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Use of newer technologies by dentists in New Zealand

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Abstract

Background and objectives: New technologies continue to be developed in clinical dentistry, but not all are adopted for use. This study aimed to update information on the use of newer technologies among New Zealand dentists and to evaluate the factors that influenced their adoption.

Methods: Electronic and postal questionnaires were sent to a random sample of 573 dentists, consisting of general dental practitioners (GDPs) and dental specialists enrolled on the Dental Council of New Zealand Dentists' Register.

Results: Responses were received from 232 dentists (40.5%). Of the 17 technologies investigated, digital intraoral radiography (88.7%), digital apex locators (77.4%) and rotary endodontic units (74.5%) were the most commonly used. Least commonly-used were digital impressions (4.7%), digital colour determination (2.8%) and ozone units (1.4%). Dentists used an average of 4.9 ± 2.5 technologies. The use of technologies showed few significant differences by dentists' personal or practice characteristics apart from a higher average among men than women ($p < 0.01$). Improving quality of care and improving efficiency were ranked as the two most important factors when deciding about using newer technologies. Since a 2007 New Zealand study, the use of digital radiography and dental laser units has increased, whereas the use of power bleaching, caries diagnosis and ozone units has decreased. The use of other technologies has remained similar.

Conclusions: Insight into the changing trends in the adoption of dental technologies heightens practitioners' and educators' understanding of what works for dentists, besides helping to shape future directions in technological developments in dentistry.

Introduction

New technologies continue to be developed for clinical dentistry, but their uptake in clinical practice is variable. Some innovations become the 'new mainstream' while others never 'catch on'. Whether technologies are adopted for use in practice depends largely on users' awareness of the innovation, their perceptions of its usefulness, communication from manufacturers and suppliers, and characteristics of communication channels (Rogers, 2003; Matthews et al., 2016; Parashos and Messer, 2006). Clinicians' decisions whether to use a technology are often made after considering several alternatives, their past experiences, and investments in technologies they have previously made (Van der Zande et al., 2013). The use of innovations such as technologies, also called 'adoption', can be seen as an individual decision-making process that is influenced by the decision-making of others. In a seminal study, Rogers (Rogers, 2003) described five categories of adopters: innovators, early adopters, early and late majority, and laggards. An innovation gets accepted first by innovators, who have specific characteristics. For example, they are more often specialists, younger, and have an extensive network. If later groups also adopt, and an innovation moves beyond the first group, adoption takes off and the innovation gets accepted by more and a greater diversity of users. As a result the innovation gets more developed, promoted, and integrated. The adoption pattern then follows an S-shaped curve: infrequent initial use, wider use as an innovation gets accepted more, until one group of non-users, 'laggards', remain. Some innovations are only used by a smaller group, the innovators and early adopters, but never move beyond what has been termed the 'adoption gap', and after a while their use peters out (Rogers, 2003; Lee et al., 2005; Parashos and Messer, 2006).

The use of specific technologies by dental professionals has been investigated in a number of studies. These include endodontic technologies (Bjørndal and Reit, 2005; Molander et al., 1996; Dahlström et al., 2015; Parashos and Messer, 2006; Parashos and Messer, 2005; Locke et al., 2013; Thomas et al., 2013), intraoral scanners (Joda et al., 2016), CAD/CAM technology such as CEREC machines (Tran et al., 2016), digital photography (Morse et al., 2010), a screening tool for periodontitis (Matthews et al., 2016), digital 3D radiography such as CBCT (Setzer et al., 2017) and digital radiography (Ting et al., 2013; Wenzel and Møystad, 2001). These studies investigated factors such as dental practitioners' opinions of, and reasons for, adopting specific technologies, and related this to practitioner and practice characteristics. Dentists' attitudes to change (Parashos and Messer, 2006; Tran et al., 2016), perceived advantages, or lack thereof, of newer technologies over conventional techniques (Parashos and Messer, 2006; Ting et al., 2013; Tran et al., 2016; Thomas et al., 2013; Locke et al., 2013; Morse et al., 2010), time and cost (Wenzel and Møystad, 2001; Tran et al., 2016; Ting et al., 2013; Joda et al., 2017; Locke et al., 2013; Morse et al., 2010), quality and safety of care (Wenzel and Møystad, 2001; Tran et al., 2016; Ting et al., 2013; Molander et al., 1996), and having received relevant training (Dahlström et al., 2015) were the most cited reasons for use and non-use of specific technologies by dentists.

Few studies have investigated the use of an ensemble of technologies by dental practitioners (Van der Zande

et al., 2015; Tay et al., 2008; John et al., 2003; Flores-Mir et al., 2006; Schleyer et al., 2006). Each of the available studies has investigated a different combination of technologies, in part due to new technologies becoming available. To keep dental curricula, dental educators, and dental professionals up to date, it is important to maintain up-to-date information on the use of these technologies in practice. We use the term 'newer technologies' to refer to medical devices used in dental health care, specifically those perceived as relatively new by dental practitioners, as described in earlier studies (Ting et al., 2013; Van der Zande et al., 2015). The term medical device can be defined as "an article, instrument, apparatus or machine that is used in the prevention, diagnosis or treatment of illness or disease"[1]. This study aimed to update information on the use of newer technologies among New Zealand dentists, and to evaluate dentists' opinion on factors that influence their decision to use newer technologies.

Methods

This study was approved by the University of Otago Human Ethics Committee (reference number D16/065). A random sample of general dental practitioners (GDPs) and dental specialists was selected from the 2015-2016 Dental Register, obtained from the Dental Council of New Zealand. From the Dental Register, 20% of the GDPs and 20% of the dental specialists registered in New Zealand (NZ) were selected. Thus, 577 participants were randomly selected (503 GDPs and 74 dental specialists). Those who did not have a clinical role or did not practise in NZ were excluded from the sample, resulting in a total of 573 eligible participants. Data were collected between March and July 2016. Each participant received a link to an electronic self-report questionnaire via email during March 2016. The electronic questionnaire used the Qualtrics® platform (Qualtrics, Provo, UT, USA), version March 2016. Participants who did not respond within two weeks were sent a reminder email. Those who did not respond to the electronic questionnaire were then sent the same questionnaire on paper by post. This postal questionnaire was accompanied by a cover letter and a reply-paid envelope. The data were analyzed confidentially. Participant ID numbers were only used to send reminders to non-responders, and responses to the questionnaire were not traceable to individuals.

Participants were asked to indicate their age, sex, year and country of primary dental qualification, dental practice location, type of primary dental setting, and the number of patients they cared for each week. In addition, information was sought on current ownership, the use and the desire to use newer technologies. Technologies were selected if there was a likelihood that they were adopted by NZ dentists in the past decade. Seventeen technologies (see Figure 1) were selected from two previous studies (Tay et al., 2008; Van der Zande et al., 2015), and participants were also able to select three 'other technologies' of their choosing (open question). Respondents were asked to select all technologies which they (a) 'have and use', (b) 'have but don't use', or (c) 'don't have but want'. The remainder (d) did not have and did not want the equipment. Participants were also asked if their dental practice had a practice website (yes/no) and/or a social media page (yes/no). To investigate possible influences on the decision to use newer technologies, respondents were asked to rank how important eight factors (see Figure 2) were when deciding to use newer technologies. An open question where they could report any other influences ('other') was also included. Factors could be ranked from most important (1) to least important (9).

1 World Health Organization (2017). Medical devices–definitions. Available at: http://www.who.int/medical_devices/definitions/en/ [Accessed November 3, 2017]

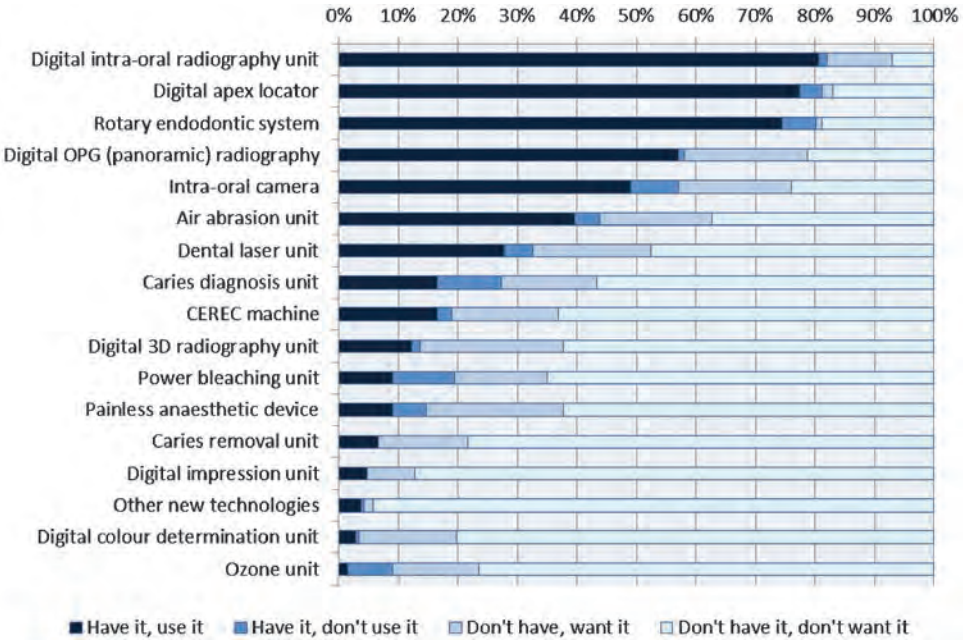

Figure 1 Percentage of New Zealand dentists who use, have, and wish to use a range of technologies

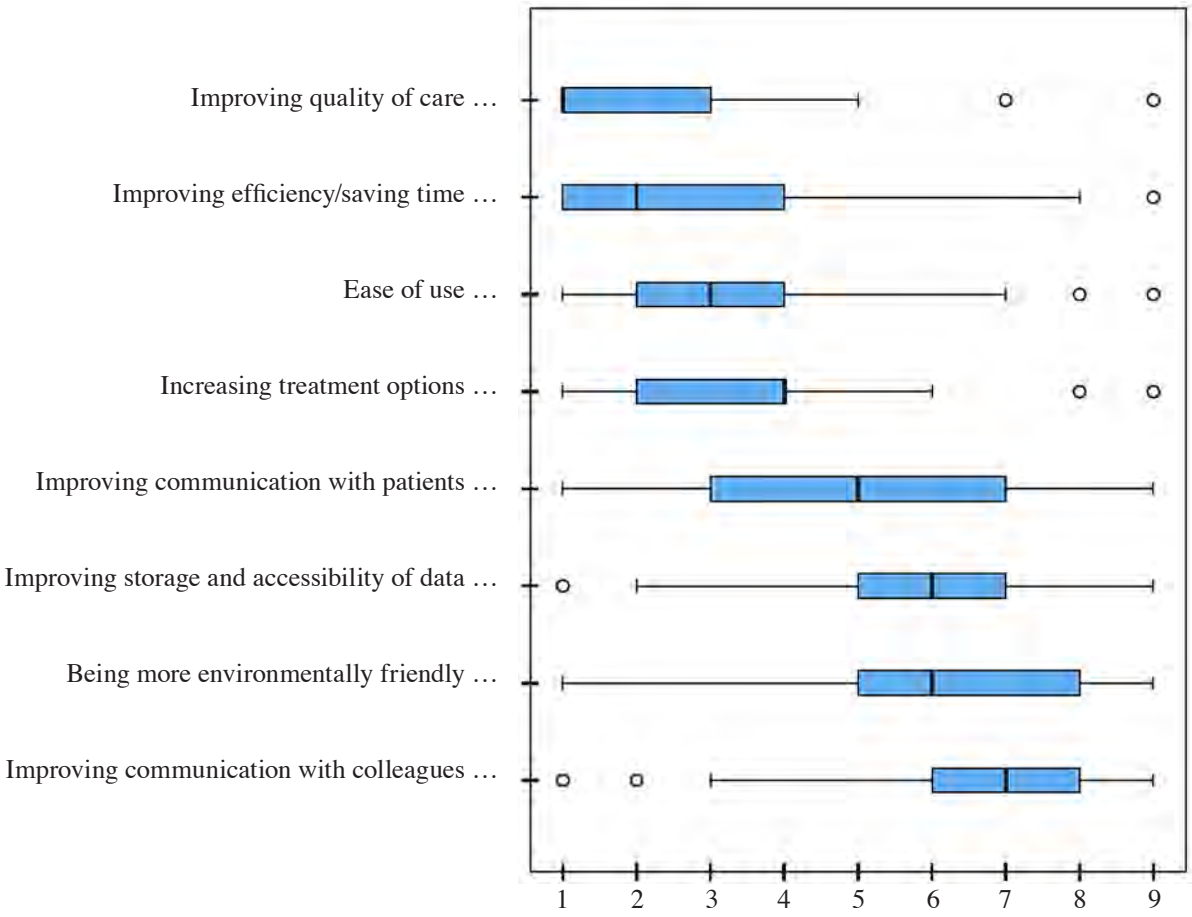

Figure 2 Aspects that are most important to dentists when deciding about using a newer technology (showing median rankings, quartiles, minimum and maximum rankings)

Analyses

Data were entered electronically and analysed using IBM Statistical Package for Social Sciences (SPSS) for Windows version 21 (IBM Corp, released 2012, Armonk, NY). For all statistical tests, a significance level of 0.05 was used. To test the statistical significance of observed associations, the Friedman test was used for repeated measures of ordinal variables, with post-hoc Wilcoxon rank tests. For continuous dependent variables, analysis of variance was used with post-hoc Tukey tests. For categorical dependent variables, Chi-square tests and (where appropriate) Fisher's exact tests were used.

Results

Responses were received from 232 of the 573 invited dentists (40.5%). Characteristics of the responding dentists and their dental practice setting are summarized in Table 1. Comparison of respondents' characteristics with the population of dentists registered in NZ (Broadbent, 2016) showed that dentists over sixty years of age appeared to be over-represented in the sample, while dentists trained outside of NZ were under-represented. Among the respondents, 212 answered the section of the questionnaire asking which newer technologies they used. Only those who had responded to the section on technologies used were included in this part of the analysis.

Newer technologies dentists had, or desired to acquire, are shown in Figure 1, in decreasing order of frequency of use. In addition to the technologies shown in Figure 1, in the category 'other technologies', dentists indicated they had and used SLR cameras (extraoral, mentioned twice), an intraoral suction device, virtual surgical planning, a scanner for 3D models, an operating microscope, an electronic obturation unit, and patient-monitoring equipment for sedation. Technologies dentists indicated they had but did not use were, in decreasing order of frequency: caries diagnosis units, power bleaching units, intraoral cameras, ozone units, painless anaesthetic devices, rotary endodontic systems, dental laser units, air abrasion units, digital apex locators, CEREC machines, digital 3D radiography systems, digital intraoral radiography systems, digital panoramic radiography, and digital colour determination systems, while one respondent had but did not use an electric pulp testing unit. More than one in five dentists indicated they desired to acquire a digital 3D radiography unit, a painless anaesthetic device, or a digital panoramic radiography system. Fewer than one in five dentists indicated they desired to acquire (in decreasing order) a dental laser unit, an air abrasion unit, an intraoral camera, a CEREC machine, a digital colour determination unit, a caries diagnosis unit, a power bleaching unit,

Table 1 Comparison of demographic characterstics of respondents and dentists registered as practising in New Zealand (brackets contain column percentages unless indicated otherwise)

	Number of GDPs and dental specialists (percentage)		Practising GDPs and dental specialists in New Zealand (percentage)[a]	
Sex				
Male	140	(60.6)	1346	(64.6)
Female	91	(39.4)	739	(35.4)
Age group *				
To 29	29	(12.7)	261	(12.5)
30 to 39	35	(15.4)	449	(21.5)
40 to 49	40	(17.5)	510	(24.4)
50 to 59	65	(28.5)	526	(25.2)
60 +	59	(25.9)[b]	339	(16.3)
Graduating cohort				
Pre-1980	67	(29.1)		
1980-1989	67	(29.1)		
1990-1999	36	(15.7)		
2000 +	60	(26.0)		
Country of qualification *				
New-Zealand	187	(81.7)	1456	(69.8)
Other	42	(18.3)[b]	629	(30.2)
Practice location				
Major cities	92	(51.1)	1198	(57.4)
Other	88	(48.9)	887	(42.5)
Number of patients per week				
0-24	34	(14.7)		
25-49	100	(43.1)		
50-74	67	(28.9)		
75-99	22	(9.5)		
100+	9	(3.9)		
Primary dental setting				
Private (solo)	53	(22.9)		
Private (group)	149	(64.5)		
Public sector	25	(10.8)		
Other	4	(1.7)		
Total	232		2085	

Note: not all categories have a 100% response rate, and missing values have been excluded from this table

* Chi-square test showed a significant difference between GDPs and dental specialists in the sample and practicing GDPs and dental specialists in New Zealand ($p < 0.05$), Cramer's $V < 0.10$

[a] Source: Dental Council of New Zealand, Workforce Analysis 2011-2012

[b] Standardized residuals <-2 or >2

a caries removal unit, an ozone unit, a digital intraoral radiography unit, a digital impression unit, a digital apex locator, or a rotary endodontic system. Other technologies dentists indicated they desired to acquire included intraoral scanners (mentioned twice) and an oral cancer screening light. In terms of internet presence, 145 dentists (68.4%) worked in dental practices that have practice websites, and 45 (21.2%) worked in practices that utilise social media.

Personal and practice characteristics of dentists who indicated using the five most common newer technologies are reported in Table 2. Respondents who graduated after 2000 were more likely to have a digital apex locator. Use of a rotary endodontic system or intraoral camera was more common in private dental practice settings, particularly in group practices. Among the less frequently used newer technologies, using an air abrasion unit ($\chi^2(2) = 9.55$, $p < 0.01$), using a CEREC machine ($\chi^2(2) = 7.49$, $p < 0.05$), and using a dental laser ($\chi^2(2) = 9.57$, $p < 0.01$) were significantly associated with dental practice setting. Use of an air abrasion unit ($\chi^2(1)= 9.43$, $p < 0.01$), a caries diagnosis unit ($\chi^2(1) = 5.70$, $p < 0.05$), a caries removal unit ($\chi^2(1) = 6.35$, $p < 0.05$) and a dental laser ($\chi^2(1) = 11.12$, $p < 0.01$) differed between men and women. Respondents used an average of 4.9 ± 2.5 technologies, with the lowest being 0 and the highest 12. No differences were found for characteristics of dentists and dental practice settings in the total average number of technologies used, except that the average was significantly greater among men than women, $t(209) = 3.18$, $p < 0.01$.

Table 3 presents a comparison of three studies which investigated the use of newer technologies: the study reported in this paper, a similar 2007 study conducted in NZ (Tay et al., 2008), and a 2013 study conducted in the Netherlands (Van der Zande et al., 2015). Although other studies which report on the use of one or a few specific technologies are available, only those presented in Table 3 reported in a comparable way on a wide range of newer technologies used by dentists. Other studies that are available, which reported on the use of one or a few specific technologies or on the use of computers by dentists, are detailed in the discussion of this paper. A greater percentage of NZ dentists now appear to be using digital radiography equipment than in 2007. The percentage of dentists indicating the use of power bleaching units, caries diagnosis units, and ozone units appears to have decreased since 2007. There appeared to be a lower percentage of dentists in the Netherlands using intraoral cameras than in NZ, but a greater percentage of dentists in the Netherlands reported using digital intraoral radiography and practice websites.

'Improving quality of care' was most often ranked by dentists as the most important factor when deciding about using a newer technology. 'Improving communication with colleagues' was regarded as least important (Figure 2). Other influences mentioned were cost (mentioned by four respondents), having no control over the budget, making money, and evidence base. The importance that dentists attached to the influences detailed in Figure 2 differed significantly (Friedman $\chi^2(7) = 674.1$, $p<0.001$). The ranking of importance differed between all influencing factors ($p<0.05$), except for the ranking between 'improving storage and accessibility of data', and 'being environmentally friendly'.

Discussion

Dentists in NZ used a range of newer technologies. The most commonly used were digital intraoral radiography, digital apex locators and rotary endodontic units. Least commonly used were ozone units, digital colour determination and digital impression units. Dentists often had, but did not use, caries diagnosis units, power bleaching units and ozone units. The technologies most wanted by dentists who had not yet invested in them were digital 3D radiography units, painless anaesthetic devices, and digital panoramic radiography systems. The main reasons dentists gave for adopting dental technologies were improving quality of care, improving efficiency, and the ease of use of a technology. Few considered improving communication with colleagues, being environmentally friendly, and improving storage/ accessibility of data as important reasons for adopting new dental technologies.

The response rate to the survey was 40.5%, which limits the generalizability of the findings. A higher participation rate would have been desirable. However, this response is comparable to the other available studies on technology use by dentists. The two studies used for comparison in Table 3 had response rates of 62.5% (Tay et al., 2008) and 31.3% (Van der Zande et al., 2015). The survey was first carried out via an online platform, which in similar studies had also led to a low response rate compared to postal surveys (Jeganath et al., 2016). In our study, the online survey was followed by a postal survey to increase representativeness of the findings. Sending the postal survey in the first instance, rather than as a reminder, might increase the response in future studies. The study presented here was part of a larger survey, and comprised two pages of a nine page questionnaire. The length of the survey may have affected the response rate. Dentists aged 60 years or older were over-represented among respondents, and dentists who received their qualification outside of NZ were under-represented**.** Studies on technology use in other professional groups have reported that both training and age may be associated with the likelihood of using technologies (Morris and Venkatesh, 2000). While this affects the representativeness of the sample relative to the source population, neither age nor qualification source were associated with the main outcomes of the study. It is thus unlikely that this representativeness issue limits the generalisability of the study findings. These weaknesses notwithstanding, an important strength of this study is that it was the first to follow up on an earlier investigation into the use of a variety of dental technologies (Tay et al., 2008) and reports on factors influencing adoption of technologies.

The adoption of a number of technologies by NZ dentists appears to have changed in recent years, in particular digital radiography. In this study, an 88.7% majority of dentists reported using digital radiography, an

Table 2 Use of the five most used technologies by dentists' characteristics (brackets contain percentages).

	Digital intra-oral radiography unit		Digital apex locator		Rotary endodontic system		Digital panoramic radiography		Intra-oral camera	
Total	171	(80.7)	164	(77.4)	158	(74.5)	121	(57.1)	104	(49.1)
Sex										
Male	108	(83.7)	99	(76.7)	101	(78.3)	74	(57.4)	67	(51.9)
Female	62	(75.6)	64	(78.0)	56	(68.3)	46	(56.1)	36	(43.9)
Age group										
To 29	18	(72.0)	24	(96.0)	21	(84.0)	16	(64.0)	10	(40.0)
30 to 39	25	(86.2)	24	(82.2)	23	(79.3)	20	(69.0)	17	(58.6)
40 to 49	30	(83.3)	25	(69.4)	25	(69.4)	25	(69.4)	20	(55.6)
50 to 59	54	(85.7)	49	(77.8)	46	(73.0)	34	(54.0)	26	(41.3)
60 +	43	(78.2)	40	(72.7)	42	(76.4)	24	(43.6)	28	(50.9)
Graduating cohort										
Pre-1980	46	(73.0)	45	(71.1)*	45	(71.4)	28	(44.4)	30	(47.6)
1980-1989	58	(89.2)	49	(75.4)	46	(70.8)	39	(60.0)	31	(47.7)
1990-1999	25	(78.1)	22	(68.8)	23	(71.9)	22	(68.8)	17	(53.1)
2000 +	40	(80.0)	46	(92.0)[a]	42	(84.0)	31	(62.0)	25	(50.0)
Country of qualification										
New-Zealand	139	(79.4)	135	(77.1)	128	(73.1)	101	(57.7)	86	(49.1)
Other	29	(85.3)	26	(76.5)	28	(82.4)	19	(55.9)	18	(52.9)
Practice location										
Major cities	68	(81.9)	60	(72.3)	60	(72.3)	46	(55.4)	37	(44.6)
Other	65	(83.3)	66	(84.6)	60	(76.9)	46	(59.0)	42	(53.8)
Number of patients per week[c]										
0-24	20	(71.4)	19	(67.9)	16	(57.1)	19	(67.9)	12	(42.9)
25-49	78	(85.7)	73	(80.2)	70	(76.9)	52	(57.1)	45	(49.5)
50-74	49	(77.8)	50	(79.4)	50	(79.4)	31	(49.2)	28	(44.4)
75+	24	(80.0)	22	(73.3)	22	(73.3)	19	(63.3)	19	(63.3)
Primary dental setting[b]										
Private (solo)	37	(78.7)	31	(66.0)	31	(66.0) *	21	(44.7)	17	(36.2) *
Private (group)	115	(82.7)	113	(81.3)	112	(80.6)	81	(58.3)	80	(57.6)
Public sector	15	(68.2)	17	(77.3)	13	(59.1)	16	(72.7)	6	(27.3)

* Chi square test significant ($p<0.05$)

[a] Standardized residuals <-2 or >2

[b] The category 'other primary dental setting' was treated as missing, due to the low number of respondents

[c] The category '100+ patients per week' was grouped with the '75-99 patients per week' category, due to the low number of respondents

increase from 34.6% in 2007 (Tay et al., 2008) and 58.3% in 2012 (Ting et al., 2013). The 2007 study was conducted among GDPs, whereas GDPs and dental specialists were included in both the 2012 study and this 2016 survey. Having a specialization may be associated with the use of newer technologies (Van der Zande et al., 2015; Lehoux et al., 2002; Ferlie et al., 2005), which could in part explain this difference. In our study, digital intraoral radiography was used by 84.7% of GDPs, and digital panoramic (OPG) radiography by 54.6%, indicating that the increase in adoption was not due to the inclusion of dental specialists. The use of digital radiography was comparable in NZ and the Netherlands. Earlier surveys reported that one in five dentists in the US state of Indiana (Brian and Williamson, 2007) and one in four in the Thames Valley region of the UK (John et al., 2003) used digital radiography. In 2012, many dentists who did not use digital radiography indicated concerns about costs and implementation issues (Ting et al., 2013), yet many more now appear to use such technologies. The types of digital radiography used were not reported in these earlier studies. Our study shows that the majority

Table 3 Comparison of the use of newer technologies across three studies

	This study	Tay et al. 2008	Van der Zande et al. 2015
Year of data collection	2016	2007	2013
Country	New Zealand	New Zealand	The Netherlands
Type of respondents	Dentists	General dental practitioners	Dentists
Digital radiography (any type)	88.7%	34.6%*	91.2%°
Intraoral radiography	80.7%		90.4%
OPG (panoramic) radiography	57.1%		57.4%
Digital 3D radiography	12.3%		8.4%
Digital apex locator	77.4%	81.4%	
Rotary endodontic system	74.5%		
Intraoral camera	49.1%	49.6%	26.1%
Air abrasion unit	39.6%	30.4%	
Dental laser unit	27.8%	11.5%	
Caries diagnosis unit	16.5%	39.3%	
CEREC machine	16.5%	16.4%	8.4%
Power bleaching unit	9.0%	35.9%	
Painless anaesthetic device	9.0%	9.6%	
Caries removal unit	6.6%		
Digital impression unit	4.7%		12.0%
Digital colour determination	2.8%		6.8%
Ozone unit	1.4%	10.6%	
Other technologies	3.8%		5.6%
Practice website	68.4%		81.1%
Practice social media	21.2%		13.3%
Digital patient information			93.6%
Digital agenda			82.7%
Digital address/financial administration			81.1%
Digital appointments/reminders			34.5%
Digital information screens			17.7%
Digital practice supply			16.9%
Total number of technologies (mean ± sd) Min-max (items)	4.9 (±2.5) 0-12 (17)	3.3 (±2.2) unreported (11)	6.3 (±2.3) 0-12 (16)

* Results reported for 'digital x-ray machine' may include digital OPG radiography as well as digital intraoral radiography

° Data obtained from the authors

of NZ dentists used digital intraoral radiography, more than half used digital panoramic (OPG) radiography, and about one in ten used 3D radiography (CBCT).

Power bleaching units, caries diagnosis units and ozone units appear to be used by fewer dentists at present, and many indicated they had these devices but did not use them. A study carried out in 2015 indicated that many NZ dentists use conventional caries diagnosis methods and that, of those who had a newer technology for caries diagnosis, no more than half use it regularly (Jeganath et al., 2016). Having, but not using, a technology may occur when expectations about a technology are not confirmed, which may then lower satisfaction with the technology and its perceived usefulness (Bhattacherjee, 2001), decreasing the desire to continue using it. Other newer technologies were used to a similar degree in 2016 and in 2007, suggesting that the adoption of these technologies has halted. Whereas studies of technology use mostly focus on increasing adoption of technologies, non-use and discontinued use (having but not using a technology) are also essential parts of technology adoption (Satchell and Dourish, 2009; Wyatt, 2014; Selwyn, 2006).

Non-use may exist because non-users actively refrain from using a technology, or because the technology is not relevant to them. Non-use often continues to exist when many users have started using a technology, and is therefore essential to understanding technology use (Satchell and Dourish, 2009). As our study shows, non-use and discontinued use are fairly common among dentists for some newer technologies.

The use of many newer technologies was similar between NZ and the Netherlands (Van der Zande et al., 2015). Intraoral cameras appear to be used by a larger proportion of dentists in NZ than in the Netherlands. It is possible that NZ dentists may favour the use of intraoral cameras due to the requirement of the Accident Compensation Corporation to take photographic records of teeth affected by injury. In contrast, digital intraoral radiography appears to be used more often by dentists in the Netherlands than by dentists in NZ, in both the current study and the 2012 study (Van der Zande et al., 2015; Ting et al., 2013).

Dentists' use of newer technologies was not significantly associated with their personal attributes or the characteristics of their place of work, except for differences by dental practice type (private solo practice, private group practice, or the public sector) in the use of rotary endodontic systems and intra-oral cameras (two of the most common technologies), air abrasion units, CEREC machines, and dental lasers (less common technologies). In other professions, organizational setting was found to be associated with technology use (Cresswell and Sheikh, 2013; Boonstra and Broekhuis, 2010). This could be due to both the size of a practice, or its financial structure. Dentists who graduated after 2000 used digital apex locators more often, possibly due to changes in the curriculum around this time. The total number of technologies used, as well as some of the less common technologies, differed between men and women. In the previous study in NZ, and in the study in the Netherlands, this was not found (Tay et al., 2008; Van der Zande et al., 2015).

Decisions regarding adoption of technologies are mainly influenced by opinions or perceptions about the technology (Matthews et al., 2016; Rogers, 2003; Parashos and Messer, 2006; Van der Zande et al., 2013). Expected performance of a technology (such as its efficiency or time-savings) as well as its ease of use are the main perceptions influencing whether a technology is used or not (Venkatesh et al., 2003; Yarbrough and Smith, 2007; Holden and Karsh, 2010). This study found that expected improvements in quality of care, improved efficiency and time saving, and ease of use were the main factors that affected decisions by NZ dentists about adoption of new technology. In other health care settings, perceptions of improved quality of care were similarly found to be an important influence on adoption of technologies (Ward et al., 2008; Fitzgerald et al., 2002), in addition to performance and ease of use.

This study was, to our knowledge, the first that compared the adoption of new technologies by dentists in the same country between two time periods. NZ dentists used a number of new technologies. Digital intraoral radiography, digital apex locators, and rotary endodontic systems were most common, and were each used by around three-quarters of dentists. The type of practice dentists worked in – a private solo or group practice or public practice–was associated with the adoption of some new technologies, and adoption differed between men and women for the overall number of technologies used. The reported use of digital radiography units and laser units has increased notably since the earlier study conducted in NZ. While the use of power bleaching units, caries diagnosis units and ozone units appears to have decreased, the use of most other technologies has remained similar. Improving quality of care and improving efficiency were the main influences dentists cited on their decisions to use a new technology. Increasing adoption of some new technologies, but also decreasing adoption of other technologies can change the ways in which oral health care is delivered. Insight into these trends in the adoption of dental technologies allows for a better understanding of what works for dentists and which technologies need further support in education and continuing professional development.

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