Autoclave monitoring and packaging in Bangkok dental offices, Thailand

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Objectives: To examine the regular practice of autoclave monitoring and autoclave dental packaging in Bangkok dental offices, Thailand.

Materials and Method: A preliminary questionnaire interview was performed in 52 private clinics in 2006 and a postal questionnaire was sent out to 629 hospital and private clinics in 2013. Questions included practices on 3 modes of sterilization monitoring: mechanical, chemical, and biological, as well as the types of packaging used.

Results: The response rate of the 2013 survey was 18% (n=113). We found improved formal education in infection control but understanding in the significance of autoclave performance monitoring was still low. Mechanical monitoring was performed the most (90.2%) compared with other types of monitoring. External and internal chemical monitoring were applied in 75% and 33% of all clinics, respectively. Biological monitoring was done in 17.9% of clinics surveyed. Only 2% performed all types of monitoring. The disposable paper/plastic pouch was the main packaging material (92.9%) for autoclave, among these 78.1% reused the pouch. Each paper/plastic pouch was reused most frequently 3 times before disposal. Hospital clinics performed better monitoring in all aspects and reused the pouch less than in private clinics.

Conclusion: Sterilization monitoring of an autoclave machine was inadequate among Bangkok dental offices and knowledge could be the contributing factor to poor practices as formal education was low. Reuse of a paper/plastic pouch was a routine practice but its impact was unknown. There is a need of better education on infection control and further study on the validity of pouch reuse.

Keywords: autoclave, infection control, monitoring, paper/plastic pouch, reuse, sterilization

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Introduction

In general dental practices, sterilization of dental instruments is an essential process to prevent cross-infection between patients [1]. The most common sterilization method utilized in dental clinics is steam sterilization with an autoclave where the heated vapor touches the surfaces of the instruments under specified time, temperature, and pressure to achieve sterility [2-6]. To ensure the effectiveness of sterilization process,

a combination of 3 modes of monitoring need to be regularly applied [7]. Mechanical monitoring involves direct observation of the machine functioning, e.g. the gauges reaching appropriate temperature and pressure [8]. Chemical monitoring involves chemical tapes, strips, or labels that change color when exposed to high temperature [8]. There are 2 types of chemical indicators: internal and external indicators. Both should be applied together because they have different advantages and disadvantages. An internal indicator helps

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ensure that the sterilizing vapor reaches the instruments inside the package; however, it may not be clearly visible once inside the package. An external indicator, such as autoclave tape, allows easy inspection right after sterilization process and helps distinguish between processed and unprocessed packages. Mechanical and chemical monitorings do not absolutely guarantee sterilization, they only help detect procedural errors and equipment malfunctions [8,9]. A third mode of monitoring using biological indicator is also required to determine sterilization achievement because it directly detects the killing of a microorganism. A biological indicator or commonly referred to as a spore test involves placing the spores of *Geobacillus stearothermophilus,* a highly

Figure 1. Representatives of autoclave dental packaging and chemical indicators. A) A dental instrument in paper/plastic pouch with an internal chemical indicator inside (*) and an arrow pointing the color change of the external chemical label on the pouch. B) An example of internal chemical indicator showing the color change if sterilization is achieved. C) A representative cloth packaging with external chemical indicator (autoclave tape) color change.

resistant microorganism, inside the autoclave. After the usual sterilization cycle, the biological indicator is retrieved for culture to detect the growth if the spore is still alive. A spore test should be determined weekly, while mechanical and chemical monitoring should be performed in every sterilization cycle [7,8].

One important aspect in sterilization process is the packaging of dental instruments. Packaging helps maintain sterility of the instruments in storage before use. An ideal package should be permeable to the vapor during sterilization but impermeable to microorganism after sterilization and in storage [10]. A paper/plastic peel pouch is the most commonly used package for autoclave machine due to its convenience of use and visibility (Fig. 1). It comprises of paper part which is permeable to vapor and the laminated transparent plastic part which is impermeable and provide strength to the package. Sealing of the pouch can be done with heat and single-use of the pouch is recommended. Cloth can also be used to package the instruments. It has the advantage in reusability and the disadvantage in invisibility of the instruments inside [10,11]

A number of studies have surveyed the sterilization practice in dental clinics in many countries [2-5]; however, to our knowledge, a survey in Thailand has not been carried out before. The aim of this study is to survey the regular practice of an autoclave use to achieve sterilization focusing on monitoring and dental packaging in Bangkok dental offices.

Materials and Method

We performed two cross-sectional descriptive surveys using questionnaire interviewing as a preliminary study in 2006 and a postal questionnaire in 2013. The study was conducted in full accordance with the World Medical Association Declaration of Helsinki [12]. The postal survey protocol was approved by Institutional Review Board of Mahidol University and was granted an exemption (COE No. MU-DT/PY-IRB 2012/16.2408). The questionnaire was anonymous. No participant's identity or confidential information was disclosed or requested. The participants freely chose to take part or stop to take part in the survey.

The 2006 study. In this preliminary study, we chose 67 private dental clinics in different districts of Bangkok that used an autoclave to sterilize the instruments and were willing to participate in the study. Exclusion criteria were clinics that did not use autoclave or were not willing to participate. The interview was in accordance to the 41-item fixed-answer questionnaire without advanced appointment with the clinic. Fifteen dental clinics declined participation due to current engagement in the dental work process.

The 2013 study. The list of all 1,410 dental offices in Bangkok was obtained from the national registry of dental practices, Bureau of Sanatorium and Art of Healing, Department of Health Service Support, Ministry of Public health, Thailand. Proportional stratified and cluster random samplings were performed to include hospital and private clinics in different areas of Bangkok. Sample

size was calculated to be 302 using Krejcie and Morgan's formula [13]. We sent out the questionnaires in the postal mail to 320 clinics. Due to low response rate, we sent out the questionnaires to another 309 clinics. The 41-item fixed-answer questionnaires contained demographic inquiries of the office and the responder and questions concerning sterilization practice and autoclave packaging. Inclusion criteria were clinics that packaged instruments for steam sterilization and the responder was willing to give information anonymously and returned the mail. Exclusion criteria included clinics that the responder was not willing to participate or not return the mail. All participants were assured that their responses were confidential and that the results would be published.

Results

The 2006 study.

Fifty-two private dental clinics participated in the study. Fifty-one clinics had 1-2 dentists treating up to 20 patients per day. Only one clinic had 6-10 dentists caring for 21-30 patients per day. All interviewees were dental assistants with minimum secondary education. None received formal education on infection control and all learned about sterilization method from the dentist or another dental assistant in the clinic.

Sterilization monitoring. All clinics surveyed used an autoclave to sterilize the instruments. From 52 clinics participated, one did not perform any kind of monitoring, one performed only mechanical monitoring, and the rest performed

chemical with or without mechanical monitoring. None of the clinics surveyed performed biological monitoring with the spore test. Autoclave tape was applied on every instrument packaging in 49 clinics, one clinic applied the tape on some of the packages, one did not have autoclave tape in the clinic and one did not package the instruments. Regarding the knowledge of the indicator color change, 90% of the dental assistants that applied autoclave tape thought that the color change on the tape equaled sterilization achievement.

Autoclave packaging. Except for one clinic that did not wrap the instruments, all used paper/plastic pouch for autoclave packaging. Most clinics (n=47) also used cloth as packaging material. All clinics reused the paper/plastic pouch. Each paper/plastic pouch was most often reused 3 times before disposal and the autoclave tape would be reapplied every time (n=50) except for 1 clinic that did not reapply the tape. The maximum time of reuse was 6 times (in 2 clinics).

The 2013 study.

From 629 questionnaires being sent out, 113 were mailed back (18% response rate); of these, 15 were hospital clinics and 98 were private clinics. Eight hospitals received Hospital Accreditation (HA). Most responders were dentists (54.9%) and dental assistants (39.8%). Among these, 44% received formal education about infection control and 42% received the training from medical or dental personnel in the workplace.

Sterilization monitoring. There was one missing data regarding this information. All responders (n=112) applied at least one type of monitoring: 22 (19.6%) applied only mechanical

indicator, 6 applied only external chemical indicator, 1 applied only internal chemical indicator, no clinic applied only biological indicator, and 83 (74.1%) performed more than one type of monitoring. However, there were only 12 clinics (10.7%) that applied all 4 types of indicators; 10 were hospital clinics.

Mechanical monitoring was performed in 101 clinics (90.2%). External chemical monitoring (using autoclave tape or observing the label outside the paper/plastic pouch package) was performed in 84 clinics (75%). Internal chemical monitoring (placing the internal indicator strip inside the pouch) was performed in 37 clinics (33%). Biological monitoring (spore test) was performed in 20 clinics (17.9%).

Fig. 2 summarizes and compares the types of monitoring performed in hospital and private clinics. Most hospital clinics performed all types of monitoring while private clinics performed mechanical monitoring the most and only 8.2% of

private clinics performed biological monitoring.

Of all the clinics that used the external chemical indicator (n=84), the indicator was applied to every instrument packaging in hospital clinics while the number in private clinic was only 57.1% (Table 1). In clinics that used the internal chemical indicator (n=37), the number of hospital clinics that applied or did not apply the indicator was equal, while most of the private clinics (65.4%) applied the indicator to only some of the packaging (Table 1). For biological monitoring (n=20), 2 clinics performed the spore test daily, 10 clinics performed weekly, 6 performed monthly, and 2 was unknown.

Regarding the knowledge of the indicator color change, only 19.5% of the clinics that used autoclave tape answered correctly, i.e. color change of the tape means that the package has been through autoclave process but does not equal sterilization of the instrument.

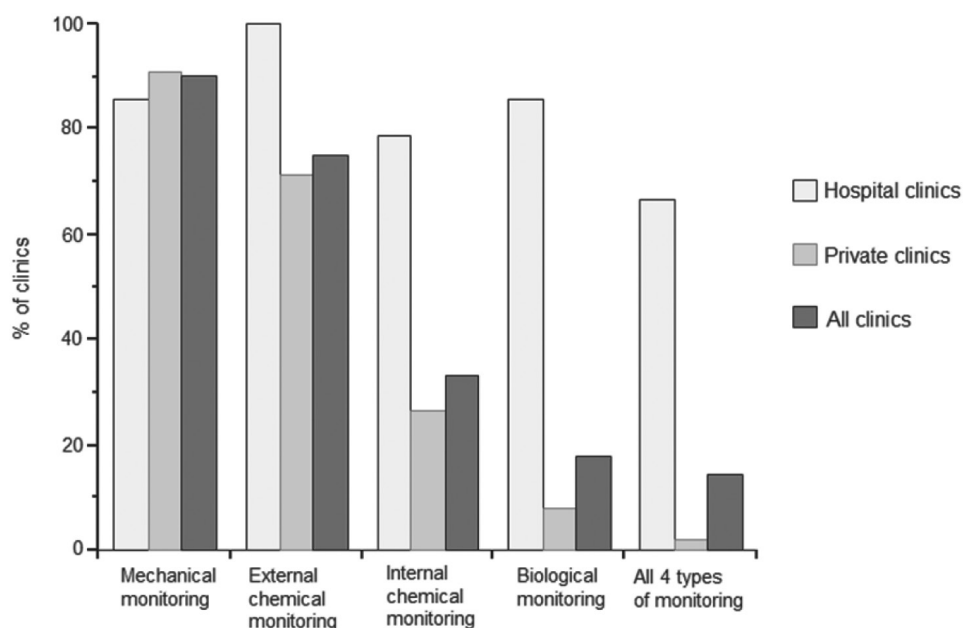*Autoclave packaging*. Most clinics (61.1%)

Figure 2. Percentages of clinics performing each type of sterilization monitoring

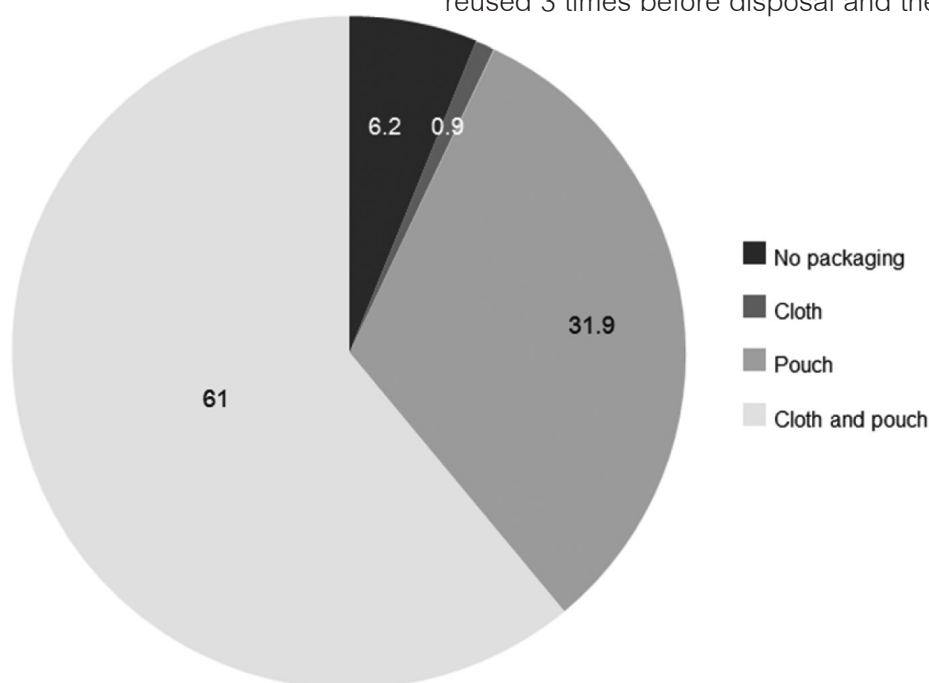Table 1. Percentages of clinics that used external and internal chemical indicators

	Hospital clinics	Private clinics	All clinics
External chemical indicator (n=84)			
Applied to all packages	100	57.1	64.3
Applied to some packages	0	34.2	28.6
Not answered	0	8.5	7.1
Internal chemical indicator (n=37)			
Applied to all packages	45.5	23.1	29.7
Applied to some packages	45.5	65.4	59.5
Not answered	9.1	11.5	10.8

Table 2. Percentages of paper/plastic pouch reuse

n=105	Hospital clinics	Private clinics	All clinics
Single-use	66.7	14.4	21.9
Reuse	33.3	85.6	78.1

used both cloth and paper/plastic pouch to package the instruments. There were 7 dental offices that did not package the instruments for sterilization at all, all of these were private clinics. One clinic used only cloth and 36 clinics used only paper/plastic pouch for autoclave packaging (Fig. 3).

From 105 clinics that used paper/plastic pouch as packaging material, 82 clinics reused the pouch (78.1%). Most private clinics (85.6%) reused the pouch while most hospitals (66.7%) disposed the pouch after single use as shown in Table 2. Each paper/plastic pouch was most often reused 3 times before disposal and the autoclave

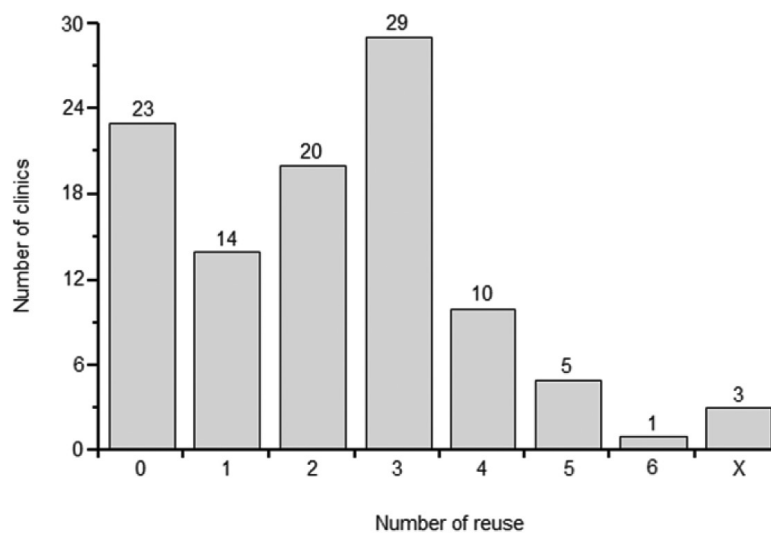Figure 3. Percentages of packaging material used

Figure 4. Times reuse of each pouch. X; not answered.

tape would be reapplied every time in 50% of the clinics that reused the pouch (Fig. 4). The maximum time of reuse was 6 times (1 clinic).

Discussion

This is the first study examining sterilization practice with an autoclave focusing on sterilization monitoring and packaging in dental clinics in Thailand. Our study involved two surveys done seven years apart in 2006 and 2013 using a questionnaire interview or a postal questionnaire, respectively. We found low levels of monitoring in both surveys. Also, the rates of the disposable paper/plastic pouch reuse were high. This study should prompt more education or monitoring regarding sterilization practice of dental clinics in Thailand.

The response rate in our 2013 survey which used postal questionnaire was only 18% while the response rate in a preliminary 2006 questionnaire interview was 77.6%. When compared with other postal questionnaire surveys on sterilization practices in other countries done between 1995

and 2012, the response rates varied from 40 to 100% [3,6,14-21]. Our low response rate was unexpected. We had to double the sample size in order to get more participants. Despite low response rate, the responses in a 2013 survey were in accordance with those of a 2006 preliminary survey suggesting actual sterilization trend in Bangkok dental clinics. It is possible that clinics with low monitoring might not want to participate in the survey. Other reasons that might contribute to low response rate included not having time to participate, and not understanding the questions. Another approach such as interviewing might be better to really gain the information.

No responders received formal education regarding infection control in a preliminary survey while 44% did in a 2013 survey. This could be due to the fact that all responders in a preliminary survey were dental assistants while in a 2013 survey most were dentists. Nevertheless, the numbers in our study were much less than those in surveys from Ireland and UK which found more than seventy percent of dental assistants receiving formal infection control education [15,22]. Since

the person performing the sterilization procedure in a clinic is most likely a dental assistant, poor knowledge on infection control might affect the sterilization practice. It could be performed without clear understanding of the significance of each type of monitoring.

The United States Centers for Disease Control and Prevention (CDC) recommended application of mechanical, chemical, and biological indicators for sterilization monitoring. Mechanical and chemical monitoring should be performed in every cycle of sterilization while biological monitoring should be performed at least weekly [7]. Our survey in 2006 found none of the 52 clinics performed all 3 modes of monitoring. There was even a clinic that did not perform any kinds of monitoring at all. Moreover, mechanical monitoring was performed in only about 50% of the clinics even though it does not require extra equipment. The levels of each type of monitoring all improved in a 2013 survey. About 10% of the clinics performed all types of monitoring and most performed more than one mode of monitoring. Still, most clinics did not perform adequate monitoring.

Less than twenty percent of the clinics surveyed in 2013 applied a biological indicator, among these, 30% performed the spore test every month which was less frequent than the weekly recommendation by the CDC. However, these numbers increased from a finding of zero biological monitoring in all clinics in a 2006 survey. Indeed, a recent review indicated that sterilization monitoring was deficient globally [2]. A survey in Scotland found only 39% and 1% of general dental practitioners to employ chemical and biological monitoring, respectively [23] Only 9.8% of dental

clinics in Italy performed both chemical and biological monitoring regularly [24].

It is possible that the significance of doing all modes of monitoring was not realized by most clinics due to inadequate education on infection control as could be exemplified from the misunderstanding in the interpretation of the external indicator color change in more than 80% of the clinics in both surveys. Also, increased cost accompanying some types of monitoring might cause the insufficient monitoring in the majority of the clinics, as found in a previous survey in Romania that cost was an important factor for infection control practice [25].

Regarding autoclave dental packaging, more clinics in a 2013 survey used paper/plastic pouches than cloth compared to the survey in 2006. A paper/plastic pouch is recommended for single use; however, reuse of a pouch is a common practice in Thailand. To our knowledge, there was no study in other countries examining whether the pouch is reused or not. Most private clinics as well as one-third of hospital clinics reused the pouches for many times before disposal. Of note was that the external chemical indicator was also reapplied only in half of the clinics that reused the pouches.

As expected, hospital clinics performed better monitoring than private clinics in all aspects. Hospital clinics with HA showed appropriate monitoring according to the guideline recommendations. Reuse of a paper/plastic pouch was also less in hospital clinics compared with private clinics.

The effectiveness of a sterilizer performance was not explored in our surveys. Previous studies in many countries have found the failure rates of

autoclave performance as monitored with a biological indicator to vary from 0 to 57.9% in studies done between 1976 and 2004 [4,14,15,26-28]. These results pointed toward the importance of regular maintenance of the machine as well as of monitoring autoclave performance to ensure proper functioning. Knowing the sterilization failure rate of an autoclave in dental clinics in Thailand would be of great importance and should be examined in future studies.

In summary, our study indicated inadequate monitoring of an autoclave performance in Bangkok dental offices. Most clinics performed the monitoring without clear understanding of the methods used. Reuse of a paper/plastic pouch was a regular practice which should actually prompt more rigorous monitoring. The impact of such a reuse was not known. Our findings suggested improved education on infection control especially in dental assistants as well as other possible measures to increase proper sterilization practice of dental offices in Thailand. The limitations of this study included the low response rate and the possibility of misunderstanding of a questionnaire. Also, we surveyed only clinics in Bangkok, a capital city of Thailand. The situations in rural clinics could be different. Future studies should explore the effectiveness of sterilization performance and factors affecting sterilization practice in dental clinics across the country.

Acknowledgement

References

1. Neiburger EJ. Cross-contamination with dental equipment. *Lancet* 1993; 341: 181.
2. Oosthuysen J, Potgieter E, Fossey A. Compliance with infection prevention and control in oral health-care facilities: a global perspective. *Int Dent J* 2014; 64: 297-311.
3. AlNegrish A, Al Momani AS, Al Sharafat F. Compliance of Jordanian dentists with infection control strategies. *Int Dent J* 2008; 58: 231-236.
4. Acosta-Gio AE, Mata-Portuguez VH, Herrero-Farias A, Sanchez Perez L. Biologic monitoring of dental office sterilizers in Mexico. *Am J Infect Control* 2002; 30: 153-157.
5. van Doornmalen JP, Dankert J. A validation survey of 197 hospital steam sterilizers in The Netherlands in 2001 and 2002. *J Hosp Infect* 2005; 59: 126-130.
6. Kearns HP, Burke FJ, Cheung SW. Cross-infection control in dental practice in the Republic of Ireland. *Int Dent J* 2001; 51: 17-22.
7. Kohn WG, Collins AS, Cleveland JL, Harte JA, Eklund KJ, Malvitz DM, Centers for Disease C, Prevention. Guidelines for infection control in dental health-care settings--2003. *MMWR Recomm Rep* 2003; 52: 1-61.
8. Spry C. Understanding current steam sterilization recommendations and guidelines. *AORN J* 2008; 88: 537-550; quiz 551-534.
9. Centers for Disease C. Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008. 2008; https://www.cdc.gov/hicpac/pdf/guidelines/Disinfection_Nov_2008.pdf. Accessed 10 October 2016.

10. Association of periOperative Registered Nurses. Recommended practices for selection and use of packaging systems for sterilization. *AORN J* 2007; 85: 801-812.

11. Reichert M, Young JH. Sterilization Technology for the Health Care Facility. 2 ed: Jones & Bartlett Learning; 1997.

12. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* 2013; 310: 2191-2194.

13. Krejcie RV, Morgan DW. Determining Sample Size for Research Activities. *Educ Psychol Meas* 1970; 30: 607-610.

14. Coulter WA, Chew-Graham CA, Cheung SW, Burke FJ. Autoclave performance and operator knowledge of autoclave use in primary care: a survey of UK practices. *J Hosp Infect* 2001; 48: 180-185.

15. Healy CM, Kearns HP, Coulter WA, Stevenson M, Burke FJ. Autoclave use in dental practice in the Republic of Ireland. *Int Dent J* 2004; 54: 182-186.

16. Wood PJ. Infection control practices of Rhode Island dental hygienists and certified dental assistants. *J Dent Hyg* 1995; 69: 212-222.

17. King TB, Muzzin KB. A national survey of dental hygienists' infection control attitudes and practices. *J Dent Hyg* 2005; 79: 8.

18. Su J, Deng XH, Sun Z. A 10-year survey of compliance with recommended procedures for infection control by dentists in Beijing. *Int Dent J* 2012; 62: 148-153.

19. McCarthy GM, Koval JJ, John MA, MacDonald JK. Infection control practices across Canada: do dentists follow the recommendations? *J Can Dent Assoc* 1999; 65: 506-511.

20. Matsuda JK, Grinbaum RS, Davidowicz H. The assessment of infection control in dental practices in the municipality of Sao Paulo. *Braz J Infect Dis* 2011; 15: 45-51.

21. Elkarim IA, Abdulla ZA, Yahia NA, Al Qudah A, Ibrahim YE. Basic infection control procedures in dental practice in Khartoum-Sudan. *Int Dent J* 2004; 54: 413-417.

22. Burke FJ, Coulter WA, Cheung SW, Palenik CJ. Autoclave performance and practitioner knowledge of autoclave use: a survey of selected UK practices. *Quintessence Int* 1998; 29: 231-238.

23. Smith AJ, Bagg J, Hurrell D, McHugh S. Sterilization of re-usable instruments in general dental practice. *Br Dent J* 2007; 203: E16.

24. Monarca S, Grottolo M, Renzi D, Paganelli C, Sapelli P, Zerbini I, Nardi G. Evaluation of environmental bacterial contamination and procedures to control cross infection in a sample of Italian dental surgeries. *Occup Environ Med* 2000; 57: 721-726.

25. Bancescu AA, Ciufecu C, Skaug N, Palenik CJ. Infection control practices and compliance to national recommendations among dentists in Romania. *Int Dent J* 1999; 49: 260-268.

26. Skaug N, Lingaas E, Nielsen O, Palenik CJ. Biological monitoring of sterilizers and sterilization failures in Norwegian dental offices in 1985 and 1996. *Acta Odontol Scand* 1999; 57: 175-180.

27. Scheutz F, Reinholdt J. Outcome of sterilization by steam autoclaves in Danish dental offices. *Scand J Dent Res* 1988; 96: 167-170.

28. McErlane B, Rosebush WJ, Waterfield JD. Assessment of the effectiveness of dental sterilizers using biological monitors. *J Can Dent Assoc* 1992; 58: 481-483.