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Microbiological Hazard Analysis in Dental Technology Laboratories

Joanna Verran, J. Fraser McCord, Christopher Maryan and Rebecca L. Taylor

Abstract - *Dental technicians are trained in a range of skills involved in the fabrication of prostheses used in the mouth and facial region. Items entering the dental laboratory are essentially inert materials which have been in contact with the patient's mouth, saliva, and possibly blood. Appliances leaving the laboratory are then returned to the clinician to be tried/inserted in the patient's mouth. Relatively little attention has been paid to infection control policy within dental laboratories, perhaps due to perceived and/or actual remoteness from patients, lack of appropriate training, and lack of relevant research. More controlled studies are desirable, in order to identify any potentially hazardous procedures, and to make an assessment of risk for these procedures.*

KEY WORDS: Infection control; Microbiology; Dental technology

INTRODUCTION

Dental technicians are trained in a range of skills involved in the fabrication of prostheses used in the mouth and facial region. Dental laboratories may be attached to University Dental Hospitals, dental clinics/surgeries, or they may be entirely independent facilities of widely differing size. Unlike dentists in the clinic, dental technicians do not always have direct contact with a patient, hence the risk of cross-infection may be deemed less significant by the parties concerned.

The dental laboratory is designed for the manufacture and adjustment of orthodontic and prosthodontic appliances. The production of an appliance involves reproduction of the exact surface dimensions of the patient's mouth, using impression materials. The impression is then used to pour (usually gypsum-based) casts that imitate the patient's dental/oral features and the appliance is made to fit onto these casts. Thus the production, or remodelling or repair of appliances all involve the movement of impressions, casts and appliances from patient via surgery to laboratory (*Figure 1*), during which the potential for microbial contamination of material and personnel is not insignificant.

Specimens and materials sent to the dental laboratory have a range of stabilities and are likely to have been in contact with the patient's oral fluids including saliva, and possibly blood. Since microorganisms in blood and saliva can survive for long periods of time on inanimate surfaces, there is the possibility that materials which have been placed in the mouths of patients could constitute a source of infectious material[1–3]. It has been understood for many years that cross contamination and therefore cross infection is a significant occupational risk in any health care profession[4]. However, little attention has been paid to cross-infection control within dental laboratories, whose staff may work to general guidelines only[1,5,6]. Eventually, in the early 1990s, minimum protection procedures, standards and lines of responsibility were identified[7,8], and the American Dental Association (ADA) and the British Dental Association (BDA) published specific recommendations for the dental laboratory[2,9].

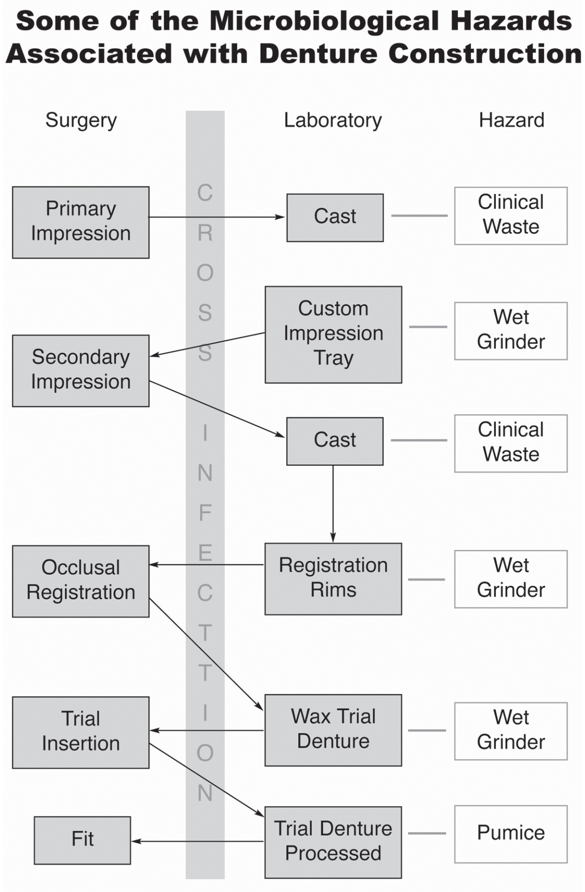


Figure 1. *Some of the microbiological hazards associated with denture construction*

Laboratories are also facing increased legal responsibilities, both to the public and to employees, under UK and EU laws such as the Health and Safety at Work Act, and the Medical Devices Directive[10–13]. In commercial laboratories, responsibility for effective infection control procedures is placed on the laboratory owner, although non-commercial laboratories, for example teaching laboratories, must also comply with the regulations.

Ultimately however, responsibility for infection control falls to the dentist[11].

Cross-infection hazards appear ill defined within the dental laboratory, perhaps for a number of reasons: perception of distance from patients; lack of appropriate training for personnel, and lack of scientific research in the area. Several papers have described the potential for cross-infection within the laboratory, but few have actually demonstrated its occurrence. Microorganisms are present in most environments, and one can assume the dental technology laboratory to be no exception. It is the assessment of hazard and the analysis of risk provided by the presence of these microorganisms during a given procedure which requires consideration. In the food industry, this 'HACCP' (Hazard analysis and critical control points) approach is common[14–17], and principles have been applied elsewhere, for example in the domestic environment. Yet there have been no comprehensive studies on the potential microbiological hazards encountered by dental technicians, hence no assessment of risk can be made.

The dental laboratory presents a challenge to the existing cross-contamination and infection control procedures[18,19]. The construction of prostheses involves several stages in the clinic and in the laboratory, and as a consequence, dental impressions, maxillomandibular registration bases and apparatus, and trial and final prostheses are all exposed to contamination from the environment, from personnel, and from the patients' mouths[8,20,22,23]. The procedures of greatest risk would appear to be those about which most papers have been published – disinfection of impressions, and aerosol generation via pumice slurry during polishing. In both cases, the presence of actual and opportunist pathogens has been demonstrated. Studies on risks posed by viruses are fewer, not necessarily because of a lesser perceived risk, but probably due to the difficulties and hazards associated with culturing viruses. This review will collate existing data, and consider specific hazard areas within dental laboratories, enabling a preliminary assessment of risk to be made. In addition, we report on several microbiological studies on potential risk associated procedures in dental technology laboratories, focusing on the processes through which specimens pass on entering the dental laboratory.

IMPRESSIONS

A wide variety of impression materials are currently available, depending upon the application required, with irreversible hydrocolloids being used for primary impressions by 88% of dental practitioners recently surveyed[26]. The BDA recommends that all impressions should be thoroughly rinsed in water prior to shipment to the laboratory to remove gross contamination[2,8], although clearly this will not provide any disinfection.

Previously, generic products such as sodium hypochlorite were recommended by the BDA for the disinfection of impression materials[25]. It has been well documented that immersion in certain disinfectant solutions, including sodium hypochlorite[27–29] may distort irreversible hydrocolloids due to imbibition. This is however, a contentious finding, as other publications have indicated no detrimental effect from sodium hypochlorite[30–32], perhaps due to compatibility issues between the disinfectant and impression materials studied. Spray disinfectants have been used as an alternative to immersion due to their convenience of use and minimal distortion of materials. However, there are serious concerns with the use of such sprays both in terms of antimicrobial efficacy and the generation of harmful microbial aerosols.

Advice can now be sought from the manufacturers of impression materials, because they are obliged by the Medical Devices Directive to provide information on the most suitable disinfectants[24], which are kitemarked (CE) to demonstrate conformity to European directives[2]. Recommendations are indicated for disinfection, but there is no universally recognised disinfection protocol applicable for all impressions.

Some authorities recommend that materials should be disinfected as they enter and leave the laboratory[19]. Commercial laboratories may receive samples from a large geographical area, thus transport time may also be an issue when specimens arrive, in terms of microbiological contamination. It is often assumed that the dentist has disinfected the sample, because of their responsibility in this context[2], hence the technician may not. Conversely the technician might routinely disinfect the specimen on arrival, resulting in one or two disinfections – procedures which may also affect the dimensional stability of the delicate impression materials[4]. There is, of course, the third alternative where no appropriate disinfection is carried out.

Recently a survey of US dental laboratories revealed a lack of communication between dentists, dental staff and dental laboratory personnel with regard to disinfection of impressions[33]. A clear understanding of whose responsibility it is to disinfect is required to ensure optimal safety for staff, and the best performance of the impression material. The BDA, BDTA (British Dental Trade Association) and Dental Laboratories Association[2,10–12,25] jointly and unequivocally state that all impressions and appliances must be cleaned and disinfected prior to despatch to the laboratory. Clearly this is not adhered to in all cases.

To preserve the hydrocolloid impressions in a moist state, specimens usually arrive at the laboratory moistened, perhaps wrapped in tissue, in plastic bags. The predominant organisms potentially multiplying in this moist environment may well not be of oral origin, but derived from the water in which the tissue was moistened. The use of water containing some form of disinfectant is suggested. The presence or absence of disinfection in this context is significant, since the moist environment, coupled with the inevitable presence of microorganisms and of nutrients from saliva/food debris etc. in the specimen, can facilitate the multiplication of contaminants.

Estimates show that approximately 67% of all samples received in laboratories are contaminated[34]. Rinsing impressions under running water only removes 40–90% of bacteria[35,36], and should be regarded as merely a preliminary gross decontamination. Traces of blood and saliva can present a potential risk even after impressions are surface-decontaminated or disinfected[35,37], and care should always be taken when handling such items in order to minimise cross contamination and infection.

There is clearly a need for a large scale survey of microbiological contamination of impression materials to enable a valid risk assessment to be performed. Results obtained in a range of studies certainly indicate the presence of opportunist pathogens contaminating the materials.

DENTURES

Procedures associated with denture construction involve the movement of the prosthesis between the surgery and the laboratory. The principal route of infection is from the patient to the dental technician. However, the prostheses can be contaminated during processing in the laboratory. Microorganisms may be transmitted from prosthesis to prosthesis, to the technician, and potentially back to the patient from the laboratory[18,20].

A recent report has indicated that not only the denture surfaces become colonised by microorganisms, but because of the porosity of the denture acrylic, contamination occurs throughout the denture[38] (hence disinfection might not be entirely effective), and the surface treatments carried out in the laboratory might release more microorganisms from within the material.

The polishing of a previously used denture following a normal adjustment procedure was found to produce massive contamination of the pumice slurry[22,39,40]. There is also potentially a risk for individuals whose new dentures are produced alongside such repairs. In a study by Wakefield[18], ten sterilised dentures were sent to different laboratories. After repair, nine of the dentures were contaminated with pathogens, thus cross-contamination must have occurred in the laboratory, and the prostheses were not disinfected before being returned to the patient. Ideally, the history of the prosthesis requires recording to enable the origin of contamination to be determined –there might, for example, be a higher prevalence of drug resistant contaminants found in laboratories associated with hospitals, as is seen by the presence of MRSA in patients whose presenting complaint was denture stomatitis[41].

THE LATHE

Several studies have demonstrated the polishing lathe to be a major source of contamination. The rag wheel can cross-contaminate, the lathe generates infected aerosol, and the pumice slurry provides a culture medium suitable for the growth of many environmental microorganisms, if not disinfected[39,40,42,43]. Regular disinfection is essential, since microbial counts rise between disinfection events[21]. Even in dental technology non-clinical (teaching) laboratories, pumice slurry is rapidly contaminated with skin and environmental bacteria, these organisms often being opportunistic pathogens[22]. Hence disinfection is also essential in this context.

LOW RISK EQUIPMENT AND ACTIVITIES

Stagnant water in baths maintained at specified temperatures will inevitably support the growth of microorganisms, but the likelihood of these organisms contaminating personnel is minimal, although they may be transferred onto appliances. Isolates tend to be environmental, or derived from skin. Impression agars have been shown not to support the growth of microorganisms, due to the lack of nutrients, and the repeated heating process used to liquefy the medium[21].

Plaster casts have been shown to harbour microorganisms[44]. In addition to the presence of fungal spores within the powder, and of airborne contaminants, microorganisms from impressions can be transferred to casts during pouring, where they can remain viable[34].

Plaster traps are essentially settling tanks for the waste produced by in-house procedures, and are situated beneath sinks within the laboratory. The production and alteration of prostheses follows a process of manufacture of impressions and casts and utilisation of the lathe for adjustment and polishing. Waste such as plaster from casts is removed by cleansing with water, collecting in the plaster traps. The traps prevent drains from blocking, by enabling the settling of particulate matter, so that liquid flows off the top. Clearly, the traps will be heavily contaminated, but might not pose a hazard unless disturbed, for example during cleaning. Perhaps the addition of a non-irritant disinfectant to the trap prior to cleaning might be beneficial to reduce numbers. Clothing to protect from splashes and inhalation of particles would minimise exposure of personnel to the unpleasant malodorous mixture of particulate matter potentially encased in biofilm.

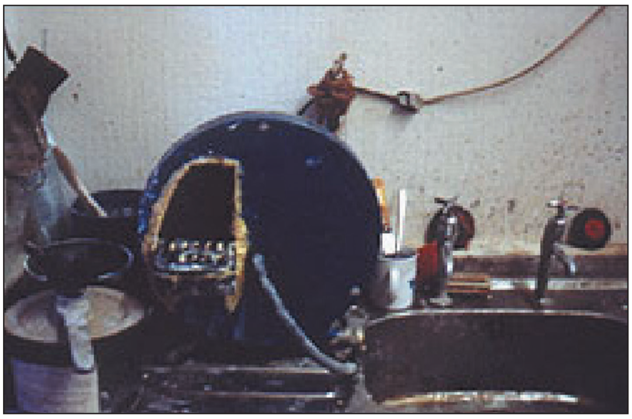
PERSONAL PROTECTION

Raw materials used in dental laboratories are varied. The use of Polymethylmethacrylate preparations, and a range of toxic solvents requires COSHH assessments and appropriate handling to ensure that the health of personnel is not affected[45]. The success of such procedures has not been reported.

Personnel might consider appropriate barrier clothing such as masks to protect the airway, and safety goggles to protect against eye damage and infection during abrasion of prosthesis by pumice slurry. Gloves protect cuts or abrasions from infection, but may themselves pose a hazard, for example during use of the lathe wheel. It has been suggested that the lathe should be fitted with a plastic shield and be faced towards a wall rather than the middle of the laboratory, to minimise aerosols[8]. Latex gloves should not be worn when dispensing, mixing and handling polyvinylsiloxane putty materials, as this increases the setting time for the impression material. Protective clothing should be worn in the laboratory at all times[7]. Laboratory coats should only be worn in the laboratory, and no outside clothing should be taken into the area[1,46].

Serological surveys have shown that dental technicians have a significantly higher prevalence of hepatitis B markers than the general population[47,48], thus personnel might help protect themselves by immunisation. Lodi and

Figure 2a–d. *Damp, untidy sites within a dental laboratory which could predispose to microbial growth if left unattended.*



co-workers[49] suggested that dental auxiliary staff may be at slightly increased risk of Hepatitis C, thus reinforcing the need for dental health care workers to maintain high standards of cross-infection control measures. The risk for HIV transmission is, however, low[50].

LABORATORY DESIGN AND CONDUCT

Good practice should involve the use of strict zoning areas within the laboratory, being divided into receiving, production and shipping areas. It should be implicit that laboratories and offices should be clean (*Figure 2*), but enforcement is virtually impossible owing to the numbers and diversity of laboratories.

Regular cleaning and disinfection of surfaces and floors, dismantling and cleaning of rag wheels, stones and other attachments will also maintain a good hygienic environment and attitude amongst personnel.

Disposal of waste requires the separation of clinical and non-clinical waste items – if there is doubt, then the assumption should be made that waste is clinical. Items such as tissues, sharps and items contaminated with blood or saliva must be transported in appropriately labelled containers. All clinical waste must be sent for high temperature incineration, or soft clinical waste can be buried in deep-fill land sites[45,51,52]. The authors are unaware of any current guidelines specifically regarding the disposal of pumice and plaster slurries.

CONCLUSION

Overall, a barrier technique, separating contaminated material from other surfaces, is successful in minimising the inadvertent spread of microorganisms in the dental laboratory[19] (*Figure 1*). Appropriate disinfection procedures should be carried out, and good laboratory practice maintained. However, in order to supplement the information provided by a number of small, independent studies, a widespread survey of dental technology laboratories should be carried out, to enable the determination of true risks and hazards (HACCP approach). Continued monitoring of particular hazardous procedures is recommended, to ensure that personnel and patients are protected as far as possible from infection due to poor practices within the profession.

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ADDRESS FOR CORRESPONDENCE

Professor Joanna Verran, Department of Biological Sciences, Manchester Metropolitan University, Chester St., Manchester M1 5GD, UK. E-mail: j.verran@mmu.ac.uk

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