**RESULTS:** Over 12 weeks, 531 participating pharmacists recorded 6230 clinical interventions from 2,013,923 prescriptions, with a median intervention rate of 0.23% of prescriptions. No significant differences were seen between the 3 groups that used documentation software; as expected, however, the pharmacies that used this software had a significantly higher documentation rate compared to the pharmacies without documentation software. The most common interventions were related to drug selection problems (30.8%) and educational issues (24.4%). Recommendations were often related to a change in therapy (40.0%), and 41.6% of interventions were self-rated as highly significant. Drug groups most commonly subject to an intervention included antibiotics, glucocorticoids, nonsteroidal antiinflammatory drugs, and opioids.

**CONCLUSIONS:** The documentation system allowed for the determination of the frequency and types of DRPs, as well as the recommendations made to resolve them in community pharmacy practice. Use of the software, including its electronic prompts, significantly increased the documentation of interventions by pharmacists.

**KEY WORDS:** clinical pharmacy, community pharmacy, drug-related problems, pharmaceutical care.

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to detect, prevent, and resolve DRPs in the community setting.<sup>7</sup> The process of a pharmacist identifying and preventing or resolving a DRP can be termed a *clinical intervention*. While pharmacists undertake clinical interventions as part of their duty of care, the current practice is not to routinely document them unless there is some imperative, such as to facilitate communication to others involved in the patient's care or to adequately record details of a potentially litigious situation. International community pharmacy studies have estimated that pharmacists perform clinical interventions at varying rates, ranging between 0.09% and 2.69% of prescriptions.<sup>8-12</sup> However, there is no standardized documentation system that allows pharmacists to record these interventions; therefore, it is difficult to determine how many and what types of DRPs are occurring and being resolved within the community pharmacy environment.

The aim of the PROMISE (Pharmacy Recording of Medication Incidents and Services electronically) trial was to estimate the number and nature of DRPs detected and clinical interventions performed within community pharmacy in Australia. In addition, several versions of documentation software, including one that incorporated electronic decision support, were tested to determine which features best improved documentation rates.

## Methods

For this study, a clinical intervention was defined as "any professional activity by the pharmacist directed towards improving the quality use of medicines and resulting in a recommendation for a change in the patient's medication therapy, means of administration or medication-taking behavior."<sup>13</sup> An electronic intervention documentation system (PROMISE Intervention software) was designed to allow community pharmacists to quickly document DRPs and their clinical interventions. The DRP classification system developed for the previous PROMISE pilot study was modified,<sup>13,14</sup> resulting in the DOCUMENT DRP Classification system; this scheme was incorporated into the PROMISE Intervention software. The basic PROMISE Intervention software generated a pop-up window that allowed the pharmacist to record details of the intervention, which were then sent to a secure repository. The system was integrated into the community pharmacies' existing dispensing program.

### PARTICIPANTS AND GROUP ALLOCATION

The PROMISE trial involved 210 community pharmacies across 3 states of Australia, which represented approximately 5% of all Australian pharmacies. To recruit pharmacies for the project, the Pharmacy Guild of Australia faxed expression of interest forms to an estimated 3000 pharmacies in the 3 states. A total of 334 pharmacies expressed in-

terest in participating in the project, from which 210 pharmacies were invited to participate. The pharmacies were enrolled in the study in the order that they expressed interest and the only inclusion criterion was that the pharmacy had 1 of the 2 commercial dispensing systems involved in the study. However, the pharmacies needed to form a representative sample of pharmacies within Australia according to their prescription volume and location, where the representative groups consisted of average weekly prescription volume (8 groups: ≤400, 401-600, 601-800, 801-1000, 1001-1200, 1201-1400, 1401-2000, and >2000), and location (2 groups: metropolitan or rural). Therefore, once the target population had been reached within one group (such as rural pharmacies with large prescription volumes), no additional pharmacies with those specifications were enrolled.

The PROMISE Intervention software was installed in 186 of the 210 pharmacies, collectively called the *software pharmacies*; participating pharmacists were asked to classify and record DRPs and their clinical interventions for 12 weeks. The 186 software pharmacies were further divided into 3 different software groups to determine the effect of different support mechanisms aimed at facilitating an increased level of documentation using the recording system. Software pharmacies were randomly allocated into groups: group 1 had only the PROMISE Intervention software (40 pharmacies); group 2 had the PROMISE Intervention software plus a timed general reminder activated at 11 AM and 3 PM daily to encourage pharmacists to document interventions (73 pharmacies); and group 3 had the PROMISE Intervention software, the timed general reminder, and an electronic decision support prompt (73 pharmacies) (Figure 1). The electronic decision support prompt was activated when pharmacists dispensed prescriptions for esomeprazole 40 mg or pantoprazole 40 mg; it encouraged pharmacists to approach suitable patients to discuss the possibility of decreasing the dose of their proton pump inhibitor with GP consultation.<sup>15</sup> This prompt was chosen because it was of topical interest within Australia at the time of the trial, with evidence-based guidelines from the Australian National Prescribing Service being published the month before the trial began. Esomeprazole and pantoprazole were the third and fifth most commonly prescribed items on the Australian Pharmaceutical Benefits Scheme in 2009, costing the government an estimated \$270 million (US\$) per year.<sup>16</sup> This electronic prompt aimed to decrease the annual cost to the government for prescription medications, as well as improve the quality of medicine use for Australian patients.

To collect a true representation of intervention and documentation behavior in the absence of the PROMISE Intervention software, 24 pharmacies that did not have the software installed were also studied; these were referred to as the *no-software pharmacies*. The no-software pharmacy data were collected on paper-based forms by trained pharmacist observers over a working week (8 hours a day for a

5-day period from Monday to Friday). Data collected included the pharmacists' current methods of documenting DRPs and interventions, the actual clinical intervention rate, and the documented clinical intervention rate. A sample of 38 software pharmacies was also observed over a 5-day period to determine the percentage of actual performed interventions that were being recorded through the PROMISE Intervention software (Figure 1), as it was predicted that not all performed interventions would be recorded.

Participating pharmacists were trained in the use of both the DOCUMENT DRP Classification system and the PROMISE Intervention software in either face-to-face or online training sessions, or both.

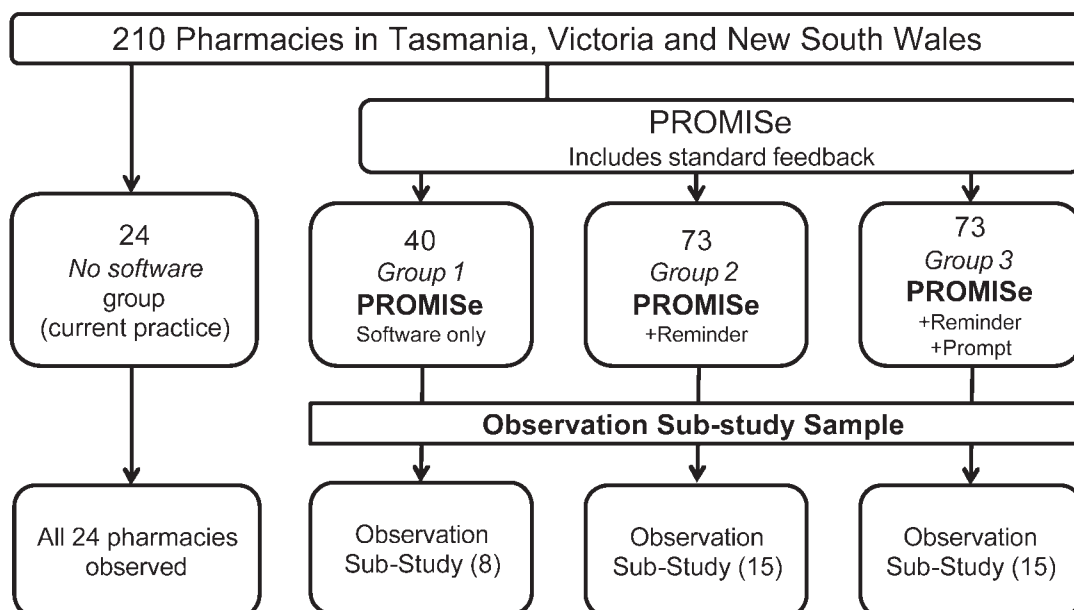
#### DATA COLLECTION

After performing an intervention, participating pharmacists were asked to record it using the DOCUMENT DRP Classification system. The PROMISE Intervention software could be accessed from the main screen of the dispensing system. Some data were pre-populated, such as the drug involved (using Anatomical Therapeutic Chemical [ATC] codes,<sup>17</sup> where substances are divided into different groups according to the organ or system on which they act), whether the prescription was an original issue or a refill, and the age and sex of the patient. Pharmacists were required to select a DOCUMENT DRP category, such as drug selection, dosing, compliance, or education issue (Table 1), and select up to 4 recommendations to give to the patient. They were also required to categorize their perception of the clinical significance of the intervention, with a highly significant intervention defined as "requiring or

preventing a GP or hospital visit." Finally, the time taken to conduct the intervention and any additional notes regarding the intervention could be entered by the pharmacist. More than 1 DRP and subsequent clinical intervention could be entered for a single prescribed drug, if necessary. Observation periods commenced in week 3 of the trial and concluded in week 10 (Figure 2); participation in the observation substudy was voluntary. Information was gathered from participating pharmacists before and after the trial period via online surveys, including demographics and an assessment of their ability to detect and solve DRPs through the use of a validated survey. Information about the pharmacies was also collected via online surveys completed by pharmacy owners or managers, and site visits to each pharmacy were undertaken by the project team.

#### ANALYSIS

$\chi^2$  Tests were used to determine if the samples were representative of the population of pharmacies. Mann-Whitney or Kruskal-Wallis  $\chi^2$  tests, as well as Spearman correlations, were used on the post-trial dataset because of the nonparametric nature of the data to determine the factors influencing intervention rate. Statistical analyses were performed using PASW Statistics 17 (SPSS Inc., Chicago, IL). Statistical analysis showed that the sample size for the observational substudy would detect a difference in intervention rate of at least 0.1% (1 in 1000 prescriptions) with 100% power, and a difference of 0.05% would be detected with a power of 90% (performed with the *sampsi* command in Stata 11, StataCorp LP, College Station, TX), with a standard first-type error of  $\alpha = 0.05$ .



**Figure 1.** Group allocation during the PROMISE (Pharmacy Recording of Medication Incidents and Services electronically) trial.

The study was approved by the Tasmanian Health and Medical Human Research Ethics Committee. The study was overseen at all stages by an expert advisory panel consisting of pharmacy academicians, practicing pharmacists, government employees, and a consumer representative.

## Results

Of the 210 participating pharmacies, 209 completed the trial successfully; 1 pharmacy withdrew due to the unforeseen sale of the business. The sample of pharmacies was representative of all Australian pharmacies, based on location (extent of rurality) and weekly prescription volume ( $\chi^2 = 8.0$ ,  $df = 9$ ;  $p = 0.53$ ). There was also a representative sample of pharmacies within each of the software groups ( $\chi^2 = 20.7$ ,  $df = 18$ ;  $p = 0.29$ ). Of the 531 pharmacists, 430 (81%) completed some form of training, with 19 (3.5%) completing the face-to-face training only, 215 (40.5%) completing the online training only, and 196 (37%) completing both forms of training.

## INTERVENTION RATES

During the course of the study, 531 enrolled pharmacists dispensed 2,013,923 prescriptions for 483,147 patients. A total of 6755 clinical interventions were documented, 525 of which were not included in this analysis as they related to either over-the-counter medications or symptom-based requests to the pharmacist. The remaining 6230 prescription-based interventions equated to an average of 3.3 clinical interventions documented for every 1000 prescriptions dispensed throughout the trial or 12.9 interventions per 1000 patients. The overall median intervention rate was 0.23% (2.3 interventions in 1000 prescriptions). In the sample of 38 software pharmacies that were observed for one week during the trial, it was determined that, on average, only 49% of performed clinical interventions were actually documented.

Overall, there was a decline in the recording of interventions over the course of the 12-week trial (Kruskal-Wallis:  $\chi^2 = 184.6$ ,  $df = 11$ ;  $p < 0.01$ ; J-T statistic = -13.3;  $p < 0.01$ ), despite a constant number of prescriptions being dispensed (Figure 2).

**Table 1.** DOCUMENT DRP Classification System

Category and Description	Code	Description
<b>D—Drug selection</b> Problems relating to the choice of drug prescribed or taken	D1 D2 D3 D4 D5 D6 D7 D0	Duplication Drug interaction Wrong drug Incorrect strength Inappropriate dosage form Contraindications apparent No indication apparent Other drug selection problem
<b>O—Overdose or underdose</b> Problems relating to the prescribed dose or schedule of a drug	O1 O2 O3 O0	Prescribed dose too high Prescribed dose too low Incorrect or unclear dosing instructions Other dose problem
<b>C—Compliance</b> Problems relating to the way the patient takes the medication	C1 C2 C3 C4 C5 C0	Taking too little Taking too much Erratic use of medication Intentional drug misuse (including over-the-counter drugs) Difficulty using dosage form Other compliance problem
<b>U—Undertreated</b> Problems relating to actual or potential conditions that require management or prevention	U1 U2 U3 U0	Condition undertreated Condition untreated Preventative therapy required Other untreated indication problem
<b>M—Monitoring</b> Problems relating to monitoring the efficacy or adverse effects of a drug	M1 M2 M0	Laboratory monitoring Nonlaboratory monitoring Other monitoring problem
<b>E—Education or information</b> Patient requests for further information about a drug or disease state	E1 E2 E0	Patient requests drug information Patient requests disease management advice Other education or information problem
<b>N—Not classifiable</b> Problems that cannot be classified under another category	N0	Clinical interventions that cannot be classified under another category
<b>T—Toxicity or adverse reaction</b> Problems relating to the presence of signs or symptoms that may be attributed to a drug	T1	Toxicity, allergic reaction, or adverse effect present
DRP = drug-related problem.		



## TYPES OF INTERVENTIONS

The 2 most common types of interventions were related to drug selection problems ( $n = 1918$  [30.8%]), such as drug interaction or incorrect strength prescribed, and educational issues prompted by patient requests ( $n = 1518$  [24.4%]). Incorrect doses were the third most common intervention ( $n = 1253$  [20.1%]). Pharmacists were able to assign up to 4 recommendations for each clinical intervention, and a total of 10,103 recommendations were recorded (mean 1.6 recommendations per intervention). Frequently, the type of recommendation made by the pharmacist related to a change in therapy ( $n = 4038$  [40.0%]), in particular a drug or a dose change. Pharmacists commonly provided counseling and education for the patient ( $n = 2569$  [25.4%]) or referred the patient to the prescriber ( $n = 1925$  [19.1%]). Relationships between the types of recommendations made for each clinical intervention showed that a recommendation for change in therapy was more likely to occur with DRPs related to either drug selection (42.1% of category) or dosage problems (29.1%). Interventions where a referral to the GP was required were also more likely to occur with DRPs related to either drug selection (33.6% of category) or dosage problems (19.6%), but were also common with toxicity-related interventions (14.1%).

Pharmacists indicated that 41.6% of the recorded clinical interventions had a high clinical significance (defined as "preventing or requiring a GP or hospital visit"). More significant clinical interventions tended to be associated

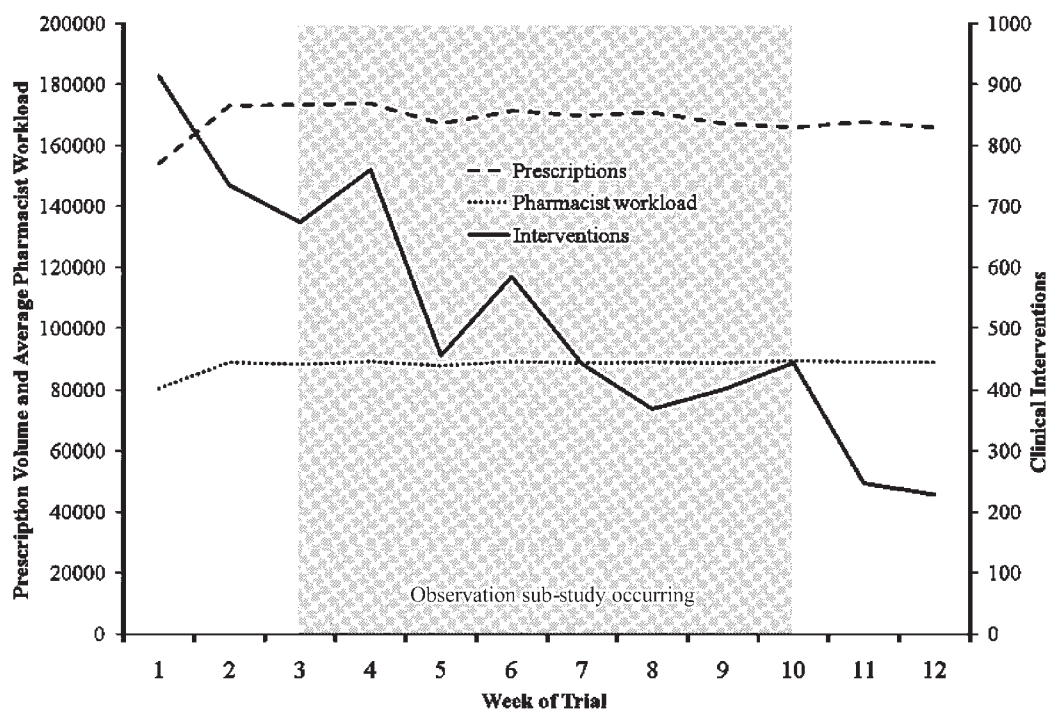
with recommendations such as a drug change, referral to the prescriber or a hospital, or monitoring. Less clinically significant interventions were more commonly associated with information or educational recommendations (Table 2). Pharmacists were significantly more likely to record the interventions ranked with a higher clinical significance as opposed to those ranked with a lower clinical significance ( $\chi^2 = 14.0$ ,  $df = 1$ ;  $p < 0.01$ ).

Original prescriptions were only 45.4% of all dispensed prescriptions but were linked to 77.9% of all documented interventions. The intervention rate was significantly higher for original prescriptions (0.37%) than refills (0.09%;  $\chi^2 = 1856.5$ ,  $df = 1$ ;  $p < 0.01$ ).

## DRUGS INVOLVED IN INTERVENTIONS

Phenoxymethylpenicillin had the highest rate of interventions per number of individual prescriptions, at 1.16% (55 interventions from 4748 prescriptions), followed by erythromycin, with 0.98% (68 interventions from 6963 prescriptions). Interventions on these antibiotics generally occurred due to a drug selection problem (55.3%) such as a drug interaction (13.0%), incorrect strength (15.4%), the presence of a contraindication (5.7%), or a dosing issue (19.5%).

Other drugs with relatively high rates of intervention included pantoprazole (0.66%; 176 interventions in 26,749 prescriptions), prednisolone (0.64%; 113 interventions in 17,788 prescriptions), esomeprazole (0.52%; 260 interven-



**Figure 2.** Number of interventions recorded, prescriptions dispensed, and average pharmacist workload during the 12-week trial in the pharmacies using the PROMISE (Pharmacy Recording of Medication Incidents and Services electronically) Intervention software.

tions in 50,079 prescriptions), tramadol (0.47%; 75 interventions in 16,067 prescriptions), and oxycodone (0.46%; 95 interventions in 20,748 prescriptions). Interventions involving pantoprazole and esomeprazole most commonly involved education (39.8% and 32.3%, respectively) or occurred due to a drug selection issue (34.7% and 30.0%, respectively). Interventions involving prednisolone generally occurred due to dosing issues (42.4%), whereas interventions involving tramadol and oxycodone were most commonly due to drug selection problems (38.6% and 28.4%, respectively), such as a drug interaction or inappropriate dosage form.

Examples of interventions recorded during the trial for these medications included:

1. A patient taking simvastatin 80 mg presents to the pharmacy with a prescription for erythromycin 800 mg twice a day. The pharmacist recognizes the potential for an interaction and recommends that the patient temporarily discontinue the simvastatin therapy during the antibiotic course, decreasing the risk of myopathy.
2. A patient presents to the pharmacy with a prescription for prednisolone 50 mg 4 times daily. The pharmacist believes the dose is too high and contacts the prescriber, who confirms the directions should read 50 mg daily for 4 days.

3. A patient is taking oxycodone 20 mg twice a day and reports to the pharmacist that he is constipated. The pharmacist recommends preventive therapy for constipation during therapy with oxycodone.

When the ATC Level 4<sup>17</sup> drug groups were analyzed, the groups that were subject to the highest frequency of interventions included  $\beta$ -lactamase-sensitive penicillins (1.08%; 56 interventions in 5162 prescriptions); non-steroidal antiinflammatory acetic acid derivatives, including indomethacin and diclofenac (0.57%); macrolide antibiotics (0.56%); oral glucocorticoids (0.55%); and other opioids, including tramadol (0.47%). The top 10 drugs for interventions per prescription can be seen in Table 3.

### FACTORS AFFECTING INTERVENTION RATES

Over the 12-week trial, the intervention rate varied between the 3 software groups. Group 1 recorded a median rate of 0.19% (1.9 interventions per 1000 prescriptions), group 2 recorded a rate of 0.20%, and group 3 recorded a rate of 0.28%. These differences were not statistically significant over the trial (Kruskal-Wallis:  $\chi^2 = 4.0$ ,  $df = 2$ ;  $p = 0.14$ ). When intervention rates were calculated on the first 4 weeks of data, there was a significant difference between the groups, with group 1 recording a median intervention rate of 0.28%,

group 2 recording a rate of 0.29%, and group 3 recording a rate of 0.39% (Kruskal-Wallis:  $\chi^2 = 5.8$ ,  $df = 2$ ;  $p = 0.048$ ; J-T statistic = 2.4;  $p = 0.02$ ). The timed general reminder at 11 AM and 3 PM in groups 2 and 3 did not cause an increase in the overall intervention rates of these groups but did cause statistically significant alterations in the distribution pattern of recorded interventions ( $\chi^2 = 79.2$ ,  $df = 24$ ;  $p < 0.01$ ), with a larger number of interventions being recorded in the hour following the reminders.

Comparisons between the no-software and group 3 software pharmacies showed a significantly higher median rate of interventions documented within the group 3 pharmacies, with no-software pharmacies recording a median rate of 0.00 and group 3 pharmacies recording a median rate of 1.21 clinical interventions for every 1000 prescriptions dispensed (Mann-Whitney  $U = 14.0$ ,  $z = -5.2$ ;  $p < 0.01$ ). Interestingly, the median rate of interventions performed, as determined by observation, was also significantly higher within the group 3 pharmacies, with no-software pharmacies performing a median rate of 1.54 and group 3 pharmacies performing a median rate of 3.00 clinical interventions for every 1000 prescriptions dispensed (Mann-Whitney  $U = 101.0$ ,  $z = -2.7$ ;  $p < 0.01$ ).

**Table 2.** Recommendations Made and Their Clinical Significance

Category and Subcategory		Low Clinical Significance, n (%)	High Clinical Significance, n (%)	Total
<b>Change in therapy</b>				
R1	Dose increase	326 (50.7)	317 (49.3)	643
R2	Dose decrease	428 (52.1)	393 (47.9)	821
R3	Drug change	280 (32.5)	582 (67.5)	862
R4	Drug formulation change	241 (62.6)	144 (37.4)	385
R5	Drug brand change	62 (64.6)	34 (35.4)	96
R6	Dose frequency/schedule change	335 (62.6)	200 (37.4)	535
R7	Prescription not dispensed	117 (37.6)	194 (62.4)	311
R8	Other changes to therapy	187 (48.6)	198 (51.4)	385
<b>Referral required</b>				
R9	Refer to prescriber	737 (38.3)	1188 (61.7)	1925
R10	Refer to hospital	6 (16.2)	31 (83.8)	37
R11	Refer for medication review	37 (47.4)	41 (52.6)	78
R12	Other referral required	24 (40.7)	35 (59.3)	59
<b>Provision of information</b>				
R13	Education or counseling session	1746 (68)	823 (32)	2569
R14	Written summary of medications	187 (70)	80 (30)	267
R15	Recommend dose administration aid	44 (58.7)	31 (41.3)	75
R16	Other written information	485 (80.7)	116 (19.3)	601
<b>Monitoring</b>				
R17	Monitoring: nonlaboratory	132 (47.3)	147 (52.7)	279
R18	Monitoring: laboratory test	58 (33.1)	117 (66.9)	175
<b>Total</b>		5432 (53.8)	4671 (46.2)	10,103

Relationships between the workload within the pharmacy and intervention rates were also examined, showing a statistically significant negative trend between the prescription volume during the trial and the pharmacy's overall intervention rate (Spearman  $\rho = -0.23$ ;  $p < 0.01$ ). An average pharmacist workload was determined by dividing the pharmacy's weekly prescription volume by the number of full-time equivalent pharmacists; as workload increased, it was found that the intervention rate of the individual pharmacist significantly decreased (Spearman  $\rho = -0.23$ ;  $p < 0.01$ ).

The number of hours spent by pharmacists on continuing education (CE) annually was significantly related to their intervention rate (Kruskal-Wallis:  $\chi^2 = 18.4$ ,  $df = 3$ ;  $p < 0.01$ ; J-T statistic = 4.2;  $p < 0.01$ ), as was their score on a DRP questionnaire (Spearman  $\rho = 0.16$ ,  $p < 0.01$ ). Age, sex, graduation year, and employment position (eg, owner, manager, or employee) were not found to influence the intervention rate. The level of training that the pharmacist completed also appeared to significantly affect the pharmacist's intervention rate, with pharmacists who had completed both face-to-face and online training having a significantly higher intervention rate than pharmacists with no training (Kruskal-Wallis  $\chi^2 = 66.4$ ,  $df = 3$ ;  $p < 0.01$ ; J-T statistic = 7.9;  $p < 0.01$ ).

## Discussion

### INTERVENTION RATES

The intervention rate seen in the PROMISE trial is consistent with that of previous studies, both in Australia and other countries.<sup>8-12,14</sup> However, comparisons between the studies are difficult, as the definitions of DRPs recorded are not always consistent. For example, some studies have included administrative errors as clinical interventions, which were not included in the PROMISE trial. Also, results from observation of PROMISE trial pharmacies identified that pharmacists

did not document up to half of the interventions they performed. Therefore, although the median intervention rate was recorded at 0.23 clinical interventions per 100 prescriptions, it is likely that the actual rate of performance of clinical interventions was considerably higher.

The PROMISE Intervention software was also shown to increase the number of interventions both performed and documented compared to the no-software group. This suggests that the presence of the software may increase awareness of clinical interventions, reminding pharmacists to document their interventions and providing an adequate platform for the recording, as well as encouraging them to perform interventions that they otherwise may not have made. A 5-day observation period may not have been an adequate observation duration to give a true description of current practice; however, because of time and financial restrictions, this was the longest achievable timeframe. We also believed that 5 days was long enough to overcome the Hawthorne effect that can hinder observational studies.<sup>18</sup>

Pharmacists could record DRPs and clinical interventions related to over-the-counter medicines, but this was not mandatory and was not the focus of the trial. Also, the PROMISE system recorded only the number of prescriptions during the trial, not the number of over-the-counter sales; therefore, an intervention rate on over-the-counter items could not be adequately calculated. Hence, they were excluded from the dataset prior to analysis. However, we acknowledge the importance of this area and the need for further study.

### TYPES OF INTERVENTIONS

The types of interventions seen in the PROMISE trial were similar to those of previous studies, although direct comparisons to international literature are difficult due to the varying classification systems. Most studies have shown drug selec-

**Table 3.** Top 10 ATC Level 4 Drug Group Interventions as a Proportion of Their Prescriptions

Level 4 ATC Code	Description	Interventions, n	Prescriptions, n	Total, %
J01CE	$\beta$ -Lactamase-sensitive penicillins	56	5,162	1.08
M01AB	Acetic acid derivatives and related substances	66	11,528	0.57
J01FA	Macrolides	199	35,371	0.56
H02AB	Glucocorticoids, oral	140	25,264	0.55
N02AX	Other opioids	75	16,067	0.47
R03BA	Glucocorticoids, inhaled	76	16,988	0.45
R03AK	Adrenergics and other drugs for obstructive airway diseases	92	21,446	0.43
J01CA	Penicillins with extended spectrum	204	48,490	0.42
A02BC	Proton pump inhibitors	515	122,911	0.42
S01AA	Antibiotics	62	15,977	0.39

ATC = Anatomical Therapeutic Chemical.



tion, drug-drug interactions (which were classified under “drug selection” in PROMISE), and dosage issues as being the most common prescription DRPs requiring intervention.<sup>9,10,19,20</sup> Most international studies did not record educational interventions within the pharmacy; therefore, it is not possible to compare this category of interventions.

### DRUGS INVOLVED IN INTERVENTIONS

The database of DRPs that resulted from the PROMISE trial has the potential to become more comprehensive should the PROMISE Intervention software be implemented more widely and could be considered a tool for monitoring medication safety in Australia. The drugs most commonly involved in clinical interventions in this trial were varied, with the most common being antibiotics: phenoxymethylpenicillin and erythromycin. All of these interventions were on original prescriptions (not refills); therefore, this may have contributed to a high intervention rate for these antibiotics resulting from a significantly higher number of interventions overall being associated with original prescriptions. It is also possible that pharmacists were more proactive with antibiotic dispensing and, therefore, more likely to assess the dose and presence of allergies or contraindications for each person.

Pantoprazole and esomeprazole were in the top 5 drugs most commonly subject to an intervention, likely due to the presence of the electronic decision support prompt. When the 282 interventions linked to the prompt were removed, the remaining 233 interventions produced a much lower intervention rate of 0.19%. It was also interesting to note the high number of interventions for drugs such as prednisolone, tramadol, and oxycodone, which all have the potential for serious adverse effects should they be used incorrectly. The most common drugs in the PROMISE trial were different than those identified in other community studies, where cardiovascular system and nervous system drugs were more commonly detected.<sup>21,22</sup> However, systemic antibiotics, prednisolone, and analgesics were identified as some of the most common drugs implicated in DRPs requiring hospital admission,<sup>2,3</sup> which may indicate that pharmacists are resolving many DRPs that may have otherwise resulted in hospital admission.

### FACTORS AFFECTING INTERVENTION RATES

The timed general reminder at 11 AM and 3 PM did not appear to influence the overall intervention rate in groups 2 and 3, but there was an increased intervention rate in the time immediately following the reminder, which may indicate that the reminder altered the time of day that the pharmacists recorded their interventions.

A significant decline in intervention rate was seen over the 12 weeks of the trial, and there may be several explanations for this finding. Although the electronic prompt seen in group 3 pharmacies did not contribute to a significant differ-

ence between the overall intervention rates of the pharmacies, it may have contributed to the significant difference seen between the groups in the first 4 weeks of the trial. Because of the nature of the prompt, the group of eligible patients is likely to have been exhausted after approximately 1 month, as most patients suitable for therapy reduction would have been identified within the first month of the trial. This may have contributed to the decline in the prompted intervention rate and, subsequently, a decrease in the overall intervention rate during the trial, resulting in no significant differences overall between the 3 software groups.

The overall number of interventions involving pantoprazole and esomeprazole was significantly increased by the presence of the prompt, which indicates that an electronic prompt could significantly increase the number of interventions performed on a specific drug.<sup>15</sup> The introduction of a rotation system for the prompts, where different interventions are targeted periodically, may be more successful at maintaining the optimal rate of interventions over a longer period. There is also a possibility that the pharmacies experienced trial fatigue, where the system reminders no longer triggered the pharmacists to record their interventions. This phenomenon has been noted in previous electronic prompt studies.<sup>23-25</sup> Another possible factor contributing to the decline of documented interventions may be the remuneration model used in PROMISE, whereby the pharmacies were provided with an initial payment and a payment on completion of the trial, rather than a performance-based remuneration scheme. By improving the remuneration scheme and using a rotating electronic prompt system, we believe that the intervention rate seen within the first 4 weeks could be maintained on a longer basis.

Results from the PROMISE trial showed that decreasing a pharmacist's workload has the potential to increase the number of DRPs detected within the community pharmacy environment. This is consistent with a study of 672 pharmacies, which suggested that the more prescriptions pharmacists dispensed per hour, the more likely they were to have a higher rate of dispensing drugs with potential drug-drug interactions<sup>26</sup>; therefore, higher pharmacist workloads could be associated with lower clinical intervention rates.<sup>11,26</sup> By decreasing the pharmacist's workload, the number of clinical interventions detected could be increased, improving medication use and patient safety.

Analysis of the results also revealed a significant correlation between the reported annual level of CE and the pharmacist's documented clinical intervention rate, where higher intervention rates were recorded by pharmacists with a larger number of annual CE hours. This trend is consistent with studies of the impact of continuing medical education (CME) on physician performance, which have concluded that CME improved physician performance<sup>27-30</sup> and, in some cases, health outcomes for patients.<sup>30</sup> A recent study in the US showed that pharmacists self-report that CE increases their



clinical knowledge and the level of patient care they provide,<sup>31</sup> which could likely lead to an increased clinical intervention rate.

To our knowledge, the PROMISE trial was the largest study of clinical pharmacy interventions in Australia and one of the largest in the world. The PROMISE Intervention software increased the number of interventions performed, and this number can likely be further increased through the employment of several strategies: rotating electronic prompt campaigns, decreased pharmacist workloads, and increased pharmacist access to and use of CE. The most common DRPs seen in PROMISE pharmacies were related to drug selection problems and educational issues, both of which could be resolved by the pharmacist and/or patient in the majority of cases. The drugs most commonly involved in interventions were antibiotics (phenoxymethylpenicillin and erythromycin), which generally required an intervention due to a drug interaction or incorrect dosage.

Based on these results, the Australian government has provided funds to support the national implementation of a clinical intervention documentation system in community pharmacy.

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## Problemas Relacionados a Medicamentos Detectados en Farmacias de Comunidad en Australia: el Estudio PROMISE

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### EXTRACTO

**TRASFONDO:** Los problemas relacionados a medicamentos (PRMs) son una carga para los sistemas de cuidado de salud. Las farmacias de comunidad están idealmente localizadas para detectar, prevenir, y resolver estos PRMs.

**OBJETIVO:** Determinar el número y naturaleza de los PRMs detectados y las intervenciones clínicas realizadas por farmacéuticos de comunidad en Australia, utilizando un sistema electrónico.

**MÉTODOS:** Se diseñó un sistema de documentación electrónica y se integró a la programación de despacho existente en 186 farmacias para permitir la documentación detallada de las intervenciones clínicas realizadas para prevenir o resolver PRMs. Las farmacias participantes se colocaron aleatoriamente en tres grupos: Grupo 1 tenía la programación de documentación, el Grupo 2 tenía la programación de documentación y un recordatorio programado para documentar las intervenciones, y el Grupo 3 tenía la programación de documentación, el recordatorio programado para documentar las intervenciones y una ayuda electrónica para la toma de decisiones. Los farmacéuticos clasificaban los PRMs, documentaban las recomendaciones que hacían y estimaban la significancia clínica de la intervención. Se completó además, un sub-estudio observacional, que incluyó farmacias sin la programación electrónica de documentación, para verificar la tasa de intervención.

**RESULTADOS:** Durante 12 semanas, 531 farmacias participantes documentaron 6,230 intervenciones clínicas de 2,013,923 recetas, para una tasa mediana de intervención de 0.23% de las recetas. No hubo diferencias significativas entre los tres grupos de “programas”, sin embargo las farmacias con los programas electrónicos tuvieron una tasa de documentación significativamente mayor comparada con las farmacias que no tenían los programas. Comúnmente, las intervenciones de los farmacéuticos estaban relacionadas a problemas de selección del fármaco (30.8%) y asuntos de educación (24.4%). Las recomendaciones fueron frecuentemente relacionadas a cambio en terapia (40%), y el 41.6% de las intervenciones fueron auto-clasificadas como altamente significativas. Los grupos de fármacos que más comúnmente requirieron intervención incluyeron antibióticos, glucocorticoides, anti-inflamatorios no-esteroidales, y opioides.

**CONCLUSIONES:** Los programas electrónicos de documentación en farmacias de comunidad permitieron la determinación de la frecuencia y tipos de PRMs y de las recomendaciones hechas para resolverlos. El uso de estos programas, incluyendo los avisos electrónicos, aumentó significativamente la documentación de intervenciones por los farmacéuticos.

Traducido por Giselle Rivera-Miranda

## Interventions Pharmacothérapeutiques par les Pharmaciens Communautaires Australiens: l'Étude PROMISE

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### RÉSUMÉ

**INTRODUCTION:** Les problèmes de pharmacothérapie (PPT) sont un fardeau important des systèmes de santé. Les pharmaciens communautaires détiennent une position privilégiée dans le système de santé pour l'identification, la prévention et la résolution des PPT.

**OBJECTIF:** Déterminer le nombre et la nature des PPT détectés et des interventions cliniques effectuées par les pharmaciens communautaires Australiens à l'aide d'un système électronique.

**DEVIS EXPÉRIMENTAL:** Un système de documentation électronique a été mis au point et intégré dans le logiciel de distribution de médicaments de 186 pharmacies afin de permettre aux pharmaciens d'enregistrer les détails de leurs interventions cliniques ayant pour but de prévenir ou résoudre des PPT. Les pharmacies participantes ont été assignées au hasard à l'un des trois groupes suivants: Groupe 1: logiciel de documentation; Groupe 2: logiciel plus relance rappelant de documenter l'intervention; Groupe 3: logiciel, relance et une boîte de dialogue aidant à la décision clinique. Les pharmaciens devaient classifier le PPT, entrer la recommandation effectuée et estimer l'implication clinique de leur intervention. Le nombre d'interventions dans un groupe témoin de pharmacies n'ayant pas accès au logiciel a aussi été mesuré.

**RÉSULTATS:** Au cours d'une période de 12 semaines, 531 pharmaciens participants ont enregistré 6,230 interventions cliniques sur un volume total de 2,013,923 prescriptions, soit un taux médian d'intervention de 0.23% des prescriptions. Aucune différence n'a été observée entre les 3 groupes, mais les pharmacies ayant accès au logiciel avaient un taux de documentation significativement plus élevé que les pharmacies n'ayant pas accès au logiciel. Les interventions les plus fréquentes impliquaient le choix du médicament (30.8%) et l'éducation (24.4%). Les recommandations portaient principalement sur un changement de thérapie (40.0%). Les pharmaciens ont évalué la portée clinique de leur intervention comme hautement significative dans 41.6% des cas. Les médicaments faisant l'objet le plus fréquemment d'une intervention incluaient les antibiotiques, les glucocorticoïdes, les médicaments anti-inflammatoires non-stéroïdiens, et les opiacés.

**CONCLUSIONS:** Le système de documentation permet de déterminer la fréquence et le type d'interventions cliniques portant sur des PPT effectuées par les pharmaciens communautaires. L'utilisation d'un logiciel, incluant ces relances et boîtes de dialogue, augmente significativement la documentation de telles interventions par le pharmacien.

Traduit par Suzanne Laplante