Computerised prescribing: assessing the impact on prescription repeats and on generic substitution of some commonly used antibiotics

David A Newby and Jane Robertson

ABSTRACT

Objectives: To assess the impact of two interventions on computer-generated prescriptions for antibiotics — (i) an educational intervention to reduce automatic computerised ordering of repeat antibiotic prescriptions, and (ii) a legislative change prohibiting the "no brand substitution" box being checked as a default setting in prescribing software — and to compare these findings with those of a similar survey we conducted in 2000.

Design and setting: Prospective audit of consecutive prescriptions for four antibiotics (amoxycillin, amoxycillin/clavulanate, roxithromycin, and cefaclor) commonly prescribed for upper respiratory tract infections in community pharmacies in New South Wales and Queensland between 1 November 2008 and 31 January 2009.

Main outcome measures: Primary outcome: rate of repeat prescription ordering on computer-generated versus handwritten prescriptions. Secondary outcome: rate of checking of the "no brand substitution" box on computer-generated versus handwritten prescriptions.

Results: Data were collected on 2807 prescriptions presented to 51 pharmacies (50 in NSW, one in Queensland), of which 2354 were computer-generated. Repeats were ordered on 1633 computer-generated prescriptions (69%) compared with 183 handwritten prescriptions (40%). These proportions were identical to those found in 2000, although the rates of computer prescribing were much higher in this study (84% v 54%). This difference in repeat prescribing was statistically significant (odds ratio adjusted for clustering at pharmacy level, 2.87; 95% CI, 2.32–3.55). Twenty-three (1%) of the computer-generated prescriptions had the "no brand substitution" box checked compared with 3 (0.7%) of the handwritten prescriptions (27% and 1%, respectively, in our previous survey).

Conclusions: The legislative change which disallowed having the "no brand substitution" box checked as a default setting in prescribing software had a dramatic impact on the checking of the "no brand substitution" box. In contrast, there was no sustained effect of educating prescribers about software default settings relating to repeat prescribing of antibiotics. Other actions are required if unnecessary repeat prescriptions for some medicines, such as antibiotics, are to be reduced.

MJA 2010; 192: 192–195

A recent Australian survey found that almost 90% of general practitioners used a computer in their practice, and, of these, nearly 95% used them for electronic prescribing.[1] Potential advantages of computerised prescribing include increased legibility, patient-specific dosing suggestions, reminders to monitor drug therapy, drug–drug and drug–allergy interaction checking, and guidance on correct drug choice.[2] However, several possible negative effects have been identified, such as prescribing for the wrong patient, and selecting the wrong medication.[3] Computerised prescribing may also affect the quality use of medicines. A review of repeat prescribing of medications for chronic conditions identified a number of potential problems, including missing adverse drug reactions, poor compliance and the accompanied wastage of resources, because of a lack of review by the physician at the time the repeat prescription is issued to the patient.[4] Computerisation has been identified as a significant contributor to the increase in repeat prescribing by making the generation of repeats easier.[5]

We have previously reported a study in 2000 that identified the impact of computerised prescribing on repeat prescriptions for four antibiotics (amoxycillin, amoxycillin/clavulanate, roxithromycin, and cefaclor) that are commonly used for upper respiratory tract infections (URTIs).[6] We compared the rates of repeat ordering, and the checking of the "no brand substitution" box, on computer-generated and handwritten prescriptions, validating our manual data collection using computer records from a sample of the participating pharmacies. Almost 70% of computer-generated prescriptions had repeats ordered, compared with only 40% of handwritten prescriptions. A follow-up survey of patients showed that over 60% had had a repeat prescription dispensed when one was ordered. The rate of checking of the "no brand substitution" box (indicating that the pharmacist is to specifically dispense the antibiotic as prescribed and not a [cheaper] generic antibiotic) was also significantly higher on computer-generated compared with handwritten prescriptions (27% v 1%; data available from the authors).

After our study was conducted, two interventions were mounted in response to these findings. First, the National Prescribing Service (NPS) undertook an educational campaign advising doctors on how to change their computer settings to avoid the automatic insertion of repeats on antibiotic prescriptions. This included highlighting the problem in a Prescribing Practice Review[7] and providing guides on the NPS website for altering the default settings for the common prescribing software packages.[8] The second intervention was a change to the National Health (Pharmaceutical Benefits) Regulations to prohibit prescribing software from checking the "no brand substitution" box as a default setting.[9]

Our aim in the study we report here was to assess the impact of these two interventions on the ordering of repeats and the checking of the "no brand substitution" box on computer-generated prescriptions for the same four antibiotics that we examined in 2000.

METHODS

The study was conducted between 1 November 2008 and 31 January 2009, and involved undertaking a prescription audit in

Rates of repeat ordering on computer-generated and handwritten prescriptions for four antibiotics: results of this study and comparison with our earlier study[6]

	2000 study[6]		2008 and 2009 study			
					Odds ratios (95% CI)	
Repeat ordering	Computer-generated prescriptions	Handwritten prescriptions	Computer-generated prescriptions	Handwritten prescriptions	Unadjusted	Adjusted*
Overall crude rates	461 (69%)	228 (40%)	1633 (69%)	183 (40%)	3.34 (2.72–4.11)	2.87 (2.32–3.55)
By antibiotic						
Amoxycillin	129 (58%)	36 (17%)	401 (53%)	51 (26%)	3.11 (2.19–4.41)	3.07 (2.16–4.37)
Amoxycillin/clavulanate	119 (76%)	54 (47%)	566 (79%)	66 (50%)	3.88 (2.64–5.71)	3.19 (2.14–4.76)
Roxithromycin	125 (70%)	81 (55%)	453 (76%)	44 (51%)	3.02 (1.90–4.80)	2.38 (1.49–3.80)
Cefaclor	88 (80%)	57 (57%)	213 (75%)	22 (54%)	2.59 (1.32–5.06)	2.36 (1.18–4.74)

* For potential correlations resulting from clustering of prescriptions at the pharmacy level. ◆

community pharmacies. Pharmacies were identified from two sources. First, past students of the Master of Pharmacy program at the University of Newcastle were sent invitation packages by email. Second, the pharmaceutical wholesalers, Symbion Pharmacy Services and Sigma Pharmaceuticals, distributed invitation packages to customers as part of usual deliveries from their Newcastle depots. The invitation packages contained an information sheet, a consent form, and a reply-paid envelope.

Pharmacists who agreed to participate collected data on 20 consecutive prescriptions for the four antibiotics of interest (amoxycillin, amoxycillin/clavulanate, roxithromycin, and cefaclor), or for 4 weeks, whichever came first.

Only original prescriptions were included, and data were collected on the type of prescriptions (computer-generated or handwritten), the antibiotic ordered, whether a repeat had been ordered, and whether the "no brand substitution" box had been checked. The sex of the person for whom the prescription was written, and their concession card status, were also recorded. Dental and veterinary prescriptions, prescriptions for paediatric formulations, and prescriptions written for nursing home and aged care residents were excluded.

The study was approved by the Human Research Ethics Committee of the University of Newcastle.

Statistical analysis

The analysis was conducted using Stata version 10.0 (StataCorp, College Station, Tex, USA) and SPSS version 16.0 (SPSS Inc, Chicago, Ill, USA) statistical software packages. The primary outcome was the rate of repeat ordering on computer-generated versus handwritten prescriptions. The secondary outcome was the rate of checking of the "no brand substitution" box on computer-generated versus handwritten prescriptions.

The rates for computer-generated and handwritten prescriptions were compared by calculating odds ratios (ORs) and 95% confidence intervals. Logistic regression analysis using generalised estimating equations (GEEs)[10] was used to calculate an adjusted OR to adjust for potential correlations resulting from clustering of prescriptions at the pharmacy level.

It was estimated that a sample of between 30 and 80 pharmacies would be required to detect a difference of 15%–25% in the rate of repeat ordering between computer-generated and handwritten prescriptions. This was based on our previous study, which found that the proportion of handwritten prescriptions with repeats ordered was 40%, assuming each pharmacy would contribute about 35 prescriptions to the audit, and that 80% of the prescriptions would be computer-generated ($\alpha = 0.05$; power, 80%; intracluster correlation coefficient, 0.1).

RESULTS

Sixty-three graduates of the Master of Pharmacy program were approached, of whom 13 agreed to participate. Pharmaceutical wholesalers delivered 500 invitations on two occasions; 38 pharmacists approached in this way consented to their pharmacy taking part in the study. All but one of the 51 participating pharmacies were in New South Wales; the remaining one was in Mossman, Queensland. The NSW pharmacies were located in the Newcastle/Hunter region (31), the Central Coast (12), outer Sydney (4), and the Mid North Coast (3).

Details on 2807 antibiotic prescriptions were captured, of which 2354 (84%) were computer-generated and 453 (16%) were handwritten. The sample included 953 prescriptions for amoxycillin (34%), 847 for amoxycillin/clavulanate (30%), 682 for roxithromycin (24%), and 325 for cefaclor (12%). These proportions are broadly similar to prescriptions subsidised by the Pharmaceutical Benefits Scheme (PBS) for these agents over the period of the data collection.[11] More of the prescriptions were written for females (61%), and just over half (53%) were for concession card holders. This compares with 59% females, and 61% concession card holders in our 2000 survey (data available from the authors).

Repeat ordering

Of the 2354 computer-generated prescriptions, repeats were ordered on 1633 (69%) compared with only 183 (40%) on the 453 handwritten prescriptions (Box). After adjusting for clustering at the pharmacy level, the odds of having a repeat ordered were significantly higher for computer-generated prescriptions than for handwritten prescriptions (adjusted OR, 2.87; 95% CI, 2.32–3.55). This observation was consistent for the individual antibiotics examined, although the rates of repeat ordering differed (Box). These results were almost identical to those in our 2000 study[6] (Box).

"No brand substitution" box checking

Only 23 (1%) of the computer-generated prescriptions had the "no brand substitution" box checked compared with three (0.7%) of the handwritten prescriptions. In our previous study we found that 27% of the computer-generated prescriptions had the "no brand substitution" box checked, compared with 1% of the handwritten prescriptions (data available from the authors).

DISCUSSION

We found that computer-assisted prescribing continues to be associated with a significantly higher rate of repeat ordering for antibiotics that are commonly used to treat URTIs, and this rate is largely unchanged from our survey of 8 years ago[6] despite interventions to educate doctors about computer default settings and antibiotic prescribing. In contrast, we found a dramatic reduction in the checking of the "no brand substitution" box since 2000, with both handwritten and computer-generated prescriptions now having similar, very low rates. The notable differences between the studies are the substantial increase in use of computers for prescribing (84% of prescriptions were computer-generated in this study compared with 54% in 2000[6]), and the impact of a mandated change to disallow having the "no brand substitution" box checked as a default setting in prescribing software.

We cannot calculate an exact response rate for this study, as some pharmacies would have received multiple invitations to take part from the wholesalers. However, we recruited more pharmacies for this survey than for our previous study (51 v 35), and the large numbers of prescriptions and differences in repeat ordering rates provided sufficient power to examine the primary outcome. Some of the pharmacists in this study had participated in 2000 and may have remembered our previous findings. We asked pharmacists to record consecutive prescriptions, but it is possible that pharmacists recorded more data on computer-generated prescriptions than on handwritten prescriptions. However, the proportion of computer-generated prescriptions in this study (84%) is consistent with other estimates of the use of computers for prescribing in Australia.[1]

A major strength of this study is that we used the same data collection methods as in 2000. While there was a slightly lower proportion of prescriptions for concession card holders in this more recent study (53% v 61%), we do not believe this altered the study findings. Patients with concession cards are more likely to be older and sicker, and may therefore be more likely to require a repeat of their antibiotic prescription than those without a concession card, but this would tend to create a bias towards finding a smaller difference than was observed in this study. It is also possible that the small numbers of doctors who write prescriptions by hand are different from those who use computers, and may see a different population of patients. However, we found that the rate of repeat ordering was identical in the larger number of handwritten prescriptions in our 2000 study.[6] We believe that the differences we observed reflect the true overall differences in rates of repeat ordering associated with computer systems, and will apply Australia-wide.

In our 2000 study, we estimated that the increases in ordering of repeats associated with computer-assisted prescribing resulted in over 500 000 additional prescriptions nationally for these four antibiotics annually.[6] Given the substantially higher use of prescribing software in 2008 and 2009, we would expect that the number of additional prescriptions would be even greater than 500 000 per year. This potential excess of prescriptions is occurring on the background of a gradual decline in antibiotic prescribing over time.[12] However, antibiotic prescribing for URTIs in Australia remains high, particularly for adults.[13,14] Further, studies in lower respiratory tract infections have shown that repeat prescribing is rarely required.[15] While we did not include data on the indication for treatment in our study, the antibiotics we chose are those commonly used for respiratory tract infections.[12] Therefore, the continued high rate of repeat ordering for these antibiotics remains a concern.

Our results cannot be used to suggest that the NPS campaign to educate doctors did not have any effect on repeat ordering, as this study was conducted several years after the educational program was undertaken. However, it does suggest that any changes that may have occurred were not sustained over time. Seven principles to effecting successful behaviour change have been identified.[16] These are: providing a strong rationale for the behaviour change; clearly defining the target behaviour; providing reminders for change; using credible models of behaviour change; providing opportunities for rehearsal; providing reinforcement and feedback; and monitoring.[16] While the NPS education campaign about modifying the software settings followed the first two of these principles, a one-off campaign such as this lacked reminders, reinforcement and feedback, and did not monitor the behaviour change over time. There also needs to be a perceived advantage in changing behaviour.[17,18] In this situation, the changes to the software defaults encouraged by the NPS could have a negative consequence on prescribing, as it would require the doctor to enter the desired number of repeats for all medications for chronic conditions, and not just antibiotics, and this would slow the prescribing process. While interventions such as providing information have been shown to produce behaviour change in the short term,[19] sustaining change over the longer term is much harder, and relapse rates are high.[20] Other approaches are required if these high levels of repeat ordering are to be addressed.

The stark contrast with our findings about the checking of the "no brand substitution" box indicates the dramatic and sustained effect of a legislative change. However, making a similar change to prevent software programs from defaulting to the maximum number of repeats would be difficult. Although it could be argued that doctors should make a conscious decision on the quantity ordered and number of repeats on all prescriptions, such a change to the software will be unpopular with prescribers as it may slow down the prescribing process for all medications.

Another solution could be to encourage software manufacturers to modify their default settings for some antibiotics so that repeat ordering is an active decision by the prescriber. However, in the absence of prescribing software standards, such changes are unlikely. The NPS is currently examining the features of prescribing software that enhance the usefulness to the clinician and consumers, promote patient safety, and support quality of care.[21]

An alternative legislative approach would be to remove the ability to order repeats on the PBS for some antibiotics. Patients with an URTI could still receive one course of antibiotics, returning to their doctor after that course if they remain unwell. Physicians could order extended courses, when required, using the authority system of the PBS. Although this could put significant burden on the authority system, the use of the "streamlined" authority mechanism, which does not require approval from the Department of Health and Ageing, could reduce the workload.

Our results indicate that the rate of repeat ordering of antibiotics that are commonly used for URTIs remains high as a result of computerised prescribing. Our study suggests that other actions would be required to complement the educational campaigns to encourage more appropriate prescribing of antibiotics.

ACKNOWLEDGEMENTS

We thank Emily Walkom for assistance with data entry and proofing the manuscript, Patrick McElduff for support with the statistical analysis, and the pharmacists who participated in the data collection.

COMPETING INTERESTS

None identified.

AUTHOR DETAILS

David A Newby, BPharm, PhD, Senior Lecturer in Clinical Pharmacology
Jane Robertson, BPharm, MMedSci, PhD, Senior Lecturer in Clinical Pharmacology
School of Medicine and Public Health, University of Newcastle, Newcastle, NSW.
Correspondence:
david.newby@newcastle.edu.au

REFERENCES

1 Henderson J, Britt H, Miller G. Extent and utilisation of computerisation in Australian general practice. *Med J Aust* 2006; 185: 84-87.
2 Kuperman GJ, Gibson RF. Computer physician order entry: benefits, costs, and issues. *Ann Intern Med* 2003; 139: 31-39.
3 Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. *JAMA* 2005; 293: 1197-2003.
4 De Smet P, Dautzenberg M. Repeat prescribing: scale, problems and quality management in ambulatory care patients. *Drugs* 2004; 64: 1779-1800.
5 Harris CM, Dajda R. The scale of repeat prescribing. *Br J Gen Pract* 1996; 46: 649-653.
6 Newby DA, Fryer JL, Henry DA. Effect of computerised prescribing on use of antibiotics. *Med J Aust* 2003; 178: 210-213.
7 National Prescribing Service. Prescribing practice review 21: antibiotic prescribing in general practice. Sydney: NPS, 2003. http://www.nps.org.au/health_professionals/publications/prescribing_practice_review/archive/Prescribing_Practice_Review_21 (accessed Jan 2010).
8 National Prescribing Service. GP prescribing software — settings for repeats. Sydney: NPS, 2007. http://www.nps.org.au/health_professionals/tools/prescribing_software_tools/medical_director/tools/PresRepeatsMapping_antibiotics (accessed Jan 2010).
9 Australian Government. National Health (Pharmaceutical Benefits) Regulations 1960 (No. SR 1960 No. 17). Canberra: Attorney-General's Department, 2008.
10 Liang K, Zegar S. Longitudinal data analysis using generalized linear models. *Biometrika* 1986; 73: 13-22.
11 Medicare Australia. Pharmaceutical benefits schedule item reports. Apr 2009. https://www.medicareaustralia.gov.au/statistics/pbs_item.shtml (accessed Jan 2010).
12 Australian Institute of Health and Welfare, National Health Performance Committee. Appropriate use of antibiotics. In: National report on health sector performance indicators 2003. Canberra: AIHW, 2004: 84-85. (AIHW Cat. No. HWI 78.) http://www.aihw.gov.au/publications/index.cfm/title/10085 (accessed Jan 2010).
13 Patterson CA, Mackson JM, Weekes LM. Antibiotic prescribing for upper respiratory-tract infections in primary care. *Commun Dis Intell* 2003; 27: S39-S41.
14 Pan Y, Henderson J, Britt H. Antibiotic prescribing in Australian general practice: how has it changed from 1990–91 to 2002–03? *Respir Med* 2006; 100: 2004-2011.
15 Macfarlane J, Prewett J, Rose D, et al. Prospective case–control study of role of infection in patients who reconsult after initial antibiotic treatment for lower respiratory tract infection in primary care. *BMJ* 1997; 315: 1206-1210.
16 Sanson-Fisher R, Cockburn J. The use of behavioural change principles to promote rational prescribing: a review of commonly used interventions. *Aust Presc* 1993; 16: 82-87.
17 Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *Lancet* 2003; 362: 1225-1230.
18 Grol R, Wensing M. What drives change? Barriers to and incentives for achieving evidence-based practice. *Med J Aust* 2004; 180 (6 Suppl): S57-S60.
19 Grimshaw JM, Thomas RE, MacLennan G, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Int J Technol Assess Health Care* 2005; 21: 149.
20 Cockburn J. Adoption of evidence into practice: can change be sustainable? *Med J Aust* 2004; 180 (6 Suppl): 66-67.
21 National Prescribing Service. Research project: evaluation of the safety, quality and usefulness of electronic prescribing systems in general practice. Sydney: NPS, 2009. http://www.nps.org.au/research_and_evaluation/research/current_research/evaluation_of_electronic_prescribing_systems (accessed Jan 2010).

(Received 20 May 2009, accepted 1 Sep 2009) ❑