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A Comparison between Two Methods of Teaching Hospital Pharmacists about Adverse Drug Reactions: Problem-based Learning versus a Didactic Lecture

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The aim of this study was to compare the effectiveness of two teaching methods, problem-based learning (PBL) and a didactic lecture, in the continuing education of pharmacists about adverse drug reactions (ADRs). Fifty pharmacists were recruited from four hospitals within the United Kingdom: 16 pharmacists (hospital$_1$) underwent PBL, 15 pharmacists (hospital$_2$) received a didactic lecture, and 19 pharmacists (hospital$_3$ and hospital$_4$) were the control group and did not receive any formal teaching intervention. Immediately prior to any teaching interventions, all participants completed an ADR test. All groups completed the same ADR test 6 months later. Records of ADR reporting rates by the participants were examined for defined periods pre- and post-teaching interventions. The PBL participants demonstrated a significant improvement in the mean rank scores for both the MCQ and the clinical cases analysis sections of the test. Participants who received the didactic lecture significantly improved only in the MCQ section of the test. No significant differences in either section of the test were detected for the control participants. The PBL participants were the only group to significantly improve their mean rank ADR reporting rate post-intervention. The results of this study indicate that PBL has benefits compared to a didactic lecture method in educating pharmacists about ADRs and enhancing their motivation to report adverse drug reactions.

Keywords: Problem-based learning, Continuing education, Adverse drug reactions

INTRODUCTION

Education and training have an essential role in supporting the concepts of clinical governance and clinical risk in health services. Adverse drug reactions (ADRs), a clinical risk issue, continue to cause patient harm worldwide (Miller, 1974; Lazarou, Pomeranz and Corey, 1998), and post marketing surveillance programmes have been established for monitoring their occurrences. One such programme, the yellow card reporting scheme, was established in the UK in 1964 by

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the Committee on Safety of Medicines (CSM) as an early warning system for the detection of previously unknown ADRs. Despite over 350,000 ADR reports submitted from doctors, dentists and, more recently, pharmacists, under-reporting continues to be a problem (Inman, 1996; Lumley *et al.*, 1986; Bateman, Sanders and Rawlins, 1992; Belton *et al.*, 1995; Martin *et al.*, 1998).

The inclusion of pharmacists as acknowledged reporters to the yellow card scheme followed a pilot study that demonstrated the valuable contribution that clinical pharmacists made to the reporting of ADRs (Lee *et al.*, 1997). In supporting this extended role, the CSM and Royal Pharmaceutical Society of Great Britain (RPSGB) acknowledged the importance of educating and training pharmacists to report appropriately (CSM, 1997). Since 1997, 3 UK studies have been published investigating pharmacists' reporting of ADRs; all highlighted the role of education and training in promoting awareness of ADRs and reporting rates (Green *et al.*, 1997; Ferguson and Dhillon, 1998; Green *et al.*, 1999a,b). However, little has been published investigating the relationship between different types of educational approach and their impact on ADR reporting by pharmacists.

During the last twenty years, problem-based learning (PBL) has been described as one of the most significant innovations in teaching (Vernon and Blake, 1993). PBL has been studied extensively in medical education (Barrows, 1983; Bligh, 1995) but relatively few pharmacy programmes using a PBL approach have been evaluated (Fielding and Jang, 1981; Love and Shumway, 1983; Fischer, 1994).

The principle factor underpinning PBL is that the stimulus for learning should be the presentation of a problem or situation that the learner must resolve (Boud, 1985). It has been claimed that PBL helps students to retain knowledge for longer, apply that knowledge in a clinical context, develop clinical reasoning and problem-solving skills, develop self-directed learning abilities and provide a learning environment that encourages deeper learning, while being motivating and relevant for the student (Neufeld and Barrows, 1974; Barrows, 1986; Schmidt, 1993). Other experts in this field have also demonstrated these attributes (Jang and Solad, 1990; Schmidt and Dolmans, 1996). However, there is still considerable debate as to whether students actually develop these strategies, and whether PBL is any better than other traditional teaching methods, with findings dependent on the tools used to assess the outcomes of these approaches (Patel, Groen and Norman, 1991).

A range of educational material has been made available to assist in educating pharmacists about ADRs. For example, an information pack for pharmacists has been distributed by the Committee on Safety of Medicines (1997); a series of continuing education articles on adverse drug reactions have been published by the Royal Pharmaceutical Society of Great Britain's Pharmaceutical Journal (*e.g.*, Lee and Hems 1997; Lee and Belton, 1997; Lee and Thomson, 1998; Lee and Bishop, 1998); a distance learning pack on ADRs has been produced by the Centre for Postgraduate Pharmacy Education (CPPE) for community pharmacists and a teaching pack has been provided by regional drug information centres. However, there is a paucity of literature pertaining to the evaluation of pharmacist-orientated educational programmes for ADR reporting. Those that have been published, mainly emanate from the United States, with many only outlining the teaching methods used (Jacinto and Kleinmann, 1983; Kimelblatt *et al.*, 1988; Keith, Bellanger-McCleery and Fuchs 1989; Morgan and Frank, 1990; Goldman, Lieberman and Kausal, 1996). All were aimed at improving the awareness, detection, knowledge, skills and reporting of ADRs. However, none evaluated the effectiveness of the educational programmes. One UK study described an ADR training programme provided by a regional CSM monitoring centre and concluded that regular training may increase the number of reports submitted by pharmacists (Randall, 1999).

The aim of this study was to compare the effectiveness of a problem-based learning (PBL) programme with a didactic, lecture-based programme, for educating hospital pharmacists about reporting adverse drug reactions (ADRs).

METHOD

The study incorporated three groups of hospital pharmacists that were geographically distinct. Group A ($hospital_1$) underwent the PBL programme, group B ($hospital_2$) received the didactic lecture method and group C ($hospital_3$ and $hospital_4$) were a control group and received no formal teaching on ADRs during the study period. An ADR test was developed to evaluate current knowledge and skills amongst all the participants. This was piloted and refined to include two sections in its final version: section one comprised 20 multiple-choice questions (MCQs) and section two comprised 5 short clinical cases.

All groups completed the ADR test at month 0 which was followed by the teaching intervention for groups A and B. All groups completed the same ADR test at month 6. The results of the test from groups A, B and C were coded and analysed using the computer software package Statistics Package for Social Sciences (SPSS) 8.0 for Windows.

Teaching Interventions

Group A participants underwent the PBL programme, developed to include ADR issues in the context of a clinical scenario. Participants of group A were divided into 3 small groups and asked to review two cases. The participants' task was to identify a problem. When all participants had evaluated the cases, pharmaceutical issues were discussed and problems identified, including the possibility of the existence of an ADR, during a brainstorming session. Using these methods, participants were able to identify their own strengths and the groups' strengths, and develop their own, and the groups', learning needs. Each participant was asked to gather the information pertinent to his or her learning needs and to reconvene with the group to feedback and discuss further issues. Participants were also encouraged to monitor their own patients for possible ADRs, and to bring examples to the next discussion group. It was intended that during these sessions, the participants would develop an increased awareness of ADRs by discussing cases and previously submitted reports.

Group B participants, who received the didactic lecture, were also divided into 3 small groups. Each group commenced the teaching session with the half-hour ADR test, time was allocated at the end of the test to provide feedback and then the one-hour lecture using transparencies was given. The lecture was divided into three areas: definitions, awareness and incidences; determination of the cause and effect of ADRs; and reporting. Throughout the lecture, the participants were asked to contribute to the session by either recalling previous experiences or answering questions directed at them in an attempt to stimulate discussion.

Participants of groups A and B were asked to complete a teaching evaluation form concerning the effectiveness of the teaching methods. The results of the teaching evaluation were coded and analysed.

Groups A, B and C were all situated in geographically distinct centres. Each centre had an established ADR reporting procedure whereby all pharmacist-completed ADR reports were directed through their drug information centres and a patient record (anonymised) of each report was stored on file. ADR reports for each participant of all groups were monitored pre-intervention from 1st April 1997 to 30th June 1998 and post-intervention from 1st July 1998 to 31st December 1998. The reporting rates for each group, pre- and post-intervention were recorded and analysed.

RESULTS

Characteristics of Participants and Centres

Fifty pharmacists were recruited from four hospitals within the UK. Sixteen pharmacists were recruited to group A ($hospital_1$) and underwent PBL, 15 pharmacists to group B ($hospital_2$) and received the didactic lecture and 19 pharmacists to the control group C ($hospital_3$ and $hospital_4$). Characteristics of the participants and the three participating centres were compared according to experience, age and size and specialities of centres. Table I presents the characteristics of the participating pharmacists. There was a higher proportion of females recruited to the study which reflected the employment patterns of the centres involved. No significant differences were identified between the years of practice post-registration or the proportions of junior and senior staff who participated from each centre. Fewer group B participants had postgraduate qualifications compared to participants of groups A and C, however the sub-groups were too small to compare statistically. The number of hospital beds covered in clinical practice by the pharmacists from groups A, B and C were 700, 700 and 1150 respectively. Table II illustrates the range of clinical specialities supported by the participating pharmacists.

Within Group Analysis of the ADR Test Scores at Month 0 and Month 6

All participants in each group completed the ADR test in June 1998 (month 0) prior to any teaching intervention and again, in December 1998 (month 6). The summary results of the test scores for groups A, B and C, pre- and post-teaching intervention, are shown in Table III.

Group A participants, who underwent the PBL programme, demonstrated an improvement in the mean ADR test scores for both sections 1

TABLE I Descriptive summary of the participating pharmacists ($n = 50$)

Classification variable	Group A PBL group ($n = 16$)	Group B Didactic lecture group ($n = 15$)	Group C Control group ($n = 19$)
Ratio of male:female participants	7:9	1:14	1:18
Length of time practising as a pharmacist (years):			
0–2 years	6	6	6
3–5 years	4	3	4
6–10 years	5	3	5
11–15 years	1	1	2
16 years or more	0	2	2
Median number of years for group	5	4	4.5
Junior:Senior ratio of participants (Grades A–C:Grades D–F)	6:10	7:8	11:8
Number (%) of participants with postgraduate qualifications	14 (87.5)	7 (46.7)	14 (73.7)

TABLE II Details of the clinical areas covered by the participants ($n = 50$)

Clinical area	Group A PBL group ($n = 16$)	Group B Didactic lecture group ($n = 15$)	Group C Control group ($n = 19$)	Total (%)
Resident	5	2	0	7 (14)
General medical	4	8	10	22 (44)
Surgical	4	2	2	8 (16)
Specialist	3	3	7	13 (26)
Total (%)	16 (32)	15 (30)	19 (38)	50 (100)

TABLE III Summary of ADR test scores pre- and post-intervention for all groups

	Pre-intervention Scores (%) Month 0			Post-intervention Scores (%) Month 6		
	Section 1 (MCQ)	Section 2 (Cases)	Overall score	Section 1 (MCQ)	Section 2 (Cases)	Overall score
GROUP A (PBL group) ($n=16$)						
Mean	68.81	65.16	66.98	74.00	83.19	78.59
Median	68.50	62.50	65.50	73.50	86.75	78.75
Standard Deviation	4.37	23.71	12.61	5.84	12.17	6.43
Minimum	61.00	20.00	42.00	66.00	62.50	67.50
Maximum	76.00	100.00	86.25	88.00	100.00	89.00
GROUP B (Didactic lecture group) ($n=15$)						
Mean	64.40	52.50	58.45	71.13	62.33	66.73
Median	66.00	57.50	61.75	75.00	60.00	67.50
Standard Deviation	5.64	22.30	11.66	8.73	14.28	9.17
Minimum	55.00	10.00	35.00	55.00	35.00	49.00
Maximum	74.00	77.50	74.25	80.00	87.50	82.25
GROUP C (Control group) ($n=19$)						
Mean	64.68	65.03	64.86	63.95	63.42	63.68
Median	64.50	70.00	64.50	66.00	60.00	61.88
Standard Deviation	6.34	17.74	9.59	8.59	14.22	8.32
Minimum	54.00	30.00	48.50	48.00	40.00	50.50
Maximum	76.00	92.50	79.50	77.00	90.00	83.00

Overall scores computed as average of section 1 and section 2 scores.

(MCQ) and 2 (cases) when the ADR test was repeated after 6-months. The mean rank scores for sections 1, 2 and the overall score were all significantly higher post-intervention compared to pre-intervention (Wilcoxon $z=-2.382$, $p=.017$; Wilcoxon $z=-3.073$, $p=.002$; Wilcoxon $z=-2.897$, $p=.004$ respectively).

Group B participants, who received the didactic lecture, demonstrated an improvement in both the mean scores for sections 1 and 2 of the ADR test after 6 months. For section 1 of the test (MCQ) the mean rank score was significantly higher post-intervention (Wilcoxon $z=-2.276$, $p=.023$). Despite an improvement in the mean scores for section 2 of the test (cases), the mean rank score did not differ significantly post-intervention. For the overall score, the mean rank was significantly higher post-intervention compared with the pre-intervention scores (Wilcoxon $z=-2.358$, $p=.018$).

Group C participants, the control group for this study, the mean ADR test scores for sections 1 (MCQ) and 2 (cases) decreased marginally. However, the differences in the scores, between month 0 and month 6, were not statistically significant.

Between Group Analysis of ADR Test Scores at Month 0 and Month 6

A between group analysis was undertaken to identify whether there were any differences in the participants' ADR test scores at months 0 and 6. The mean rank ADR test scores were compared between the participants recruited to groups A, B and C (Table IV(a)).

The pre-intervention scores did not differ significantly between groups A, B and C. However, the post-intervention scores for section 1 (MCQ), section 2 (cases) and overall were significantly different for groups A, B and C (Kruskal Wallis $\chi^2=11.797$, $p=.003$; Kruskal Wallis $\chi^2=17.304$, $p<.0001$; Kruskal Wallis $\chi^2=20.019$, $p<.0001$ respectively).

To determine the differences between the different teaching approaches and the control group for the post-intervention ADR test scores, paired analysis was undertaken for groups A & B, A & C and B & C using the Mann-Whitney U-test (Table IV(b)).

Group A (PBL) participants' mean rank post-intervention score was significantly higher for section 2 (cases) and the overall score when compared to those scores for group B participants (didactic lecture) (Mann-Whitney $U = 30.000$, $p < .0001$; Mann-Whitney $U = 36.000$, $p = .001$ respectively).

When group A (PBL) post-intervention scores were compared with those of group C (control group), section 1 (MCQ), section 2 (cases) and the overall score were all significantly higher for group A participants (Mann-Whitney $U = 47.500$, $p = .001$; Mann-Whitney $U = 42.500$, $p < .0001$; Mann-Whitney $U = 27.000$, $p < .0001$ respectively).

Group B (didactic lecture) participants' mean rank post-intervention scores were significantly higher only in section 1 (MCQ) of the test when compared with those of group C participants (control group) (Mann-Whitney $U = 79.000$, $p = .027$).

Evaluation of Teaching

All participants from groups A and B completed a teaching evaluation form (100% response rate). The mean rank responses for the twenty-three questions were compared between the participants of groups A and B. The responses for which the mean ranks were significantly different are shown in Table V.

TABLE IV (a) Summary of the differences in mean rank scores between groups for the ADR test

Groups compared	Differences between the mean rank scores of the ADR test using the Kruskal Wallis Test statistic					
	Pre-intervention Score Month 0			Post-intervention Score Month 6		
	Section 1	Section 2	Overall	Section 1	Section 2	Overall
Group A ($n = 16$) Group B ($n = 15$) Group C ($n = 19$)	No difference $\chi^2 = 5.139$ $p = .077$	No difference $\chi^2 = 3.468$ $p = .177$	No difference $\chi^2 = 3.729$ $p = .155$	$\chi^2 = 11.797$ $p = .003$	$\chi^2 = 17.304$ $p < .0001$	$\chi^2 = 20.019$ $p < .0001$

Group A = PBL group; Group B = Didactic lecture group; Group C = Control group.

(b) Summary of the significant differences in mean rank scores between paired groups for the post-intervention ADR test scores using the Mann-Whitney test

Groups compared	Significant differences in mean rank scores between paired groups for the post-intervention ADR test scores at month 6 using the Mann-Whitney test		
	Section 1	Section 2	Overall
Group A (PBL) ($n = 16$) Group B (didactic) ($n = 15$)	No difference $U = 109.500$ $p = .678$	A > B $U = 30.000$ $p < .0001$	A > B $U = 36.000$ $p = .001$
Group A (PBL) ($n = 16$) Group C (control) ($n = 19$)	A > C $U = 47.500$ $p = .001$	A > C $U = 42.500$ $p < .0001$	A > C $U = 27.000$ $p < .0001$
Group B (didactic) ($n = 15$) Group C (control) ($n = 19$)	B > C $U = 79.000$ $p < .027$	No difference $U = 141.500$ $p < .972$	No difference $U = 106.000$ $p < .205$

Group A = PBL group; Group B = Didactic lecture group; Group C = Control group.

Analysis of ADR Reporting Changes for Groups A, B and C

The number of reports from each of the three centres was obtained. During the 14-month period prior to the teaching, group A participants had submitted 7 ADR reports to the CSM, group B participants had submitted 7 ADR reports whilst participants of group C had submitted none. After the teaching and the 6-month follow up period, group A participants had submitted 20 ADR reports, group B participants had submitted 1 report and group C participants had submitted none (Fig. 1). During the 6-month follow-up period, one pharmacist (from group A) was lost from the study and would have been unable to submit ADR reports.

The yellow-card reporting rate per month was calculated for the 14-month pre-intervention phase and the 6-month post-intervention phase for each group. The monthly reporting rates were compared between pre- and post-intervention for each group. The mean rank reporting rate for group A had significantly increased post-intervention (Wilcoxon $z = -2.383$, $p = .017$). The mean rank reporting rates for groups B and C did not differ significantly post-intervention.

DISCUSSION

The aim of this study was to compare the effectiveness of two methods of teaching clinical pharmacists about ADRs. The difficulties inherent in comparing the effectiveness of PBL against other teaching methods have been recognised (Patel *et al.*, 1991). However, the results indicated that a PBL approach to learning about ADRs may have had a greater influence on the application of pharmacists' knowledge and skills in the clinical setting.

This study examined three groups of clinical pharmacists. Whilst these numbers were sufficient to be analysed statistically and participants were selected for homogeneity with respect to length of time qualified and the ratio of junior

TABLE V Significant differences identified from the students' evaluation of teaching sessions

Question asked	Group	Responses				Mann-Whitney *U* test *p* value
		VG			*G*	
How would you consider the tutor's effectiveness?	A ($n = 16$)	12			4	$p = .022$
	B ($n = 15$)	7			8	
		SD			*D*	
The course was poorly co-ordinated	A ($n = 16$)	11			5	$p = .017$
	B ($n = 15$)	4			11	
		SA	*A*	*U*	*D*	
I was given the opportunity to think critically	A ($n = 16$)	5	9	2	0	$p = .007$
	B ($n = 15$)	2	4	5	4	
		SA	*A*	*U*	*D*	
I was encouraged to identify problems	A ($n = 16$)	8	8	0	0	$p = .005$
	B ($n = 15$)	2	8	3	2	
		SA	*A*	*U*	*D*	
I was able to solve problems	A ($n = 16$)	2	13	1	0	$p = .003$
	B ($n = 15$)	1	5	3	6	
		SA	*A*	*U*	*D*	
There was group discussion work	A ($n = 16$)	7	9	0	0	$p = .001$
	B ($n = 15$)	1	7	3	3	

VG = very good; G = good; SA = strongly agree; A = agree; U = uncertain; D = disagree; SD = strongly disagree.

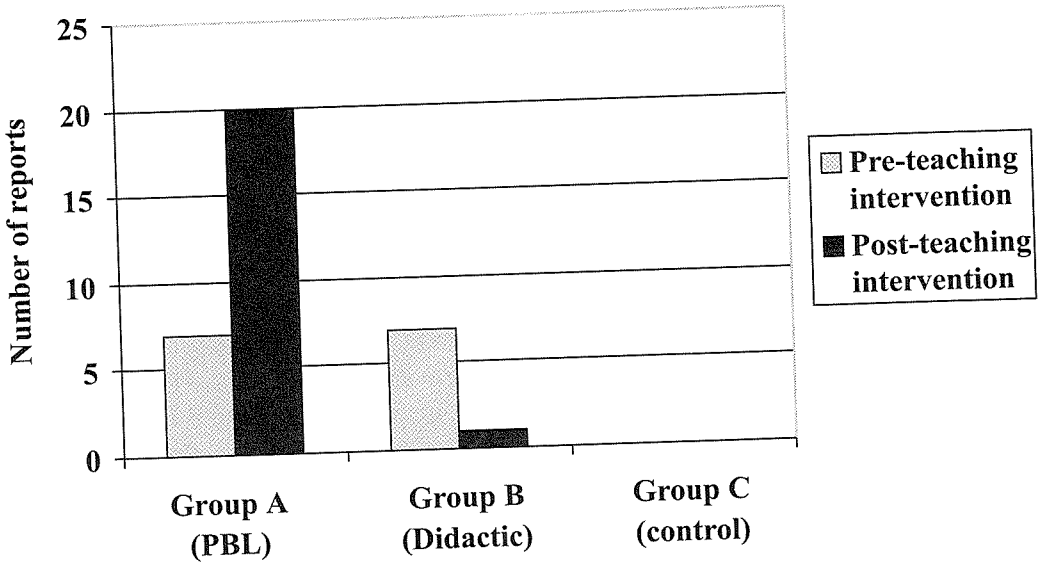

FIGURE 1 Summary of ADR reporting information from each centre ($n = 3$).

to senior staff, a range of factors might have influenced the results obtained. Each group of pharmacists worked in a separate and distinct hospital and was therefore influenced by the managerial and educational ethos of that hospital, the managerial structure, attitudes towards further professional training and different facilities available for such training. Also, the individuals involved may have influenced the type of learning that took place and therefore the results obtained. There were a higher number of females, compared to males, recruited to the research project and although groups B and C had one male participant each, group A had 7 males. Although not evaluated in this study, the gender composition of the groups may have had an influence on the learning and assessment (Beard and Hartley, 1984).

As a primary measure of the effectiveness of the teaching methods, this study used the scores obtained from an ADR test. Section one of the test comprised 20 MCQs and was designed to assess factual knowledge about ADRs and the criteria for reporting. By comparing the results of section one, both the PBL and didactic lecture methods provided participants with the factual knowledge necessary to significantly improve their test scores. Section two of the ADR test was designed as 5 short patient case studies. Only group A participants (PBL programme) demonstrated a statistically significant improvement in these scores. The lack of significant improvement for group C participants, on either section of the test, suggested that the improvements in section scores were more likely to have been influenced by the teaching interventions than external factors.

Previous studies on the benefits of PBL compared with didactic teaching methods (Schmidt, 1993; Neufeld *et al.*, 1974; Barrows, 1986) indicated that PBL encourages an inquisitive style of learning and this results in deeper learning as shown by better retention of information over a longer period of time. Orthodox lecturing, although economical with time, results in a more passive style of learning, which tends not to be retained over long intervals. However, other studies have concluded that PBL courses were no better than traditional methods of teaching in terms of academic effectiveness (Vernon *et al.*, 1993). The results obtained in this study demonstrated that over

the six-month period, participants of both groups A and B were able to recall sufficient pertinent information to answer the MCQ questions correctly, irrespective of the method of learning.

PBL has also been claimed to enhance students' abilities to apply knowledge in a clinical context; to develop self-directed learning abilities and to create a learning environment that is motivating and relevant for the student (Barrows, 1983; Neufeld *et al.*, 1974; Barrows, 1986). However, a meta-analysis of PBL research questioned whether PBL courses were better than traditional teaching for improving clinical effectiveness (Vernon *et al.*, 1993). The findings of this study indicate that the PBL approach produced an improvement in the participants' abilities to analyse the clinical cases compared with those of the other groups. The ADR test scores were compared between all groups pre-intervention, and no statistically significant differences were found.

For the 23 questions asked in the teaching evaluation, 17 of the mean rank responses from group A and B participants did not differ significantly. If a teaching programme and the facilitator of that programme are effective in the style of teaching method used, then one would anticipate that the participants' responses to the majority of questions in the evaluation would be similar. However, the evaluations differed significantly in the mean rank responses to questions that emphasised qualities synonymous with PBL such as critical thinking, encouragement to identify problems, ability to solve problems and to discuss in small groups. Participants from group A showed a greater tendency to respond positively to these characteristics of the teaching session compared with group B participants. This finding is supported by the educational literature, which claims that PBL consistently produces favourable student evaluations (Patel *et al.*, 1991).

The second measure employed to assess the effect of the different teaching methods in this research was the change in the number of ADR reports made by the groups. From the improved monthly reporting rate it would appear that the PBL approach with group A participants had been effective. Some studies (Vernon *et al.*, 1993) have suggested that PBL improves the clinical performances and skills of students compared with students educated by traditional methods, whilst other studies (Patel *et al.*, 1991) have failed to demonstrate these improvements. This study would appear to support the association between PBL and improved clinical skills, because some of the participants significantly improved the number of reports made. However, a number of participants continued not to report. The reasons for failure to report were not investigated in this research. Only one participant from group B reported an ADR during the six-month period post-intervention. This suggests that the didactic teaching method did not influence the participants' reporting rates. The control group participants submitted no ADR reports for either of the periods measured, indicating that no teaching supports clinical pharmacists in a *status quo* position.

ADR reporting is dependent on many factors of which teaching is only one. This study indicated that provided the environment for reporting is right, comprehensive systems and procedures are in place and there is encouragement to report, then a problem-based learning approach to educating pharmacists about ADRs can have a positive influence on their skills and abilities to report.

CONCLUSIONS

This research supports a PBL approach to educating clinical pharmacists about ADRs and their reporting. The nature of the PBL sessions in this study placed the drive for learning firmly with the participants. Their enthusiasm led to continued group meetings which resulted in further learning and acquisition of knowledge as

demonstrated by the improved ADR test scores on all sections (MCQ and short patient cases) and a sustainability and motivation that led to continued and increased ADR reporting over a six-month period.

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