Effectiveness of a national approach to prescribing education for multiple disciplines

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WHAT IS ALREADY KNOWN ABOUT THIS SUBJECT

- Junior doctors and other new prescribers often do not receive adequate therapeutics and prescribing education during their undergraduate education.
- The National Prescribing Curriculum is a nationally available online course in Australia to supplement university prescribing education by offering short modules on common therapeutic topics for students from multiple disciplines of health care.

WHAT THIS STUDY ADDS

- Students from multiple disciplines who have received different levels of education on clinical pharmacology and pharmacotherapy enhance their therapeutic knowledge from standardized short modules in prescribing.
- A national online approach to prescribing education can help improve prescribing and therapeutics education.

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AIMS

To evaluate the effectiveness of a national approach to prescribing education on health professional students' prescribing and therapeutics knowledge, across multiple disciplines.

METHODS

In a university examination setting, 83 medical, 40 pharmacy and 13 nurse practitioner students from three different universities completed a set of multiple choice questions (MCQs) before and after completing an online module from the National Prescribing Curriculum (NPC). To minimize overestimation of knowledge, students had to indicate the level of certainty for each answer on a three-point scale. MCQs were scored using a validated certainty-based marking scheme resulting in a composite score (maximum 30 and minimum -60). Students were asked to rate their perception of usefulness of the module.

RESULTS

At the pre-module phase, there were no significant differences in the composite MCQ scores between the medical (9.0 ± 10.3), pharmacy (10.2 ± 10.6) and nurse practitioner (8.0 ± 10.7) students. The scores improved significantly for all groups at the post-module phase ($P < 0.01$ for all groups) by similar extents (post-module results: medical, 14.5 ± 9.6 ; pharmacy, 14.4 ± 9.9 ; nurse practitioner, 12.1 ± 9.6). 39.4% of the MCQs answered incorrectly with high level of certainty at the pre-module phase were still answered incorrectly with high level of certainty at the post-module phase. Almost all students (with no significant difference between the groups) found the NPC modules, post-module MCQs and feedback useful as a learning tool.

CONCLUSIONS

A national online approach to prescribing education can improve therapeutics knowledge of students from multiple disciplines of health care and contribute towards streamlining interdisciplinary learning in medication management.

Introduction

Prescribing is an important part of medical practice but may not necessarily be a strong focus in the training of medical students or other health professionals. Responding to the need, expressed particularly by junior doctors [1], for high quality prescribing education in Australia, the National Prescribing Curriculum (NPC), a nationally standardized curriculum in prescribing, was developed in 2001. A web-based course founded on the World Health Organization's Guide to Good Prescribing [2], the NPC currently comprises 28 modules covering common therapeutic topics. NPC modules have been designed for individual, self-paced learning or can be used as part of small group work. The modules are written by subject experts and undergo a rigorous peer review process during their development. Each module aims to educate the student about prescribing and therapeutic issues related to a clinical topic, and help them to develop their own personal drug formulary for the clinical condition.

When the NPC was initially developed, its focus was on teaching senior medical students in Australian universities how to write an appropriate prescription based on defining a patient's problem, specifying the therapeutic objective, choosing the optimal non-drug and drug therapy, and advising the patient how best to use the chosen therapy. The format of the NPC modules has largely remained the same since its inception. However, in recent years, there has been an increased focus on interactive activities, for example with de-identified peer answers and expert feedback, to allow the students to self-evaluate their performance. The focus of the NPC has diversified to include other health professionals, and minor adjustments have been made to accommodate this change (e.g. replacing the specific term 'doctor' with a more generic term of 'prescriber').

It has been shown that short prescribing courses run locally by universities and hospitals enable new prescribers to develop their own personal formulary of preferred drugs for specific conditions and to improve prescribing [3]. The NPC aims to do the same but it differs from these courses in that it is the only nationally available prescribing and therapeutics course internationally for students from multiple healthcare disciplines.

In the 10 years since its inception, the user base of NPC, which has largely remained an optional learning resource at most universities, has expanded from its original target cohort of senior medical students. In response to legislative changes extending prescribing rights to nurse practitioners, and the necessity for pharmacists to have broader knowledge of therapeutics, NPC modules are now used by an increasing number of pharmacy and nurse practitioner schools. The NPC is also being used in hospitals and healthcare organizations across Australia as a professional development resource.

Previous student surveys have shown that students find the NPC a useful learning resource [4, 5]. However, no

objective assessment had been carried out to determine the improvement of students' knowledge after completing a NPC module.

The primary aim of this study was to evaluate the impact of NPC modules on students' knowledge and confidence on prescribing and therapeutics for participating medical, pharmacy and nurse practitioner students. Students' answers to the multiple choice questions (MCQs) and their levels of certainty before and after completing a NPC module were compared.

Methods

The study was conducted at Austin Clinical School and Rural Health Academic Centre of the University of Melbourne in Victoria, the School of Pharmacy at the University of Tasmania in Tasmania and the School of Nursing at the University of Sydney in New South Wales. Ethics approval was obtained from the human research ethics committees of each participating university and written consent was obtained from all study participants before their inclusion in the study.

All students from the above-mentioned schools who would have started using the NPC in the second semester of 2011 were invited by their course convenor to volunteer for the study. Students participating in the study were not given their standard access to the NPC modules used in the study until the study was completed. Consequently, to avoid confounding, students who had already registered for the NPC prior to the study period were not eligible to participate. Demographic information was not collected as these were considered unlikely to contribute to the study outcomes.

In an examination setting, medical, pharmacy and nurse practitioner students were asked to answer a set of 10 online MCQs immediately before and after completing one of the NPC modules on chronic heart failure (CHF) or prophylaxis of venous thromboembolism (VTE). All MCQs were weighted equally. Students were not informed that the pre- and post-module MCQs were the same which prevented the students from actively seeking answers to the MCQs while completing the modules. The MCQs were written by subject experts and face-validated by their peers to ensure that the questions related to the module content and were pitched at the right level. While the medical and pharmacy cohorts were split between CHF and VTE, given there were only 13 nurse practitioner students, the latter were asked to answer the MCQs for CHF only. Broadly, the type of MCQs that the students were required to complete can be categorized into clinical pharmacology and pharmacotherapy. The MCQs for the VTE module are provided as examples in Table 1.

For each MCQ, students were asked to indicate how certain they were of their answer on a three-point certainty scale of low, medium and high (example in Figure 1). The

Table 1

VTE related MCQs that the students were required to answer before and after completing the VTE module

1. Mr Blithe is a 65-year-old admitted to hospital to undergo major abdominal surgery. Which of the following would be the recommended thromboprophylaxis of choice for Mr Blithe?			
a.	Dabigatran	b.	Enoxaparin
c.	Fondaparinux	d.	Low dose unfractionated heparin
2. Which of the following agents used in thromboprophylaxis is a direct thrombin inhibitor?			
a.	Dabigatran	b.	Dalteparin
c.	Fondaparinux	d.	Rivaroxaban
3. In a patient undergoing high risk surgery, which of the following test results will not influence the prescription of a pharmacological agent for thromboprophylaxis?			
a.	Serum creatinine	b.	Platelet count
c.	Activated partial thromboplastin time	d.	White cell count
4. Mrs Sugar is a 68-year-old lady admitted to hospital for surgery on a fractured hip. She has peripheral vascular disease. Which of the following would be the most appropriate thromboprophylaxis regimen to recommend for Mrs Sugar?			
a.	Enoxaparin and graduated compressions stockings	b.	Dalteparin
c.	Low dose unfractionated heparin	d.	Aspirin
5. Which of the following statements about mechanical methods for thromboprophylaxis (graduated compression stockings, intermittent pneumatic compression devices, venous foot pump) is true?			
a.	Mechanical devices reduce the risk of death	b.	Mechanical devices reduce the risk of pulmonary embolism
c.	Mechanical devices are more effective than anticoagulants	d.	Mechanical devices are used as an adjunct to pharmacological therapy to increase efficacy
6. Mr Jung presents for an elective hip replacement operation. He is an otherwise well 77-year-old man but has a creatinine clearance of 25 ml min ⁻¹ due to a history of polycystic kidney disease. What form of prophylaxis would you offer him?			
a.	Fondaparinux 2.5 mg daily	b.	Enoxaparin 20 mg daily
c.	Enoxaparin 40 mg daily	d.	Dabigatran 220 mg
7. Which of the following are contraindications to the use of enoxaparin for VTE prophylaxis?			
a.	Platelet count of 110 000 µl ⁻¹	b.	History of heparin-induced thrombocytopenia
c.	History of peptic ulcer disease	d.	Mild hypertension
8. Which one of the following should you monitor in a patient receiving enoxaparin 40 mg subcutaneously daily for thromboprophylaxis?			
a.	Activated partial thromboplastin time (APTT)	b.	International normalized ratio (INR)
c.	Urinalysis	d.	Serum creatinine
9. Mrs Small is admitted to hospital to undergo elective total hip replacement. She is to be prescribed enoxaparin 40 mg subcutaneously daily. Which of the following would not be an appropriate therapeutic goal in prescribing enoxaparin?			
a.	Prevent a pulmonary embolus	b.	Prevent a deep vein thrombosis
c.	Decrease thrombin formation	d.	Reduce risk of coronary artery thrombosis
10. Mr Brown has recovered from a total right hip replacement and is to be discharged home. He is to be prescribed oral thromboprophylaxis for 35 days. Which of the following would be the most appropriate oral thromboprophylaxis for Mr Brown?			
a.	Unfractionated heparin	b.	Warfarin
c.	Rivaroxaban	d.	Clopidogrel

certainty-based questions [6] were used to assess the confidence level of students and to control for any overestimation of knowledge due to correct guesses. A validated certainty-based marking scheme [6] for reflective learning and knowledge assessment was used to provide a composite score on students' performance. Each correctly answered MCQ scored 3 marks if answered with high certainty, 2 marks for medium certainty and 1 mark for a low level of certainty. Conversely, if a MCQ was answered incorrectly, 6 marks were deducted if certainty level was high, 4 marks deducted for a medium level of certainty and none deducted if the level of certainty was low. The maximum total composite score a student could obtain was 30 and the minimum was -60.

It was anticipated that the students would require on average 45 min to complete the module and approximately 20 min each to complete the pre- and post-MCQ

surveys. At the end of the post-module MCQs, students were also asked to rate anonymously how useful they thought the module and the pre- and post-module MCQs were as a learning tool.

Data were analyzed using SPSS v19. Paired *t*-tests were used to compare the composite pre- and post-module scores of the students who completed the two modules.

To determine whether completing the module improved the students' prescribing and therapeutic knowledge and confidence, the outcome measures were grouped into six ordinal categories based on whether the answers were correct or incorrect at different levels of certainty. The pre- and post-responses for a subject were adjusted using generalized estimating equations. The Kruskal-Wallis test was used to analyze the data on students' perceptions on the usefulness of the NPC.

Question 1

1. Which one of the following should be considered an important long-term therapeutic goal in the management of a patient with chronic heart failure? *

☐ Reduce systolic BP below 100 mmHg

☐ Prevent decompensated heart failure

☐ Increase renin-angiotensin activation

☐ Reduce lipid levels

How certain are you that your answer is correct? *

☐ Low ☐ Medium ☐ High

Continue

15%

Figure 1

An example (first MCQ from the CHF module) showing how the MCQ and the certainty-based question were presented to the students on their computer screen. Students could not proceed to the next question unless they answered the MCQ and indicated the level of certainty for their answer

Results

A total of 136 students (83 medical, 40 pharmacy and 13 nurse practitioner) participated in the study. The participation rate was approximately 80% of the eligible students for all groups. None of the students who refused to participate did so due to study-related reasons.

The CHF module was completed by 42 medical students, 20 pharmacy students and the 13 nurse practitioner students. The VTE module was completed by 41 medical students and 20 pharmacy students. All student cohorts answered more MCQs correctly with higher levels of certainties in the post-module phase compared with the pre-module phase. However, there were no significant differences in the change in total composite scores between the two modules for both medical students ($P = 0.09$) and pharmacy students ($P = 0.83$) and none of the MCQs was consistently answered incorrectly by the students. Hence, the two modules were pooled by the student group for further analysis. The composite scores of all groups were normally distributed at the pre- and post-module phases.

All student cohorts answered more MCQs correctly in the post-module phase compared with the pre-module phase. There was no significant difference in the mean scores between the three groups at the pre- and post-module phases and the scores improved significantly ($P < 0.01$) for all groups at the post-module phase (Table 2). Significant differences were seen in the certainty levels of the answers for all student groups, with more of the MCQs

answered correctly with higher certainty levels and lower levels of certainty in incorrect answers ($P < 0.01$ for all groups; Table 3). However, across all groups, 39.4% (37/94) of the MCQs answered incorrectly with high levels of certainty at the pre-module phase did not improve at the post-module phase.

In the survey, a significantly higher proportion of pharmacy students perceived the pre-module MCQs to be easy compared with the other students. However, they found the MCQs equally useful as a learning resource as the other groups (Figure 2). Furthermore, the marks obtained by individual pharmacy students were similar to the marks obtained by medical or nurse practitioner students at the pre-module stage (Figure 2). For the pre-module MCQs, there was no significant difference in the marks obtained by students who perceived them to be easy compared with those who did not ($P = 0.7$). Almost all students found the post-module MCQs (97.1%, 132/136 students) and the feedback (94.9%, 129/136) to their answers to be useful learning resources. A substantial proportion (91.2%, 122/136) of students also suggested that completing the modules helped them answer the MCQs.

Discussion

The findings of this study suggest that the NPC model is effective in providing prescribing and therapeutic education to students from multiple disciplines of healthcare nationally. After completing the modules, all student groups substantially improved their knowledge and confidence, implying that students of all three disciplines can benefit from a curriculum completely focused on therapeutics and prescribing.

This finding also highlights the usefulness of standardized prescribing and therapeutic education to a wide spectrum of health professional students at different years of their study given that the three student groups in the study had received different levels of pharmacology and pharmacotherapy training. The medical and pharmacy students were in the final year of their undergraduate study, and the nurse practitioner students were at the end of the second semester of the first year of a 2 year post-graduate course. The level of pharmacology education the three groups had received was also different. Medical students receive a structured programme in clinical pharmacology delivered as stand-alone topic sessions combined with clinical topic seminars with their final year teaching placements in general medicine, general surgery and general practice. Similarly, a considerable amount of the pharmacy students' third and fourth year university education is clinical pharmacology. Given the nature of their course, pharmacy students would have received more pharmacotherapy teaching than the other groups. The nurse practitioner students had received no clinical pharmacology or pharmacotherapy teaching when they were

Table 2

Composite scores of the three student groups before and after completing the modules

Student group	Pre-module composite score Mean $\pm$ SD	Post-module composite score Mean $\pm$ SD	Difference in means (Post-pre)	95% CI of the difference	P value (paired t-test)
Medical	9.0 $\pm$ 10.3	14.5 $\pm$ 9.6	5.5	4.2, 7.0	<0.01
Pharmacy	10.2 $\pm$ 10.6	14.4 $\pm$ 9.9	4.2	3.3, 6.3	<0.01
Nurse practitioner	8.0 $\pm$ 10.7	12.1 $\pm$ 9.6	4.1	3.3, 8.0	<0.01

Table 3

Proportions of MCQs answered correctly and incorrectly at the three levels of certainties by medical, pharmacy and nurse practitioner students

Student cohort	Total number of MCQs (Student number $\times$ 10)	Level of certainty	Answers Pre		Post		P value (generalized estimating equations)	
			Correct (%)	Incorrect (%)	Correct (%)	Incorrect (%)		
Medical (n = 83)	830	High	53.9	46.2	79.6	20.3	<0.01	
		Medium	27.6	22.2	47.8	26.9		
		Low	12.2	18.8	4.9	4.5		
Pharmacy (n = 40)	400	High	67.5	32.6	79.5	20.5	<0.01	
		Medium	29.0	16.5	58.5	19.7		
		Low	6.5	5.3	1.3	1.5		
Nurse practitioner (n = 13)	130	High	55.4	44.6	72.3	27.7	<0.01	
		Medium	26.2	16.9	30.0	14.6		
		Low	15.4	21.5	4.6	8.5		

enrolled in the study although they had previously worked as registered nurses without prescribing rights with a minimum of 5 years experience.

It has been suggested that knowledge gained through short educational activities, similar to the NPC, is retained over an extended period of time, albeit at reduced levels [7]. Students would therefore be expected to translate some of their gained knowledge to clinical practice. Additionally, completing short context-based modules [8], such as the NPC, that include feedback and peer responses [9], encourages critical thinking and problem solving for prescribing and the application of therapeutics in general.

Almost all students in our study considered the NPC to be a valuable learning resource. Student perceptions are strong drivers in generating interest in an educational resource and enhancing its teaching potential [10], more so for largely self-directed and optional courses such as the NPC.

Of concern is the high proportion of students from all cohorts who were confident of their wrong answers at the pre-module phase who remained confident of their incorrect responses after completing the modules. Well-founded confidence of health practitioners enhances the delivery of health care but their overconfidence can potentially have undesirable consequences, such as mismanage-

ment or suboptimal treatment [11]. For such students, it appears that providing educational information is not sufficient to change their preconceptions and therefore personalized feedback on the correctness and accuracy of answers would be required to reduce overconfidence in knowledge [12].

The pre- and post-MCQs and certainty-based questions appear to have a role in enhancing the students' learning processes and would augment the teaching potential of the NPC. However, unless personalized feedback is provided, not all students will gain sufficient knowledge from this learning activity. Computerized feedback, which has proven to be useful [13], would have to be incorporated for the pre- and post-module MCQs to be highly effective as a learning resource.

Given the importance of prescribing education in the final years of university training for future prescribers [14], and that medication errors are the most prevalent forms of medical error [15], the NPC can fill the gap in prescribing education in Australia. A recent Australian study suggests that medical courses do not prepare interns adequately for safe and effective prescribing [16]. Similarly, with 72% of authorized nurse practitioners and 39% of nurse practitioner candidates in Australia prescribing medications as a part of their role [17], prescribing education is undoubtedly essential for future nurse practitioners.

Figure 2

Results from the anonymous student perception survey. * indicates significant difference between the three groups. The proportion of pharmacy students who found the pre-MCQs easy was significantly higher than the proportions for medical and nurse practitioner students. ■, pharmacy; ■, medical; ■, nurse practitioner

The need for prescribing education for pharmacy students is not as obvious as for medical practitioners and nurse practitioners since pharmacists do not prescribe restricted medications. However, in Australia, as is happening internationally, the pharmacists' role in active prescribing is growing and they can initiate over the counter medicines, including pharmacist only medicines that were once scheduled as prescription only medicines, e.g. ophthalmic chloramphenicol, proton pump inhibitors, oral fluconazole and topical corticosteroids. The positive views of the need for streamlined prescribing education expressed by pharmacy students in our study bodes well for the rapidly evolving professional role of pharmacists in helping patients manage their multiple medications. Equipped with enhanced prescribing knowledge similar to what is offered to other health professionals, pharmacists may be better placed to offer advice when alternative prescribing options are more appropriate [18, 19], and to take on a more active role in a multidisciplinary setting [20]. Pharmacists can also benefit from a more comprehensive understanding of the prescribing process, illustrated in the NPC, to communicate better with both the patient and the prescriber.

A limitation of this study is that the students had to complete the modules in a controlled examination setting, which is contrary to how the NPC is usually used. The NPC is designed as a skills-based, reflective educational resource to be completed by students at a self-determined pace or taught in small group settings. It was not possible

to ascertain whether the students completing the NPC modules in their usual setting would benefit similarly to those in the study, nor was it possible to determine if supplementation with classroom teaching would lead to better outcomes.

Although the students were not informed that the pre- and post-modules were the same, exposure to the MCQs at the pre-module phase may have influenced their post-module scores. Also, the performance on the MCQs cannot be directly associated with prescribing skills as MCQs do not reflect a real world prescribing task. Another limitation is that each student group was from a single university only and the study was conducted for two of the 26 NPC modules. The results therefore may not be representative of all medical, pharmacy or nurse practitioner students across Australia or students from other universities and of other modules in the NPC. Asking more MCQs would have offset some of the generalizability issues. However the task would have been onerous to the students and could also have led to fatigue related biases given that the students were required to complete the module and pre- and post-MCQs in one sitting.

In conclusion, this study shows that the NPC can enhance the prescribing and therapeutics knowledge of student health professionals from multiple disciplines, and contribute to equipping students to be good prescribers and to use medicines judiciously. With prescribing rights currently being considered for a wider group of health professionals, the NPC can be a valuable resource for

streamlining interdisciplinary teaching. The NPC model is effective in providing standardized prescribing and therapeutics education to diverse health professionals working in the same health system.

Competing Interests

Santosh Khanal, Michelle Koo and Yeqin Zuo are employees of NPS: MedicineWise which runs the NPC. Other co-authors do not have any conflict of interest.

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