Competency assessment for infection control in the undergraduate dental curriculum

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Objectives: This study aimed at investigating the introduction of an infection control competency assessment on undergraduate dental student's awareness and knowledge of infection control.

Method: A short course, including an introductory lecture and a three component competency based assessment exercise testing student's knowledge and ability in infection control measures was incorporated into the previously established training programme. The assessment exercises included a written test of students' knowledge of the Infection Control Policy, a unit management exercise and a hand hygiene assessment. The infection control competency was initially incorporated into the final term of the second year in 2004 and is now an established part of the 5-year dental undergraduate degree programme. Re-assessments were scheduled (at the start of third year) for students failing to meet the required standard as successful completion of this course was compulsory prior to students being allowed to treat their first patients. Student performance over the last 2 years on this course and during their first year on clinic were analysed to determine potential improvements in student knowledge and application in infection control. Examination results from the year 3, infection control spot test were compared with those of earlier years. In addition, the opinions, as assessed by questionnaire analysis, of dental staff and students on the infection control competency were obtained.

Results: All students successfully completed the infection control competency (either at first or second attempt) and were subsequently allowed to enter clinical training in year 3. Significant improvements were seen in students passing the course at their initial attempt, 42% and 78%, in the 2004 and 2005 academic years, respectively. Also subsequent testing of these students during their first year on clinic showed marked increases in awareness and knowledge of the infection control protocols. Staff and student feedback on this course was also found to be highly supportive of the introduction of the infection control competency.

Conclusion: Incorporation of additional formal pre-clinical teaching and introduction of an infection competency potentially provides enduring knowledge and clinical application benefits.

Key words: infection control; competency; hand hygiene; undergraduate dental education.

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Introduction

During dental procedures, dentists and their patients are at risk from a range of pathogenic microorganisms including cytomegalovirus, hepatitis-B/C virus (HBV and HCV), herpes simplex virus types 1 and 2, human immunodeficiency virus (HIV), *Mycobacterium tuberculosis*, streptococci, transmissible spongiform encephalopathies (including variant CJD), Methicillin-resistant *Staphylococcus aureus* (MRSA) and severe acute respiratory syndrome (SARS) virus (1–5). In addition there are a number of other viruses and bacteria that colonise the oral cavity and respiratory tract as well as blood borne microbes which represent a pathogenic risk. Notably, there is an increase in occurrence of antimicrobial-resistant bacteria within hospital

environments which subsequently represent a growing healthcare problem (6). Pathogenic microorganisms have the potential to be transmitted in dental settings through (1) direct contact with blood, oral fluids, or other patient materials; (2) indirect contact with contaminated objects (e.g. instruments, equipment or surfaces); (3) contact of conjunctival, nasal, or oral mucosa with droplets containing microorganisms (aerosols) generated from an infected person and propelled by coughing, sneezing, talking or use of dental instruments, e.g. sonic/ultrasonic scalers; and (4) inhalation of airborne microorganisms that can remain in the environment for long periods (7). It is therefore necessary that infection control procedures address issues of hand hygiene, instrument sterilisation, sharps handling and the use of protective barriers.

All dentists have a duty of care to their patients to ensure adequate infection control procedures are followed. Within University hospitals, where new dental personnel are trained and large numbers of patients are treated, it is therefore imperative that thorough and robust training in infection control procedures is provided. Indeed dental undergraduate students provide a significantly increased potential for cross-contamination compared with more experienced members of the dental team, emphasising the need to ensure that they are thoroughly trained and aware of protocols necessary to minimise the risk both to themselves and to their patients (8–10).

Dental education worldwide requires that graduates have a high level of medical training, clinical skills and knowledge on the control of infection. Indeed, UK General Dental Council (GDC) guidelines state that dental graduates should be able to *'implement and perform satisfactory infection control and prevent physical, chemical or microbiological contamination in the practice of dentistry'* (11). In addition, the generation of qualified dentists educated in infection control procedures is important in extending compliance in private dental practices within the community. Employing dentists not only have a responsibility to protect patients, but are also required to provide a safe environment for their employees by ensuring staff immunisations, eye and face protection, surgery clothing, protection against saliva/blood splatter and inoculation injuries. Indeed, *'failure to employ adequate methods of cross-infection control would almost certainly render a dentist liable to a charge of serious professional misconduct'* (12). Whilst an effective infection control programme and concerns over transmission of disease has always been an essential and integral part of the dental practice, over the past decade, guidelines for infection control have become more evidence-based, enabling strategies to be devised which can prevent disease transmission by interrupting one or more links in the chain of contamination.

Traditional teaching of infection control to dental undergraduate students involves lectures and clinical training where the concepts and practical aspects are discussed and demonstrated by senior dental staff. Alongside this students were required to demonstrate a thorough knowledge of the current 'Hospital Infection Control Document'. The Schools delivery of infection control teaching was considered satisfactory however we wished to see the effect of adopting a competency based approach on student awareness and practical application. The competency based approach utilised exercises which assessed students on their knowledge and ability to follow the Infection

Control guidelines before allowing them to enter clinical training.

The aim of this study was to investigate the effect of implementing a competency based approach to the teaching and assessment of infection control and subsequently analyse student performance and student/staff opinion in order to determine if any benefits could be demonstrated.

Materials and methods

Prior to implementation of the new competency dental students were taught infection control procedures by means of lectures, clinical demonstrations and issue of the hospital's infection control policy during the pre-clinical years of the undergraduate course (years 1 and 2) at the School of Dentistry. Clinical experience was subsequently gained during years 3, 4 and 5. Students' infection control performance was continually assessed by dental and nursing staff during treatment clinics in years 3, 4 and 5, and formal assessment of student knowledge and skills in this area was determined by Objective Structured Clinical Examination (OSCE) in year 4 and written professional examinations in year 5 (Fig. 1).

To enhance learning in this area an infection control competency was introduced into the pre-clinical course at the end of the summer term of year 2 (Fig. 1). Prior to implementation students were initially informed of these teaching changes and provided with clear learning outcomes via a lecture with additional reinforcement of this information provided both by email and written memo. Student competency in infection control was determined by a three

Fig. 1. Time line showing infection control teaching at Birmingham School of Dentistry. Individual infection control teaching sessions are indicated by vertical arrows. During the clinical years continuous on clinic appraisal of students infection control occurs. Asterisks indicate newly introduced competency course (OSCE, Objective Structured Clinical Examination).

- 1) List (in the order you would perform them) 3 procedures you should go through in order to make a dirty hand piece suitable for use with your next patient:- (5 marks)
- 2) List (in the order you would perform them) 6 ways dirty hand instruments should be treated prior to their use on a patient: (5 marks)
- 3) List (in the order you would perform them) the 3 steps you would undertake for dentures / impression materials prior to sending them to the laboratory:- (3 marks)
- 4) How would you deal with a blood spillage on the floor? (3 marks)
- 5) In percentage terms how effective is liquid soap and water in removing transient micro organisms? (1 mark)
- 6) What protection should you provide a patient when working supine? (2 marks)
- 7) At what stages should your unit be cleaned? (4 marks)
- 8) What do you understand by the term zoning? (2 marks)
- 9) In terms of cross infection what special precautions should be taken with a high-risk patient? (1 mark)
- 10) What do you understand by the term *universal precautions*? (2 marks)
- 11) What should you do with dental unit water lines
 - (a) between patients? (1 mark)
 - (b) At the start of a morning clinic? (1 mark)
- 12) Why should patients be asked to rinse with Chlorhexidine prior to use of ultrasonic / sonic scalers? (2 marks)
- 13) List the steps you would take after giving a local anaesthetic in re sheathing the needle and why? (2 marks)

Fig. 2. Questions on the Infection Control Test which were presented in an easy to follow question layout, containing short unambiguous questions (13). Students were given 30 min to complete the test. Shown in parenthesis after each question are the marks available for each question. A total of 35 marks were available for the test. The pass mark was set at 65%.

component assessment which included; (a) a written test, covering the key points in the 'Hospital Infection Control Policy' (Fig. 2); (b) a hand hygiene exercise, where, following instruction on correct hand washing technique, students' were assessed on their ability to wash their hands to a satisfactory standard using the 'Glitterbug' (<http://www.arrowscientific.com.au/glitterbug.html>) hand-washing system [efficient removal of the 'GlitterBug' (fluorescent dye) was determined by ultra-violet light illumination and competency required complete removal of fluorescent dye as determined by a single examiner, using predetermined criteria]; (c) a unit management exercise which assessed students on their ability to (i) decontaminate and set-up a unit prior to treatment of their first patient, and (ii) demonstrate the correct procedure for oiling dental hand pieces (Fig. 3). On discussion with teaching and support staff these areas were selected as procedures that were core to infection control and which all new clinical students needed to master prior to treating patients on clinic. As this competency course assessment evolves the incorporation of other procedures will also be considered (e.g. handling of sharps).

The infection control competency tests were performed over a 2-day period with half of the student cohort ($n = 67$ in 2004 and $n = 73$ in 2005) examined on each day. Student groups ($n = 10$ – 12) were rotated through each component and allowed 30 min to complete each of the three exercises. Supervision

2nd Year Infection Control Competency test:

Student Name:
Student Examination number:

Task 1

Prepare the unit for your first patient of the day.

Procedure	YES	NO
Student wears gloves & apron		
All Water lines run thro' for 2 minutes		
Spittoon run through for 2 minutes		
Work surfaces, bracket table cleaned with detergent, followed by alcohol wipe		
Disposable towels used for surfaces		
Plastic cover to headrest		
Appropriate use of gloves (heavy duty to clean unit, change to lay up)		

Task 2

Oil the hand piece provided

Procedure	YES	NO
Ensure correct nozzle used		

Has the student performed these procedures competently?

(In order for the student to be competent you must have answered all the questions 'yes')

YES / NO

Staff signature:

Fig. 3. Marking sheet used for assessment of the unit management exercise, listing the important aspects of unit set up. Students were required to satisfy all aspects in order to pass this component.

was provided by dental and senior nursing staff. To ensure consistency in student assessment a single trained examiner was used for the hand hygiene exercise and the written test, and a marking sheet was provided for the unit management exercise listing key aspects of unit set-up (Fig. 3). Results were collated and the students' subsequently notified of their performance. Students who passed all three components were deemed competent whilst students failing any component of the infection control competency were reassessed. An immediate re-test was provided for students failing the hand hygiene exercise whilst re-tests for the written assessment and unit management exercise were scheduled at the beginning of the autumn term of year 3 (Fig. 1). All students were required to have successfully completed all components of the infection control competency course prior to being allowed to treat patients on dental clinics.

To determine potential improvements in student knowledge and application of infection control, examination results from the previously established Infection control spot test [an unannounced written assessment run in the summer term of year 3 which was initially instigated in 2001 (Fig. 1)] were analyzed.

In order to determine student and dental staff opinion following the first year of introduction of the infection control competency course, questionnaire analysis was performed. Whilst questionnaires have recognised limitations it was felt that this approach would provide a rapid and useful insight into staff

and student perceptions (13, 14). Recommended guidelines for questionnaire design were followed and they were made short, varied in appearance and included unambiguous open and closed format questions (15, 13). Specifically, the questionnaires contained statements to which respondents were asked to indicate their level of agreement using the five point Likert-like scale.

For statistical analyses chi-squared tests were performed on student percentage pass rates and *t*-tests were performed to determine significance of difference between student average marks. *p*-values are shown where appropriate ($p \leq 0.05$ were considered significant).

Results

Initially in 2004, 46% of students passed the written test and unit management components of the infection control competency assessment at their first attempt. Following re-sits all students subsequently passed these outstanding components and were subsequently permitted to treat patients. In the following year, there was a statistically significant increase in the percentage of students passing these components (78%) at the initial attempt (Fig. 4a). Figure 4b shows the breakdown of students passing the written test component and the unit management assessment at their initial attempt, indicating a marked improvement in pass rates during the second year of the course. All students re-sitting the assessment in this subsequent year also passed. Notably, a non-significant increase in average student mark for the written test was also evident in this second year (Fig. 4c).

Following establishment of the infection control competency in 2004 it was found that improvement was also evident in student performance in the 2005 infection control spot test demonstrated by statistically significant increases in both student pass rates and average year marks (Fig. 5). Analyses indicated that these improvements were not likely to be attributable to this cohort of students being academically more able as no significant differences were found between their average examination marks and those of previous years in a range of other dental-related subjects (unpublished data).

Anonymous questionnaires were circulated and 77% of students ($n = 53$) provided feedback, with analysis indicating that in general the infection control competency assessment was highly appropriate and provided benefit (Fig. 6). These findings were also

Fig. 4. (a) Percentage of students passing the infection control competency assessment for the 2 years this course has been run. Students' performance was shown to be statistically significantly ($*p < 0.05$) improved for the second year of running. (b) Percentage of students passing the written test component (grey bar) and the unit management exercise (black bar) at their first attempt in years 2004 and 2005. (c) Average marks for the written component for the first 2 years the course was run.

supported by the dental staff ($n = 12$, 100% questionnaire compliance) who were directly involved in subsequent clinical teaching of students who had taken the infection control competency assessments (Fig. 7). Questionnaire responses also indicated that students now appeared better informed and aware of the need to implement infection control procedures when compared with previous years (Fig. 7). In general supportive comments for the infection control competency assessment were received from both dental staff (e.g. 'excellent and vital exercise' and 'a very important exercise') and student questionnaire feedback (e.g. 'helped in learning routine and why it should be carried out' and 'exercise very helpful in preparation for seeing patients and familiarisation with clinic').

Fig. 5. Distribution of the percentage of students passing (a) and their average year mark (b) for the third year infection control spot test given after one term on clinical practice for the period 2001–2005. All tests were marked by the same examiner. Data indicates that in the period prior to the introduction of the competency test (2001–2004) the results were similar both in terms of the percentage of students passing and average year percentage mark. After the students were exposed to the infection control competency course in 2004, both parameters showed a statistically significant increase ($*p < 0.05$).

Fig. 6. Distribution of dental students opinion with regard to various aspects of the infection control course. Students' average response are shown.

To date, this competency assessment has been run for 2 years covering two cohorts of students with the associated data presented in this paper; however, results will continue to be analysed and further

Fig. 7. Distribution of dental staff opinion with regard to various aspects of the infection control course. Average response of dental staff is shown.

adaptation of the teaching will be made to ensure the educational value of this exercise.

Discussion

This study compares the introduction of an infection control competency with the previously established traditional teaching approach and the resultant impact on student learning. It shows that significant improvements were seen in students' results in the already established infection control spot test. In addition positive student and staff questionnaire feedback was received which indicated increased student knowledge and application in this area. It is possible that these results were achieved due to increased student understanding of the rationale for compliance with the infection control programme due to the incorporation of additional teaching. It was also notable that significantly more students passed the infection control competency test in the second year of its implementation and that there was also a marked improvement in student performance. Potentially, these results could be explicable by improved teaching of the course during its second iteration and/or the students being more aware of the need to successfully complete it prior to progression onto their clinical training, both of which indicate enhanced knowledge of infection control in patient management within the student body.

Due to frequent media coverage, the public is now far more aware of the need for all dentists to demonstrate high standards in infection control. It is also important that routine infection control procedures are adopted for all patients as carriers of latent infection may be unaware of their condition (16, 17) or choose not to inform the dental practitioner. It should also be remembered that it is unethical to refuse dental

care to patients with a potentially infectious disease. New pathogens and risk areas constantly emerge, and as a result, infection control recommendations and guidelines are constantly changing to adapt to the new evidence base, so it is essential to have a dynamic and modifiable undergraduate curriculum. Thorough training of our undergraduate dental students in infection control is a necessity and areas that could potentially be perceived as trivial by the student cohort require particular attention. Indeed, hand hygiene may possibly represent one such area. Recent studies have shown hand hygiene to be the single most critical measure for reducing the risk of transmitting organisms (2) between patients and dental staff and in particular for controlling the spread of multi-resistant organisms. Clearly, the aim of hand hygiene procedures is to eliminate transient microflora and reduce resident microflora for the duration of the dental procedure as skin bacteria are capable of rapidly multiplying under surgical gloves if hands are not washed thoroughly with antimicrobial soap (18–21). It is therefore imperative for students to learn and adhere to high levels of hand hygiene to avoid the potential of pathogens contaminating the operator's hands during dental procedures or entering the oral cavity through torn gloves.

Within the preparation of the dental unit test (Fig. 3), we highlighted the need for careful decontamination. Specifically, we reinforced the need to ensure thorough flushing of dental unit waterlines and sterilisation of dental hand pieces and other devices. Previous studies have demonstrated that dental unit waterlines can become colonised with a variety of pathogenic microorganisms, including bacteria, fungi, and protozoa which potentially pose an epidemiologic risk (22–25). Dental hand pieces and other devices can also retain infectious material with the potential to subsequently transmit disease. A recent study of general dental practitioners within the UK found issues relating to instrument decontamination (26). Indeed, recently 4089 patients from a dental clinic in Scotland were contacted due to a dentist's admission of periodic use of unsterilised equipment. Subsequently, 1005 patients were screened for HBV, HCV and HIV although the investigation found no evidence of patient-to-patient transmission (27). A separate report however did demonstrate that patient-to-patient transmission of HBV via contaminated instruments has occurred (28).

It is important to be aware of pedagogical factors central to the delivery of the infection control course which may enhance the student learning experience and aid knowledge application. The incorporation of

the infection control competency at this time-point within the undergraduate curriculum potentially provides benefits as it ensured students were already introduced to the subject matter. Such adequate prior knowledge has been shown to be an important prerequisite for successful learning (29, 30). In addition, the varied modes of delivery of the teaching of the infection control competency course, including the didactic lecturing, student centred learning and 'hands-on' application, can potentially enhance student interest and facilitate a 'deep' learning approach to the subject (31); however, follow up of subsequent student cohorts will be required to confirm these findings. The limiting of student class size during the infection control competency exercise facilitates student centred teaching, enabling active engagement of the students in the learning process (13). Combined, these approaches should assist a 'deep' rather than a 'surface' learning, enabling subsequent application of knowledge (32, 31). Whilst it is assured that our modified curriculum will continue to guarantee all dental students have a sufficient level of knowledge to enable safe management of patients, it will be of interest to monitor the performance of the student cohorts in the latter years of the dental undergraduate course. Our preliminary data indicates potential improvements in student awareness and application and therefore it is conceivable that these benefits may be apparent in infection control assessment exercises, such as OSCE, and also importantly, during clinical procedures. Indeed it is proposed that further information will be gathered to determine any long-term benefit in infection control performance, as the students progress through the course.

As dental educators it is constantly necessary to reflect upon our teaching and its delivery, particular in areas subject to frequent change. Infection control represents one such important area whose teaching requires continuous evaluation due to its ever-changing evidence-base. We must therefore be ready to modify its delivery and incorporate extra teaching to specifically address related emerging areas.

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