

Factors involved in the translation of continuing professional development programmes into clinical practice among Victorian dentists

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Abstract

Background: Continuing professional development (CPD) programmes have traditionally been seen as an important means by which dentists keep up-to-date with current advances in the field. Recent legislative changes in Victoria have resulted in the introduction of mandatory CPD for dentists. Despite this, there is limited available information on the effectiveness of the translation of these programmes into clinical practice.

Methods: Participants undertaking CPD programmes in endodontics and implant dentistry were surveyed using three questionnaires over three time-frames: pre-CPD, post-CPD and three months following the programme (delayed). The course format of the programmes involved both didactic lecture and interactive hands-on components.

Results: Overall response rates of 94 per cent for pre-CPD and post-CPD questionnaires, and 77 per cent for the delayed impact-on-practice questionnaire were achieved. Programmes in both disciplines were found to be effective in facilitating the uptake of the new technologies taught in the courses. The time-series design of the present survey was effective in identifying dentists' background knowledge, experiences and biases, and in evaluating the translation of CPD programmes into clinical practice.

Conclusions: A variety of discipline-related and participant-related factors were identified which may influence the uptake of learned concepts and techniques by participants undertaking CPD programmes. Educators must be cognizant of these issues to ensure that these programmes positively impact on clinical practice, in particular the adoption of technological advances or technical aspects and relating it to the biological goals of treatment, thus facilitating an overall improvement in health care outcomes.

Key words: Questionnaire survey, CPD, endodontics, implants.

Abbreviations and acronyms: CE = continuing education; CDE = continuing dental education; CPD = continuing professional development; NiTi = nickel titanium.

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INTRODUCTION

Dentistry has seen rapid advances in diagnostics and treatment in recent years. In particular, the disciplines of endodontics and implant prosthodontics have seen some major technological and biological advances, leading to the development of innovative new treatment strategies.¹⁻⁶

The advent of rotary nickel titanium (NiTi) instrumentation techniques and matched obturation techniques represents a significant development in endodontic therapy which aims to overcome some of the limitations of traditional stainless steel hand instrumentation protocols.^{7,8} It has been shown that these techniques produce rounder, more centred canals, facilitating the safe preparation of the apical region of the tooth to larger sizes, thereby allowing better access for irrigants, medicaments and obturation materials, resulting in better microbial control.⁹⁻¹² Implant dentistry has also undergone some major advances, with improvements in implant and prosthetic design and the development of various surgical and prosthodontic protocols.¹ Rapid developments in this field have resulted in a wide range of implant systems and procedures being available in the commercial market-place.¹³

With these changes, there has been a growing interest in developing strategies which encourage the adoption of best evidence into clinical practice. Formal continuing education (CE) and continuing professional development (CPD) programmes have traditionally been an important means by which clinicians have kept abreast of the latest developments in dentistry. There is, however, little information available on the

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effectiveness of these programmes in changing clinical practice behaviour.¹⁴ Morgan and Harrison, in a comprehensive review of continuing dental education practices in Australia, noted that, "if future actions such as the mandating of CE are to be determined by an evidence base, rather than merely a strongly held belief in its worth, those providing CE or CPD must be able to demonstrate their contribution to clinical effectiveness".¹⁴

Recent legislative changes in Victoria have resulted in the introduction of mandatory CPD for dentists from 1 January 2005.¹⁵ At this time, with the introduction of mandatory CPD, the need for clinicians to keep up-to-date with current advances has never been more relevant. Concurrently, CPD courses, which clinicians rely on to obtain the most current information, must also be of a certain standard, with efforts made to determine the effectiveness of learned concepts from these programmes into clinical practice.

While the importance of evaluating the effectiveness of CPD programmes on clinical practice behaviour has been acknowledged, there appears to be little consensus on the performance criteria that should be used, or on how these should be established. Jordan¹⁶ noted that the field of impact evaluation lacks not only validated research methods, but also an agreed agenda for future research. In determining an appropriate research methodology, it has been acknowledged that course evaluations should go beyond a "satisfaction questionnaire".^{16,17} The use of time-series designs has also been proposed to provide increased insight into the impact of CPD programmes on clinical practice.^{18,19}

The aim of the present study was to investigate and report on the factors involved in the translation of learned concepts into clinical practice among general dentists attending CPD programmes in Victoria. The study focused on two disciplines which have undergone significant technological and biological advances in recent years – endodontics and implant dentistry.

MATERIALS AND METHODS

Survey design and implementation

A pilot questionnaire series was tested on six volunteer postgraduate students undertaking preclinical training at The University of Melbourne, Australia. The questionnaires were also pre-tested for content validity, reliability and clarity by two senior specialists in the disciplines of endodontics and prosthodontics. The survey instrument was subsequently modified to arrive at the final version (a copy of the questionnaire is available on request from the authors). The survey instrument consisted of three separate questionnaires administered to participants of implant and endodontic CPD short (1 day) and long (3–4 day) courses organized through the School of Dental Science, The University of Melbourne, and the Australian Society of Endodontology, Victorian Branch, in 2005. The endodontic programmes involved the teaching of

contemporary rotary NiTi instrumentation and obturation techniques. The implant programmes covered treatment planning, surgical and prosthodontic aspects of implant therapy. All short and long courses involved both lecture and hands-on workshops as a part of their format. A total of six CPD courses were surveyed as a part of the study (two 1-day and two 4-day endodontic courses; one 1-day and one 3-day implant courses). Participant numbers in individual courses ranged from 11 to 20 dentists.

The surveys were categorized into pre-CPD, immediate post-CPD and delayed impact-on-practice questionnaires which covered the following topics: (a) pre-CPD questionnaire (mailed to participants one month prior to course) which included general questions (socio-demographics and continuing education philosophies) and discipline-specific questions such as clinical background and experience specific to the course that participants were undertaking (implant or endodontics); (b) immediate post-CPD questionnaire (completed immediately following course) which identified participants' views of course content and assessed their willingness to adopt learned concepts into practice; (c) delayed impact-on-practice questionnaire (mailed to participants three months following course) which identified what impact CPD had on actual clinical practice and assessed barriers encountered in implementing these changes.

A combination of closed-ended, open-ended and 5-point bipolar Likert scale questions were used for the questionnaire surveys. The categories of the Likert scale for two question types were worded: (a) strongly agree → strongly disagree and (b) very important → not important. The questionnaires were accompanied by a letter explaining the objectives of the survey and requesting participation. The pre-CPD and delayed impact-on-practice questionnaires were mailed to participants along with a reply paid envelope at the relevant time frames. All questionnaires were de-identified and coded to ensure confidentiality. Non-responders were sent a reminder letter and a second copy of the relevant questionnaire. The study was approved by the Health Sciences Human Ethics Subcommittee of The University of Melbourne.

Data management

The data collection period extended from April 2005 to April 2006. The raw data were collected and manually entered into Microsoft® Excel spreadsheets (Microsoft Corporation, WA, USA). Any non-numerical data were numerically coded to facilitate data analysis. Statistical analysis was performed using the SPSS™ (SPSS Inc., Chicago, IL, USA) Statistical Software package. Standard statistical methods were employed to provide measures of association between questions, including McNemar's, Pearson's Chi and Fisher's exact tests (as part of Chi-square tests). The Gamma test was used to test for associations between

Table 1. Participant numbers and questionnaire response rates for specific courses

CPD programme	Pre-CPD	Response rate (%) Post-CPD	Delayed
1-day Endodontic programmes	38/39 (97%)	38/39 (97%)	31/38 (82%)
4-day Endodontic programmes	37/39 (95%)	37/39 (95%)	29/37 (78%)
1-day Implant programme	8/11 (73%)	8/11 (73%)	6/8 (67%)
3-day Implant programme	19/19 (100%)	19/19 (100%)	13/19 (68%)
Total	102/108 (94%)	102/108 (94%)	79/102 (77%)

Table 2. Socio-demographics of survey participants*

	CPD programme				
	1-day Endo (n=38)	4-day Endo (n=37)	1-day Implant (n=8)	3-day Implant (n=19)	Total (n=102)
Year of graduation					
1955-1964	0	2 (5)	0	0	2 (2)
1965-1974	8 (21)	4 (11)	1 (13)	2 (11)	15 (15)
1975-1984	7 (18)	1 (3)	1 (13)	0	9 (9)
1985-1994	10 (26)	11 (30)	1 (13)	5 (26)	27 (26)
1995-2004	13 (34)	19 (51)	5 (63)	12 (63)	49 (48)
Gender					
Female	13 (34)	18 (49)	4 (50)	7 (37)	42 (41)
Male	25 (66)	19 (51)	4 (50)	12 (63)	60 (59)
Practice type					
Solo	14 (37)	4 (11)	6 (75)	4 (21)	28 (27)
Group	24 (63)	33 (89)	2 (25)	15 (79)	74 (73)

*Percentage of total participants in parentheses.

ordinal scales (e.g., Likert-based questions). The significance level was set at $P < 0.05$.

RESULTS

A total number of 108 participants attended the various endodontic and implant CPD courses. The breakdown of participants attending specific disciplines, along with the individual and grouped response rates is shown in Table 1.

Pre-CPD questionnaires

Socio-demographics of course participants

General socio-demographic data of the participants of the various courses are reported in Table 2. Overall, the majority of participants (48 per cent) had graduated in the previous 10 years. Most of the participants

(73 per cent) were employed in group practices, with a similar distribution pattern observed within individual courses except participants of the 1-day implant programme, where 75 per cent worked in solo practices. The majority of the 102 dentists surveyed practised within Victoria (93 per cent), with most located within the Melbourne metropolitan zone (84 per cent). While the large proportion of the 102 participants obtained their undergraduate dental qualification from Melbourne (60 per cent), 24 per cent had originally graduated from overseas dental schools. Some dentists (12 per cent) also held a postgraduate qualification, with most holding a dental qualification (e.g., GradDipClinDent, FRACDS). Two participants held non-dental postgraduate qualifications (MA, MBA).

CPD experiences and philosophies

A large proportion of the participants (43 per cent) reported that they had attended CPD programmes in the respective disciplines in the previous two years, with most dentists attending courses involving both theory and hands-on components (71 per cent). Many of the participants emphasized the importance of a hands-on component when asked about the strengths and weaknesses of the courses they had attended. When participants were asked what factor had the greatest influence in their decision to attend a postgraduate course, the background of the presenters of the programme was found to be a key reason for their attendance/non-attendance (Fig 1). The question was originally worded in such a way as to ascertain if there were factors "other than the topic itself" which may influence dentists' willingness to participate in a CPD

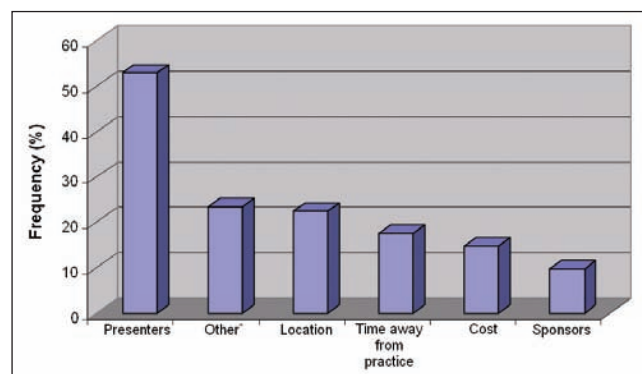


Fig 1. Responses to pre-CPD question: "Which of the following have the greatest influence on your decision to attend a postgraduate course?"

*"Other" category: topic/course content" 19%; "need for further training". 3%; "course accredited by dental board" 1%; time of the week 1%.

course. Nevertheless, 19 per cent of the 102 participants wrote "topic/course content" as a reason for attending in the "Other" category.

A series of Likert-based questions were asked of all participants to determine their attitudes and philosophies towards CPD. Because of the relatively low numbers within each of the five Likert scale points, data from the surveys were reclassified into three groups of "agree", "neutral", and "disagree" respectively for further analysis and interpretation. Significant associations in responses to particular questions were identified using the Gamma test within certain subgroups of the participant pool when compared with overall responses. When these results were cross-analysed with dentists' year of graduation, a higher proportion of recent graduates reported that their undergraduate education dictated the way they practised dentistry (Gamma = -0.355, P=0.002), used the internet more frequently to improve their dental knowledge base (Gamma = -0.500, P<0.001), and relied more on colleagues to advise them on new materials and techniques (Gamma = -0.320, P=0.01). In the subgroup of dentists who held postgraduate qualifications, significantly more participants felt that their undergraduate education *did not* dictate the way they practised dentistry (Gamma = 0.627, P=0.01). This group also preferred to wait for independent evaluations prior to trying new materials and techniques (Gamma = -0.722, P=0.01) and indicated that they had undertaken the course to improve their clinical skills (Gamma = -1.000, P=0.01). Dentists employed in group practices were more likely to rely on colleagues to advise them on new materials and techniques than solo practitioners (Gamma = -0.383, P=0.04).

Overall, most participants (72 per cent) agreed that they relied on formal CPD programmes to keep up-to-date in practice, with 92 per cent having undertaken their particular course to improve their clinical skills, and 35 per cent of participants reported that they had undertaken the programme to fulfil Dental Practice Board requirements.

Clinical background: discipline-specific questions

Endodontic CPD programmes

When asked: "Do you use rubber dam in endodontics?", 84 per cent of the 75 dentists attending the endodontic programmes responded that they "always" used rubber dam during endodontic treatment, while 16 per cent used it "sometimes". All participants provided endodontic treatment in their practices prior to attending the CPD programmes. In response to the question: "Which of the following irrigants do you presently use during endodontic treatment", the use of a wide range of irrigants was reported by participating dentists (sodium hypochlorite 95 per cent, EDTA 76 per cent, local anaesthetic 44 per cent, hydrogen peroxide 12 per cent, saline 11 per cent, chlorhexidine 5 per cent). A combination of irrigants

including both sodium hypochlorite and EDTA was used by 73 per cent of the dentists. Calcium hydroxide was used as an inter-appointment medicament by 97 per cent of the participants, while 92 per cent used Ledermix paste. Both medicaments together were used by 89 per cent of dentists. Formocresol was used by one participant.

Prior to their endodontic course, 37 per cent of the 75 participants reported that they used rotary NiTi instruments in their clinical practice. Of those who did not use NiTi, 53 per cent reported that it was due to lack of experience, while 28 per cent felt that the instruments were too fragile and had concerns with instrument fracture. Of dentists who used NiTi, 93 per cent felt canal preparation was faster, 82 per cent felt that canal curvatures were maintained and 78 per cent felt that obturation was easier. Rotary NiTi files were used as single-use instruments by 26 per cent of participants, largely to reduce the risk of fracture. Other technologies used by dentists during endodontic treatment included digital radiography (43 per cent), electronic apex locators (37 per cent) and the Therafil® (Dentsply, USA) obturation system (17 per cent).

Implant CPD programmes

Of the 27 dentists attending the implant CPD courses, 30 per cent reported that they provided implant-related treatment prior to the programme, with all of these dentists only providing the prosthetic phase of implant therapy. When asked: "How did you learn the skills required for implant treatment?", all had been taught by colleagues and many through self-study (63 per cent). Of the 19 dentists who did not provide implant-related treatment, 84 per cent felt that it was too expensive or their patient base could not afford this treatment modality, while 79 per cent indicated it was because of a lack of experience.

Most of the dentists referred their patients for implant treatment (96 per cent). When asked: "To whom do you refer your implant patients?", 62 per cent referred to prosthodontists, 58 per cent to periodontists, 46 per cent to oral surgeons and 12 per cent to general dentists experienced in implant treatment. When asked about factors which were most important in deciding between placing an implant or undertaking endodontic treatment of a tooth, the majority (93 per cent) considered restorability as the key factor, while 67 per cent reported that the complexity of endodontic treatment can affect their decision to replace a tooth requiring endodontic treatment with an implant (Fig 2). The importance of various treatment-related issues which can impact on implant outcome was assessed through a series of Likert-type questions. The presence of an adjacent endodontically treated tooth *with* an apical radiolucency was viewed by 74 per cent of implant participants to impact on implant outcome, while 26 per cent felt that the presence of an adjacent

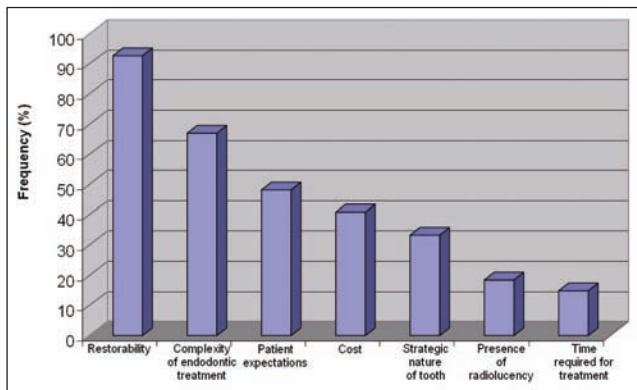


Fig 2. Responses to pre-CPD question to implant participants: “What factors do you feel are important in deciding to place an implant instead of endodontic treatment or retreatment for a tooth?”

endodontically treated tooth *without* an apical radiolucency impacted on implant outcome. Overall, 22 per cent indicated that an adjacent endodontically treated tooth impacted on implant outcome regardless of periapical status. All participants classified aesthetics to be “very important” or “important” in impacting on implant outcome.

Immediate post-CPD

Perceived value of course

Immediately following their respective CPD courses, most participants were positive about the course content and level of presentation of the various programmes. When asked: “Considering the course fees and loss of income, do you feel the course was worthwhile?”, 80 per cent of the 75 endodontic programme participants and 89 per cent of the 27 implant participants responded affirmatively. All implant participants and 97 per cent of the endodontic participants felt that they could implement what they had learned into clinical practice. When participants were asked what barriers they could foresee in implementing the concepts they had learnt in their CPD activity, 29 per cent of the 75 endodontic participants could not foresee any barriers (Fig 3). In contrast, only one participant out of the 27 dentists attending implant programmes felt there were no barriers to translating

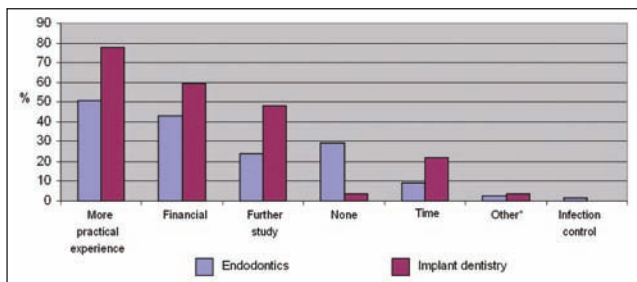


Fig 3. Responses to immediate post-CPD question: “What barriers do you foresee in implementing the concepts you have learned from this course?”

* “Other” category included: Endodontics – patient demographics 1%; do not own practice 1%. Implant dentistry – patient demographics 4%.

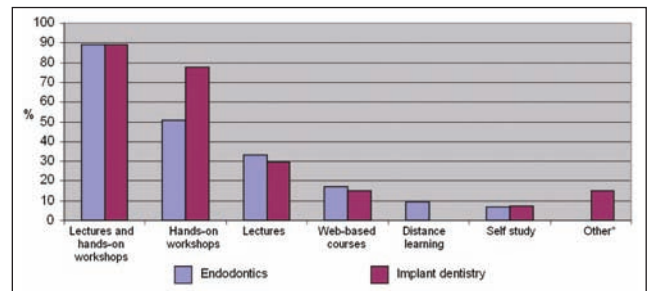


Fig 4. Responses to immediate post-CPD question: “What forms of CPD initiatives do you feel would be most beneficial in this field?” * “Other” category included: Implant dentistry – supervised training and demonstration with specialist 7%; mentoring programme 7%.

the concepts that were learnt in the CPD programme into clinical practice (Fisher’s Exact test, $P=0.006$). Implant participants felt that the need for further study (Fisher’s Exact test, $P=0.03$) and more practical experience (Fisher’s Exact test, $P=0.02$) were significantly greater barriers than endodontic programme participants in transferring the information learnt from their respective CPD programmes into clinical practice (Fig 3).

Preferred format for future CPD strategies

When participants were asked about suggestions for CPD formats and topics that they felt would be most beneficial in the respective disciplines of endodontics and implant dentistry, most dentists felt that the lecture and hands-on workshop format was most beneficial (Fig 4). CPD programmes presenting clinical updates were seen to be most useful by participants in both disciplines (Fig 5).

Delayed impact on practice

Impact on practice

Following a minimum of three months after attending their respective CPD courses, 90 per cent of the 60 respondents who had attended endodontic courses and 53 per cent of the 19 implant participants felt that their practice had changed as a result of attending their programmes (Fisher’s Exact test, $P=0.001$). One participant in the endodontic category did not answer any further questions because of not working at that particular time. Of the respondents, 81 per cent reported that they currently used rotary

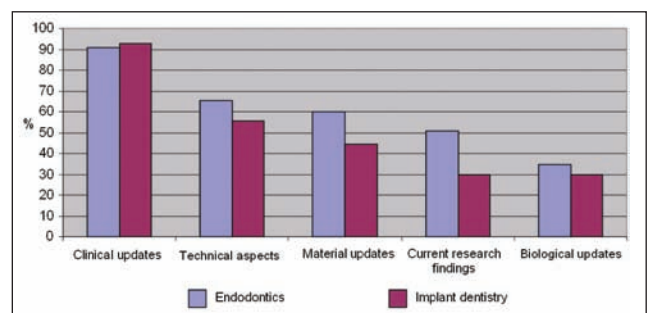


Fig 5. Responses to immediate post-CPD question: “What forms of CPD topics do you feel would be most beneficial in this field?”

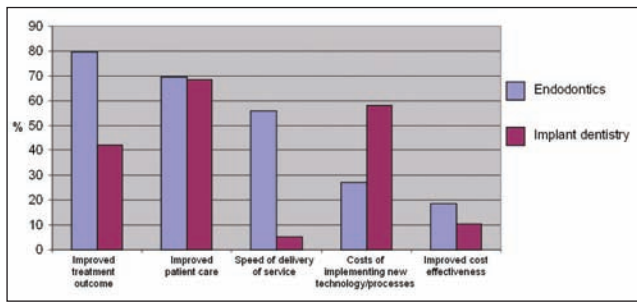


Fig 6. Responses to delayed impact-on-practice question: "What factors did you find were important in dictating a shift in your practice towards the clinical concepts learned in your CPD activity?"

NiTi techniques for various stages of endodontic instrumentation. Of the implant participants who reported a change in their clinical practice, all were treatment planning for implant dentistry, and 58 per cent of the 19 respondents reported that they provided the prosthetic stage of implant treatment. None of the respondents had undertaken the surgical phase of implant treatment.

When the uptake of implant and rotary NiTi technology was compared between disciplines, a significant shift was noted for both disciplines in the number of "new" providers of implant treatment and rotary NiTi endodontic treatment three months following their respective CPD courses. Of the implant participants, 6/11 participants who provided implant treatment did not provide implant treatment prior to the programme (McNemar test, $P=0.03$). Of the endodontic programme participants, 30/48 dentists who used rotary NiTi procedures were "new" users of the technology following their CPD programme (McNemar test, $P<0.001$). Comparing implant and endodontic participants, the rate of uptake of technology was not significantly different for both groups following their CPD programmes.

Of the dentists who reported no change in their clinical practice following their programmes (6/60 endodontic participants, 9/19 implant participants), the reasons given included: their respective practices were not equipped for implant treatment or rotary NiTi techniques, and that the socio-demographics of their practice did not make it economical to incorporate the concepts learned in their respective CPD programme. Four implant participants also reported that they were yet to encounter an appropriate patient needing implant treatment at the time of survey completion.

When dentists were asked what factors they had found were important in dictating a shift in their practice towards the concepts they had learned in their CPD activity, contrasting issues were identified by implant and endodontic course participants (Fig 6).

When dentists were asked about the impact of their participation in the respective CPD programmes to their clinical practice using Likert-based questions, most endodontic participants (90 per cent) reported

that they had a better understanding of NiTi systems and procedures and that their root canal preparations were technically better (81 per cent) following their CPD course. A large proportion of respondents (73 per cent) reported that they felt their treatment outcomes were better. All implant programme respondents reported that they had a better understanding of the treatment planning issues and implant systems available for implant treatment.

Following their respective courses, implant and endodontic course participants reported differences in their patterns of referrals and treatment of implant and endodontic cases. Endodontic course participants reported that they treated more cases ($\chi^2=21.83$, $DF=1$, $P<0.001$) and referred less for specialist management ($\chi^2=8.441$, $DF=1$, $P=0.01$) when compared with implant participants. When asked for additional comments concerning the effectiveness of these CPD programmes in impacting on their clinical practice, implant course participants felt that while the 1- and 3-day short courses served as a good introduction to implant treatment, different formats to the traditional educational strategies were suggested as possibly being more beneficial. Some of the suggestions included supervised clinical treatment with the aid of a specialist, mentoring programmes, and more structured ongoing courses to cater for dentists with different levels of experience (e.g., beginner/intermediate/advanced). Endodontic course participants were generally satisfied with the format of the courses, with participants preferring more technique-oriented CPD initiatives, with more demand for NiTi-based endodontic techniques. Suggestions for CPD topics in this field also included diagnosis and problem-solving in clinical practice, trauma management and endodontic retreatment.

DISCUSSION

This study investigated the factors involved in the translation of learned CPD concepts into clinical practice for participants of two different disciplines – endodontics and implant dentistry. The inherent limitations of a questionnaire survey design must be acknowledged when considering the findings from this study. Questionnaire surveys are highly reliant on high response rates to reduce the possibility of non-response bias.^{20,21} A high response rate was achieved with both pre-CPD and immediate post-CPD questionnaires largely as a result of the methods used for survey administration. The delayed impact-on-practice questionnaires did have a lower response rate when compared to the first two surveys. However, the overall response rate of 77 per cent compares very favourably with the 59 per cent overall impact-on-practice response rate reported in a similar study by Bullock *et al.*¹⁹ A limitation of the present study was the lower participant numbers in the implant courses as compared to the endodontic courses, which had to be accepted as only two courses in implant dentistry were

run by The University of Melbourne in 2005. It is acknowledged that this may affect the interpretation of any comparisons. However, the time-series study design facilitated the identification and analysis of various pre-, immediate post- and delayed post-CPD factors, which may affect the translation of these programmes into clinical practice behaviour.

A similar study by Bullock *et al.*¹⁹ identified a time-frame of six weeks following a CPD programme as being an appropriate interval for administration of a delayed questionnaire to assess impact on practice. In the present study, a longer interval of three months was selected as it was felt that a longer period was necessary to identify the uptake of the new technologies and information taught by the various programmes. It is acknowledged that an even longer interval may have yielded different results based on individual positive and negative experiences of the participants which may have influenced the adoption or non-adoption of these technologies in the longer-term.

The pre-CPD questionnaire provided a valuable tool in identifying socio-demographic, educational and clinical backgrounds of the participants. Background characteristics such as the year of graduation, postgraduate education and employment status (solo vs. group practice) were found to be associated with certain characteristics as described below, which influenced the way dentists practised, learned and interacted within the professional environment. The importance of socio-behavioural aspects in educational strategies and clinical practice behaviour has been highlighted by several authors, but the relative lack of information in this area has also been recognized.^{6,16,22}

Recognition of the different ways in which dentists learn may also influence the way in which CPD initiatives can be targeted and yet made cost-effective. For example, when year of graduation was stratified and cross-analysed, recent graduates reported that they regularly used the internet to improve their knowledge base and also relied on their colleagues to advise them on new materials and techniques. This subpopulation of dentists may potentially be better targeted by alternative CPD initiatives such as internet-based educational strategies, mentoring programmes and small study groups, with topics that may be more relevant to them.

Besides these socio-behavioural aspects, participants were also noted to have differing levels of knowledge and experience within a particular programme which may impact on the relevance of the concepts taught at an individual participant level. The pre-CPD questionnaires were used to identify dentists' clinical backgrounds and experiences in order to see if participants attending these programmes that taught recent technological advances in the respective fields had a sound biological basis for their treatment procedures, which may then play a key role in their evaluation and adoption of new technologies into clinical practice. This was one reason that the pre-CPD

endodontic and implant questions were not asked in the subsequent questionnaires. Another important reason was that not all the endodontic CPD programmes covered exactly the same material, and similarly, the implant programmes did not necessarily address the issue of perceived effect of endodontically treated teeth on implants. Ascertaining a general idea of participants' knowledge base, experiences and prejudices prior to attending a CPD programme enables the convener of the programme to appropriately plan the course content and mode of presentation that is more likely to be beneficial for the majority of participants. Assessment of learning needs has been identified as being crucial for effective continuing medical education.²³ One of the suggestions put forward by an implant course participant was to provide the participants with reading material prior to the course. While a pre-CPD survey may not be practical for all CPD courses, the provision of relevant reading material may allow participants to reflect on their individual learning needs, have a baseline level of knowledge and a common starting point prior to the programme.

The present study surveyed participants in endodontics and implant dentistry – two disciplines which have undergone some major technological changes in recent years. These technological advances were reflected in the course content of the particular programmes, with endodontic courses teaching rotary NiTi instrumentation and complementary obturation techniques while implant courses provided information and hands-on practical workshops on materials, surgical and prosthetic protocols. This study has shown that CPD programmes in both endodontics and implant dentistry significantly impacted on a change in clinical practice as reported by the participating dentists attending both disciplines. While this does provide some evidence of the impact of such programmes on clinical practice, it must be recognized that self-reporting of clinical behaviour may not necessarily correlate with actual practice.²⁴ Whether this, in turn, translates to better overall provision of dental care is difficult to determine by the findings from the present study alone. Nevertheless, it was the intention of the present study to describe the various factors involved in the translation of learned concepts into clinical practice. Different measures may be necessary to elucidate if this, in turn, equates to positive oral health care outcomes. Research strategies such as clinical audits and interviews may be more appropriate tools for such evaluations and provides scope for future research strategies.²⁵⁻²⁸

The design of the delayed questionnaire was based initially on a survey instrument used in a previous study,¹⁹ with generic questions used for both disciplines to assess if the programmes impacted on clinical practice. The use of more detailed discipline-specific questions similar to what was used in the pre-CPD questionnaires may have facilitated the identification of

more specific changes to clinical practice (e.g., rubber dam usage, types of irrigant used, implant treatment planning philosophies). This may have provided a greater depth of information on dentists' implementation of learned concepts into clinical practice and should be considered for future studies using this survey design. To date, there appears to be little consensus on an appropriate research tool for a valid and feasible method to evaluate the transfer of learned concepts into clinical practice.¹⁶ The findings from the present study highlight key considerations which need to be accounted for in future research strategies.

Both endodontic and implant CPD programmes were found to facilitate the uptake of new rotary NiTi and implant technology. The findings from this study are in agreement with a previous study by Brandt *et al.*,²⁹ which showed that participants in implant CPD programmes had a better appreciation of the complexities of implant treatment, but there was a general reluctance to undertake implant surgery. Based on Rogers' classical concepts of diffusion of innovations, "complexity" has been identified as a key element of a new or alternative clinical innovation or procedure that may partly determine its adoption or diffusion.³⁰ "Complexity" is a measure of the degree to which an innovation is perceived as difficult to understand and use. Some innovations are readily understood by most members of a social system; others are more complicated, requiring the adopter to develop new skills and understandings, resulting in a slower rate of adoption. For example, when comparing the diffusion of implant dentistry to the uptake of rotary NiTi technology, it may be considered that implant education and treatment is more complex as it involves the learning of an entirely new set of skills for treatment planning and clinical treatment. Endodontic treatment is widely prescribed in general dental practice and as such, most practitioners should have a baseline level of experience. At present, this cannot be said for implant therapy, which may require a greater attention to formal training to facilitate proper application in clinical practice.

Immediately following their respective CPD programmes, implant course participants identified the need for more practical experience and further study as significantly greater barriers to the adoption of learned concepts into clinical practice when compared to endodontic course participants. This may indicate a need for implementation of alternative educational strategies in the provision of implant education. This was also evident in the present study by the suggestions put forward by implant CPD participants on formats of future CPD activities (e.g., mentoring programmes, structured ongoing programmes in modules, supervised clinical treatment).

It is pertinent to note that teaching of new innovations and technical aspects of treatment should be perceived in the light that they should serve the

biological goals of health care. For example, while it was perceived by many dentists in this and an earlier study^{31,32} that the speed of endodontic treatment is improved with rotary NiTi and is a major factor facilitating a change towards its adoption in practice, this may not necessarily correlate with the biological goals of endodontic treatment. This is particularly relevant especially when a large proportion of participants in the pre-CPD questionnaire also reported that they used non-antimicrobial irrigants such as saline and local anaesthetic during endodontic instrumentation which have minimal or no antimicrobial or tissue dissolving capabilities.

Similarly, 26 per cent of implant participants felt that the presence of an endodontically treated tooth *without* an apical radiolucency can impact on implant outcome. A high proportion of implant participants (67 per cent) also reported that the complexity of endodontic treatment can influence their decision to replace a tooth requiring endodontic treatment with an implant. Contemporary endodontic treatment strategies presently allow predictable management of cases that may have been considered "heroic" in the past.³³⁻³⁵ The need for an appreciation of advances across disciplines is necessary to facilitate sound treatment planning to ensure the best course of care.

With these observations, it is evident that while new technologies have been developed to improve patient care and treatment outcome, their effective diffusion into the clinical setting, with an appreciation of their biologic implications is essential to facilitate overall improvement in oral health care outcomes. In convening and presenting dental CPD programmes, the educator must be cognizant of the need for an unbiased, evidence-based approach to disseminating information and make all efforts to ensure that both technical and biological aspects of the subject matter are taught. It is true that in the present climate of increased commercial pressures, this may be difficult to perform, but this is made all the more important to facilitate positive outcomes in the provision of health care.

It is relevant to note that the clinically-oriented CPD programmes surveyed were attended by dentists not primarily due to mandating of CPD, but as a result of other variables, such as an interest in the topic or presenters, or a self-perceived need to improve their clinical skills, which is in agreement with previous studies.^{36,37} Nevertheless, 35 per cent reported that Dental Practice Board requirements mandating CPD was a factor in deciding to attend their selected programme. It is conceivable that mandatory CPD may facilitate increased attendance to CPD programmes by dentists, particularly among dentists who were traditionally non-attendees or "laggards".^{38,39} Further research is required to determine whether this, in turn, can produce an overall improvement in the provision of dental care in the community. Best *et al.* noted that while the popularity of the course topic or opinion

leader may be used in planning for future CPD programmes, dentists' self-perceived needs may not be a true indicator of their real educational needs and as such may not equate to an improvement in the overall provision of dental care.³⁷ It may thus be incumbent on the educator to recognize these issues and convene programmes appropriately.

CONCLUSIONS

It is apparent that several factors can influence the effective translation of learned concepts in CPD programmes into clinical practice. The use of a time-series questionnaire design was found to be an effective tool for identifying the various discipline-related and participant-related variables which could influence the transfer of desirable learning outcomes into clinical practice. Both implant and endodontic CPD programmes were found to be effective in facilitating the adoption of the new technologies taught into clinical practice. The use of alternative educational strategies to the traditional lecture/hands-on format may be considered for particular disciplines and target audiences to allow more effective learning. With the rapidity of advances in contemporary dental practice, along with legislative changes mandating CPD activities, there is likely to be an ongoing demand for dentists to attend clinical update programmes. The onus is on the educator to ensure that these programmes identify gaps in the knowledge base and target teachings towards addressing these gaps, both from a technical aspect as well as from a biological standpoint to improve dental care outcomes.

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