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Original Article

An audit of infection control practices amongst dental students in University of Malaya, Malaysia

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Abstract A study was done to assess and compare the levels of infection control practices amongst Year 3, 4 and 5 undergraduate dental students at the Faculty of Dentistry, University of Malaya, Malaysia. This study also compared the levels of infection control practices between the operators and the assistants performing a similar task. A checklist was designed based on the *Infection Control Guidelines* published by the Faculty of Dentistry. The audit checklist criteria were specific to the operators and assistants or common to both. 10 pairs of students (operators and assistants) were randomly selected from Polyclinics A, B and C, representing Year 3, 4 and 5 students respectively (n=60). The subjects were audited as soon as they entered the clinic, during treatment and up until they exited the polyclinic. The data collected were analysed using SPSS and Rasch model. Year 3 students performed better infection control practices (1.43 logit) followed by Year 5 (0.96 logit) and Year 4 (0.94 logit) students. The operators in Year 5 and the assistants in Year 3 and 4 were more compliant to infection control practices. 100% of students complied with removal of gown before leaving the clinic. However, only 1.7% of dental students wore protective goggles or face shield during treatment and disinfected prostheses before and after inserting into patient's mouth. Introduction and reinforcement of infection control practices should be incorporated at the beginning of each academic year for all students to allow for better practice and delivery of treatment to patients.

Keywords: Clinical audit, compliance, dental students, infection control.

Introduction

Continuous dental education programmes on infection control are designed to prevent disease transmission and to promote a safe working environment amongst health-care workers (Porteous *et al.*, 2014). According to the World Health Organization (WHO), infection prevention and control measures aim to ensure the protection for those who might be vulnerable to acquiring an infection, both in the general community and while receiving health care in a range of settings (Stewart-Jones *et al.*, 2009).

The last three decades have seen improving standards in the practice of clinical dentistry globally; shortly after the start of the HIV/AIDS epidemic in the early 1980s (Gordon *et al.*, 2001; Oosthuysen *et al.*, 2014). It is widely known that some of the other blood borne viruses to which an oral health-care worker (OHCW) is susceptible to are Hepatitis B, C and D. The use of personal protective equipment (PPE) such as gloves, masks and eye protection became almost an overnight changing trend in clinical practice for all OHCWs especially with reports of potential nosocomial infections within the dental settings (Gershon *et al.*, 1998).

Today, there is a better understanding of the importance of infection control towards eliminating the spreading of diseases, thus creating a greater awareness and adherence to infection control practices amongst OHCWs. The FDI World Dental Federation has recommended that all OHCWs must have an updated understanding and knowledge on the infection control practices as part of professional ethics in providing safe clinical procedures for patients (FDI World Dental Federation, 2009).

There are studies which have scrutinized the implementation and compliance towards infection control practices amongst OHCWs and dental students. Although infection control practices among general practitioners in Taiwan had improved over time, there is still a need to increase rates of wearing protective eyewear, face mask and to disinfect impression materials (Cheng *et al.*, 2012). Studies in Brazil, India and South Africa have all reported lack of compliance towards infection control practices and the imperative need for OHCWs to undergo continuous education programme to increase the compliance rates (Oosthuysen *et al.*, 2010; Matsuda *et al.*, 2011; Singh *et al.*, 2012). Despite the dental students complying with most of the infection control practices, there were certain areas of concern which needed improvement such as wearing of protective eyewear, face shield and disinfection of impressions and prostheses (Ahmad *et al.*, 2013; Askarian and Assadian, 2009; de Souza *et al.*, 2006). However, these studies might have some drawbacks as they used self-administered questionnaires, which could have resulted in over estimation of compliance.

At the Faculty of Dentistry, University of Malaya, Malaysia, infection control practices were introduced to students when they embarked into clinical practice at Year 3. Students were given didactic teaching, clinical demonstrations and hands-on training on proper infection control practices. Each student was also provided with *Infection Control Guidelines* (Omar *et al.*, 2013). This publication details the general guidelines for safe working practices as well as a checklist for the various treatment phases. The *Infection Control Guidelines* also has information on immunization, barrier techniques and management of needle stick injury. Clinical supervisors and support staff continue to monitor students on their infection control practices when treating patients in clinics. However, there is no follow-up assessment or refreshers training provided when students advance to clinical years 4 and 5.

The purpose of this study was to evaluate, by means of observation, the compliance of the dental students towards infection control practice through a clinical audit. To the best of our knowledge, there has been no clinical audit regarding infection control practice amongst dental students and general practitioners in Malaysia and in the Asian region. Hence, it would be more representative and informative to conduct this clinical audit to obtain baseline data as well as to become a pilot study for larger scales of audit in the future.

Materials and methods

This study was approved by the Medical Ethics Committee, Faculty of Dentistry, University of Malaya, Malaysia (Ref. No: DF OM1301/0048(U)), and conducted in full accordance with the World Medical Association Declaration of Helsinki (World Medical Association, 2013). Sample size calculation was done based on an average population of 80 students for each clinical year. Since this study included students from clinical years 3, 4 and 5, the average population used in the sample size calculation was 240 at confidence level: 95% and confidence interval: 11. Based on the sample size calculation, 60 undergraduate students from clinical years 3, 4 and 5 were randomly selected to participate in this study after providing an informed consent. The clinical audit checklist was compiled using the *Infection Control Guidelines* (Omar *et al.*, 2013). This checklist comprised of four sections of infection control practice: (i) before the student entered clinic, (ii) preparation before treatment, (iii) during treatment, and (iv) after treatment.

The authors have listed two examples of criteria which were assessed for each of the four sections in the checklist as shown in Table 1.

A pilot test was first conducted to ensure calibration between the two auditors and reproducibility of criteria in the checklist. Based on the results of the pilot study, the checklist had a kappa score of K=0.50, which indicated adequate reliability. A discussion ensued when both observes differed in their observations and a conclusion was made on how best to

rate a criterion. The kappa score for the final study was K= 0.63, which indicated 'substantial agreement'.

60 dental undergraduate students consisting of operators and assistants were randomly selected from clinical years 3, 4 and 5 respectively. Once selected, the information such as operator's and assistant's name, gender, type of clinic and work station identification number were recorded. The criteria in the audit checklist were either specific to the operator or the assistant, or common to both. For some of the criteria, if the operator/assistant did not perform a particular procedure in the clinical session they were being audited, they will not be evaluated for the criterion and the auditor will instead tick on the 'Not assessed' column. Otherwise, all criteria will have a 'Yes' or 'No' tick next to it. The study subjects were audited carefully following the criteria stated on the checklist as soon as they entered the clinic, during the treatment and up until they left the clinic.

The data obtained was tabulated and analysed using Statistical Package for Social Science (SPSS) software version 12.0.1. One-way ANOVA was used to compare compliance levels between students in clinical years 3, 4 and 5. It was further analysed using the Rasch analysis to obtain the level of compliance and to produce an interval-scaled data for comparisons between students in clinical years 3, 4 and 5 (Fox and Jones, 1998). Rasch analysis was used as a measurement model as it allowed the authors to use the current sample size of 60 measured against 41 items (infection control criteria) which is similar to a psychometric assessment model (Houts *et al.*, 2016). Rasch analysis allows researchers to (1) ensure a better match between the items measured and the target population, (2) avoid measurement gaps, (3) flag quantitatively problematic items which may not appear problematic from qualitative results, and (4) allow for a preliminary check of the measurement properties of the scale (Houts *et al.*, 2016).

The Person-Item map resulting from the Rasch analysis would show the student distribution against the items that were used in the checklist. The mean for items was set at 0 logit. Items or guidelines that are above the item mean are those that are more difficult for students to comply with, whereas those below the item mean are easier for them to comply with. Students who are above the person mean are those who have higher levels of compliance while those below the person mean are those who demonstrate lower levels of compliance. The difficulty estimate of each item from each treatment phase was also produced using the Rasch analysis.

Results

The distribution of infection control practices of the 60 undergraduate dental students who participated in this clinical audit is shown in Table 2.

One of the more difficult criterions for students to comply was wearing of face shield and goggles (6.20 logits) of which only an average of 1.7% of students complied with this criterion as shown in Fig. 1 which was generated using the Rasch model. On the contrary, the criteria easiest to comply with were: re-sheathing of needle, disposal of clinical wastes, removal of gown before leaving clinic and wearing gloves throughout the clinical sessions. 100% of students complied with these criteria (Fig. 1).

Fig. 2 showed the comparison between students in the clinical years 3, 4 and 5. Based on Fig. 2, Year 3 students complied best with the infection control guidelines that were in place (mean= 1.43 logits). Meanwhile, Year 4 (mean= 0.94 logit) and Year 5 (mean= 0.96 logit) students did not adhere well to the standard infection control protocols.

Year 5 students were more varied in their infection control practices compared to the Year 3 students but there was no significant difference between all three clinical years (at p=2.50) (Fig. 3). There were also several students from clinical years 3 and 5 who demonstrated high levels of infection control practices.

Fig. 4 showed the comparison between assistant and the operator in all 3 clinical years. In Year 3 (mean= 1.52 logit)

and Year 4 (mean= 1.05 logit), the assistants exhibited better infection control practices compared to the operators (Year 3, mean= 1.35 logit; Year 4, mean= 0.82 logit). In comparison, the operators in Year 5 showed better compliance towards infection control practices with mean= 1.16 logit.

The difficulty estimate of each item from each section in the checklist was also produced using Rasch analysis as shown in Table 3. The item difficulty estimates were then plotted in the form of boxplots for each of the section or phases of treatment (Fig. 5). In Fig. 5, it is shown that students were able to adhere to infection control practices before they entered clinic (mean= -1.93). However, the data showed that they tend to neglect the infection control practices while preparing for the intended treatment (mean= 0.089), during treatment (mean= -0.48), and after treatment (mean= -0.36). Fig. 5 also showed that the quality of infection control practices varied the most while they were treating a patient.

Table 1 Examples of criteria assessed in the checklist

Checklist	Yes	No	Procedure not done	Operator	Assistant
Before entering clinic					
Subject wore covered shoes					
Subject wore clinical coat					
During clinical session (preparation)					
Subject had taken only instruments that have been properly autoclaved					
Subject practised proper and correct hand hygiene technique					
During clinical session (during treatment)					
Subject wore gloves throughout treatment					
Subject disinfected primary or working impression(s) taken					
After clinical session					
Subject disinfected and sanitized all used instruments					
Subject removed PPE following correct sequence					

Table 2 Infection control criteria which were audited, by percentage for each clinical year

CHECKLIST	Year 3		Year 4		Year 5		Average	
	O (%)	As (%)	O (%)	As (%)	O (%)	As (%)	O (%)	As (%)
(A1) Subjects appeared tidy and had hair tied.	90		100		100		97	
(A2) Subject wore covered shoe.	72		60		75		69	
(A3) Subject wore clinical coat.	100		90		80		90	
(A4) Subject removed all ornaments and accessories (except wedding band).	65		100		85		83	
(A5) Subject did not have nail varnish.	100		100		85		95	
(A6) Subject did not bring their bags into clinic.	100		95		85		93	
(B1) Subject ensured both clean area and working area were clean and tidy.	NA	100	NA	90	NA	90	NA	93
(B2) Subject had taken only instruments that have been properly autoclaved.	NA	100	NA	100	NA	80	NA	93
(B3) Subject had placed protective barrier on all surfaces of dental workstation.	NA	40	NA	30	NA	30	NA	33
(B4) Subject ensured that instruments and folders were placed in clean and working area respectively.	NA	80	NA	70	NA	40	NA	63
(B5) Subject with long hair wore hair cap prior to treatment.	80		85		50		72	
(B6) Subject practiced proper and correct hand hygiene technique.	80		65		70		72	
(B7) Subject adorned personal protective equipment in correct sequence.	70		90		80		80	
(B8) Subject used face shield or goggles prior to treatment.	2		2		1		1.7	
(B9) Subject prepared bib and protective eye gear for patient prior to treatment.	NA	100	NA	100	10	90	10	97
(C1) Subject wore gloves throughout treatment.	100	NA	100	NA	90	10	97	10
(C2) Subject placed the used instrument only in working area or swivel table.	90	100	100	100	100	80	97	93
(C3) Subject did not leave the working area before de-gloving.	10	100	0	70	NA	50	5	73
(C4) Subject placed the contaminated products in the orange plastic only.	100	NA	10	NA	80	10	63	10
(C5) Subject disinfected the equipment(s) before sharing with next cubicle.	NA	NA	NA	NA	NA	20	NA	20
(C6) Subject disinfected the primary or working impression taken.	NA	NA	10	NA	10	NA	10	NA
(C7) Subject disinfected prosthesis taken out from patient’s mouth.	NA	NA	NA	NA	10	NA	10	NA
(C8) Subject re-sheathed needle cap after administration of local anaesthetic.	NA	NA	20	NA	10	NA	15	NA
(C9) Subject disinfected wax for try-in or any prosthesis from laboratory before inserting into patient’s mouth.	NA	NA	10	NA	10	NA	10	NA

Table 2 (continued from previous page)

CHECKLIST	Year 3		Year 4		Year 5		Average	
	O (%)	As (%)	O (%)	As (%)	O (%)	As (%)	O (%)	As (%)
(C10) If needed, subject removed gown and PPE before leaving clinic (e.g. to accompany patient to radiology, toilet break).	NA	0	10	10	30	10	20	10
(C11) If needed, subject removed glove on one hand when he/she wants to take an additional instrument or a document.	NA	10	NA	90	NA	50	NA	50
(C12) Subject changed to a new pair of gloves wore torn during treatments.	NA	NA	NA	NA	NA	NA	NA	NA
(C13) Subject requested for new instruments if the instrument used was accidentally dropped on the floor.	NA	NA	10	10	NA	NA	10	10
(C14) Subject did not touch others part of body, such as face or eyes with used gloves during treatment.	80	10	70	70	60	70	70	50
(C15) Subject washed the X ray film which was taken out from patient's mouth before passing to assistant.	NA	NA	40	NA	30	NA	35	NA
(C16) Subject placed burs into dappen glass containing Rotasept solution after every use.	50	NA	20	NA	30	NA	33	NA
(C17) Subject had disposed the waste according to clinical and non-clinical waste.	90	100	100	100	100	100	97	100
(C18) Subject had disposed the sharp instruments and/or needles into sharps bin.	NA	NA	NA	20	NA	NA	NA	20
(D1) Subject wiped the used instruments before soaking in disinfecting solution- Meddis.	NA	50	NA	70	NA	30	NA	50
(D2) Subject disinfected and sanitized all used instruments.	NA	90	NA	90	NA	80	NA	87
(D3) Subject disinfected the instruments in Meddis solution for 10 minutes.	NA	60	NA	100	NA	20	NA	60
(D4) Subject disinfected with PPE, including heavy duty gloves.	NA	60	NA	20	NA	100	NA	60
(D5) Subject disinfected and sanitized all surfaces.	NA	40	NA	60	NA	20	NA	40
(D6) Subject removed PPE following correct sequence.	100	100	80	80	70	80	83	87
(D7) Subject practiced correct hand washing after disinfection procedures.	90	90	90	70	70	80	83	80
(D8) Subject removed gown and PPE before leaving clinic.	100	100	100	100	100	100	100	100

O: Operator; As: Assistant; A: Before clinical session; B: Preparation during clinical session; C: During clinical session; D: After clinical session; NA: Not Assessed.
*The procedures done at clinical sessions were not common for all the polyclinics. Therefore, results for the criteria that were not assessed are not tabulated in the table above.

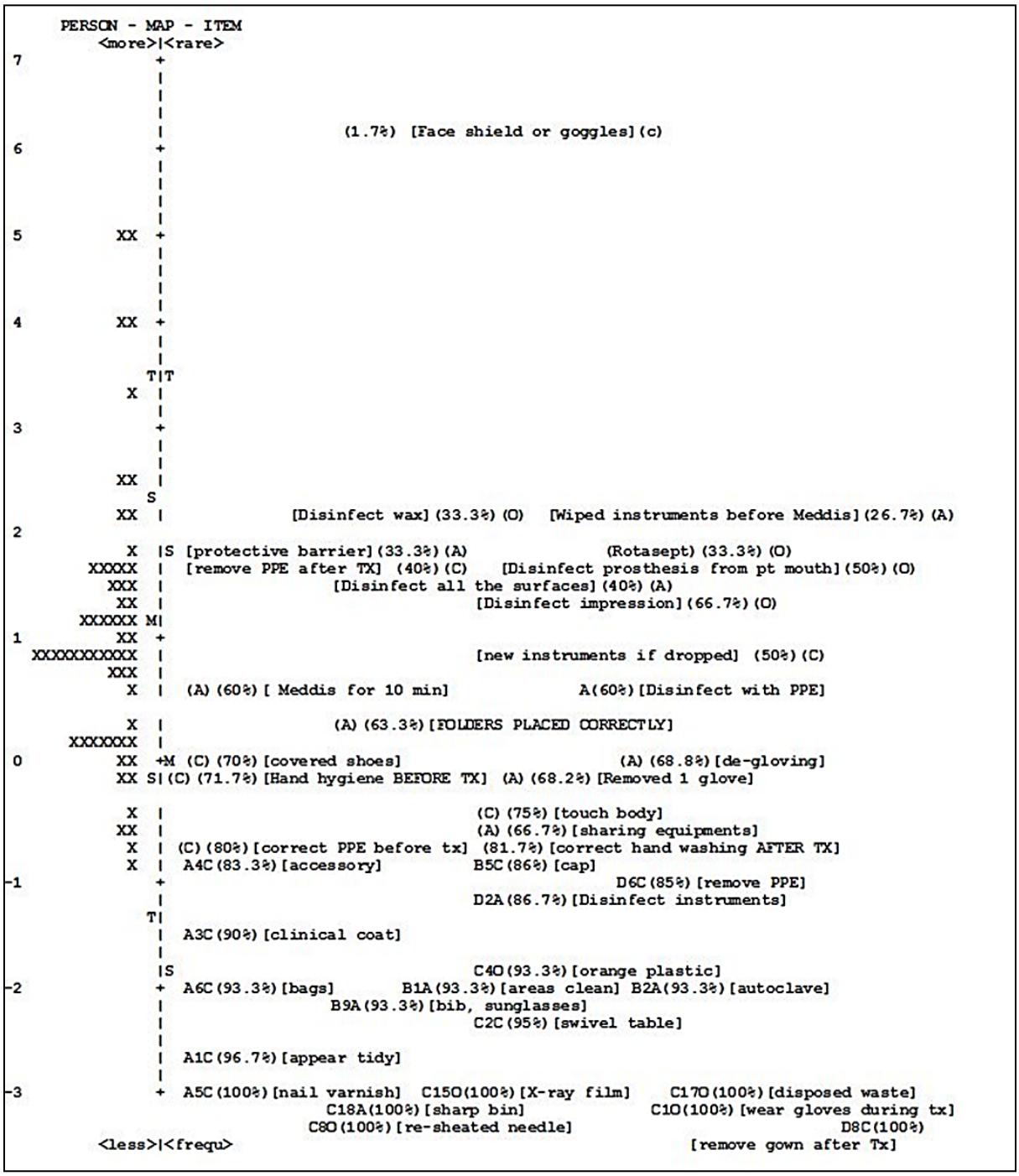

Fig. 1 Item-Person map of person and item distribution along the logit scale.

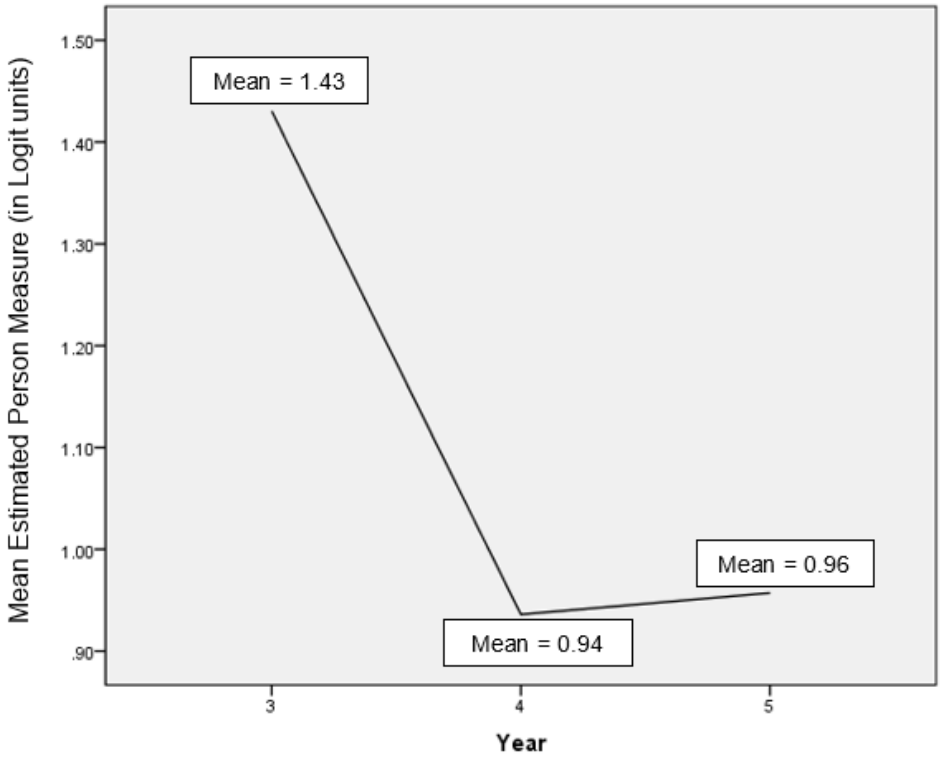

Fig. 2 Mean estimated person measure by year of study.

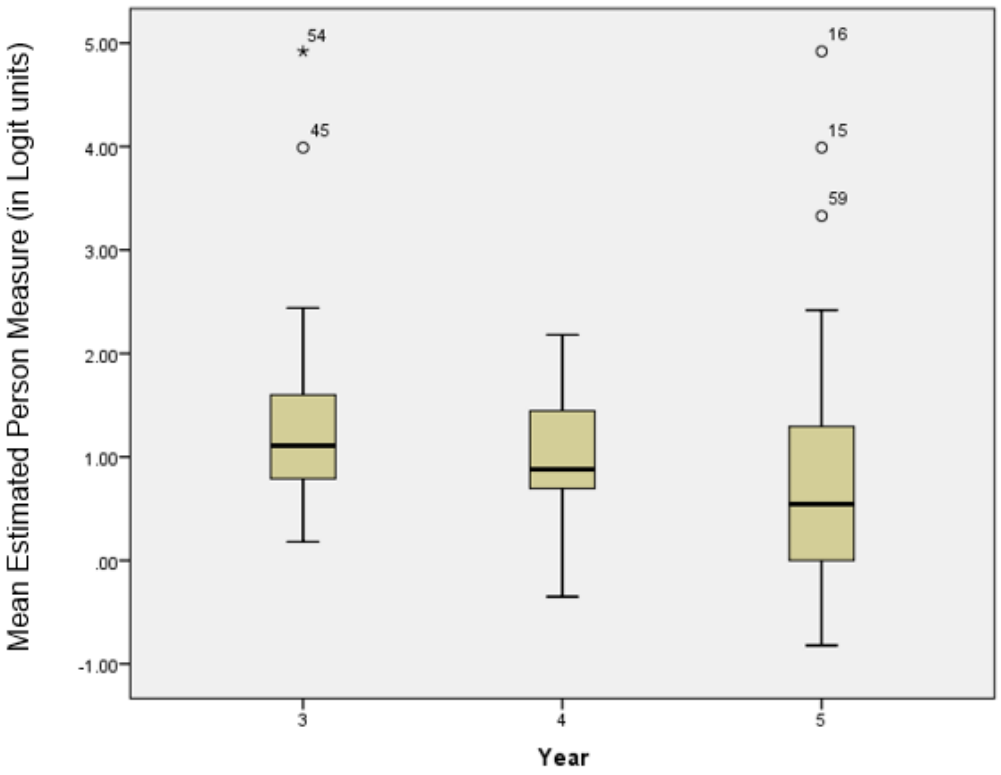

Fig. 3 Boxplots of the distribution of estimated person measures by year of study.

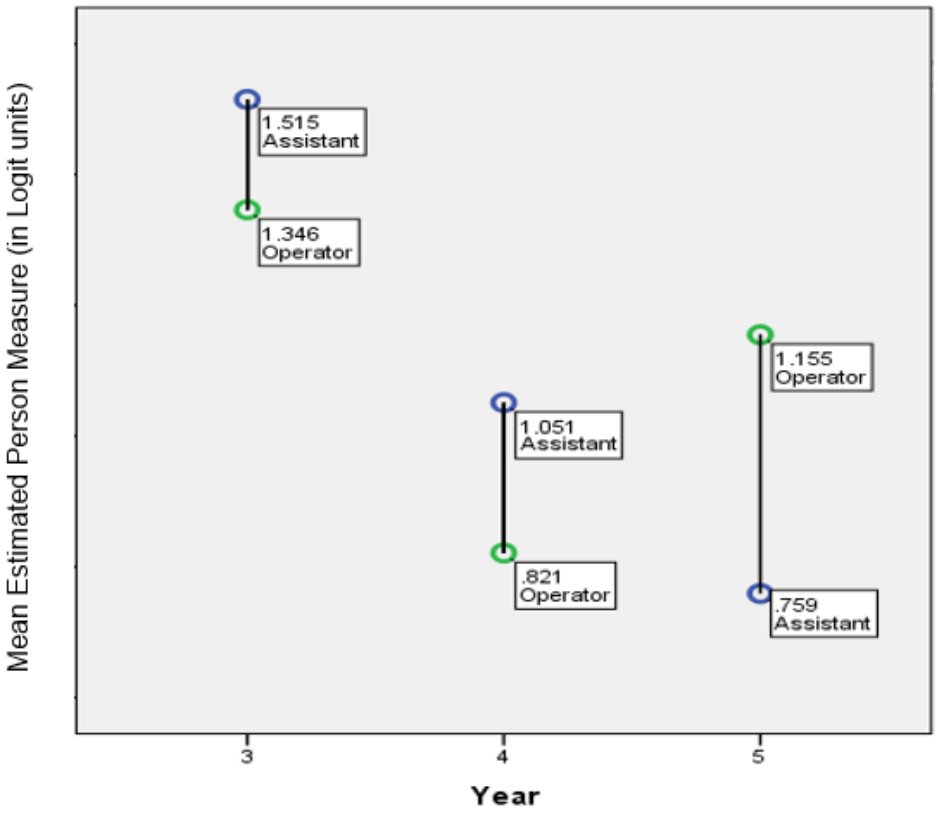

Fig. 4 Comparison of mean measures of assistants and operators by year of study.

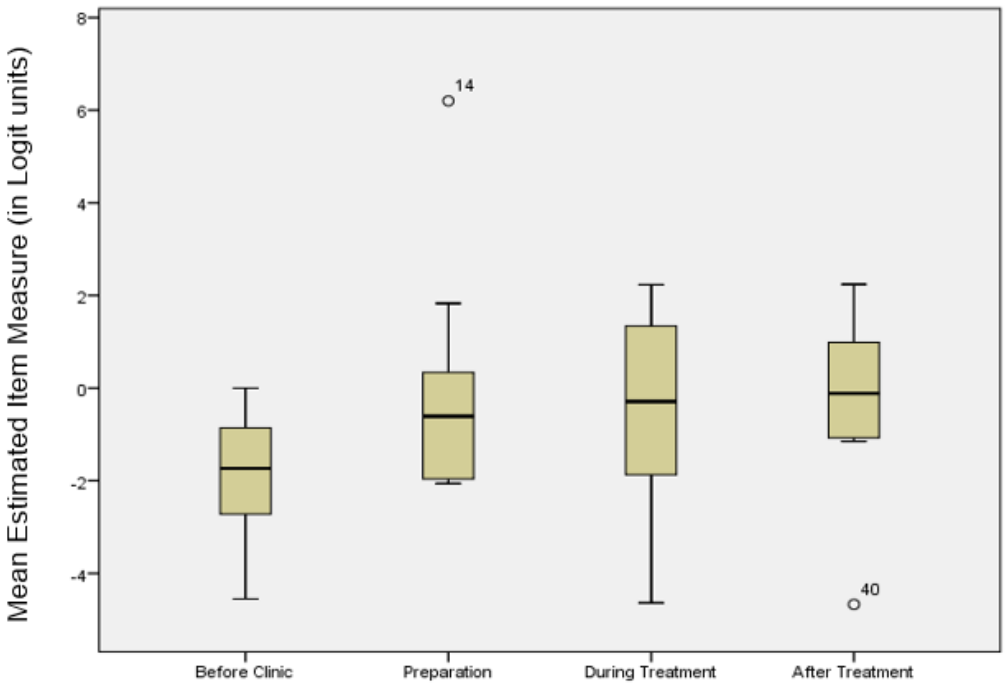

Fig. 5 Boxplots of the distribution of estimated person measures by treatment phase.

Table 3 Estimate item measure at the various treatment phases

Treatment Phase	Mean	Standard deviation
Before Clinic	-1.93	1.58
Preparation	0.089	2.62
During Treatment	-0.48	2.01
After Treatment	-0.36	2.12

Discussion

A study which looked at competency assessment of students in subsequent clinical years showed a statistically significant increase in infection control competence between the two years they were assessed (Milward and Cooper, 2007). This could potentially indicate enhanced knowledge of infection control in patient management amongst the students as they progressed into advanced clinical years in dental school. However, results from the present study indicated that Year 3 dental students complied best with infection control procedures, followed by the Years 4 and 5 students. Year 3 students were newly introduced to the clinical settings and this could be the reason for them to adhere to guidelines more closely than the senior students. Moreover, Year 3 students were taught on infection control procedures at the beginning of their academic session, rendering them to remember these protocols better than Year 4 and 5 students. The better compliance towards the guidelines by the younger practitioners was previously reported and exposure to infection control education was highlighted as a possible reason (Oosthuysen *et al.*, 2014).

The present study also compared the compliance of the operators and assistants towards infection control, and it was found that the assistants in Years 3 and 4 were able to assist satisfactorily and comply better with infection control practices when compared to their operators. On the contrary, in the Year 5 clinics, operators performed significantly better than their assistants, who displayed more relaxed behaviour towards assisting and infection control practices. A dynamic clinical pairing with an efficient assistant can reduced chair-side time and increase the quality of clinical procedures performed (Ahmad *et al.*, 2012). Therefore, students should be reminded of the benefits of clinical pairing and the responsibilities that each student in a pair have towards providing the best treatment possible for a patient with infection control protocols in place.

Hand hygiene has been identified as one of the most important infection control practices to prevent transmission of diseases (Oosthuysen *et al.*, 2014). In the present study, it was observed that during the clinical session, some Year 3 students (35%) had not removed their watches and rings which were proven to significantly harbour bacteria and pose as a risk factor for the spread of infectious diseases (Fagernes and Lingaas, 2011; Field *et al.*, 1996). Additionally, good hand hygiene would be difficult to achieve if the rings and watches were not removed prior to hand washing (Trick *et al.*, 2003).

Barrier protection of surfaces and equipment can prevent contamination of clinical contact surfaces, but is particularly effective for those surfaces that are difficult to clean (Oosthuysen *et al.*, 2014; Kohn *et al.*, 2004). Hence, it is important that the potentially risky areas are covered with a transparent protective film, and removed immediately at the end of the procedure. However, in the present study, only an average 33% of the students placed the provided protective barrier on all surfaces of the dental workstation compared to the 69% dentists in Sao Paolo (Macinko *et al.* 2006).

PPE forms an effective barrier against transmission of any infection when used appropriately and in combination with other protective measures, (Oosthuysen *et al.*, 2014). Gloves, protective masks and

eyewear were also considered as an essential PPE that prevents microbial contamination in OHCWs and patients in a dental setting. All students audited in the present study wore gloves during treatment and the results were in agreement with other similar studies (Singh *et al.*, 2012; Ahmad *et al.*, 2013). The compliance rate displayed by students in the present study were better than the 68% and 93% achieved by dental practitioners who were surveyed in Taiwan in 1999 and 2010 respectively as well as the 82% of practitioners surveyed in Jordan (Al-Omari *et al.*, 2005). Another study in South Africa reported that only 88% of practitioners and 66% of assistants always wore gloves during treatment (Oosthuysen *et al.*, 2010).

The present audit found only 1 (1.7%) out of the 60 students wore protective eyewear/goggles while carrying out treatment. On the other hand, only 26% of OHCWs in Taiwan, (Cheng *et al.*, 2012), 14% of OHCWs in Yemen (Halboub *et al.*, 2015), 17% of dental students in Cape Town (Mehtar *et al.*, 2007), and 33% of dental students in Jordan (Qudeimat *et al.*, 2006) reportedly wore protective eyewear in the clinics. Such findings were largely contrasted with a study which reported a compliance rate of 80-82% (Oosthuysen *et al.*, 2010). The results of the present clinical audit showed a poor level of awareness towards the probability of disease transmission via aerosol and blood splatters to the eyes as well as the possibility of accidental trauma due to flying debris. In view of that, dental students, both operators and assistants, should be encouraged to wear masks and protective eyewear at all times during treatment.

In the present audit, an average 33% of operators had placed used dental burs into the disinfecting solution. A similar finding was observed in a study done in Brazil where 41% of dental students disinfected their used burs (Abreu *et al.*, 2009). Dental burs would be contaminated with blood, saliva, necrotic tissue and potential pathogens during use (Whitworth *et al.*, 2004). In addition, the complex structural architecture of dental burs make pre-cleaning and disinfection difficult to achieve (Morrison and Conrod, 2010). Hence, soaking used burs in disinfecting solutions will help remove bacteria, viruses and fungi (Ott *et al.*, 2009).

Infection control practices in developing countries have not been widely indexed and most of the hospitals have insufficient infection control programs due to indigence of awareness or poorly trained personnel (Jain *et al.*, 2010). In dental schools, emphasis on infection control practices should be developed during early dental education and an acceptable standard of practice should be maintained during the clinical years (Singh *et al.*, 2010). Efforts are needed to improve attitudes of students to constantly improve knowledge and motivate them to adhere to infection control guidelines. These efforts will build a strong foundation amongst students towards a more professional conduct whilst treating patients. Refresher courses could be conducted at the beginning of every academic semester before the students are allowed to treat any patients. Continuous monitoring through a similar clinical audit should be conducted. More educational programs, seminars, as well as training workshops on infection control for dental students would be beneficial towards improving infection control practices daily.

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