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Root Canal Treatment and Demand for Continuing Education among Thai Dental Practitioners

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Abstract:

Background: In recent times, there have been significant advancements in the techniques and materials used for root canal treatment. Nevertheless, there is a lack of study on the current methods used for root canal treatment among dentists in Thailand. Therefore, the primary purpose of this study was to investigate the current root canal treatment procedures and the demand for continuing education among Thai dental practitioners.

Methods: The survey, consisting of two sections and a total of 25 questions, was randomly distributed to 412 dentists in Thailand, both online and offline. Data on demographics, information on current root canal treatment protocols, and demand for continuing education, were collected. The association between demographic data and current root canal treatment protocols was analyzed using the chi-square test. The data gathered were analyzed using the JASP statistical software version 0.18.

Results: Three hundred and ninety-four questionnaires were completed. Sixty percent of the respondents (236) regularly performed root canal treatment. Most respondents treated one to five anterior teeth weekly. Seventy-six percent of the respondents did not use magnification. Fifty-eight percent of the respondents used an electronic apex locator in conjunction with a radiograph to determine the working length. Forty-four percent of the respondents used hand files for mechanical instrumentation. Sodium hypochlorite was the most used irrigant, while cold lateral compaction was the preferred obturation technique. The participants revealed the most interest in enrolling in two to three-day short seminar courses.

Conclusion: More Thai dental practitioners strictly followed the standard protocol compared to the previous survey. The short seminar courses were the most preferred program for continuous education.

Keywords: Questionnaire, Root canal treatment, Survey, Thai dentist, Endodontics, Continuing education.

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1. INTRODUCTION

Dental innovations and technologies have advanced tremendously in the last couple of decades [1]. Improved medications and technology, as well as advancements in materials and clinical procedures, have increased the possibility of preserving teeth for a lifetime [2, 3]. Root canal treatment is intended to either prevent or treat periradicular periodontitis [4]. The efficacy of root canal cleaning and shaping directly influences the outcome of the treatment [5, 6]. The attainment of a successful

outcome necessitates the establishment of a standard of practice, while the integration of novel technologies may result in superior benefits [7]. Nevertheless, it is evident that both general practitioners and endodontists deviate from standard procedures for root canal treatment [8].

Numerous studies have been conducted on root canal treatment procedures among dental practitioners across the globe [9-13]. Most inquiries relate to topics, such as the tooth isolation technique, the procedure for determining the working length, the techniques and instruments used for root canal preparation and obturation, and the prescription of antibiotics or analgesics [14-19]. Additionally, the attitudes of dentists towards root canal therapy are often a subject of interest [20-22].

Root canal treatment involves difficult clinical procedures, which include enlarging a root canal without procedural errors (ledging, transportation, apical perforation), maintaining the proper working length, making an appropriate selection of preparation size, and effectively disinfecting with irrigation and adequate obturation. Every treatment step has an impact on the treatment outcome. When performing root canal treatment, aseptic working conditions are required. The absence of rubber dam isolation during root canal treatment is considered a violation of standard procedure. According to recent studies, endodontists and general practitioners rarely use rubber dams to isolate teeth during endodontic procedures [23]. Contemporary endodontics recommend using rotary and hand nickel-titanium instruments due to their super-elastic metal alloy properties, which result in less straightening and better-centered preparations. Many studies have shown that most dental practitioners (75%) still use conventional stainless-steel files to shape canals [24], and 78% of general dentists do not use NiTi rotary files in their practice [25]. The primary solution for the root canal's disinfection is NaOCl because it can dissolve organic materials, necrotic tissue, and biofilm in the root canal. However, the study shows that over 50% of dental practitioners still use normal saline solution as the main irrigant [8]. Gutta-percha is the most common filling material used in root canal treatment. Studies have indicated that a minority of practitioners utilize alternative root canal filling materials, including silver point or paste.

In Thailand, achieving a degree as a doctor of dental surgery requires completing a six-year curriculum of study [26]. The Thai Dental Council has established a minimum requirement of root canal treatment in two teeth as a prerequisite for dental degree graduation [24]. However, there is a lack of studies investigating the proportion of dentists who continue to perform root canal procedures post-graduation.

A previous study [10] indicated the Thai dentists to maintain their current knowledge and adapt their root canal procedures from what they have learned in dental school. However, the most recent survey on root canal treatment practices by Thai dentists was published in 2002. Given the significant advancements in root canal technology, it is crucial to assess current protocols employed by Thai dentists. Therefore, this study focused on two primary objectives: (1) evaluate the current procedures used for root canal treatments by Thai dentists, and (2) measure the demand for continuing education on this topic among this population. This research aimed to provide data that can inform the development of undergraduate dental curricula and continue education programs, ultimately improving the proficiency and knowledge of dentists performing root canal treatments.

2. MATERIALS AND METHODS

2.1. Study Design, Population, and Setting

This was a cross-sectional study conducted on endodontic treatment practices among Thai dentists. The population consisted of 15,951 Thai dentists currently holding an authorized dental license, as recorded by the Thai Dental Council in 2019.

2.2. Sample Size Calculation

The sample size was obtained by the Yamane sample size formula [n = N / {1 + N (e)^2}] [27]. For instance, the margin of error (e) was set at 0.05 and the population (N) was 15,951. The result of the sample size (n) calculation was 390 participants.

2.3. Study Instrument

The questionnaire was developed using the Thai language and divided into two sections. Part 1 included demographic information, such as gender, age, years in practice, level of education, and place of work. Part 2 covered contemporary approaches and methodologies used to perform root canal treatment and continuing education demands. To ensure validity and clarity, a pilot test was conducted by distributing the questionnaire to a sample of 10 general dentists and 3 endodontists. The responses were analyzed using Kappa statistics to identify any ambiguous or unclear questions. These were corrected before the final version was distributed for the main study.

2.4. Data Collection

This study has employed a voluntary sampling design for data collection. Two methods were utilized: (1) online questionnaires disseminated through social media platforms to reach a wider range of Thai dental practitioners, and (2) data directly collected from participants attending the annual academic conference organized by the Dental Association of Thailand. Data collection occurred from August 2020 to July 2021.

2.5. Statistical Analysis

The data were imported into and analyzed using the JASP statistical software (version 0.18; JASP Team, 2023). Descriptive analysis was used to evaluate the data, which comprised frequency distribution and percentages. The chi-square test was used to determine the relationship between years in practice and the root canal treatment procedure and continuing education demand. A significant level was set at 0.05.

2.6. Ethical Consideration

This study was approved by the local ethics review

board of the university. The respondents' contribution to this study was entirely voluntary. Participants were provided with complete details about the study through the participant information document. All individuals who volunteered to take part in the survey provided their signature on an informed consent document. The provided information consisted of the study's objectives, the protocol for data storage, and the contact details of the investigator available for participant inquiry. A ballpoint pen was offered as a token of appreciation for the individuals who filled out the form.

3. RESULTS

3.1. Characteristics of Participants in the Study

The participants' demographic information is presented in Table **1**. A total of 412 individuals provided responses to the survey. Eighteen questionnaires were discarded because they were incomplete, and the respondents did not work as dentists at the time. As a result, 394 questionnaires were included in the analysis.

Among the 394 dentists, 256 (65%) were female, whereas 138 (35%) were male. Dentists between the ages of 21 and 30 had the highest responses (40%), while dentists between 50 and 60 had the lowest proportion (8%). Most participants (61%) possessed a bachelor's degree. An approximately equal proportion of participants possessed certificates, master's degrees, and doctoral degrees (13%). The respondents' workplace was mainly a public hospital (52%), followed by a private clinic, university, and private hospital.

3.2. Routine Root Canal Treatment Practice by Thai Dental Practitioners

One hundred and six respondents (27%) no longer performed root canal treatment, while 52 respondents (13%) provided emergency treatment only. The remaining 236 respondents (60%) routinely performed endodontic treatment (Table **2**).

Table 1. Demographic details of study participants.

Demographic Variables	Number of Respondents (%)
Gender	-
Male	138 (35)
Female	256 (65)
Age	-
21-30 years old	159 (40)
31-40 years old	106 (27)
41-50 years old	60 (15)
51-60 years old	29 (8)
Above 60 years old	40 (10)
Years in practice	-
0-5 years	141 (36)
6-10 years	62 (16)
> 10 years	191 (48)
Level of education	-
Bachelor’s degree	240 (61)
Certificate	51 (13)
Master’s degree	53 (13)
Doctoral degree	50 (13)
Place of work	-
Public hospital	205 (52)
Private hospital	24 (6)
Private clinic	131 (33)
Dental school/university	34 (9)

Table 2. Routine root canal treatment by Thai dental practitioners.

Questions	Number of Respondents (%)
Do you still Perform Root Canal Treatment?	-
Always	236 (60)
Emergency only	52 (13)
Never	106 (27)
How many teeth do you perform root canal treatment on average per week?	-
1-5 teeth	186 (79)
6-10 teeth	18 (12)

(Table 2) contd.....

Questions	Number of Respondents (%)
11-15 teeth	9 (4)
16-20 teeth	5 (2)
Above 20 teeth	8 (3)
Which type of tooth do you perform the root canal treatment on? †	-
Anterior	233 (99)
Premolar	209 (89)
Molar	135 (57)
Do you take pre-operative radiograph?	-
Always	215 (91)
Sometimes	21 (9)
Never	0
Which type of magnification device do you use during root canal treatment?	-
No	179 (76)
Dental loupes	41 (17)
Dental operating microscope	16 (7)
Which isolation method do you use?	-
Rubber dam	207 (88)
Cotton roll	25 (10)
Saliva ejection	2 (1)
None	2 (1)
Which method do you use for working length determination?	-
Tactile	5 (2)
Radiograph alone	79 (34)
Electronic apex locator alone	15 (6)
Electronic apex locator with radiograph	137 (58)
What is the primary instrument that you use for mechanical instrumentation?	-
Stainless steel hand file	104 (44)
Nickel-titanium hand file	42 (18)
Nickel-titanium rotary file (continuous rotation)	50 (21)
Nickel-titanium rotary file (reciprocal rotation)	40 (17)
Which type of irrigation do you use? †	-
Distilled water	10 (4)
Normal saline solution	82 (35)
Sodium hypochlorite solution (NaOCl)	224 (95)
Ethylene Diamine Tetra Acetate (EDTA)	137 (58)
Chlorhexidine solution	56 (24)
Hydrogen peroxide	10 (4)
What is the primary intracanal medicament you use (in the case of multi-visit)?	-
None	1 (0)
Calcium hydroxide (fresh mix)	150 (64)
Premixed calcium hydroxide	72 (31)
Formocresol	8 (3)
Others	5 (2)
What is the primary obturation technique that you use?	-
Silver point	1 (0)
Single cone technique	28 (12)
Cold lateral compaction technique	168 (71)
Warm vertical technique	29 (12)
Others	10 (4)
What is the primary type of root canal sealer you use?	-
None	3 (1)
Zinc oxide eugenol-based sealer	154 (65)
Resin-based sealer	43 (18)
Calcium hydroxide-based sealer	15 (6)
Calcium silicate-based sealer/bioceramic-based sealer	17 (7)
Others	4 (2)

(Table 2) contd.....

Questions	Number of Respondents (%)
In which situation do you prescribe antibiotics? †	-
Pain	67 (28)
Percussion	17 (7)
Sinus tract opening	88 (37)
Swelling	195 (83)
Which step often causes an error in your root canal treatment? †	-
Diagnosis	14 (6)
Access cavity preparation	72 (31)
Working length determination	99 (42)
Mechanical instrumentation	89 (89)
Irrigation	5 (2)
Medication	3 (1)
Obturation	83 (35)
Which step is the most time-consuming in your root canal treatment?	-
Access cavity preparation	42 (18)
Working length determination	45 (19)
Mechanical instrumentation	96 (41)
Irrigation	3 (1)
Medication	1 (0)
Obturation	49 (21)

Note: †The question allowed multiple responses.

Most dental practitioners typically performed root canal treatment on an average of 1 to 5 teeth weekly (79%). The majority of respondents (99%) reported treating anterior teeth most frequently, followed by premolars (89%) and molars (57%).

About 91% of the participants took preoperative radiographs. Only 76% used magnification devices during the treatment. About 88% of the respondents reported using rubber dams, while 58% used an electronic apex locator and a radiograph to determine working length. Among the participants, 44% of dentists mainly used stainless steel hand files for mechanical instrumentation. Sodium hypochlorite was the most used irrigant (95%), and cold lateral compaction was the preferred obturation technique (71%). Zinc oxide eugenol-based sealers were used by 65% of the respondents.

3.3. Continuing Education Demands and Attitudes toward Root Canal Treatment

Most respondents (52%) desired to improve their obturation technique, followed by mechanical instrumentation (45%) and working length determination (35%) (Table **3**). About 72% of the respondents reported having insufficient experience during their undergraduate studies. Most participants (57%) primarily updated their knowledge by attending an academic conference, while a smaller percentage relied on surfing the internet (20%) or reading research articles (14%). Most respondents (48%) preferred improving and developing their knowledge by participating in a two-to-three-day seminar or conference, while 27% preferred spending three to four months on endodontic courses. Among the respondents, 52% of them had neutral attitude, 32% were satisfied, and 16% were dissatisfied with root canal treatment.

Table 3. Continuing education and attitude toward root canal treatment.

Questions	Number of Respondents (%)
Which Phase of Treatment are you Intending to Develop? †	-
Diagnosis	27 (11)
Access cavity preparation	57 (24)
Working length determination	83 (35)
Mechanical instrumentation	106 (45)
Irrigation	17 (7)
Medication	21 (9)
Obturation	122 (52)
Do you have enough experience in root canal treatment from your undergraduate studies?	-
Yes	67 (28)
No	169 (72)
What is the primary resource you use for continuing your education?	-
Internet	47 (20)
Academic conference	134 (57)

(Table 3) contd.....

Questions	Number of Respondents (%)
Research article	34 (14)
None	21 (9)
Which type of continuing education course do you expect to enroll in?	-
Short seminar (2-3 days)	114 (48)
Short course (3-4 months)	64 (27)
Certificate (1 years)	28 (12)
Post-graduate education (2 years)	10 (4)
Diploma (3 years)	20 (8)
What is your level of satisfaction with your root canal treatment practice?	-
Very dissatisfied	7 (3)
Dissatisfied	30 (13)
Neither dissatisfied nor satisfied	123 (52)
Satisfied	59 (25)
Very satisfied	17 (7)

Note: †The question allowed multiple responses.

Table 4. Years in practice and comparison of root canal treatment procedures (*P*<0.05).

Procedure	Years in Practice			*P*-value
	0-5	6-10	>10	
Use of rubber dam	-	-	-	-
Yes No	88 3	37 7	82 19	0.003*
Treating molars	-	-	-	-
Yes No	41 50	27 17	67 34	0.010*
Use of magnification	-	-	-	-
Yes No	15 76	16 28	19 82	0.022*
Use of electronic apex locator	-	-	-	-
Yes No	66 25	29 15	57 44	0.065
Use of NiTi rotary files	-	-	-	-
Yes No	29 62	24 20	37 64	0.036*
Use of calcium silicate-based sealer	-	-	-	-
Yes No	5 86	4 40	8 93	0.701

Note: *statistical significance.

3.4. Relationship between Years in Practice and Root Canal Treatment Procedure

A chi-square test of independence was conducted between years in practice and root canal treatment procedure (Table **4**). There was a statistically significant association found between years in practice and using rubber dam (P = 0.003), treating molars (P = 0.010), using magnification (P = 0.022), and using NiTi rotary files (P = 0.036). There was no statistically significant association found between years in practice and using an EAL (P = 0.065) or a calcium silicate-based sealer (P = 0.701).

3.5. Relationship between Years in Practice and Continuing Education Demands

The chi-square test also revealed significant associations between years in practice and the source of continuing education (P < 0.001), preferred course type (P < 0.001), and level of satisfaction (P = 0.008) (Table **5**). Respondents who had 0–5 and 6–10 years of practice experience were likely to update their knowledge through the internet and academic conferences. Those with 6–10 years of experience were likely to enroll in a 3-year program more than other groups, who stated short-duration programs of 2-3 days or 3–4 months. Respondents with 0–5 years of experience had a higher level of dissatisfaction than those with 6–10 and >10 years of experience.

4. DISCUSSION

A total of 412 questionnaires were collected through both online and offline methods. However, 18 questionnaires were excluded from the analysis due to incomplete

Table 5. Years in practice and comparison of continuing education and level of satisfaction (*P*<0.05).

Demand for Continuing Education	Years in Practice			*P*-value
	0-5	6-10	>10	
Source of continuing education	-	-	-	-
Internet	30	10	7	<0.001*
Academic conference	37	26	71	
Research articles	10	6	18	
None	14	2	5	
Preferred course type	-	-	-	-
Short seminar (2-3 days)	24	14	76	<0.001*
Short course (3-4 months)	37	14	13	
Certificate (1 year)	20	3	5	
Post-graduate (2 years)	5	2	3	
Diploma (3 years)	5	11	4	
Level of satisfaction	-	-	-	-
Very dissatisfied	5	2	0	0.008*
Dissatisfied	15	5	10	
Neutral	50	20	53	
Satisfied	17	9	33	
Very satisfied	4	8	5	

Note: *statistical significance.

answers, resulting in a final sample size of 394 complete questionnaires. The sample size for this study was determined to be 390 respondents. A sampling technique was employed with a predetermined allowable error rate of 5%. Therefore, the total number of respondents exceeded 390, representing Thai dental practitioners. This diverse sample size has offered valuable insights into the prevailing trends in root canal treatment among dental practitioners in Thailand. The study observed a notably low online response rate of 25%. This finding has been found to be consistent with prior research conducted in Turkey, which reported a response rate of 31.3% [23]. The potential cause of the diminished response rate may be attributed to an excessive number of questions and their extended length. In a recent study, it has been suggested that the response rate may be negatively affected by the length of the questions [28]. Our study showed 35% of male and 65% of female respondents, accounting for a 1:1.5 male-to-female ratio of Thai dental practitioners.

The use of rubber dams is required to prevent contamination, shield soft tissue from instruments and irritation, increase the visibility of operating fields, and reduce dental aerosols. In this study, 88% of Thai dental practitioners always used rubber dams during endodontic treatment, which is considerably higher than in previous studies, where over 70% of dentists did not report using rubber dams [9, 23, 29]. Similarly, in the studies conducted in Saudi Arabia and Nigeria, 90% of the participants have reported using cotton rolls [30, 31]. In agreement with the results of the Western Norwegian study, which found that recently graduated dentists tended to adhere firmly to the principles taught regarding rubber dam use, Thai dentists used rubber dams more frequently than in the previous survey [32, 33]. Even though most Thai dental practitioners have reported using rubber dams during endodontic treatment, some dental practitioners did not report its use, which may be due to a lack of experience or patient acceptability issues.

This study found that 91% of respondents always obtained preoperative radiographs, whereas only 60–65% performed according to the Thai study conducted in 2002 and the Turkish study conducted in 2015 [23, 32]. Evidently, the number of Thai dentists taking preoperative radiographs has increased in recent years. However, 34% of respondents in this study used preoperative radiographs alone to determine working length. Because radiographs only show the root canal in two dimensions that overlap with anatomical structures, they cannot provide the correct working length [34]. Therefore, the combination of EAL and radiograph is the most accurate method to determine the working length.

Thai dental practitioners have emphasized a greater number of visits to complete root canal treatment due to their predominant use of hand files (62%), instead of NiTi rotary files (38%), for mechanical instrumentation. Since their introduction in 1988, NiTi rotary files have contributed to more favorable endodontic treatment outcomes, particularly in the case of curved roots, as evidenced by their flexibility. In addition, NiTi has the potential to reduce complications and is practical [35].

This study has revealed around 4% of dental practitioners to continue using hydrogen peroxide. This finding is consistent with a previous Thai study conducted in 2002 [32], which reported that more than 80% of dental practitioners at that time used a combination of sodium hypochlorite (NaOCl) and hydrogen peroxide, a practice they had been instructed in undergraduate school. This suggests that some Thai dentists still use the outdated irrigant for root canal treatment, even though hydrogen peroxide is no longer commonly used.

Presently, endodontic treatment, including the development of new instruments and materials, has advanced significantly. The studies conducted in 2001 and 2006 have indicated resin-based sealers to be the gold standard for root canal sealers. This is because of their

superior bond to the structure of the tooth over the long term, which produces an excellent apical seal. In this study, however, the utilization of ZOE for root canal sealers was more prevalent among dental practitioners (65%) than resin-based sealers (18%). This also relates to a prior investigation in which 61–70% of participants reported using ZOE [30, 36]. Most dentists reported to continue using the ZOE sealer since it was first used during their undergraduate years and is readily available and affordable.

There are many obturation techniques employed in the field of endodontic treatment. Several of these techniques have shown comparable success rates. A clinician may choose from a variety of techniques and approaches that work best. Based on the findings of the present study, it has been observed that 71% of dentists performed the cold lateral compaction technique for the obturation of root canals. This outcome aligns with the conclusions gathered from a previous study conducted in Belgium [37]. The other techniques that were chosen by respondents were the warm vertical technique and the single cone technique, respectively. The cold lateral compaction technique was the most common technique because most Thai dental schools taught it mainly in undergraduate education. However, the cold lateral compaction technique may not be appropriate for some teeth in which apical complexity is present. Recently, calcium silicate-based sealers have been introduced to endodontic fields, which play an essential role in root canal obturation due to their hydrophilicity and slight expansion after setting. This can be used with a single cone obturation technique, which is more convenient and effective [38]. However, this sealer has not been widely used by Thai dentists.

A previous study showed the most common procedural errors during endodontic treatment by Thai dental practitioners to be locating canal orifices and pain control during visits, which is different from the present study, where the most common procedural errors were working length determination, mechanical instrumentation, and root canal obturation [32]. These changes may result from enhanced visibility with dental loupes, dental operating microscopes, and Cone Beam Computed Tomography (CBCT), which can identify missed canals.

An association was discovered between years of practice and rubber dam isolation. As the number of years in practice increased, the percentage of dentists using rubber dams decreased accordingly. This result has been found consistent with previous studies that have shown general practitioners with years of experience ranging from one to ten years to use rubber dams significantly more than other groups [12]. In contrast, the treatment of molars increased in conjunction with years of experience, a pattern that can be attributed to the rising use of NiTi rotary files and magnification. This could be because root canal treatment of the molars is challenging due to the complexity of root canal morphology, their position within the mouth that is difficult to access, and the practice being time-consuming. Therefore, groups with more clinical experience had a higher proportion of molar treatments. In addition, the age of practitioners increases with years of practice, causing natural vision to begin to deteriorate, which becomes evident at age 40 [39]. Therefore, the use of magnification increases with more years of practice.

Dental practitioners in Thailand have been found to be interested in continuing their studies on a short-term basis. About 75% of the respondents were interested in applying to study courses with a study period of 2-3 days to 3-4 months, while courses with a study period of more than 1 year were interesting to less than 10%. This could potentially be attributed to the rise of social media and the internet, which render knowledge sources more readily available and conducive to learning from any location and at any time. Thus, it can be stated that institutions of higher education would have to adapt their continuing education programs to accommodate contemporary demands.

CONCLUSION

A greater proportion of Thai dentists adhered rigorously to standard root canal treatment protocols. A marginal shift has been observed in the prevalence of root canal treatment among dental practitioners in Thailand, as some respondents have reported to continue using materials or techniques that were previously taught in dental institutions, even though some materials are no longer in use. With respect to the demand for continuing education, most respondents indicated that they desire to gain knowledge through participation in short seminars of a few days and training courses of a few months. There were also fewer individuals interested in obtaining postgraduate degrees.

AUTHORS' CONTRIBUTION

All authors have accepted responsibility for the manuscript's content and consented to its submission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

ABBREVIATION

CBCT = Cone Beam Computed Tomography

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the ethics committee of the Rangsit University (RSUERB 2020-016).

HUMAN AND ANIMAL RIGHTS

All research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2008.

CONSENT FOR PUBLICATION

Informed consent was obtained from all subjects involved in the study.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article is available in the Zenodo Repository at https://zenodo.org/records/12205598, reference number 12205598.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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