Dental Assistants: A Literature Review

Health Professions Regulatory Advisory Council (HPRAC)

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Dental Assistants:
A Literature Review

Prepared by the Planning Unit
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Please take the time to complete an anonymous two-minute Literature Review Survey to inform us how this review met, or did not meet, your needs.

OBJECTIVES

The objective of this rapid literature review was to identify information on dental assistants (DAs) in order to provide the Health Professions Regulatory Advisory Council (HPRAC) members with a clearer understanding of the merits and risks of regulating DAs. Information on seven topics was requested: (1) patient safety and potential for risk of harm (physical, mental, physiological, psychological) for dental x-rays, sterilization procedures, and inhalation sedation; (2) emerging techniques and technologies and how/if they are used by DAs; (3) interprofessional collaboration; (4) history of the profession (including any recent evolution in education and training); (5) examples of practice settings and service delivery/care models; (6) demographic information and trends on DAs; and (7) the impact of DAs on access, outcomes, and productivity.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

Individual peer-reviewed articles and review articles published between 2001 and 2010 were identified through the Ontario Ministry of Health and Long-Term Care's computerized library database, PubMed, and Google scholar. The requestors specifically asked for a search of the following resources *Canadian Dental Association Journal* and *Oral Health & Dental Practice Management.* Grey literature was identified through Google and relevant government websites. The search emphasized, but was not limited to research focusing on Ontario and Canada. Literature on scope of practice, regulations, licensure and certification, competencies and other related topics were excluded from this review. The search was limited to English sources and therefore may not capture the full extent of literature in non-English speaking countries. Additionally, given the broad scope of this review and the limited time frame, a more focused search for specific areas may be required in the future.

The Medical Subject Heading (MeSH) terms "Dental Assistants", "Radiography, Dental", "Conscious Sedation" and "Infection Control, Dental" were used in combination with the following keywords to identify relevant articles and documents for this review: "Ontario", "Canada", "radiation protection", "inhalation sedation", "dental instrument", "interdisciplinary", "multidisciplinary", "disinfectant", "infection control", "workforce", "exposure", "history", "evolution", "adverse effect", "adverse event". The requestors also specifically asked that the following keywords be used: "dental assistants", "risk", "patient safety", "public protection", "x-ray", "energy", "sterilization", "supervision", "dentists", "interprofessional", "collaboration", "demographic trends", "model of care", "technology (emerging)", "dental hygiene and assistants", "training" "educational requirement", "medical radiography", "dental probing", "periodontal screening", "device-fitting", "access to care", "health outcomes", "efficacy", "productivity", "practice setting", "services", "costs", "fees", "inhalation", "analgesia", and "nitrous oxide". The requestors also asked for research on dental therapists in the UK and New Zealand to be included where relevant.

Dr. Carlos Quiñonez, at the University of Toronto, provided research suggestions for the review. A total of 111 references were identified and cited in this review: 20 review articles, 68 original research papers from peer-reviewed journals, and 23 documents from the grey literature. Tables 3 to 11 in Appendix 2 consist of summary tables with details for each of the sources cited in the review. In total, the searching for relevant material and the writing of this review took approximately five weeks to complete by two people.

SUMMARY OF MAIN FINDINGS

- Overall, there is limited, high quality literature on DAs for the majority of these topics. In addition, information on patient safety and new techniques was generally for the entire dental profession as opposed to for DAs. Caution should therefore be taken in generalizing from the findings presented from this review.

Patient safety issues and potential for risk of harm – dental x-rays/radiography, sterilization and inhalation sedation

- Evidence suggests that since the 1990s, the total number of diagnostic medical examinations (both medical and dental) across jurisdictions has increased by approximately 50%.
- *Dental x-rays/radiography:* The evidence suggests that, compared to other sources of radiation, exposure to radiation and the risk of cancer from dental x-rays is relatively low. For example, one study found that the estimated risk of a fatal cancer developing from two intraoral bitewing exposures, or from a dental tomography, is approximately one tumour for every two million exposures.
- *Infection control:* Overall, several reviews concluded that there is a low risk of disease transmission in dental settings for prion disease (e.g., Creutzfeldt-Jakob Disease), SARS, and opportunistic pathogens (e.g., Legionnaires' disease).
- *Inhalation sedation:* The evidence suggests that adverse events from the use of inhalation sedation (i.e., nitrous oxide/oxygen sedation) are relatively rare. For example, one review found a mortality rate of nine in 1,000,000 patients following administration of oxygen/nitrous oxide/halothane. Despite these relatively low risks, the literature stressed the importance of weighing the risks/benefits of radiographic needs, ensuring optimal standards of infection control and decontamination procedures, and awareness of contraindications for inhalation sedation.

Emerging dental technique and technologies

- Six relatively new techniques and technologies were identified that may have implications for DAs (e.g., training): Cone Beam Computed Tomography (CBCT), digital radiography, digital impression technologies, nasoalveolar molding (NAM), laser technologies, and caries detection and diagnosis technologies.

History of the occupation and recent evolution in education and training

- DAs/dental therapists in North America, the UK and New Zealand have existed for almost a century, if not longer in some jurisdictions. For example, in Ontario, the Ontario Dental Assistants Association or ODAA (then the ODN & AA) was formed in 1927.
- Up until 1960, DAs in Ontario learned on the job and were not formally educated. Since 1960, the ODAA has been the certifying body for formal training with dental assisting taught at community colleges and private career colleges.
- The literature also identified the potential role and implications for training DAs in recognizing and responding to child abuse, dental neglect, eating disorders, and substance abuse.

Interprofessional collaboration

- Three of the four references identified were largely descriptive, with examples of DAs collaborating with forensic teams in the US Air Force, Swedish medical staff treating patients with head and neck cancers, the management of paediatric patients with hypodontia [i.e., patients with congenitally missing teeth]), and disabled adults.

Practice settings and service delivery/care models

- A number of practice settings available to DAs were identified and include solo dental practices, group practices, specialty practices (e.g., oral and maxillofacial surgery, orthodontics pediatric dentistry, etc.), public health dentistry (including settings such as schools and clinics), hospital dental clinics and dental school clinics.
- Research on DAs in service delivery/models of dental care was limited. DAs were identified in residential care facilities and general dental practices for disabled patients, as well as in health promotion at schools, day care centres and institutions and in the self-care of clients.

Demographic information/trends

- *Demographics:* The DA workforce is predominately made up of older, white females.
- *Salaries:* Hourly wages for a DA in a Canadian dental practice varied from province to province and office to office. The hourly wages in 2009 for DAs in Ontario was $19.79 in general practice and $20.82 in specialty practices. In Ontario, the Ontario Dental Assistants Association has provided a recommended list of wages depending on the level of experience and type of assistant.
- *Supply and Demand:* In 2006, the absolute number of DAs per province ranged from 11,000 in Ontario to 106 in New Brunswick. For 2006, there was approximately one DA per 1,151 individuals in Ontario and one DA per 7,034 individuals in New Brunswick.
- *Trends:* Possible shortages in the workforce were noted for Canada, the US and New Zealand with potential reasons including increasing demands from dental establishments, insufficient numbers entering the dental therapy workforce, and patterns in applications, enrolment and graduation in the allied dental educational programs (i.e., dental assistants, dental hygienists, and dental laboratory technicians). Other issues identified in the US and New Zealand literature were: retention, uncompetitive salaries in the public sector, limited career development opportunities, students not completing DA programs, and the costs and funding of education.

Impacts of DAs on access, outcomes, productivity

- *Access:* Some evidence suggests that DAs contribute to improving access to dental care for a variety of groups (e.g., the elderly in Canada and the US, American Indians, the US rural population, and the poor). A dominant theme in the literature related but not specifically about DAs was the identification of Expanded Function Dental Assistants (EFDAs) as a potential profession to increase access to dental care.
- *Oral health/health outcomes:* Very limited research was identified that looked at the role of DAs in oral/health outcomes. Although one review found that four-handed delivery (i.e., the use of an assistant) increased retention of sealants by nine percentage points, a 10-year retrospective cohort study found that the risk for sealant failure was significantly higher in sealants placed by dentists and DAs compared to dental hygienists.
- *Productivity:* Some evidence suggests that DAs contribute to productivity in dental practices, dental student productivity and sealant programs. For example, compared to regular unassisted clinics, dental student productivity in four-handed clinics averaged 51% more patient visits and 75% higher charges daily (i.e., higher revenues).

DESCRIPTION OF THE FINDINGS

1. Patient safety issues and potential for risk of harm

1.1 Radiography

No literature was identified that assessed patient safety issues in terms of DAs specifically using X-rays/radiography; however, a broader search in terms of patient safety and dental radiography in general identified 11 relevant sources. Overall, this literature suggests that the risks from dental x-rays are low, and compared to other sources of radiation (e.g., medical exams involving radiation exposure and natural sources), risks from exposure to dental x-rays is small. Due to the technical nature of this literature, Appendix 1 provides a list of terms for this section.

Increased use of dental x-rays

Evidence suggests an increased use of dental x-rays across jurisdictions. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) estimates that the total number of diagnostic medical examinations (both medical and dental) have risen from 2.4 billion to 3.6 billion, an increase of approximately 50% since the previous survey (undertaken between 1991 and 1996) (UNSCEAR, 2008). Dental x-rays are the most frequent type of examination involving radiation in the UK (Hart & Wall, 2002) and is the primary source of diagnostic ionizing radiation to the head and neck for individuals in the US (Barnholtz-Sloan & Kruchko, 2007).

Comparison of exposure

Compared to other sources of radiation, the exposure of radiation from dental x-rays is relatively small both in terms of estimated exposure (ADA, 2010) and effective dose* (Jain, 2010). A UK study found that although dental radiology has increased substantially (by 50%), the very low effective doses for dental x-rays would preclude their greater numbers from having a significant impact on the overall collective dose† (Hart & Wall, 2002). Table 1 provides a comparison of estimated exposure of dental x-rays compared to other sources. As the table shows, exposure to natural sources of radiation per year is estimated to be higher than a bitewing‡ radiograph or full-mouth series x-ray (ADA, 2010).

* An effective dose represents the dose that the total body could receive (uniformly) that would give the same cancer risk as various organs getting different doses. See: http://www.hps.org/publicinformation/ate/q1252.html

† Collective dose is the sum of the individual doses received in a given time period by a specified population from exposure to a specified source of radiation. See: http://hps.org/publicinformation/radterms/radfact41.html

‡ Bitewing x-rays show the upper and lower back teeth and how the teeth touch each other in a single view. These X-rays are used to check for decay between the teeth and to show how well the upper and lower teeth line up. They also show bone loss when severe gum disease or a dental infection is present. See: http://www.webmd.com/oral-health/dental-x-rays

Table 1: Comparison of estimated exposure of radiation from various sources	
Source	Estimated exposure (mSv)
Man made	
Dental	
Bitewing radiographs	0.038
Full-mouth series	0.150
Medical X-rays	
Lower gastrointestinal tract radiography	4.060
Upper gastrointestinal tract radiography	2.440
Chest radiograph	0.080
Natural	
Cosmic (Outer Space) Radiation: Average radiation from outer space In Denver, CO (per year)	0.510
Earth and Atmospheric Radiation: Average radiation in the U.S. from Natural sources (per year)	3.000
Source: ADA, 2010. Adapted from Frederiksen, N.L. (1995). X-Rays: What is the Risk? Texas Dental Journal 112,(2),68-72.	

Table 2 below provides a comparison of the effective dose and the equivalent background exposure[§] to radiation for various types of dental x-rays and for computed tomography (CT). As the table shows, intraoral and extraoral dental x-rays have effective doses ranging from 5.0 to 388 µSv, the equivalent of 0.6 to 47 days of background exposure. This is compared to newer dental x-ray technologies such as cone-beam imaging with effective doses ranging from 20 to 599 µSv or three to 75 days of background exposure and CT effective doses ranging from 20 to 10,000 µSv or two days to three years of background exposure.

Table 2: Effective Dose from Diagnostic X-Ray Examinations and Equivalent Background Exposure		
Source	Effective dose (µSv)	Equivalent background exposure (days)
Various techniques of intraoral dental x-rays (e.g., posterior bitwigns, FMX: D-speed film)	5.0 - 388	0.6-47
Various techniques of extraoral dental x-rays (e.g., panoramic, cephalometric)	3-26	0.5-3
Various techniques of cone-beam imaging[**](e.g., 3D Accuitomo, PreXion, Promax 3D)	20-599	3-75
Various techniques of computed tomography (e.g., Somaton 64 MDCT, abdomen, barium enemas – chest)	20-10,000	2 days – 3 years
Adapted from Jain, 2010.		

Notably, epidemiological studies comparing cancer rates in high- and low-background radiation regions have repeatedly failed to show any association with background levels in the US or in other countries. It also appears that radiation doses at levels of as much as several times natural background do not play a significant role in increasing cancer above the natural incidence rate (Russell Ritenour & Gibbs, 2010).

Risks of dental x-ray/radiography exposure

Risks can be categorized into deterministic and stochastic groups. Deterministic effects of x-ray exposure are those where the severity of the effect expands with increasing exposure. Implicit in this concept is that

[§] Background radiation is radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices. See: http://hps.org/publicinformation/radterms/radfact3.html

[**] Cone-beam imaging is a relatively new three-dimensional imaging technology, which has been specifically developed for imaging of the teeth and jaws (Dawood et al. 2009).

there is a threshold below which effects do not occur. Examples of deterministic effects include birth defects which have a threshold of 100-250 mSv,[††] cataract of the lens of the eye which has a threshold of two Gy[‡‡] of exposure, and radiation burn which has a three Gy threshold of exposure (Ludlow, 2009).

A stochastic effect occurs by chance and may occur without a threshold level of dose, is proportional to the dose and whose severity is independent of the dose. In the context of radiation protection, the main stochastic effect is cancer.[§§] Due to the relatively low and localized exposure of dental and maxillofacial imaging (Ludlow, 2009), much of the potential risks identified in the literature are stochastic and focus on the risk of cancer. In general, the literature suggests that with the exception of x-rays involving full-mouth series performed 15-40 years ago (Longstreth et al. 2004, see also Barnholtz-Sloan & Kruchko 2007), the risk of cancer from dental x-rays is low.[***] For example, Beneyto et al.'s (2007) review of the literature on European guidelines and the protocols of performance of selection criteria in dental radiology cited a number of studies that found:

- The estimated risk of a fatal cancer developing from two intraoral bitewing exposures, or from a dental tomography is of the order of one tumour for every two million exposures.
- In the case of panoramic radiology, the lifetime risk of fatal cancer is 0.21-1.9 per million.
- For an intra-oral radiograph, the risk of cancer is 0.02-0.6 per million.

A 2009 review of children's exposure to diagnostic medical radiation and cancer risk also found that studies of diagnostic x-rays and risk of childhood brain tumors have not observed an increased risk with exposure. Therefore, overall, there is little evidence that post-natal diagnostic exposure increases childhood cancer risk (Linet et al. 2009).

However, a study reassessing patients' risk related to common dental radiographic exposures using the 2007 revised estimates of the radiosensitivity of tissues by the International Commission on Radiological Protection found that the dental radiographic procedures evaluated in the 1990 ICRP study are 32 to 422% riskier than previously thought. The authors suggested using specific types of x-rays over others (e.g., digital receptors or F-speed film instead of D-speed film, rectangular collimation instead of round collimation) (Ludlow et al. 2008). Even these doses are comparatively lower compared to other radiation including natural sources (see Russell Ritenour & Gibbs, 2010).

1.2 Infection control

With the exception of two commentaries (Ng et al. 2007a, Moffat, 2003), no research was identified that examined the risks involved in sterilization procedures carried out specifically by DAs. Ng et al (2007a) discussed the role of the DA in infection control for digital radiographic procedures noting that these procedures offer unique infection control challenges but, "[w]ith understanding of basic principles and

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[††] Sv or Sievert is the International System of Units unit for dose equivalent equal to 1 joule/kilogram. Frequently used are the mSv (millisievert) and the µSv (microsievert). See: http://hps.org/documents/Medical_Exposures_Fact_Sheet.pdf

[‡‡] Gray (Gy) is the international system (SI) unit of radiation dose expressed in terms of absorbed energy per unit mass of tissue. The gray is the unit of absorbed dose and has replaced the rad; 1 gray = 1 Joule/kilogram and also equals 100 rad. See: http://hps.org/publicinformation/radterms/radfact79.html

[§§] See: http://hps.org/publicinformation/radterms/radfact142.html

[***] Studies finding an increased risk of certain cancers (e.g., meningiomas, childhood brain tumours) associated with dental x-ray exposure have been documented but studies in other populations have not confirmed these results or the methodology was problematic (see Barnholtz-Sloan & Kruchko, 2007; Linet et al. 2009; Russell Ritenour & Gibbs, 2010).

practice in a clinical setting, the DA should be able to easily master these procedures" (Ng et al. 2007a). In the second commentary, Moffat (2003) endorses the formal education and licensure of DAs and notes that, "proper application of surgical and sterilization techniques are equally important to patient safety. Formally educated DAs have the knowledge required to recognize this. Our expertise allows us to understand the difference between sterilization and disinfection, and the relative importance of both. These tasks are nearly always performed by DAs, without direct supervision…public safety demands that those responsible for sterilization be knowledge experts" (Moffat, 2003).

A broader search that included general risks to patients in the context of infection control (including sterilization) in dental practices identified 14 relevant references. Overall, although there is a low risk of disease transmission in dental settings for prion disease††† (Azarpazhooh & Fillery, 2008; Walker et al. 2008; Azarpazhooh & Leake, 2006; Porter, 2003), SARS (Samaranayake & Peiris, 2007), and opportunistic pathogens such as *Pseudomonas aeruginosa* and *Legionella pneumophila* present in contaminated dental unit water systems (Pankhurst & Coulter, 2007; Walker & Marsh, 2007; Depaola et al. 2002) and *Methicillin-resistant S. aureus* (MRSA) (Kleven et al. 2008), a majority of the reviews acknowledged that the *potential* risk of disease transmission in dental settings requires optimal standards of infection control and decontamination procedures (e.g., Azarpazhooh & Leake, 2006; Porter, 2003; Samaranayake & Peiris, 2007; Harrel & Molinari, 2004). One review of instrument management in the dental office noted that dentistry has developed definitive guidelines for infection control, which, if followed, can produce sterile instrumentation on a consistent basis. However, the authors stress that "sterilization is a complex process requiring specialized equipment, adequate space and, most importantly, qualified personnel who are provided with ongoing training" (Depaola & Fried, 2009).

1.3 Inhalation sedation

No studies were identified that examined patient safety/risk in the context of DAs administering inhalation sedation. A broader search for patient safety/risks in inhalation sedation in dentistry resulted in 12 references identified. Overall, the literature found that adverse events from the use of inhalation sedation (i.e., nitrous oxide/oxygen sedation) are relatively rare (e.g., Collado et al. 2007; Lyratzopoulos & Blain, 2003; Malamed & Clark, 2003). For example:

- One review looking at the evidence for the use of inhalation sedation (IHS) instead of dental general anaesthesias for dental treatment for children found limited high quality research. However, the existing evidence suggested that morbidity associated with IHS is minor and infrequent, with studies reporting only minor side effects associated with IHS (mainly nausea/vomiting and headache), in 5–13% of patients. Additionally, no major adverse events (i.e., death, unplanned hospitalization) were reported in the reviewed literature for IHS, with no deaths reported in over one million cases (Lyratzopoulos & Blain, 2003).
- A review to define the risks for anaesthesia and sedation outside the operating room found that in the dental office, a mortality rate of nine in 1,000,000 was reported following administration of oxygen/nitrous oxide/halothane in the UK. However, the number of deaths in the UK has decreased from 100 (1970-79) to 20 (1990-99) (Melloni, 2007).

††† Prion diseases are a group of rare fatal neurodegenerative disorders in human and animals that are histopathologically characterized by spongiform change within the central nervous system such as Sporadic Creutzfeldt-Jakob disease, or sCJD (Porter, 2003).

- A review examining the incidence of adverse events of conscious sedation with 50% nitrous oxide/oxygen premix and including studies involving dental care, identified one study that estimated a risk for a serious adverse events directly due to the gas of 3/10,000 administrations (Collado et al. 2007).

Single studies also support these conclusions (Boynes et al. 2010, Hulland et al. 2002, Malamed & Clark, 2003). In particular, a study in Ontario found that the use of either oral midazolam or nitrous oxide–oxygen as single agents provides safe and effective conscious sedation in the pediatric dental outpatient population (Hulland et al. 2002).

However, some studies suggest that there are still some risks involved with inhalation sedation. One review noted that even with the relatively insoluble nature of nitrous oxide and its rapid onset and fast elimination, a prolonged administration to an obese individual may result in delayed recovery because of the modest tendency for nitrous oxide to accumulate in body fat (Baker and Yagiela, 2006). Additionally, a number of contraindications were identified. These include, but are not limited to, individuals with cystic fibrosis; patients with mental or psychiatric conditions or drug addictions or recovering from drug addictions (Clarke, 2009); individuals with significant chronic obstructive pulmonary disease (Clark, 2009; Becker & Rosenberg, 2008); patients with upper respiratory tract infections, blocked sinuses, blocked nasal passages due to allergies, and mouth breathers (Clark, 2009; Becker & Rosenberg, 2008); and patients who have received ocular surgery or middle ear surgery (Clarke, 2009). Heightened sexual awareness was also identified (Malamed & Clark, 2003). Although not related to patient safety per se, the potential abuse of nitrous oxide (Collado et al. 2007; Clark, 2009) and biohazards of chronic exposure to nitrous oxide were other risks noted (mainly by dental personnel) (Malamed & Clark, 2003; Brunick & Clark, 2010).

Several US states are now including nitrous oxide administration and monitoring into their state practice acts for DAs, although this varies between the states (Brunick & Clark, 2010; DANB, 2010). For example, according to the US Dental Assisting National Board, the roles of DAs in sedation and anesthesia varied with Arkansas the only state allowing DAs to induce sedation using nitrous oxide and nine states have regulations that expressly prohibit it. Six states allow DAs to administer nitrous oxide, another 14 states allow DAs to prepare/assist in the administration, and 34 states allow DAs to monitor patients undergoing nitrous oxide sedation (DANB, 2010).

2. Emerging dental technique and technologies

Six relatively new techniques and technologies were identified that may have implications for DAs; however, information on how emerging dental techniques and technologies directly relate to DAs was, in general, limited. These included Cone Beam Computed Tomography, digital radiography, digital impression technologies, nasoalveolar molding, laser technologies, and caries detection and diagnosis technologies. Potential risks, if noted in the literature, are also discussed below.

Three references in this review identified Cone Bean Computed Tomography (CBCT) as a relatively new three-dimensional imaging technology for the imaging of teeth and jaws. Caution is stressed (i.e., weighing the risk against the benefits of radiation exposure to patient) on appropriate use and application of this technology (Dawood et al. 2009; Perschbacher, 2009; Danforth et al. 2003). Radiography is also moving from film to digital radiography with one reference stressing that training will be needed because digital radiographs are becoming more and more prevalent in dental practice (Ng et al. 2007b). A commentary on digital impression technologies (an alternative to physical impression technologies) described the DA's role

with a new system that eliminates physical impression taking for crowns, bridges, and other dental restoratives while improving work flow, saving time for the practice and providing a positive dental experience for the patient (Garvey, 2007).

Nasoalveolar molding (NAM) represents a paradigm shift from the traditional methods of presurgical infant orthopedics (Grayson et al. 2005). Notably, in their discussion of NAM, Grayson et al. (2005) conclude that the clinical skills required for treating patients with NAM may be advanced by the training of a DA or laboratory technician to make adjustments to the moulding plate under direct supervision of the practicing clinician. One commentary also identified the potential role of DAs as Laser Safety Officers to oversee safety and effective delivery of laser technologies in dental practices, and also understanding laser technology to train staff and educate patients (Rice, 2005).

In addition to the emerging techniques and technologies listed above, some of the literature discussing new and emerging techniques and technologies in dentistry stressed the importance of (ongoing) education and training. For example, the DA is often required to develop the set of skills specific to a particular dentist's specialization (e.g., endodontic procedures). Additionally, significant learning curves are often involved even for basic restorative procedures that the assistants may be required to keep pace with, especially if the new systems are technique sensitive (Carlson et al. 2007).

3. History of the occupation and recent evolution in education and training

3.1 History

DAs in North America and dental therapists in the UK and New Zealand have existed for almost a century and longer in some jurisdictions. In the US, Dr. C. Edmund Kells is attributed with hiring the first female DA in 1885 (Carney, 2010; Roberts, 2007). According to an editorial in the *Journal of the California Dental Association*, Kells recognized the need to overcome the prevailing social norms to make dental care accessible for women who could not be accompanied by a chaperone (Carney, 2010). In the UK, while dental therapists could be considered by the general public and dental profession as a new additional team member since their introduction to general dental practice in 2002, historical evidence suggests that there were 'dental dressers' performing equivalent roles almost a century ago (Rowbotham et al. 2009). Similarly, New Zealand established a School Dental Service and the training of Dental Therapists or 'Dental Nurses' began in 1920 (BADT, 2009). In Ontario, the Ontario DAs Association (ODAA, then the ODN & AA) was formed in 1927 (ODAA, 2010).

3.2 Evolution of the education of DAs

Limited information on the history and evolution of the education of DAs in Ontario or Canada was identified. In Ontario, up until 1960, DAs learned on the job and were not formally educated. In 1960, the Royal College of Dental Surgeons appointed the ODAA to be the certifying body for formal training of Ontario DAs (ODAA, 2010). Dental assisting in Ontario is taught at community colleges and private career colleges in Ontario. A formal education in a recognized facility will provide DAs with a body of knowledge in behavioural sciences, biomedical sciences, oral health sciences, and dental assisting theory and practice (ODAA, 2010).

Information on the history and evolution of education for DAs was also identified for: (1) oral and maxillofacial radiographic imaging education in Finland, Norway, and Denmark (Peltola et al. 2009), (2)

education and training of DAs in the US (Jackson Brown et al. 2005) and (3) the education and training of dental therapists in the UK and New Zealand (Rowbotham et al. 2009; Coates et al. 2009). For example, in the US DAs received accredited education through academic programs at various institutions including community/junior colleges, technical colleges/institutes, vocational schools, universities / four-year colleges, dental schools and 11 other kinds of settings in 2002-2003. Graduates of these programs usually receive certificates or diplomas. Although the majority of academic dental assisting programs take nine to 11 months to complete, some schools offer accelerated training, part-time educational programs or training via distance education (Jackson Brown et al. 2005). It should be noted that many individuals employed as DAs have received on-the-job training rather than as students in formal training programs (Waldman & Perlman, 2008).

Potential evolutions in the education and/or training of DAs were also identified. For example, some authors discussed the importance of education and training for DAs regarding how to recognize and respond to child abuse or dental neglect (Nuzzolese et al. 2009), eating disorders (e.g., anorexia nervosa and bulimia nervosa) (DiGioacchino DeBate & Tedesco, 2007), and substance abuse (e.g., tobacco use) (AMERSA, 2002). Three additional proposals that may impact DAs were suggested in the literature. First, in the US, three midlevel dental workforce models proposed to improve access to oral health care (i.e., the advanced dental hygiene practitioner; the community dental health coordinator; and the dental health aide therapist) may also have implications for the dental education community (McKinnon et al. 2007, see also Haden et al. 2001). With teamwork regarded as essential for high quality dental care, the need to develop interprofessional curricula has also been recommended (Evans et al. 2010; Gore et al. 2006). Last, an editorial discussing the changing role of DAs in the US recommended a national standard of education and a standard credential that all states would recognize (Roberts, 2007).

4. Interprofessional collaboration

Very limited research was found in terms of interprofessional collaboration and/or its outcomes in dentistry. Examples included collaboration between DAs and forensic teams in the US Air Force (Hanks, 2008) and Swedish hospital dental personnel working with medical staff to treat patients with head and neck cancers (Röing et al. 2006). Another article examining the oral health needs of disabled adults argued that dental management of patients with disabilities, at all levels of severity, demands an interdisciplinary approach with the dental team (including the DA) working with other health care providers, family members and social service agencies to facilitate therapy and home care (Stiefel, 2002). Of interest, one UK study of dental therapists involved in the multidisciplinary management of paediatric patients with hypodontia‡‡‡ (Ranka et al. 2010). The study found that all of the initial treatment prescribed in the small cohort could have been carried out by a dental therapist but only four out of the 34 patients was seen by a dental therapist (Ranka et al. 2010).

5. Practice settings and service delivery/care models

A number of practice settings available to DAs were identified, including solo dental practices, group practices, specialty practices (e.g., oral and maxillofacial surgery, orthodontics and dentofacial orthopedics, endodontics, periodontics, prosthodontics and pediatric dentistry, public health dentistry (including settings such as schools and clinics), hospital dental clinics and dental school clinics (MDA, 2010; ADA, 2010b;

‡‡‡ According to Rank et al. (2010), hypodontia specifically describes the absence of one to six teeth excluding third molars, but is most often used when a patient has congenitally missing teeth.

ADA, 2010c). The US military was another prominent practice setting for DAs (see for example, Luciano et al. 2006; Diaz-Cruz, 2006). DAs were also recognized as central in general dental practices wishing to incorporate outpatient hospital dentistry (Sani & Spencer, 2001).

Research evidence assessing DAs in service delivery/models of dental care was limited. Two studies on dental care models identified and/or described the role of DAs; one study described the role of DAs in residential care facilities and general dental practices for patients with disabilities (Lawton, 2002) and the other identified DAs as central in health promotion at schools, child day care centres and institutions as well as the self-care of clients in Finland (Nordblad, 2004). In addition, one Ontario study undertaken in the Wellington-Dufferin-Guelph Health Unit found that the majority of dental professionals, including DAs, did not provide proven smoking cessation services. The authors concluded that an opportunity exists to increase the proportion of dental professionals providing proven smoking cessation interventions as part of routine patient services. (Brothwell & Armstrong, 2004).The majority of service delivery/care models where DAs were central was aimed at improving access to care and is discussed in more detail under the section, "Impacts of DAs on access, outcomes, and productivity".

6. Demographic information/trends

Information (where available) for demographics, salaries, supply and demand, and key trends of the DA labour market for four jurisdictions (Ontario, New Zealand, the UK and US) are discussed below.

6.1 Demographics

The DA workforce is predominately women (Rosmus, 2005; see also Broadbent, 2009; McDonough, 2009; Dental Therapy Technical Advisory Group, 2004). In New Zealand and the US in particular, the mean age of the work force is over 45 years old (Broadbent, 2009; McDonough, 2009). There is also an under-representation of ethnic groups in the dental workforce in general in both these jurisdictions (Dental Therapy Technical Advisory Group, 2004; Neumann, 2004). In New Zealand, the representation of ethnic groups and younger practitioners is increasing for dental therapy (Broadbent, 2009) but in the US, the ethnic profile of dental and allied personnel has not significantly changed (Neumann, 2004).

6.2 Salaries

In Canada, DA salaries vary greatly from province to province, and office to office (ODAA, 2010). Hourly wages in 2009 for a DA in a general practice work setting ranged from CDN $14.24 per hour in Newfoundland to $25.53 in Alberta and in specialty practice work settings, wages ranged from $17.61 in Newfoundland to $27.52 in Alberta (Canadian Dental Assistants' Association, 2010). In Ontario, the ODAA has provided a recommended list of wages depending on the level of experience (new graduate vs. three to five years of experience) and type of assistant (e.g., Level I, Level II, Treatment Coordinators, etc.) that ranges from $15/hour to $24 - $32/hour (ODAA, 2010). In the US, median annual wages for DAs were USD $32, 380 in May 2008 with the middle 50% earned between $26,980 and $38,960. The lowest 10% earned less than $22,270, and the highest 10% earned more than $46,150 (US Bureau of Labor Statistics, 2010). In 2004, dental therapy salaries in New Zealand on average range between NZD $25,000 and $47,000, with significant regional differences and variations of working hours and leave entitlements (Dental Therapy Technical Advisory Group, 2004).

6.3 Supply and Demand

In 2006, the absolute number of DAs per province ranged from 11,000 in Ontario to 106 in New Brunswick (Quiñonez, 2009). In addition, the absolute numbers of dental public health practitioners that were DAs for seven provinces ranged between 140.47 in Ontario to six in Manitoba (Quiñonez, 2009). No information regarding the number of DAs per capita was identified for Ontario/Canada. However, using Statistics Canada population estimates, there was approximately one DA per 1,151 individuals in Ontario and one DA per 7,034 individuals in New Brunswick[§§§].

In the US, DAs held about 295,300 jobs in 2008. About 93% of all jobs for DAs were in offices of dentists. A small number of jobs were in the Federal, State, and local governments or in offices of physicians. More than one-third of DAs worked part time in 2008 (US Bureau of Labor Statistics, 2010). In New Zealand, a total of 682 dental therapists were listed on the Dental Council of New Zealand (DCNZ) register who first registered prior to the 2008 reporting period, and 648 held a current Annual Practicing Certificate (APC). A total of 69.0% of dental therapists in New Zealand worked full-time and almost all (85%) working in the District Health Board sector. Variation in the dental therapist-to-population ratio by area in New Zealand was also noted (Broadbent, 2008).

6.4 Key Trends

Possible shortages in the workforce were noted for Canada, the US and New Zealand (Moffat, 2002; Waldman, 2008; Neumann, 2004; Brown et al. 2007; Dental Therapy Technical Advisory Group, 2004). Potential reasons for shortages included the needs of the increasing numbers of large dental establishments in the US (Waldman, 2008); insufficient numbers entering the dental therapy workforce in New Zealand (Dental Therapy Technical Advisory Group, 2004); and patterns in applications, enrolment and graduation in the allied dental educational programs (Neumann et al. 2004). In contrast, dental therapists in the UK were projected to increase between 2001 and 2021 (UK Department of Health, 2004). According to the US Bureau of Labor Statistics, the job prospects of DAs for entry-level positions are excellent; although some dentists prefer to hire experienced assistants, those who have completed a program or have met state requirements to take on expanded functions within the office (US Bureau of Labor Statistics, 2010). Other trends in the US and New Zealand literature included potential issues of retention of workforce capacity if salaries and terms and conditions in the public sector are not competitive with private sector conditions (Dental Therapy Technical Advisory Group, 2004), limited career development opportunities (Dental Therapy Technical Advisory Group, 2004), students not completing DA programs (Waldman, 2008), and the cost and funding of education affecting the attractiveness of dental careers (Neumann, 2004).

7. Impacts of DAs on access, outcomes, and productivity

7.1 Access

Overall, the literature suggests that DAs contribute to or are important in improving access to dental care for a variety of groups including the elderly in Canada and the US (Morreale et al. 2005), American Indians

[§§§] This is based on Statistics Canada's population estimate of Ontario for 2006, which was 12,665,300 and for New Brunswick was 745,700. The number of DAs per capita was found by dividing Ontario's 2006 population with the absolute number of DAs in Ontario (11,000) and New Brunswick's 2006 population with its absolute number of DAs (106). See: http://www40.statcan.gc.ca/l01/cst01/demo02a-eng.htm for population estimates.

(Orano, 2005), the US rural population (Skillman et al. 2010), and the poor (Beazoglou et al. 2005; Chaffin et al. 2003; Allison et al. 2004). For example, the authors of an analysis of the dental safety net in Connecticut, US, estimated that the output of safety-net clinics would increase by at least 80% if these clinics had the same allied health staffing levels (e.g., DAs) as those of private practices (Beazoglou et al. 2005). However, while a report looking at access issues to dental services in Quebec identified DAs as an important staff member in programs targeted at improving access to the underprivileged, the authors do note that their role can be fulfilled by dentists and dental hygienists and appropriately trained dental students (Allison et al. 2004).

A dominant theme in the literature was the identification of Expanded Function Dental Assistants (EFDAs) as a potential option to increase access to dental care (Mertz & O'Neil, 2002; Gehshan & Wyatt, 2007; Skillman et al. 2010; Luciano et al. 2006). According to Gehshan & Wyatt (2007), EFDAs are a dental professional (sometimes called registered dental assistants in expanded function) that are licensed and in practice in 17 US states. They work under the direct supervision of a dentist to prepare or finish up restorations, take x-rays, apply sealants and fluoride varnishes, and polish teeth. They also can perform limited cleanings, called "toothbrush cleanings" with a rubber cup or brush that are well-suited to young children. Some states such as Tennessee (Halpern, 2010), Minnesota (Cooper et al. 2006) and Kansas (Villalpando et al. 2006) have addressed access issues through EFDAs. EFDAs have also been utilized by the US Department of Defence to address the challenges of a shrinking pool of dentists with the large number of service members requiring dental care before deployment (Luciano et al. 2006). An overview of US oral health noted that pilot studies have shown the expanded practice models to be safe and effective and these practices have been successful in reaching underserved populations. However, the authors note that regulatory changes around scope of practice are a slow process and a few states have implemented major changes (Mertz & O'Neil, 2002). In addition, according to one article, EFDAs are in short supply in many US states and dentists are not accustomed to working with them. The authors however, do not elaborate on the reasons for these challenges (Gehshan & Wyatt, 2007).

7.2 Oral Health/Health Outcomes

Limited research looking specifically at the role of DAs in improving oral health or health outcomes was identified. The review found research looking at DAs in the provision of sealants (Griffin et al. 2008; Folke et al. 2004) and preventive care (Pienihäkkinen & Jokela 2002). Although a review of four-handed delivery (i.e., the use of an assistant) in the dental practice examining whether it increases the retention and effectiveness of dental sealants found the presence of a second operator increased retention by nine percentage points (Griffin et al. 2008), a 10-year retrospective cohort study comparing the effectiveness of molar sealants placed by dentists, dental hygienists and DAs found that the risk for sealant failure was significantly lower in sealants placed by dental hygienists compared to those placed by dentists or DAs. Notably, differences in the DA group highlighted the need for continued training and re-evaluation of technical competency of all who apply sealants (Folke et al. 2004).

7.3 Productivity

A limited number of articles suggested that DAs may contribute to dental practice productivity (Skillman et al. 2010, Conrad et al. 2010), dental student productivity (Holmes et al. 2009, Lam et al. 2009), and sealant programs (Scherrer, 2004; Scherrer et al. 2007). For example, a study of productivity in Oregon dental practices found that visits per week are significantly related to the number of assistants present, among other factors (e.g., number of dentist hours worked) (Conrad et al. 2010). Compared to regular unassisted

clinics, dental student productivity in four-handed clinics averaged 51% more patient visits and 75% higher charges daily in the four-handed clinic. However, the increased revenues may not be sufficient to offset the increased expenses incurred in the four-handed clinical operation (e.g., the hiring of a DA) (Holmes et al. 2009).

Please take the time to complete an anonymous two-minute Literature Review Survey to inform us how this review met, or did not meet, your needs.

APPENDIX 1

Key Terms for Radiography

1. Measurements

Dose: A general term used to refer either to the amount of energy absorbed by a material exposed to radiation (absorbed dose) or to the potential biological effect in tissue exposed to radiation (equivalent dose). ****
Dose rate: The radiation dose delivered per unit time.††††
Cumulative dose: The total dose resulting from repeated exposures of ionizing radiation to the same portion of the body, or to the whole body, over a period of time.‡‡‡‡
Sv or Sievert: The International System of Units (SI) unit for dose equivalent equal to 1 joule/kilogram. The sievert has replaced the rem; one sievert is equal to 100 rem. One millisievert is equal to 100 millirem. §§§§
Gray (gy): the international system (si) unit of radiation dose expressed in terms of absorbed energy per unit mass of tissue. The gray is the unit of absorbed dose and has replaced the rad. 1 gray = 1 joule/kilogram and also equals 100 rad. *****
Collective dose: the sum of the individual doses received in a given time period by a specified population from exposure to a specified source of radiation.†††††

2. Risk Assessment Terms

Effective dose: Effective dose is not a real physical quantity, but is a "manufactured" quantity invented by the International Commission on Radiological Protection (an international scientific group). It is calculated by multiplying actual organ doses by "risk weighting factors" (which give each organ's relative radiosensitivity to developing cancer) and adding up the total of all the numbers—the sum of the products is the "effective whole-body dose" or just "effective dose." These weighting factors are designed so that this "effective dose" supposedly represents the dose that the

**** See: http://hps.org/documents/Medical_Exposures_Fact_Sheet.pdf
†††† See: http://hps.org/publicinformation/radterms/radfact63.html
‡‡‡‡ See: http://hps.org/publicinformation/radterms/radfact49.html
§§§§See: http://hps.org/documents/Medical_Exposures_Fact_Sheet.pdf
***** See: http://hps.org/publicinformation/radterms/radfact79.html
††††† See: http://hps.org/publicinformation/radterms/radfact41.html

total body could receive (uniformly) that would give the same cancer risk as various organs getting different doses. Example: the lungs receive 2 mSv (they have a weighting factor of 0.12) and the thyroid receives 1 mSv (it has a weighting factor of 0.05). The effective dose is (2×0.12) + (1×0.05) = 0.29 mSv. This model says that the cancer risk from the whole body getting 0.29 mSv uniformly is the same as the lungs getting 2 mSv and the thyroid getting 1 mSv (and no other organ getting a significant dose).This is quite theoretical, as there is uncertainty of how radiation causes cancer, if it causes cancer at these low levels, etc. ‡‡‡‡‡

Weighting factor (W_T): A multiplier that is used for converting the equivalent dose to a specific organ or tissue into what is called the "effective dose." The goal of this process was to develop a method for expressing the dose to a portion of the body in terms of an equivalent dose to the whole body that would carry with it an equivalent risk in terms of the associated fatal cancer probability. It applies only to the stochastic effects of radiation.§§§§§

Radiation weighting factor: the factor by which the absorbed dose (rad or gray) must be multiplied to obtain a quantity that expresses, on a common scale for all ionizing radiation, the biological damage (rem or sievert) to the exposed tissue. It is used because some types of radiation, such as alpha particles, are more biologically damaging to live tissue than other types of radiation when the absorbed dose from both is equal. This replaces the term quality factor in the latest system of recommendations for radiation protection.******

Equivalent dose: the product of absorbed dose in tissue multiplied by a quality factor (now known as a radiation weighting factor), and then sometimes multiplied by other necessary modifying factors, to account for the potential for a biological effect resulting from the absorbed dose. It is expressed numerically in rems (traditional units) or sieverts (si units).

Per caput effective dose: The average effective dose (in mSv) is a measure of the relative potential hazard or risk to the patient. The *collective dose* (expressed in man-Sv) is the product of the number of persons examined and the average dose per examination. If the collective dose is divided by the total population (patients as well as those not exposed), then we get the *per caput effective dose* (in mSv). It is a measure of the risk to the population from a particular category of radiation usage and offers a convenient parameter for comparing risks from different applications (e.g. diagnostic radiology vs. diagnostic nuclear medicine); all medical applications vs. industrial applications or the nuclear fuel cycle).††††††

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‡‡‡‡‡See: http://www.hps.org/publicinformation/ate/q1252.html

§§§§§ See: http://hps.org/publicinformation/radterms/

****** See: http://hps.org/publicinformation/radterms/radfact122.html

†††††† See: Nagaratnam, A. (2002). Medical Applications of Radiation : Worldwide Scenario (Data Based on UNSCEAR 2000): Editorial. *IJNM, 17(2 & 3): 49-51.*

3. Other

Stochastic effect: Effects that occur by chance and which may occur without a threshold level of dose, whose probability is proportional to the dose and whose severity is independent of the dose. In the context of radiation protection, the main stochastic effect is cancer.‡‡‡‡‡‡
Deterministic effect: The severity of which varies with the dose and for which a threshold is believed to exist. Deterministic effects generally result from the receipt of a relatively high dose over a short time period. Skin erythema (reddening) and radiation-induced cataract formation is an example of a deterministic effect (formerly called a nonstochastic effect).§§§§§§
Background radiation: Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices. It does not include radiation from source, byproduct, or special nuclear materials regulated by the nuclear regulatory commission. The typically quoted average individual exposure from background radiation is 360 millirems per year. *******

‡‡‡‡‡‡ See: http://hps.org/publicinformation/radterms/radfact142.html
§§§§§§ See: http://hps.org/publicinformation/radterms/radfact59.html
******* See: http://hps.org/publicinformation/radterms/radfact3.html

APPENDIX 2

Table 3 – Literature on Patient Safety/Risk of Harm in X-rays/Dental Radiography †††††††

No.	Description	Reference
	Review Articles on Patient Safety/Risk of Harm in X-rays/Dental Radiography	
1	Meningiomas are among the most common primary intracranial tumors. Although the vast majority of these tumors are considered histologically benign, the incidence of complications can be high. Few studies have investigated the causes and risk factors for meningioma; this review highlights the current state of knowledge. Gaining a better understanding of the origin of this disease is essential so that treatments and outcomes can be improved and prevention strategies can be developed. The authors note that the strongest evidence for high-dose radiation exposure in the development of meningiomas comes from individuals who underwent therapeutic radiation treatment to the head or neck for neoplastic conditions, whereas the strongest evidence for low-dose radiation exposure comes from the tinea capitis cohort studies. Studies of meningioma risk in atomic bomb survivors who received moderate to high doses of radiation - depending on their distance from the hypocenter of the bomb explosion—are less consistent, as is evidence from diagnostic radiation exposure from dental x-ray studies. The primary source of diagnostic ionizing radiation to the head and neck for individuals in the United States is from diagnostic dental x-ray studies. In particular, full mouth series and panoramic dental radiographs use radiation beam conversion points that include parts of the meninges. Initial studies in Los Angeles, California showed that individuals who had repeated full-mouth dental x-ray exposure, particularly before the age of 20 or before 1945, were at a four-fold increased risk of developing a meningioma (p value < 0.01). However, studies conducted in populations outside the United States did not confirm these results. The authors of the most recent study of this exposure in the United States found that there was an increased risk of meningiomas associated with dental x-ray exposure (OR [95% CI] 2.06 [1.03–4.17]), but only for full-mouth series that were performed at least 20 years ago when the radiation exposure was much greater than it is currently. Taken together, these studies imply that the radiation exposure obtained from diagnostic dental radiographs could be associated with meningioma risk, but with a long latency period of at least two decades. Other types of diagnostic x-ray studies, such as computed tomography scans, have not yet been studied on a large enough scale to form conclusive results. The authors conclude that other than increasing age, the most consistently confirmed risk factor for meningioma is ionizing radiation exposure, despite the fact that many other environmental, lifestyle, and genetic risk factors have been studied with inconclusive results. Further studies are needed that fully integrate environmental exposure and lifestyle information with genetics, but for these studies to be scientifically meaningful they will require large sample sizes, rigorous long-term follow-up, and high-quality measurement of environmental exposure and lifestyle factors.	Barnholtz-Sloan, J.S. & Kruchko, C. (2007). Meningiomas: Causes and risk factors. *Neurosurg Focus.* 23(4): E2.

††††††† Please note the studies, programs, and findings presented in this table may originate from jurisdictions with health systems that are significantly different from Ontario's. If there is intent to draw heavily from one or more sources presented in this table, we recommend that you contact the lead author of this review for assistance with evaluating the local applicability.

No.	Description	Reference
2	Although the radiological doses used by dentists are low individually, patients are often exposured to many repeat dental radiographic examinations. The 'routine' use of dental radiography, such as screening of all patients using dental panoramic radiography (DPRs) or a random decision to take a dental radiograph, will inevitably lead to unnecessary patient exposure. The use of Radiographic Referral Criteria has now become a legal requirement for all practitioners in Europe following the adoption of European Legislation. All exposures to x-rays should be clinically justified and each exposure should be expected to give the patient a positive net benefit. Recently the European Commission has published guidelines on radiation protection in dental radiology. Guidelines have previously been available in a number of European countries and also within the United States. At the present time, no specific guidelines have been published within Spain. The aim of this review article is to provide the Spanish dentist with guidance as to the appropriateness of different radiographic techniques for a variety of clinical conditions and also the frequency with which they should be taken. This summary focuses on the section entitled "Radiation dose and risks" in the article. Radiation dose and risks: The biological effects of ionizing radiation can be extremely damaging. Somatic deterministic effects predominate with high doses of radiation, while somatic stochastic effects predominate with low doses. Dental radiology employs low doses and the risk of stochastic effects is very small. The estimated risk of a fatal cancer developing from two intraoral bitewing exposures, or from a dental panoramic tomography, is of the order of one tumour for every two million exposures. In the case of panoramic radiology, the weighted dose equivalent from a panoramic examination was calculated to be 3.85-30 μSv, corresponding to a lifetime risk of fatal cancer (per million) of 0.21-1.9. For an intra-oral radiograh the effective dose is 1-8.3 μSv and the risk of cancer is 0.02-0.6. These figures assume best practice is employed. A panoramic radiograph may be associated with an effective dose the same as one to five days additional background radiation, while two bitewing radiographs would be equivalent to about one day. However lower levels of risk are associated with newer equipment and techniques. Recent studies have showed that the 72.79% of dental x-ray sets in Spain operate at 70 kVp, 88.02% employ a 20 cm of focus-to-film distance (PID) and the majority of this equipment employ a six cm diameter round beam. Ekta-speed dental film was used in the 10.24 % of the cases and intraoral digital imaging was used by 11.95% of practitioners. A particular problem arises from the inclusion or exclusion of the salivary glands in the calculation of dose. The salivary glands have previously not been included as an organ in effective dose calculations. However, the most recent document from the International Commission on Radiation Protection (ICRP) has recognised this omission in view of the apparent relationship between dental radiography and increased risk of salivary gland tumours. The most recent ICRP document has included salivary tissue as a remainder organ and their inclusion in dose calculations increases the rate of risk of inducing tumours by a factor of two. The main conclusion of this study was to emphasise that 'All patients must have a clinical history taken prior to any radiological examination and when radiographs are clinically indicated, intra-oral radiographs should be considered first because of their better detail and lower radiation dose". Within Spain, it is necessary to change the dentist's attitude to the use of ionising radiation. This requires a readjustment to the new regulations on radiological safety of the patient and also to reinforce the need for justification for all radiographic examinations used in dental radiological diagnosis.	Beneyto, Y.M., Alcaráz Baños, M., Pérez Lajarín, L. & Rushton, V. E. (2007). Clinical justification of dental radiology in adult patients: A review of the literature. *Med Oral Patol Oral Cir Bucal,* 12: E244-251.

No.	Description	Reference
3	While the etiology of most childhood cancers is largely unknown, epidemiologic studies have consistently found an association between exposure to medical radiation during pregnancy and risk of childhood cancer in offspring. The relation between early life diagnostic radiation exposure and occurrence of pediatric cancer risks is less clear. This review summarizes current and historical estimated doses for common diagnostic radiologic procedures as well as the epidemiologic literature on the role of maternal prenatal, children's postnatal and parental preconception diagnostic radiologic procedures on subsequent risk of childhood malignancies Risk estimates are presented according to factors such as the year of birth of the child, trimester and medical indication for the procedure, and the number of films taken. The paper also discusses limitations of the methods employed in epidemiologic studies to assess pediatric cancer risks, the effects on clinical practice of the results reported from the epidemiologic studies, and clinical and public health policy implications of the findings. Gaps in understanding and additional research needs are identified. Important research priorities include nationwide surveys to estimate fetal and childhood radiation doses from common diagnostic procedures, and epidemiologic studies to quantify pediatric and lifetime cancer risks from prenatal and early childhood exposures to diagnostic radiography, computed tomography, and fluoroscopically-guided procedures. In terms of dental radiography in particular, the authors provide the following information: • Risks for childhood brain tumors with exposure to early life diagnostic radiation: In general, studies of diagnostic x-ray examinations and risk of childhood brain tumors, including studies of astrocytoma specifically, have not observed an increased risk with exposure. Although one study of brain tumors observed an increased risk of childhood brain tumors in individuals with a history of five or more full mouth dental x-rays at least 10 years before diagnosis, this has generally not been confirmed in other studies. • Risks for other childhood cancers with exposure to early life diagnostic radiation: Overall, there is very little evidence that exposure to post-natal diagnostic exposure increases childhood cancer risk. However, it is noteworthy that repeated exposure to diagnostic exams during adolescence has been associated with increased risk of breast cancer later in life in patients with scoliosis, and there has been some suggestion that exposure to dental x-rays in childhood may increase risk of meningioma later in life. Exposure to low-to-moderate levels of environmental ionizing radiation at an early age has also been shown to increase later-life cancer risk in individuals exposed to atomic bomb radiation. It is thus possible that if a small increased risk of cancer due to diagnostic radiation exposure exists, most studies are not adequately powered or have limited assessment of childhood and adolescent cancer occurrence, and thus failed to be able to detect onset of cancer later in life.	Linet, M.S., Kim, K. & Rajaraman, P. (2009). Children's exposure to diagnostic medical radiation and cancer risk: Epidemiologic and dosimetric considerations. *Pediatr Radiol* 39, (Suppl 1), S4.
Articles in Peer-Reviewed Journals on Patient Safety/Risk of Harm in X-rays/Dental Radiography		

No.	Description	Reference
4	This is a commentary discussing recent innovations in radiography in dental practice. The author states that: there was a time when it took a few minutes to expose a tooth to get a diagnostic image, which meant that patience was a virtue for the patient as well as the clinician. All this was at the expense of the safety of the patient and in many cases the person who exposed the patient as well. Today the outcome of such research seems miniscule compared to the sophisticated technology in front of us. Simply put, diagnostic intraoral radiographs changed the way dentists treated their patients. Today's intraoral radiography options are superior to those of the past, primarily due to the development of digital radiography, beginning with Trophy Radiology's introduction of the RVG sensor. The widest application for intraoral radiography has long been and continues to be in identifying caries. In fact, the ever-increasing demand to detect and treat the disease in an early stage has probably sped the evolution of enhanced caries detection methods, including revolutionary software. Some seasoned clinicians have resisted the transition from film to digital radiography based on the perceived advantages and disadvantages to their practices -perhaps they are nearing retirement, believe that films are superior diagnostically, are in denial of the technology or some or all of the above in combination. However, I really can't make a blanket statement that all practices should immediately switch to digital or anything along those lines. However, I can say with certainty that digital sensors have numerous advantages over film and that intraoral radiography is in the digital age. I believe that extraoral radiography's future is digital as well. But let us not forget that the advent of panoramic radiograph changed the way dentists viewed the oral cavity and for many clinicians defined the scope of their practice. While the oral surgeon looked at impacted third molars, the periodontist examined the height of the crestal bone; while the orthodontist evaluated the temporomandibular joint, the otolaryngologist sought to diagnose sinus pathology. Panoramic radiography had all of a sudden become a one-stop solution to all types of maxillofacial imaging needs. It would probably be right to say that this modality remains to be the most abused, overused and under diagnosed imaging modality in dentistry because of its relatively low resolution coupled with limitations of projection geometry and magnification factors. Still, we cannot ignore the marked contribution of it to the world of extraoral imaging. Modern day panoramic radiography units emit about the same radiation as 4-16 periapical radiographs. As with intraoral radiography, digitization has brought gains in terms of dramatically shorter image acquisition times and the ability to manipulate images. Patient positioning is now more flexible, and some units like Morita's Veraviewepocs house both cephalometric and panoramic imaging modalities in one body. The above unit and others like it also offer optional 3D imaging, which is arguably the most significant recent development in oral and maxillofacial radiography. With the advent of Cone Beam computed tomography (CBCT) the question of use and abuse also rises, and rightfully so. CBCT at present is indicated only for hard tissue imaging and is not to be used as a replacement for panoramic, cephalometric or intraoral radiography. The article also provides a table Effective Dose from Diagnostic X-Ray Examinations and Equivalent Background Exposure (see Table 1 of the article).	Jain, R. (2010). Radiology: Yesterday, today and tomorrow. *Oral Health & Dental Practice Management.* October. Available at: http://www.oralhealthjournal.com/issues/story.aspx?aid=1000389430 Last accessed: November 2010.

No.	Description	Reference
5	This article discusses the dose and risk in dental diagnostic imaging with an emphasis on dosimetry of CBCT (cone beam computed tomography). The focus here is on the difference between deterministic and stochastic risks outlined by the author. Technological advances and innovations in medicine have produced significant benefits for society evidenced by healthier, longer lives. Early disease detection in many instances involves diagnostic imaging that exposes patients to radiation. While timely detection and treatment of disease is critical to improving outcomes, radiographic procedures carry with them an inherent risk that must be overbalanced by the potential benefits of improved health and longevity. The ALARA principle (As Low As Reasonably Achievable) is a concept for reducing the dose from diagnostic imaging to insure as high a benefit/risk ratio as possible. The increased use of evidence based patient management may be expected to further enhance the benefit/risk ratio. In dentistry we have many examples of evidence-based care incorporating the use of diagnostic imaging procedures with good benefit risk ratios. Use of radiographic imaging criteria for caries detection is a good example of the use of conventional imaging techniques in the detection, monitoring, and treatment of one of the most common oral diseases. Cone beam computed tomography (CBCT) is a promising but relatively young technology which does not as yet have the weight of evidence needed to judge how this will be most useful in patient management and where alternate modalities may be more efficacious. Recent reviews of the literature suggest that evidence supporting diagnostic efficacy of CBCT for most tasks is lacking. An important aspect of our judgement to use diagnostic imaging is a consideration of the risk of harm that accompanies exposure to x-rays. Because different harms and risks are associated with different types of exposures, it is not surprising that our patients are often confused about the real risks associated with diagnostic imaging. We can categorize risks into stochastic and deterministic groups. A stochastic effect is one where the chance of occurrence of the effect increases with increasing exposure but does not affect the severity of the effect. Cancer is an example of a stochastic effect. Evidence for a cancer risk from exposure to x-rays has been documented down to 100 mGy for an adult exposure and 10-20 mG for fetal exposure. A linear-no-threshold hypothesis of x-ray risk fits most data for cancer development. But extrapolation of this data must be used to estimate risks from the lower doses that are utilized for diagnostic imaging. Heritable (germ cell) mutations are another stochastic effect. To date, no expressions of germ cell mutations have been observed in human populations. Deterministic effects of x-ray exposure are those where the severity of the effect increases with increasing exposure. Implicit in this concept is that there is a threshold below which effects do not occur. Examples of deterministic effects include birth defects which have a threshold of 100-250 mSv, cataract of the lens of the eye which has a threshold of 2 Gy of exposure, and radiation burn which has a 3 Gy threshold of exposure. None of these effects will be found with the relatively low and localized exposures that are used for dental and maxillofacial imaging.	Ludlow, J.B. (2009). Dose and risk in dental diagnostic imaging: With emphasis on dosimetry of CBCT. *Korean Journal of Oral and Maxillofacial Radiology* 39, 175-184.

No.	Description	Reference
6	Background: In 2007, the International Commission on Radiological Protection (ICRP) revised estimates of the radiosensitivity of tissues including those in the maxillofacial region. The authors conducted a study to reassess patients' risk related to common dental radiographic exposures using the 2007 ICRP recommendations. Methods: The authors used a tissue-equivalent head phantom to measure dose. They calculated effective doses by using both 1990 and revised 2007 ICRP recommendations. Effective dose is a calculation that takes into consideration the different sensitivities of organs to long-term effects from ionizing radiation. It is the preferred method for comparing doses between different types of exposures. Results: Effective doses (per the 2007 ICRP) in microsieverts were as follows: full-mouth radiographs (FMX) with photo-stimulable phosphor (PSP) storage or F-speed film with rectangular collimation, 34.9 µSv; four-image posterior bitewings with PSP or F-speed film with rectangular collimation, 5.0 µSv; FMX using PSP or F-speed film with round collimation, 170.7 µSv; FMX with D-speed film and round collimation, 388 µSv; panoramic Orthophos XG (Sirona Group, Bensheim, Germany) with charge-coupled device (CCD), 14.2 µSv; panoramic ProMax (Planmeca, Helsinki, Finland) with CCD, 24.3 µSv; posteroanterior cephalogram with PSP, 5.1 µSv; and lateral cephalogram with PSP, 5.6 µSv. These values are 32 to 422 percent higher than those determined according to the 1990 ICRP guidelines. Conclusions: Although radiographs are an indispensable diagnostic tool, the increased effective doses of common intraoral and extraoral imaging techniques are high enough to warrant reconsideration of means to reduce patients' exposure. Clinical Implications: Clinicians can reduce patients' dose substantively by using digital receptors or F-speed film instead of D-speed film, rectangular collimation instead of round collimation and radiographic selection criteria.	Ludlow, J.B., Davies-Ludlow, L.E. & White, S.C. (2008). Patient risk related to common dental radiographic examinations: The impact of 2007 International Commission on Radiological Protection recommendations regarding dose calculation. *J Am Dent Assoc* 139, 1237-1243.
7	Background: Ionizing radiation is a likely cause of intracranial meningioma. The authors determined whether the risk of intracranial meningioma was associated with past dental X-rays—specifically, posterior bitewings, full-mouth series, and lateral cephalometric and panoramic radiographs. Methods: The authors conducted a population-based case–control study of residents of King, Pierce, and Snohomish counties in western Washington State. Case patients (n = 200) had an incident intracranial meningioma that was confirmed histologically during life between January 1995 and June 1998. The authors used random-digit dialing and Medicare eligibility lists to identify two control subjects to be matched to each case patient based on age and gender. Exposures were determined during an in-person interview. The authors compared self-report and dental records in a subset of study participants. Results: Of the four dental X-ray procedures evaluated, only the full-mouth series (specifically, ≥ 6 over a lifetime) was associated with a significantly increased risk of meningioma (odds ratio, 2.06; 95% confidence limits, 1.03– 4.17). However, evidence for a dose-response relation was lacking (P for trend = 0.33). The risk was elevated with the aggregate number of full-mouth series in 10-year periods from approximately 15–40 years before diagnosis, with significant elevations in the 10-year periods beginning 22–30 years before diagnosis. The risks in these analyses were even greater when only women were considered. Conclusion: Dental X-rays involving full-mouth series performed 15–40 years ago, when radiation exposure from full-mouth series was much greater than it is now, were associated with an increased risk of meningioma. The authors did not observe an increased risk with bitewings, lateral cephalometric, and panoramic radiographs.	Longstreth, Jr.,W.T., Phillips, L.E., Drangsholt, M., Koepsell, T.D., Custer, B.S., Gehrels, J. & van Belle, G. (2004). Dental x-rays and the risk of intracranial meningioma: A population-based case–control study. *Cancer* 100, 1026–1034.
Grey Literature on Patient Safety/Risk of Harm in X-rays/Dental Radiography		

No.	Description	Reference
8	This is a webpage from the American Dental Association (ADA) providing information to patients and dentists on x-rays. For patients, it discusses how x-rays work, how often radiographs should be taken, the benefits of a dental radiograph examination, how dental x-rays compare to other sources of radiation and questions about having x-rays when pregnant. For dentists, it provides information on radiation exposure, safety requirements, patient selection for dental radiographs, and additional resources. The focus of this summary is on the risks of dental x-rays/radiography. Patient version: How do dental X-rays compare to other sources of radiation? The amount of radiation that we are exposed to from dental X-rays is very small compared to our daily exposure from things like, cosmic radiation and naturally-occurring radioactive elements (for example, those producing radon). The ADA provides estimated exposure to radiation from dental X-ray with other various sources. As indicated below, a millisievert (mSv) is a unit of measure that allows for some comparison between radiation sources that expose the entire body (such as natural background radiation) and those that only expose a portion of the body (such as X-rays). The estimated exposure of bitewing radiographs is 0.038 mSv and full-mouth series is 0.150 mSv. This is compared to (1) medical x-rays: lower gastrointestinal tract radiography (4.060 mSv), upper gastrointestinal tract radiography (2.440mSv), chest radiograph (0.080 mSv); (2) natural sources: cosmic (outer space) radiation: average radiation from outer space in Denver, CO per year (0.510 mSv), and (3) earth and atmospheric radiation: average radiation in the U.S. from natural sources per year (3.000 mSv). Dentist version: Radiation Exposure Radiation exposure associated with dentistry represents a minor contribution to the total exposure from all sources (about 0.2 percent). The National Council on Radiation Protection and Measurements (NCRP) has estimated that the mean effective radiation dose equivalent from all sources in the United States is 3.6 millisieverts (mSv) per year, with about 3 mSv of this dose from natural sources and about 0.6 mSv from manmade sources. The majority of manmade radiation exposure is medical-related. It is estimated that dental X-rays contribute approximately one percent of the total dose of exposure in health care settings. Occupational exposure in dental settings is far lower than that in hospitals and medical offices. According to the NCRP, the total limit for occupational exposure is 50 mSv in one year. In addition, the lifetime occupational effective dose is limited to 10 mSv times the number of an individual's age. The NCRP concludes that occupational exposure for dental personnel will not exceed these limits, excepting for problems associated with facility design, diagnostic equipment performance, or operating procedures. For pregnant dental personnel, the radiation exposure limit is 0.5 mSv per month.	American Dental Association [ADA]. (2010a). Oral health topics: X-rays/radiography – Patient and dentist version. Available at: http://www.ada.org/2760.aspx?currentTab=2#top Last accessed: October 2010.

No.	Description	Reference
9	In dental radiography, the part of the head that receives the greatest dose is the skin in the area where the x-rays enter. A recent study on patient doses from dental x-ray exams was performed at the Department of Diagnostic Sciences, University of North Carolina School of Dentistry, Chapel Hill, North Carolina, using a realistic head phantom and state-of-the-art imaging systems (see Ludlow et al. 2008, Ref. No. #5 in this table). To put the doses in perspective, this report notes that background radiation from naturally occurring radionuclides in our environment and from cosmic rays is approximately 3,100 µSv (NCRP 160) every year. Furthermore, differences in background levels between different parts of the country are larger than the effective dose for a bitewing. Epidemiological studies comparing cancer rates in high- and low-background radiation regions have repeatedly failed to show any association with background levels in this or in other countries. It also appears that radiation doses at levels of as much as several times natural background do not play a significant role increasing cancer above the natural incidence rate. The fact that routine dental exams listed above are significantly lower that background radiation exposures leads to the idea that there is no increased risk from such exams. To predict the probability of radiation causing harm, the authors calculate a quantity called the effective dose in units of the millisievert (mSv) or microsievert (µSv), where 10 mSv equals one rem in the older radiation dose units. The effective dose takes into account the type of radiation, which is x-rays in this case, and the body parts or organs involved, for example, the skin, salivary glands, bone marrow, mandible, thyroid, etc. The absorbed doses to the individual organs are, unfortunately, also expressed in mSv or µSv. The old unit for organ does was the rad, where 100 millirad (mrad) equals 1 mSv. Doses to individual organs, however, do not represent the risk or harm to the organ as various cellular repair mechanisms attenuate the radiation effects. Rather, each organ or body part is assigned a tissue weighting factors (w_T) determined by the International Council on Radiation Protection and Measurements (ICRP). For example, the w_T values for the thyroid and skin are 0.04 and 0.01, respectively, and do not have any measurement unit associated with them. The sum of the individual organ w_T values equals 1.0. Organs that do not receive radiation do not contribute to the effective dose. The w_T values are derived from review of the epidemiological data that exist for humans exposed to large amounts of radiation, primarily the survivors of the atomic weapon detonations in Hiroshima and Nagasaki. The factors indicate the relative likelihood of harm such as cancer, birth defects, or increased risk of genetic disorders in future generations, per unit dose. Since the dose to reproductive tissue is much less than 1 µSv for all of the dental exposures here, the only health issue considered is cancer induction. It is important to point out that in epidemiological studies of humans, no actual increase in cancer incidence has ever been found in groups of humans who have received effective doses below 100 mSv. The effective doses associated with dental exposures are much, much smaller than this. Nevertheless, in order to come up with some estimate of harm for purposes such as setting standards for reasonable levels of exposures in medicine, it is assumed that the probability of harm seen at high doses decreases proportionally with dose and never becomes zero. In 1995, a joint study on the role of medical radiation in thyroid cancer was conducted in Sweden by the United States and Swedish National Cancer Institute. The study showed that patients with thyroid cancer had received the same number of diagnostic x-ray studies, including dental x rays, as the general population. If it had been found that people with thyroid cancer had had more exposure, it could have indicated some connection between the radiation exposure and thyroid cancer. There is also a 1988 study funded by the National Cancer Institute and conducted in Los Angeles by a team at the University of California, Los Angeles that found a positive correlation between cancer of the parotid gland and previous dental x-ray exposure. It didn't seem to be as definitive a study as the Swedish study. The Los Angeles study information was obtained strictly from interviews with parotid cancer patients, whereas the Swedish study used actual medical records. The Los Angeles study population included only about 400 cancer patients compared with over 4,000 for the Swedish study. Also, U.S. citizens tend to move around the country during their lifetimes, which causes a bigger difference in their lifetime effective doses than is caused by variation in dental radiography practices. So, there is probably some controversy in this area. Most of the reports of epidemiologic studies showing associations between dental x ray and certain head and neck cancers were published years ago and are based on the results of dental exposures before World War II, when equipment was much cruder and doses much greater than they are today. In addition, these epidemiological studies show only associations, and do not establish a cause-and-effect relation between exposures and cancers. No such reports are associated with recent dental exposures. Risks from dental x rays are very small when compared with other medical exams involving radiation exposures.	Russell Ritenour. E. & Gibbs, S. J. (2010). Dental Patient Doses Information. *Health Physics Society.* Available at: http://hps.org/hpspublications/articles/dentaldoses.html Last accessed: October 2010.

No.	Description	Reference
10	In this report, the results of a recent survey of the frequency of medical and dental x-ray examinations in the UK and contemporary data on the radiation doses typically received by patients, are used to assess trends in the extent and pattern of the population exposure. Individual patient doses, expressed in terms of the effective dose, range from a few microsieverts for simple radiographic examinations of the teeth, limbs or chest to tens of millisieverts for prolonged fluoroscopic procedures or some computed tomography (CT) examinations. The focus of this summary will be information on dental radiography. Table 3 (see pg. 10-11 of the report) shows that the most frequent examination is dental radiography, although about half a million dental x-ray examinations are performed in NHS hospitals each year, 25 times as many (12.5 million) are conducted by dentists in primary care dental practice. This makes dentists responsible for 30% of all medical and dental x-ray examinations. However, the very low effective doses associated with dental radiography (typically 5 μSv for an intraoral examination and 10μSv for a panoramic examination result in a collective dose of only 77 man Sv and a per caput dose of only 1.3 μSv from primary care dental practice. This represents only about 0.4% of the total collective dose or the per caput dose from all x-ray examinations. The lack of a significant increase or decrease in the per caput dose from medical and dental x-rays is perhaps not surprising in view of the reported stability in total number of medical x-ray examinations in the past 15 years. Dental radiology was seen to have increased substantially (by 50%), but the very low effective doses for dental x-rays would preclude their greater numbers from having a significant impact on the overall collective dose.	Hart, D. & Wall, B.F. (2002). *Radiation exposure of the UK population from medical and dental x-ray examinations.* National Radiological Protection Board (NRPB) Report. Available at: http://medicalphysicist.co.uk/nrpb_w4.pdf Last accessed: October 2010.
11	The United Nations Scientific Committee on the Effects of Atomic Radiation reviews and evaluates global and regional exposures to radiation; and it evaluates evidence of radiation-induced health effects in exposed groups, including survivors of the atomic bombings in Japan. The Committee also reviews advances in the understanding of the biological mechanisms by which radiation-induced effects on health or on the environment can occur. Those assessments provide the scientific foundation used, inter alia, by the relevant agencies of the United Nations system in formulating international standards for protection of the public and of workers against ionizing radiation; those standards, in turn are linked to important legal and regulatory instruments. The committee last made estimates of radiation exposure levels and trends in its 2000 report. The present report updates and extends those estimates. Table 1 (see pg. 4 of the report) summarizes the updated values for average annual doses and ranges of exposure from all sources. The main natural sources of exposure are cosmic radiation and natural radionuclides found in the soil and rocks. Cosmic radiation is significantly higher at the cruising altitude of jet aircraft than on the Earth's surface. The Committee evaluated the additional radiation exposures introduced by military and peaceful activities. With regard to the peaceful uses of radiation, medical exposures were by far the dominant form. Since the previous survey (covering the period 1991-1996), the total number of diagnostic medical examinations (both medical and dental) is estimated to have risen from 2.4 billion to 3.6 billion – an increase of approximately 50%. Table 4 (see pg. 11 of the report) also provides the estimated annual collective effective dose of ionizing radiation due to medical exposures, for the period 1997-2007 and includes dental x-ray examinations. The doses for dental x-ray examinations ranged from 9,9000 man Sv to 38 man Sv. This is compared to diagnostic medical examinations which ranged from 2,900,000 to 24,000 man Sv and nuclear medicine examinations, which ranged from 186,000 to 82 man Sv.	United Nations Scientific Committee on the Effects of Atomic Radiation. (2008). *Sources and effects of ionizing radiation.* Report to the General Assembly with Scientific Annexes. Volume 1. Available at: http://www.unscear.org/docs/reports/2008/09-86753_Report_2008_GA_Report.pdf Last accessed: November 2010.

Table 4: Literature on Patient Safety/Risk of Harm in Infection Control

No.	Description	Reference
	Review Articles on Patient Safety/Risk of Harm in Infection Control (e.g., sterilization)	
1	Since August 2009, members of the Primary Care Dentistry Research Forum have taken part in an online vote to identify questions in day-to-day practice that they felt most needed to be answered with conclusive research. The question which receives the most votes each month forms the subject of a critical appraisal of the relevant literature. Each month a new round of voting takes place to decide which further questions will be reviewed. Dental practitioners and dental care professionals are encouraged to take part in the voting and submit their own questions to be included in the vote by joining the website. The paper details a summary of the findings of the seventh critical appraisal. It was developed from an original question submitted: 'What benefit is delivered for the costs of the new decontamination regulations?' To address the review question, two sub-questions have been posed: 1. What epidemiological evidence is there about cross-infection related infections caused within dental practices? The authors could find no studies that described the incidence of cross-infection related infections caused within UK dental practices, including cross-infection arising from reusable dental surgical instruments. On this basis, the scale of the problem that dental decontamination processes aim to address currently appears to be unknown. While not answering the review question, in comparison, an estimate exists of hospital-acquired infections. This is approximately nine percent of inpatients, including 273,000 non-fatal infections and 4,550 deaths per year. Since 2007, in response, the UK government has undertaken a £57.5 million NHS hospital ward 'deep cleaning' program. However, these data relate to the medical and hospital context, with uncertain applicability to the dental practice context. 2. What is the total cost of cross-infection related infections caused in dental practices? In the absence of incidence data relating to cross-infections caused in UK primary dental practices, or on the severity (including disabilities or deaths arising) of such infections, it is not possible to estimate their cost impact. No studies were found to provide insight into the potential savings in terms of the number of dental practice related cross-infections avoided by compliance with infection control guidance. Only one study, which is both quite old and specific to Australian private dental practice, attempted to quantify the costs of implementing recommended infection control procedures. This amounted to an annual amount of AU$22,461 per dentist plus AU$1,912 per practice (1994 $AUS), including loss of billable revenue, disposables, equipment, waste management and nurse time for sterilisation procedures. Summary: Although there is a literature upon the nature, implementation and adherence to generic dental infection control guidance and practice, there appears to be none, from the UK and beyond, on the epidemiological scale of cross-infection caused in dental practices and therefore also of the cost impact of cross-infection caused in primary dental practices. As a result, no 'cost of illness', or cost-benefit assessment, exists or is feasible at this time.	Fox, C. (2010). Evidence summary: what 'cost of illness' evidence is there about cross-infection related infections in dental practice? *British Dental Journal* 209, 2, 87-88.

No.	Description	Reference
2	The Centers for Disease Control and Prevention (CDC) estimates that approximately 46.5 million surgical procedures will be performed on ambulatory and inpatients in the U.S. each year. Tens of millions additional surgical procedures will be performed in outpatient dental, podiatry, and other health care related facilities. During each and every one of these surgical procedures, there will be contact with a medical/dental device or surgical instrument with a patient's sterile tissue or mucous membranes. If contaminated, the instruments/devices used during the surgery can introduce pathogens into those tissues, which can result in an infection, a risk inherent in all surgical procedures. However, the risk of infection can be significantly reduced with adherence to recommended infection control practices that include proper cleaning and sterilization of instruments/devices used during the procedure. Inadequate or improper sterilization not only poses a risk for the patient undergoing the procedure but also introduces an opportunity for person-to-person transmission and dissemination of pathogens throughout the health care facility. Therefore, disinfection and sterilization are absolutely mandatory to ensure that medical, dental and surgical instruments do not serve as sources of transmission of infectious microorganisms. Unfortunately, sterilization is often incomplete, and numerous outbreaks from improperly sterilized instruments/devices have been documented. In the dental office, the potential for transmission of disease from contaminated dental instrumentation is well supported. Several studies show a very worrisome, high degree of inconsistency in sterilization practices in dental offices. Most notably, in 1996, a review of sterilization practices showed that 68% of dentists/dental offices surveyed believed they were sterilizing their instruments but did not use appropriate chemical sterilants or exposure times; and 49% of those surveyed did not challenge autoclaves with biological indicators. In another investigation, biologic indicators were used to test the efficacy of sterilizers used in dental offices; 15 to 65% of the sterilizers were found to have positive spore tests. Operator error, rather than mechanical malfunction, was shown to have caused 87% of sterilization failures. Clearly, the results from these studies are a matter of concern for the dental profession. However, these studies were conducted in the late 1990s and early 2000s, before the widespread acceptance of standard precautions in dental practice. Fortunately, dentistry has developed definitive guidelines for infection control, which, if followed, can produce sterile instrumentation on a consistent basis. In November 2008, CDC published an updated Guideline for Disinfection and Sterilization in Healthcare Facilities, which "presents a pragmatic approach to the judicious selection and proper use of disinfection and sterilization processes; the approach is based on well-designed studies assessing the efficacy (through laboratory investigations) and effectiveness (through clinical studies) of disinfection and sterilization procedures." The topic of instrument management in the dental office is of critical importance to the profession. In order to provide a comprehensive review, this article will address instrument classification, and handling and packaging of contaminated instruments, with emphasis on evidence-based recommendations contained in the new 2008 guideline. In particular, the authors note that sterilization is a complex process requiring specialized equipment, adequate space and, most importantly, qualified personnel who are provided with ongoing training. Monitoring on a routine basis for quality assurance must accompany this process. Every member of the dental team must have a clear understanding of her/his role in the process, as well as a clear understanding of the fundamental techniques and procedures involved. Instrument processing, when performed properly, can be hard work. Proper cleaning, packaging, sterilizer loading procedures and sterilization or high-level disinfection methods must be followed--the same way every day for every instrument. All dental staff and clinicians should clearly understand the principles of instrument processing and sterilization and their responsibilities for these processes in the dental office.	Depaola, L.G. & Fried, J.I. (2009). Instrument management: Cleaning and sterilization in the dental office. *Access*, May-June. Available at: http://findarticles.com/p/articles/mi_m1ANQ/is_5_23/ai_n31916124/?tag=content;col1 Last accessed: October 2010.

No.	Description	Reference
3	The aim of this article was to provide the dental community with a brief overview of the characteristics, risk of transmission, and the infection-control implications of prions in dentistry. MEDLINE, EMBASE, CINAHL, The Cochrane Library, and relevant databases were searched, and a targeted internet search was conducted up to July 2007. Transmissible spongiform encephalopathies (TSEs) are a group of fatal neurodegenerative diseases that are rapidly progressive and always fatal, with no approved cure, and their definite diagnosis can only be obtained at post mortem autopsy. The causative agent, prion protein, resists conventional sterilization methods especially when infected tissue becomes dried onto glass or metal surfaces. To date, there are no reported definite or suspected cases of disease transmission arising from dental procedures, and there seems to be no correlation between dental treatment and TSEs. Because there is a theoretical but real risk of transmission of prion disease from dental instruments (although it is extremely low, especially in North America), as a general rule, appropriate family and medical history (including the risk for prion diseases) should be obtained from all patients, before all dental procedures. TSE research regarding diagnosis, transmission, treatment, and inactivation of prions and other transmissible amyloidoses are ongoing, and, thus, dental professionals should maintain optimal and up-to-date standards of knowledge, infection control, and decontamination. The focus of this summary is on the section, "Proper Infection Control in Treating High-risk Patients". Proper Infection Control in Treating High-risk Patients: Prion agents, unlike infectious microorganisms, resist conventional sterilization methods such as steam autoclaving, even at increased temperatures, or by ethylene oxide gas. It has been reported that human sCJD prions were more than 100,000 times more resistant to inactivation than hamster prions, which have been historically used as the standard for prion inactivation procedures. A number of commonly used chemicals and processes have been shown to be either ineffective or only partially effective in inactivation of the prion protein and cannot be depended on for decontamination. In dentistry, presterilization cleaning is an essential stage of instrument reprocessing. Any instruments contaminated with residual protein could pose some level of risk. Thus, any decontamination that removes protein residue reduces the risk. Recent studies of instrument sets from UK National Health Service Trust sterile-service departments deemed clean after treatment with washer-disinfector machines, and steam sterilization showed evidence of residual proteinaceous material on all instruments tested. Some dental instruments are difficult to clean after contamination with blood or neurovascular tissue, and, even after routine decontamination and sterilization, they may carry significant residues of material. This is especially important for endodontic files (because they have intimate contact with terminal branches of the trigeminal nerve and are difficult to clean by virtue of their design), matrix bands, retainers (because they frequently become contaminated with blood and other proteins), and used dental burrs (because they too are difficult to decontaminate). The single-use of endodontic instruments is controversial. The CDC, WHO, and British and German national organizations consider that the risk justifies the single use of endodontic instruments; other national dental organizations have no policy (United States and Canada), whereas Australian authorities consider no risk in the reuse of these instruments. Based on the WHO and CDC recommendations for suspected or confirmed CJD patients, the safest and most unambiguous method for minimizing the risk of residual infectivity is the use of single use items and equipment (e.g., needles and anesthetic cartridges) whenever possible and incinerating reusable instruments difficult to clean (e.g., endodontic files, broaches, carbide and diamond burs, and dental matrix bands). However, destruction of heat-resistant surgical instruments that come in contact with high infectivity tissues (brain, spinal cord, and eye) may not be practical or cost-effective for many devices and materials that were not designed for single use. The authors conclude by noting that a recent and comprehensive guideline on the cleaning of dental instruments is available from the Scottish Dental Clinical Effectiveness Programme. There is a need for cost-benefit and cost-effectiveness analyses of the improvement of infection control guidelines in dental practices. The British General Dental Council requires continuing dental education including education on instrument decontamination and decontamination quality-assurance programs in order to stay on the register (maintain licensure), but it is not clear how such quality-assurance programs would insure that reusable instruments were free of proteinaceous materials. It would seem prudent that other jurisdictions should add educational and continuing educational programs and materials on prion infection and instrument decontamination.	Azarpazhooh, A. & Fillery, E.D. (2008). Prion disease: The implications for dentistry. *J Endod* 34, 10, 1158 –1166.

No.	Description	Reference
4	This review explores the current understanding of the risks of (variant) Creutzfeldt-Jakob disease transmission *via* dental practice, and whether they merit the rigorous enforcement of improved standards of instrument cleaning and decontamination. The recognition of prions as novel infectious agents in humans has caused significant concern among the public and medical professionals alike. Creutzfeldt-Jakob disease (CJD) in humans has been shown to be transmissible *via* several routes, including transplantation, contaminated medical products, and *via* neurosurgery. While the likelihood of transmission *via* dentistry is undoubtedly very low, this may be amplified considerably by unknown risk factors, such as disease prevalence (particularly in the UK), altered tissue distribution of vCJD, and the failure of decontamination processes to address the inactivation of prions adequately. Since current diagnostic techniques are unable to detect PrP^{Sc} in human dental tissues, there is limited evidence for the presence of infectivity. Given these uncertainties, the control of risk by reinforced and improved decontamination practices seems the most appropriate response.	Walker, J.T., Dickinson, J., Sutton, J.M., Marsh, P.D. & Raven, N.D.H. (2008). Implications for Creutzfeldt-Jakob Disease (CJD) in dentistry: A review of current knowledge. *J Dent Res* 87, 511-519.
5	Background: Severe acute respiratory syndrome, or SARS, which has created panic in Asia and in some parts of North America, is the first epidemic of the new century. Although it has been well-contained, sporadic cases continue to emerge. Objectives: The authors trace the emergence of the SARS outbreak from southern China and its spread worldwide, discuss the viral etiology of the infection and its clinical features, and review the infection control guidelines issued during the outbreak by the health authorities in Hong Kong, the Centers for Disease Control and Prevention, the World Health Organization and the American Dental Association. They also review the prospects for a new outbreak and preventive measures. Overview: The disease, which is caused by a novel coronavirus termed the "SARS coronavirus," or SARS-CoV, essentially spreads through droplet infection and affects people of any age. It has a mortality rate ranging from 10 to 15%. A major hallmark of this disease has been the rate at which it has affected health care workers through nosocomial transmission; in some countries, up to one-fourth to one-third of those infected were in this category. However, no dental health care worker has been affected by SARS in a nosocomial or dental setting. Conclusions and Clinical Implications: Researchers believe that a combination of factors, including the universal infection control measures that the dental community has implemented and/or the low degree of viral shedding in the prodromal phase of SARS, may have obviated the spread of the disease in dental settings. The dental community should reflect on this outbreak to reinforce the currently applied infection control measures.	Samaranayake, L.P. & Peiris, M. (2007). Severe acute respiratory syndrome and dentistry: A retrospective view. *JADA* 135, 1292-1302.

No.	Description	Reference
6	Objectives: To review the evidence that the dental unit waterlines are a source of occupational and healthcare acquired infection in the dental surgery. Data: Transmission of infection from contaminated dental unit waterlines (DUWL) is by aerosol droplet inhalation or rarely imbibing or wound contamination in susceptible individuals. Most of the organisms isolated from DUWL are of low pathogenicity. However, data from a small number of studies described infection or colonisation in susceptible hosts with Legionella spp., Pseudomonas spp. and environmental mycobacteria isolated from DUWL. The reported prevalence of legionellae in DUWL varies widely from zero to 68%. The risk from prolonged occupational exposure to legionellae has been evaluated. Earlier studies measuring surrogate evidence of exposure to legionellae in dental personnel found a significant increase in legionella antibody levels but in recent multicentre studies undertaken in primary dental care legionellae were isolated at very low rate and the corresponding serological titres were not above background levels. Whereas, a case of fatal Legionellosis in a dental surgeon concluded that the DUWL was the likely source of the infection. The dominant species isolated from dental unit waterlines (DUWL) are Gram-negative bacteria, which are a potent source of cell wall endotoxin. A consequence of indoor endotoxin exposure is the triggering or exacerbation of asthma. Data from a single large practice-based cross-sectional study reported a temporal association between occupational exposure to contaminated DUWL with aerobic counts of >200 cfu/mL at 37 ºC and development of asthma in the sub-group of dentists in whom asthma arose following the commencement of dental training. Sources: Medline 1966 to February 2007 was used to identify studies for this paper. Study selection: Design criteria included randomised control trials, cohort, and observational studies in English. Conclusions: Although the number of published cases of infection or respiratory symptoms resulting from exposure to water from contaminated DUWL is limited, there is a medicolegal requirement to comply with potable water standards and to conform to public perceptions on water safety. Even in the absence of documented infection, ethical and legal obligations under health and safety legislation require health professionals to assess and manage the risk from contaminated DUWL and prevent circumstances that favour amplification of the bacterial load. By employing standard infection control principles such as a combination of biocide disinfectants and anti-retraction valves to eliminate contamination of the DUWL, the profession can create a safe working environment and thereby satisfy patients' expectations.	Pankhurst, C.L. & Coulter, W.A. (2007). Do contaminated dental unit waterlines pose a risk of infection? *Journal of Dentistry* 35, 712-720.

No.	Description	Reference
7	Objectives: Due to the presence of extended narrow bore tubing and long periods of stagnation, dental unit water systems (DUWs) can be prone to relatively high levels of microbial contamination, including the formation of biofilm and the presence of opportunistic pathogens, irrespective of the source and quality of the inflowing water. Whilst the European Union (EU) has yet to set a definitive microbiological guideline, the American Dental Association (ADA) has set a maximum of <200 colony forming units (cfu)/ml for DUWs water in the USA. The objective of this review is to discuss why microbial contamination and biofilms are so prevalent in DUWs, as well as the role of disinfectants and their potential for achieving microbial water quality levels recommended by the ADA. Study selection: The review outlines the principal factors responsible for biofilm formation in DUWs and a number of mechanisms used for microbial control. Sources: The source material contained in this review is taken from the peer-reviewed literature. Data: A variety of disinfectants are available for use, but controlled laboratory and clinical studies have shown that they can vary markedly in their efficacy and suitability for use. Some products have been shown to successfully remove biofilm and consistently reduce the microbial load of out-flowing water to <200 cfu/ml. Conclusions: The effective delivery of approved disinfectants can control the level of microorganisms in DUWs at acceptable levels. The authors, in the "Summary" section, note that many DUWs deliver water that is of poor microbiological quality and would fail to meet the ADA guidelines on DUWs water standards and the EU drinking water standard. However, there is little evidence to suggest that DUWs are responsible for many cross-infection cases. Nevertheless, dental personal and the increasing number of immunocompromised dental patients that present routinely at dental surgeries are being exposed to potentially opportunistic pathogenic bacteria through ingestion and inhalation of dental unit water. It is not sufficient to be concerned only about the microbial loading of the water being transmitted from instruments supplied by the DUWs as products for microbial control must also remove and kill the biofilm cells lining the tubing if the problem is to be reduced. Whilst techniques such as flushing may transiently reduce the total viable counts (TVC) in the water phase they do little or nothing to tackle the biofilm present on all the tubing surfaces in the DUWs. The biofilm community is a living and growing entity that acts as a haven for pathogens and will multiply in DUWs within one week resulting in the delivery of 1 x 10^5 cfu/ml to the unsuspecting dental practitioner or their patients. To reduce the potential health impact of DUWs contamination the dental practitioner must practice due diligence by undertaking measures that will reduce the microbial load of the effluent from the dental water, in the USA to <200 cfu/ml, or in the EU to <100 cfu/ml in some countries. In the last three years there has been an increase in potential products for use by dental clinicians (see Table 1, pg. 725 in the article) demonstrating that industry and the dentists have responded to the problem proactively. Industry and Government must also play their part by provision of approved and effective products, and fund research to independently test the products, that are available in the market place. There are still areas that require further work in terms of controlling the microbial loading of DUWs such as engineering of DUWs to minimise microbial contamination. Also, there are no internationally agreed standard laboratory test systems for evaluating products for efficacy against reducing biofilm or endotoxin levels in DUWs. The key to success may hinge upon a more complete understanding of the biofilm and how to control this multi-species, dynamic surface-associated community. In addition to this, all parties involved, e.g. governmental agencies, dental bodies, manufacturers and academics, must use their complementary skills to implement control mechanisms that reduce microbial control in DUWs and also develop easy, reliable, reproducible and modestly priced monitoring schemes.	Walker, J.T. & Marsh, P.D. (2007). Microbial biofilm formation in DUWS and their control using disinfectants. *Journal of Dentistry* 35, 721-730.

No.	Description	Reference
8	Objective: To briefly review the characteristics of prions, the risk of transmission and implications for infection control in dentistry. Methods: The literature on prion disease in the context of dentistry up to March 2005 was reviewed using the PubMed, MEDLINE, Cumulative Index to Nursing & Allied Health Literature, Google Scholar databases and the Web sites of the departments of health of countries affected by the disease. Results: The sporadic form of Creutzfeldt–Jakob disease (CJD) is the most common human prion disease; the mean age of those affected to date is 68 years, the mortality rate is 85% within one year, and the average death rate is one per million persons. Variant CJD (vCJD) affects people (mean age 26 years) with a history of previous extended periods of residence in certain countries, mainly in the United Kingdom. Currently, there is no evidence of human-to-human transmission of CJD or vCJD following casual or intimate contact or blood transfusion, nor is there evidence of iatrogenic transmission of vCJD in a health care setting. Furthermore, there is no evidence indicating increased occupational risk of CJD or vCJD among health workers or clustering of vCJD among people associated with a dental practice. The risk of transmission of prions through dentistry is unknown but is thought to be very low if appropriate infection control measures are taken. Conclusions: The theoretical risk of transmission of prion disease through dental treatment emphasizes the need to maintain optimal standards of infection control and decontamination procedures for all infectious agents, including prions.	Azarpazhooh, A. & Leake, JL. (2006). Prions in dentistry — What are they, should we be concerned, and what can we do? *J Can Dent Assoc* 72, 1, 53–60.
9	Background: The production of airborne material during dental procedures is obvious to the dentist, the dental team and the patient. An aerosol cloud of particulate matter and fluid often is clearly visible during dental procedures. This ubiquitous aerosolized cloud is a combination of materials originating from the treatment site and from the dental unit waterlines, or DUWLs. With the advent of the droplet spread disease severe acute respiratory syndrome, or SARS, a review of the infection control procedures for aerosols is warranted. Types of Studies Reviewed: The authors reviewed representative medical and dental literature for studies and reports that documented the spread of disease through an airborne route. They also reviewed the dental literature for representative studies of contamination from various dental procedures and methods of reducing airborne contamination from those procedures. Results: The airborne spread of measles, tuberculosis and SARS is well-documented in the medical literature. The dental literature shows that many dental procedures produce aerosols and droplets that are contaminated with bacteria and blood. These aerosols represent a potential route for disease transmission. The literature also documents that airborne contamination can be minimized easily and inexpensively by layering several infection control steps into the routine precautions used during all dental procedures. Clinical Implications: In addition to the routine use of standard barriers such as masks and gloves, the universal use of preprocedural rinses and high-volume evacuation is recommended.	Harrel, S.K. & Molinari, J. (2004). Aerosols and splatter in dentistry: A brief review of the literature and infection control implications. *J Am Dent Assoc* 135, 429-437.

No.	Description	Reference
10	Background: Prion diseases are a group of rare fatal neurodegenerative disorders in humans and animals that are histopathologically characterized by spongiform change within the central nervous system. Types of Studies Reviewed: The author reviewed all available case reports and any studies of the oral aspects of prion diseases published in peer-reviewed journals and available via PubMed. The author then outlined the risk of nosocomial transmission of prions in dental health care. Results: Sporadic Creutzfeldt-Jakob disease, or sCJD, is the most common of the acquired human prion disorders, and it typically affects elderly people and leads to rapid death. In contrast, variant CJD, or vCJD, has affected young adults from Europe, giving rise to a slow onset disorder comprising both psychiatric and neurological upset. Oral neurological manifestations are rare and seem to occur only in people with vCJD; there are no oral mucosal or gingival manifestations of prion disease. Prions can be detected in the oral tissues—usually the gingivae and dental pulp—of animals experimentally infected with prions. In contrast, prions have not been detected in the pulpal tissue of people with sCJD, and there are no data of pulpal infection in vCJD. There also are no data suggesting that prions are transmitted easily in the dental setting, but there remains the rare risk of such transmission if appropriate infection control measures are not adhered to. Clinical Implications: Few people in the United States and worldwide have prion disease. Oral manifestations are rare. Evidence suggests that the risk of transmission and acquisition of a prion infection as a result of dental treatment is rare, if appropriate infection control measures are maintained.	Porter, S.R. (2003). Prion disease: Possible implications for oral health care. *JADA* 134, 1486-1491.

No.	Description	Reference
11	**Background:** The National Institute of Dental and Craniofacial Research, or NIDCR; the American Dental Association, or ADA; and the Organization for Safety & Asepsis Procedures, or OSAP, sponsored a workshop on the topic of dental unit waterlines, or DUWLs, on Sept. 29, 2000, at the National Institutes of Health in Bethesda, Md. These organizations invited a group of experts from the ADA, NIDCR, OSAP, the U.S. Food and Drug Administration, the Centers for Disease Control and Prevention, the U.S. Department of Defense, academia and private industry to participate. **Types of Studies Reviewed:** The sponsors asked the participants to critically review the scientific literature on the subject in an attempt to determine the evidence basis for management of DUWL contamination and potential health risks, if any, in dental procedures. The ultimate goal of the workshop was to determine if a research agenda in the area of DUWLs should be pursued and what questions such an agenda should involve. **Results:** The workshop yielded four questions that need to be addressed in future research: (1) What is the safest and most effective agent(s)/device(s) for achieving microbial levels of no more than 200 colony forming units per milliliter, or CFU/mL, in the effluent dental water? (2) How should these products be evaluated and by whom? (3) What are the adverse health effects, if any, of chronic exposure to dental bioaerosol or to the agents introduced into the dental unit to treat the waterlines for both dental staff members and patients? (4) How could these health issues be evaluated? **Clinical Implications:** Developing evidence-based parameters for the management of biofilm contamination that are efficacious and cost-effective will allow clinicians to meet in proposed ADA standard of no more than 200 CFU/mL of effluent water. The authors conclude that although no disease transmission arising from DUWL microbial contamination has been conclusively documented, there is irrefutable scientific evidence that the water delivered to most dental patients is of poor microbiological quality and often would fail to meet U.S. drinking water standards. Furthermore, evidence suggests that dental personnel and the increasing number of immunocompromised dental patients are being exposed to potentially pathogenic and resistant microorganisms as a result of aerosolization of dental unit water. Of perhaps greater significance is the fact that disease transmission in association with biofilm formation has been well-documented in other health care settings. The potential for transmission of disease from contaminated DUWLs exists, in at least some populations. To minimize the potential health impact of DUWL contamination, the prudent dental practitioner should institute measures that will bring the microbial content of effluent dental water to no more than 200 CFU/mL. More research is needed, however, to determine the constitution and pathogenicity of microbial biofilm and the actual contribution of exposure to biofilm on human disease.	Depaola, L.G., Mangan, D., Mills, S. E., Costerton, W., Barbeau, J., Shearer, B. & Bartlett, J. (2002). A review of the science regarding dental unit waterlines. *J Am Dent Assoc* 133, 1199-1206.
Articles in Peer-Reviewed Journals on Patient Safety/Risk of Harm in Infection Control		

No.	Description	Reference
12	Background and Overview: In 2005 in the United States, an estimated 94,370 new, invasive infections and 18,650 deaths were associated with methicillin-resistant *Staphylococcus aureus* (MRSA); most of these infections were in people with exposures in health care settings. MRSA also has emerged as a community-based pathogen, causing primarily skin infections that are not life threatening, but occasionally causing more severe and invasive infections. The authors describe the history of MRSA; identify populations at greatest risk of experiencing MRSA colonization and infection; compare characteristics of MRSA infections occurring in health care and community settings; and summarize strategies, based on U.S. Centers for Disease Control and Prevention recommendations and the literature, to prevent transmission of MRSA in dental offices. Standard Precautions are recommended for use with all patients in all health care settings to protect health care personnel and patients from contact with microorganisms, regardless of whether the source is recognized. Standard Precautions are based on the assumption that every person potentially is infected or colonized with an organism that could be transmitted in a health care setting. These precautions include the following: (1) performance of hand hygiene before and after having direct contact with patients or when moving from a contaminated body site to a clean body site during patient care; (2) use of personal protective equipment—such as gloves, gowns, and mouth, nose, and eye protection—for anticipated contact with blood or other potentially infectious materials, mucous membranes, nonintact skin or potentially contaminated intact skin (such as that of a patient incontinent of stool or urine); (3) use of respiratory hygiene and cough etiquette; (4) placing patients who pose a risk for transmission to others (for example, those with uncontained secretions, excretions or wound drainage) in a single-patient room when available; (5) establishing policies and procedures for containing, transporting and handling patient-care equipment and devices that may be contaminated with blood or body fluids; (6) establishing policies and procedures for routine and targeted cleaning of environmental surfaces; and (7) use of safe injection practices. Conclusions and Clinical Implications: Standard infection control precautions should be enforced strictly in all ambulatory care settings, including dental offices, to prevent facility-based transmission of MRSA and other infectious agents. The authors note that in ambulatory care settings, including outpatient dental offices, strict enforcement of Standard Precautions, including making sure that gloves and gowns are used for anticipated contact with uncontrolled secretions and other potentially infectious body fluids, is considered adequate in most circumstances to prevent the transmission of MRSA and other MDROs. For this reason, dentists do not need to determine patients' MRSA status routinely by means of history-taking or surveillance cultures or testing. Dental procedures routinely require contact with saliva, blood and intraoral mucous membranes, all of which are potentially infectious. Table 3 in the article (pg. 1334) provides a summary of infection control practices such as hand hygiene and use of personal protective equipment that prevent transmission of infectious agents (including MRSA) in the dental office. Few studies have been conducted to determine whether any additional actions can improve prevention of MRSA in dental settings. Investigators in one such study described the elimination of MRSA from patients' dentures by use of common denture-cleansing solutions. Researchers in another study found that the rate of bacteremia occurring within one hour after a tooth extraction can be reduced by means of a preoperative rinse with an oral chlorhexidine solution. In dental offices, the risk of transmission of MRSA is lower than in acute care hospitals, and Standard Precautions combined with other selected measures are recommended. In the community, dentists' awareness of opportunities for direct contact and factors that facilitate MRSA transmission—such as crowding, physical contact and lack of hygiene—will facilitate their support of community prevention.	Klevens, R.M., Gorwitz, R.J. & Collins, A.S. (2008). Methicillin-resistant *Staphylococcus aureus:* A primer for dentists *JADA* 139, (10), 1328-1337.

No.	Description	Reference
13	This article discusses digital radiography for dental auxiliaries such as the dental assistant. It provides an introduction, the history of dental digital radiography, types of digital systems, technique considerations, infection control, security issues and a conclusion. The focus of this summary is on the discussion of infection control. The authors note that as with all dental procedures, universal precautions should be implemented for all radiographic procedures. It is imperative that charge coupled device (CCD) sensors and photostimulable phosphor plates (PSP) sensor plates be kept contamination-free as they are used over and over again with subsequent patients. With all of its electronic components, the CCD sensor cannot be sterilized and thus a plastic sleeve should be used to cover the sensor and the positioning of the device, protecting both from contamination. For full-mouth radiographs, this sleeve may be changed a few times during the procedure as it may become saturated with saliva and lose its shape. When changing the positioning device, the user should be cautious of removing the sleeve and the sensor as they are delicate and should be kept saliva-free. Gloves should be changed every time the positioning device is changed to decrease the chance of cross-infection. If a CCD sensor becomes contaminated, it should be wiped using a paper towel sprayed with disinfectant or a commercially available disinfectant wipe. Disinfectant should never be sprayed directly onto a CCD. PSP sensors have their own infection control requirements. When using PSP technology, the plates are placed in an infection control pouch and can be used in a positioning device just like conventional film. The plates are taken out of the pouch after the image is captured and then scanned, enabling the information that they contain to be "read" and transferred to the computer. All positioning devices should be sterilized before use. The same dental radiograph camera and control panel used for film are also used for digital radiography and this equipment must also be disinfected. Digital images are processed and viewed using a computer, and thus the associated equipment must also be protected from contamination. The computer keyboard and mouse can be protected through the use of overgloves or by placing a plastic barrier over them to avoid contact with potential contamination. Digital radiography, by virtue of the equipment and technology used, offers unique infection control challenges. With understanding of basic principles and practice in a clinical setting, the dental assistant should be able to easily master these procedures. The authors conclude that digital radiography represents one significant way that dentistry is changing in the 21st century. While some dental offices have already embraced this new technology, many others will consider it in the future. There are similarities between film and digital radiography, but understanding the differences eases the adoption of digital techniques, and optimizes results and thus patient care using the new technology. The dental assistant's role will continue to be crucial in this change, and understanding the basics of digital radiography will make the dental assistant a valuable asset to the practice, and foster the provision of outstanding patient care.	Ng, V.M., Sidhu, G. & Woods, A.J. (2007a). Digital radiography for the dental assistant. *The Dental Assistant.* September-October, 22-27.

No.	Description	Reference
14	This editorial discusses the dental assistant in the Canadian context as a "knowledge worker" and urges the profession to mandate formal training for dental assistants and have recognized licensure. Below is selected text from the editorial..Knowledge workers possess a formal education and continue that education throughout their career in an ongoing effort to remain up-to-date. Knowledge workers are very mobile within their area of specialization, a result of the increasingly transitory nature of work. In the knowledge society, education must never stop. There is no hierarchy to knowledge. Either it is relevant to a particular situation or it is not. For example, proper application of surgical and sterilization techniques are equally important to patient safety. Formally educated dental assistants have the knowledge required to recognize this. Our expertise allows us to understand the difference between sterilization and disinfection, and the relative importance of both. These tasks are nearly always performed by dental assistants, without direct supervision. In the era of Walkerton and the recent $27.5-million settlement in the Ontario EEG-Hepatitis B class action lawsuit against Dr. Ronald Wilson, public safety demands that those responsible for sterilization be knowledge experts. Ultimately, the dentist is responsible. It is your profession and it is your job to make sure that patients receive proper dental health care in your office. The public looks to you to do the right thing. The argument that there are not enough formally trained dental assistants to meet current demand in various parts of Canada is spurious. The answer is not to lower the standards of care but to increase the supply of knowledge workers. It should be mandatory that every dental assistant in every dental practice be formally educated and have recognized licensure. Properly trained people are those who have received a recognized formal education. This is the only way we can ensure that dental standards are maintained and that dental patients across Canada receive safe health care.	Moffat, B. (2003). 21st century dental assistants are knowledge workers. *The Dental Assistant* May/June. Reprinted from the Journal of the Canadian Dental Association June 2002. Available at: http://findarticles.com/p/articles/mi_m0MKX/is_3_72/ai_103996609/?tag=content;col1 Last accessed: November 2010.

Table 5: Literature on Patient Safety/Risk of Harm in Inhalation Sedation

No.	Description	Reference
	Review Articles on Patient Safety/Risk of Harm in Inhalation Sedation	
1	Few studies into conscious sedation with 50% nitrous oxide/oxygen premix (50% N_2O/O_2) have been conducted in accordance with Good Clinical Practice in Clinical Trials. Of the 140 articles retained in this review (which included studies in the dental setting), the incidence of adverse events (AEs) varied in the range of 0 – 68% according to the indications. When other drugs and/or local anaesthesia were used concomitantly, the relative risk for nausea and vomiting increased whereas it decreased for vertigo or hallucinations. Only one study examined potential causal relationship between serious AEs and the 50% N_2O/O_2 gas itself, giving a risk for a serious AE directly due to the gas of 3/10,000 administrations. No analysis of the effect of the method of administration was possible, nor could conclusions be drawn relating to the risk of occupational exposure.	Collado, V., Nicolas, E., Faulks, D. & Hennequin, M. (2007). A review of the safety of 50% nitrous oxide/oxygen in conscious sedation. *Expert Opin. Drug Saf.* 6,(5), 559-571.
2	Purpose of review: The purpose of this review is to define risks for anesthesia and sedation outside the operating room, and to suggest how to prevent these risks and maintain quality of care. Recent findings: There are no recent data on risk for anesthesia outside the operating room, except information derived from the American Society of Anesthesia Closed Claims project, which indicates there is a higher risk for office-based anesthesia. In the dental office, approximately 300,000 patients per year undergo general anaesthesia for minor dental procedures in the UK. In deaths occurring on the dental chair (26 between 1984 and 1993) following cardiorespiratory failure, the postmortems did not clarify the cause of cardiac arrest. A mortality rate of nine in 1,000,000 was reported following administration of oxygen/nitrous oxide/halothane. The number of deaths in the UK, however, has decreased from 100 (1970–79) to 20 (1990–99). Inappropriate patient selection (ASA 3) may have contributed to anesthetic complications, but deaths in young healthy patients have also been described; overall, care was judged to be poor. The incidence of mortality in GA perfomed for dentistry procedures has decreased in the latest reviews to 1–1.5 cases per million. Summary: Complications of anesthesia outside the operating room are not well studied, although a few closed claims are appearing in the literature suggesting there is a higher risk. Topics discussed focus on MRI and surgical procedures, principally dental, plastic, and gastrointestinal endoscopy. Risk factors for these procedures are identified and quantified and measures to reduce them discussed, with emphasis on full oxygenation and end-tidal carbon dioxide monitoring. Nonoperating room anesthesia requires skills, experience and organization. Quality can only be assured by ensuring all alternative locations adhere to operating room standards.	Melloni, C. (2007). Anesthesia and sedation outside the operating room: How to prevent risk and maintain good quality. *Curr Opin Anaesthesiol* 20, 513–519.

No.	Description	Reference
3	Although the incidence of mortality with pediatric sedation is unknown, estimates of fatal outcomes made two decades ago extended from 1:100,000 with opioid analgesics to lower numbers with some non-opioids. Current mortality rates associated with general anesthesia may be as low as 1:250,000, which is a dramatic improvement over the 1:1,560 rate of a half century ago. The dental literature documents a significant association of adverse incidents with sedation in pediatric dentistry. Reported nonfatal events range from temporary inconveniences (nausea, delayed recovery) to permanent brain injury. The major cause of serious negative outcomes is hypoxia. Inadequate ventilation in the pediatric population has commonly involved patients who are generally healthy. Nevertheless, loss of airway and acute hypoxia are more likely to occur in patients with pre-existing conditions that affect respiration. Medical disorders that potentially compromise ventilation during sedation include restrictive and obstructive lung diseases. Obesity is a condition in which patients are considered to have chronic extrinsic restrictive lung disease as well as other compromised systems (e.g., cardiovascular, gastrointestinal), all of which can contribute to major injuries during sedation. The purpose of this review was to describe the potential influence of childhood obesity on pharmacosedation in pediatric dentistry and provide specific recommendations for managing obese patients. Increasingly common in the United States, childhood obesity poses specific challenges to the dentist. The greatest of these involve the increased potential for respiratory complications because of fat-induced restrictive lung disease and obstructive sleep apnea. Cardiovascular complications associated with obesity alone are rare in the pediatric patient, although hypertension is more likely. Gastrointestinal problems include increased likelihood for aspiration, necessitating strict fasting requirements. Sedative drugs dosed on total body weight may oversedate obese patients; dosages based on lean body mass may undersedate and usually produce a decreased duration of effect. Extra precautions regarding drug selection (such as avoiding opioids) and proper patient positioning can help minimize the incidence of complications are rare in the pediatric patient, although hypertension is more likely. Gastrointestinal problems include increased likelihood for aspiration, necessitating strict fasting requirements. Sedative drugs dosed on total body weight may oversedate obese patients; dosages based on lean body mass may undersedate and usually produce a decreased duration of effect. Extra precautions regarding drug selection (such as avoiding opioids) and proper patient positioning can help minimize the incidence of complications. The authors also note that local anesthetics are also dosed according to total body weight. Nitrous oxide is a relatively insoluble inhalation anesthetic and has a rapid onset and fast elimination. Even with nitrous oxide, however, prolonged administration to an obese individual may result in delayed recovery because of the modest tendency for nitrous oxide to accumulate in body fat.	Baker, S. & Yagiela, J.A. (2006). Obesity: A complicating factor for sedation in children. *Pediatr Dent* 28, 487-493.

No.	Description	Reference
4	This review paper examines (using systematic methodology) the evidence for the use of inhalation sedation (IHS) instead of dental general anaesthesia (DGA) for dental treatment. It finds that this is an area of healthcare lacking high-quality clinical evidence (i.e. derived from randomized controlled trials). However, evidence from seven case series studies (level of evidence 3) of variable quality and design is examined. Those studies suggest that IHS is effective for a large proportion (83–97%) of selected subgroups of children who would have otherwise required DGA. This may represent 45–64% of all children who are referred for DGA. There is a remarkable degree of consistency between all studies in the reported treatment effectiveness of IHS, despite differences in design and populations treated. IHS is particularly suitable for orthodontic treatment, for older children, and for children requiring no more than four extractions. Morbidity associated with IHS is minor and infrequent, and user satisfaction is high, or higher compared with DGA. For example, one comparative and three other studies provide information on morbidity. In the comparative study, IHS was found to be similar or superior to DGA for morbidity, with only minor side effects reported, mainly nausea/vomiting and headache. In the other studies, only minor side effects associated with IHS are reported, mainly nausea/vomiting and headache, in 5–13% of patients. Additionally, no major adverse events (death, unplanned hospitalization) are reported in the reviewed literature for either method. This is not surprising, given the small number of patients treated by the reviewed studies. In general, death as a result of DGA is very rare (one death in many thousands of DGA episodes) but IHS has a superior safety record, with no death reported in over one million cases. The superior morbidity profile of IHS compared with DGA40 may be at least partly responsible for the higher level of user (child and parental) satisfaction with IHS. However, there is a lack of any large studies of post-operative morbidity Comparing with DGA, IHS requires significantly longer time per episode and more treatment sessions per patient. In teaching dental hospitals, staffing costs for IHS are estimated to be cheaper by about a third compared with outpatient DGA. Indications for further areas of research are made.	Lyratzopoulos, G. & Blain, K. M. (2003). Inhalation sedation with nitrous oxide as an alternative to dental general anaesthesia for children. *Journal of Public Health Medicine* 25, 4, 303–312.
Articles in Peer-Reviewed Journals on Patient Safety/Risk of Harm in Inhalation Sedation		
5	Objective: The goal of this study was to identify and quantify complications occurring with the administration of anesthesia for the dental treatment of patients with special needs. Methods: Anesthesia providers completed a standardized evaluation form, delineating possible complications for 202 consecutive ambulatory patients receiving anesthesia within the University of Pittsburgh School of Dental Medicine Special Needs Clinic (UPSDM). Results: Statistical analysis of four types of administered anesthesia (i.e., nitrous oxide, oral sedation/anxiolysis, intravenous sedation, and general endotracheal anesthesia) showed that the overall complication rate was 23.8%. Evaluation of the data showed complications that were considered either mild (95.8%), or moderate (4.2%), while no reports of severe complications occurred. Airway obstruction and nausea/vomiting were the most frequently encountered complications. Variables found to affect the incidence of anesthetic complications included ASA classification, anesthetic technique, Mallampati airway classification, and type of dental procedure performed. Conclusions: An evaluation of the results of the study showed that the majority of complications that occurred with anesthesia during care of patients with special needs were mild and did not lead to severe adverse events. The findings show that anesthesia administered during dental treatment for patients with special needs is safe and effective.	Boynes, S.G., Moore, P.A., Lewis, C.L., Zovko, J. & Close, J.M. (2010). Complications associated with anesthesia administration for dental treatment in a special needs clinic. *Spec Care Dentist* 30(1), 3-7.

No.	Description	Reference
6	Nitrous oxide/oxygen sedation remains a viable option for managing a patient's pain and anxiety in the dental office. There are several advantages to its use and relatively few contraindications. Knowing how to minimize the operator's exposure to the gas is also an important consideration. N2O/O2 sedation has a long-standing history of safety and success and it is likely that this type of sedation will be used far into the future. It is necessary to educate the entire office team on the biohazard issues of nitrous oxide safety in the dental office and keep abreast of sound scientific literature in this area. Many states are starting to include nitrous oxide administration and monitoring in their state practice acts for dental assistants.	Brunick, A. & Clark, M. (2010). Nitrous oxide and oxygen sedation: An update. *Dental Assistant* 79, 4, 2 2-3, 26, 28-30. *Abstract only*

No.	Description	Reference
7	This article was written as material for a continuing education course offered through the American Dental Association for dentists, dental hygienists, and assistants. The report states that modern general anesthesia and conscious sedation procedures are predictable, effective, and safe with appropriate patient selection, drugs and techniques. The use of conscious sedation in dentistry in office-based settings continues to increase. Nitrous oxide is the most commonly used inhalation anesthetic (sedative) used in dentistry, and has withstood the test of time with an excellent safety record. It reduces anxiety, pain, and memory of the treatment experienced, and is a valuable component of the armamentarium available to clinicians. Nitrous oxide/oxygen conscious sedation is frequently used in oral surgery, particularly in the extraction of third molars, periodontal surgery, and in patients with behavioural or developmental issues. There are a number of relative contraindications to the use of nitrous oxide, though no known absolute contraindications. If patients are unable to breathe adequately through their noses, insufficient nitrous oxide will be inhaled for sedation. These patients include those with upper respiratory tract infections (such as colds and influenza), blocked sinuses, blocked nasal passages due to allergies, and mouth breathers. Nitrous oxide should not be administered to patients who have received ocular surgery that included introducing a gas bubble in the eye (perfluoropropane or sulfur hexafluoride), as nitrous oxide inhalation can result in the gas bubble expanding and causing eye damage or delaying postsurgical healing. Similarly, patients who have undergone middle ear surgery (tympanic membrane graft) should not receive nitrous oxide sedation. The distending ability of nitrous oxide gas can also be problematic in patients with colostomy bags or bowel obstructions, as well as in patients with blocked eustachian tubes (the tympanic membrane can become distended following inhalation of the gas). Cystic fibrosis patients are relatively contraindicated due to the cystic spaces present that may become distended. In patients receiving bleomycin sulfate therapy for neoplasms, an increased incidence of pulmonary fibrosis and other lung diseases is found. Pneumoencephalography, pneumothorax, and chronic obstructive pulmonary disease (COPD) are additional relative contraindications to nitrous oxide/oxygen sedation. Patients with hypoxic drive, whereby their breathing is regulated by the drive to breathe when hypoxia is present as opposed to breathing by normal biophysiological feedback mechanisms, are at slightly increased risk during nitrous oxide sedation. The mood-altering effects of nitrous oxide may be a contraindication in patients with some mental or psychiatric conditions, patients with drug addictions or recovering from addictions, patients under the influence of drugs or alcohol, and patients self-administering barbiturates. Patients with true phobias, as well as those taking sleep-inducing medication, antidepressants, or psychotropic drugs should be evaluated carefully before nitrous oxide sedation is considered. Nitrous oxide use in pregnant women should be avoided during the first trimester, as if any damage to the fetus occurs, sedation with nitrous oxide could be automatically implicated. Before using nitrous oxide sedation in any pregnant patient, the patient's physician or ob/gyn should be consulted. Patients must complete or, in the case of existing patients, update a detailed medical history prior to receiving care or being considered candidates for nitrous oxide/oxygen sedation. If there is any doubt that the patient is a suitable candidate, use of nitrous oxide/oxygen sedation should be postponed until the patient's physician or specialist has been consulted. It is essential that the patient (or parent or guardian) complete and sign an informed consent form after discussion of the sedation and treatment and before receiving treatment– otherwise, legal ramifications exist. Patients must receive written instructions, and thorough contemporaneous records must be kept. One unit (Accutron) offers an adjunctive device that prints out the flow of gas and percentage of nitrous oxide administered to a patient, which then becomes part of the patient record. Nitrous oxide abuse by dental health care professionals can occur. It is important to monitor the amount of nitrous oxide used for dental treatments – should a discrepancy occur between the actual and expected volume present, abuse should be considered as a possible explanation. Repeated exposure to high levels of nitrous oxide does have negative consequences, including possible teratogenic and reproductive effects. Chronic nitrous oxide exposure results in inactivation of methionine synthease, a Vitamin B-12 dependent enzyme. Neurologic dysfunction, megaloblastic anemia, bone marrow depression and peripheral cytopenia can all occur with repeated or long exposure to nitrous oxide (whether occupational or related to nitrous oxide abuse). Scavenging is essential during nitrous oxide/oxygen sedation. It is important that room ventilation and scavenging are adequate to prevent the build-up of nitrous oxide in dental operatories. Nasal hoods contain scavengers that remove exhaled nitrous oxide through a vacuum to the outside world, reducing the possibility of build-up of nitrous oxide in the dental office. It is unacceptable and substandard care to use a nasal hood that does not include scavenging. Handheld monitoring devices can be used to assess the trace levels of nitrous oxide present in the office and the effectiveness of the scavenging.	Clark, M. (2009). Back to the future: An update on nitrous oxide/oxygen sedation. ADA Continuing Education Recognition Course. Available at: http://www.ineedce.com/courses/1606/PDF/NitrousOxide.pdf Last Accessed: November 2010.

No.	Description	Reference
8	Nitrous oxide is the most commonly used inhalation anesthetic in dentistry and is commonly used in emergency centers and ambulatory surgery centers as well. When used alone, it is incapable of producing general anesthesia reliably, but it may be combined with other inhalation and/or intravenous agents in deep sedative/general anesthestic techniques. However, as a single agent, it has impressive safety and is excellent for providing minimal and moderate sedation for apprehensive dental patients. To gain a full appreciation of the pharmacology, physiologic influences, and proper use of nitrous oxide, one must compare it with other inhalation anesthetics. The purpose of this continuing education (CE) article is to provide an overview of inhalation anesthetics in general and to address nitrous oxide more specifically in comparison. Nitrous Oxide: Nitrous oxide has low potency (Minimum alveolar concentration = 104), but its impressive record of safety allows use of sub-MAC concentrations that are ideal in allaying apprehension and anxiety regarding injections of local anesthetics and treatment in general. Respiratory and cardiovascular functions are minimally influenced, especially when compared with changes produced by more potent agents. However, caution is advised because this analysis fails to address considerations when nitrous oxide is combined with other anesthetics, sedatives, or opioids. These agents not only lower the MAC for nitrous oxide but work synergistically in depressing respiratory and cardiovascular function. The authors also outline some of the risks involved in administering nitrous oxide including. Some risks relating to patients included: (1) Gas volume and pressure can become dangerously high within an obstructed bowel, pneumothorax, or the middle ear if patency of the eustachian tube is compromised by inflammation. Rupture of the tympanic membrane is possible during administration of nitrous oxide, and negative pressure may develop following discontinuation, leading to serous otitis possibly contributing to postoperative nausea and vomiting. Pain also may be experienced when nitrous oxide is administered to patients with a sinusitis. Expansion of gas bubbles in the eye following retinal surgery may lead to severe consequences; the potential risk of hypoxemia but this risk is only high for a matter of minutes and has been documented only when high concentrations (70%) have been delivered by full mask or by endotracheal tube; (2) the potential abuse of nitrous oxide; (3) some authorities suggest that nitrous oxide should be avoided in patients with significant chronic obstructive pulmonary disease. Reasons cited include not only its depression of hypoxemic drive, but also, because high oxygen concentrations are delivered with nitrous oxide, its use may remove the stimulus for hypoxemic drive. However, if the principles of moderate sedation are followed, the patient can always be instructed to breathe more deeply; (4) Nitrous oxide has been implicated in the adverse effects on health seen in those individuals who are chronically exposed to trace amounts of the drug including infertility, spontaneous abortion, blood dyscrasias, and neurologic deficits. These concerns pertain only to chronic exposure; it is presumed that healthy surgical patients could receive nitrous oxide without harm. The authors also note that With its long history of safety in medicine and dentistry, nitrous oxide sedation can be used safely for almost all patients routinely treated in the ambulatory dental setting. In fact, it could be argued that nitrous oxide is the safest of all the modalities available for sedation in dentistry. However, similar to any other pharmacologic agent, nitrous oxide may not be suitable for all patients. It is very important to carefully review the medical history of a patient and to consider the small number of situations in which nitrous oxide sedation may be contraindicated or may at least pose a relative contraindication. The inability to use a nasal mask is an absolute contraindication to the use of nitrous oxide (e.g., those who cannot inhale adequately through the nose because of anatomic and/or disease-induced nasopharyngeal obstructions, and those who cannot tolerate and sustain placement of the nasal mask because of psychological and/or cognitive disturbances) It should be used cautiously when those diagnosed with schizophrenia or bipolar disorder are treated. For the pregnant patient who is apprehensive and requires urgent dental care, nitrous oxide should be regarded as the sedation agent of choice.	Becker, D.E. & Rosenberg, M. (2008). Nitrous oxide and the inhalation anesthetics. *Anesth Prog* 55,124-131.

No.	Description	Reference
9	Inhalation sedation utilizing nitrous oxide-oxygen has been a primary technique in the management of dental fears and anxieties for more than 150 years and remains so today. Though other, more potent, anesthetics have been introduced, nitrous oxide is still the most used gaseous anesthetic in the world. Administered properly with well-maintained equipment, the nitrous oxide-oxygen technique has an extremely high success rate coupled with a very low rate of adverse effects and complications. Current concerns with nitrous oxide the authors outline included: the potential abuse of nitrous oxide, sexual awareness related to the use of nitrous oxide, and the potential biohazards of chronic exposure.	Malamed, S.F. & Clark. M.S. (2003). Nitrous Oxide-Oxygen: A New Look at a Very Old Technique. *Journal of the California Dental Association,* May. Available at: http://www.cda.org/library/cda_member/pubs/journal/jour0503/malamed.htm Last accessed: November 2010.
10	Objective: A total of 1,112 pediatric outpatient sedations, by either nitrous oxide–oxygen inhalation (N_2O) or oral midazolam, administered over a 10-year period were reviewed. Patient responses and outcomes were evaluated to ascertain the safety of these sedation techniques. Study design: A total of 819 patients were included in this study. Patient health status, age, weight, behavior, treatment rendered, and length of treatment were recorded. Vital signs (heart rate, blood pressure, oxygen saturation) were recorded for the N_2O group. Complications and successful completion of treatment were also noted. Results: Both the N_2O and midazolam groups demonstrated a low complication rate with a high rate of successful completion of treatment. Patients receiving N_2O were somewhat older on average and underwent a greater number of surgical procedures than patients in the midazolam group. Vital signs recorded in the N_2O group were observed to remain stable throughout treatment. Conclusions: The use of either oral midazolam or nitrous oxide–oxygen as single agents provides safe and effective conscious sedation in the pediatric outpatient population.	Hulland, S.A., Freilich, M.M. & Sandor, G.K.B. (2002). Nitrous oxide–oxygen or oral midazolam for pediatric outpatient sedation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 93,643-646.

No.	Description	Reference
11	There are many safe and effective medications available to the dental practitioner for producing conscious sedation. Given the many sedatives available, all possessing slightly different clinical characteristics and various degrees of risk, careful consideration needs to be given to the objectives of the sedation when deciding which pharmacologic agents to use. Before making plans to sedate dental patients, however, one needs to make sure that several "layers" of risk management are in place to ensure the sedation procedure is as safe as possible. Included in this risk management plan is a complete understanding of the regulations that define conscious sedation and the training that is required to deliver this state of depressed consciousness. Careful attention also needs to be given to selecting appropriate dental patients for sedation. A thorough understanding of the patient's physical and psychologic status is necessary when making decisions about sedation. Because most dental disease is not life threatening, dental treatment needs tend to be primarily elective in nature. Considering the training requirements for delivering inhalational or enteral conscious sedation with a single agent, it is prudent to limit this type of sedation to the patient population that is healthy (e.g., ASA I and II) and psychologically stable as a way of minimizing risk. The amount of additional risk one encounters when sedating more medically compromised patients (ASA III and greater) should suggest that deferring elective dental treatments until the health status improves is prudent. In situations in which an improvement in the patient's health status is not likely, referral to someone with more experience sedating medically compromised patients is strongly recommended. Equally important to the conscious sedation risk management plan is an assurance that the patient understands what is meant by conscious sedation and that their treatment expectations are realistic. Finally, even though conscious sedation is safe when all precautions are followed, being prepared to manage unexpected sedation-related emergencies is necessary. The principles of risk management covered in this article are applicable to other articles in this issue, in which N2O/O2 inhalational sedation and enteral sedation in adults and children are discussed. The remaining article in this section that reviews the prevention of medical emergencies and the pharmacologic agents necessary to treat emergency events that are likely to occur in dental settings further enhances the level of preparedness necessary when administering conscious sedation to adults and children.	Jackson, D.L. & Johnson, B.S. (2002a). Conscious sedation for dentistry: Risk management and patient selection. *Dental Clinics of North America* 46,(4),767-80. *Abstract only*
12	There are clearly many safe and effective sedatives available to the dental practitioner for reducing patient fear and improving their level of comfort. Careful consideration needs to be given to the objectives of the sedation when deciding which pharmacologic agents to use because they all possess slightly different clinical characteristics and various degrees of risk. Patient selection also is critical when making decisions about sedation because the patient's expectations and general health status factor into keeping the procedure safe. N2O/O2 sedation is an excellent choice for managing the mildly fearful dental patient or when minimal sedation is desirable. Among the sedatives administered enterally, the benzodiazepines are the most commonly used, and for good reason. These drugs are safe, effective, and offer a host of different personalities from which the dentist can choose. If used wisely and thoughtfully, the dentist can tailor the effects and duration of onset and recovery to the needs of the patient and the expected parameters of the appointment. When N2O/O2 sedation is combined with a single enteral sedative, a more profound level of CNS depression is achieved that can be modestly altered by changing the concentration of inhaled nitrous oxide. With these many pharmacologic alternatives, many different dental patient populations can be sedated in a safe, effective manner, thus allowing the delivery of most dental treatments in a setting of reduced psychologic and physiologic stress. These pharmacologic sedatives have truly opened up a wonderful world of possibilities for the comfortable delivery of dental care, and should be integrated into every office's repertoire for delivery of care.	Jackson, D.L. & Johnson, B.S. (2002b). Inhalational and enteral conscious sedation for the adult dental patient. *Dental Clinics of North America* 46,(4),781-802. *Abstract only*
Grey Literature on Patient Safety/Risk of Harm in Inhalation Sedation		

No.	Description	Reference
13	This is a document from the Dental Assisting National Board outlining US state regulation and education requirements for dental assistants' roles in sedation and anesthesia. For example, in most states, dental assistants can monitor patients that have been given nitrous oxide but with the exception of one state (Arkansas), most can not induce. Administering and preparing/assisting in administering nitrous oxide also varies among the states. Education requirements also vary among the states.	Dental Assisting National Board [DANB]. (2010). State regulation of dental assistants' roles sedation and anaesthesia. Available at: http://www.danb.org/PDFs/SedationAnesthesiaTable.pdf Last accessed: November 2010.

Table 6: Literature on Interprofessional Collaboration

No.	Description	Reference
	Articles in Peer-Reviewed Journals on Interprofessional Collaboration	
1	Objectives: To determine the role of the dental therapist in the multidisciplinary management of paediatric patients with hypodontia in the UK. Hypodontia specifically describes the absence of one to six teeth excluding third molars, but is most often used when a patient has congenitally missing teeth. Design: Hypodontia data collection sheet. Subjects and methods: Fifty patient records were randomly selected from patients who had attended over the last five years to a multidisciplinary hypodontia clinic at Birmingham Dental Hospital. Data regarding the age, sex, level of cooperation, complaints, oral health, medical and dental history, genetic history, teeth present and teeth missing, occlusion, treatment carried out and treatment outstanding were collected. Subsequent statistical analysis was done with SPSS. Results: Sixteen patients had acquired hypodontia and 34 patients had congenital hypodontia. Those with acquired hypodontia were excluded from this study. Of the 34 with congenital hypodontia 22 were male and 12 female. The mean age of these patients was 13 years (+/- 3 SD). Fifteen patients had more than six teeth missing. Teeth most commonly missing were upper lateral incisors. Sixtyeight percent had familial hypodontia and nine percent had hypodontia related to a syndrome. Of the prescribed treatments, oral hygiene instruction with disclosing and dietary advice was prescribed in 16, scaling in five, fissure sealants in two, preventive resin restoration in one, study models in ten, simple conservation in 11 and extractions in 17 patients. In addition to this, all 34 patients had treatment plans for orthodontic and advanced restorative treatment. Conclusion: All of the patients in this study were managed with a combination of orthodontic and restorative treatment. In this group of patients, it was seen that a dental therapist could have carried all of the initially prescribed treatments effectively. Disappointingly not all the patients were given dietary advice or oral hygiene instructions, which is paramount for this group of patients to maintain their dentition and facilitate long term treatment planning. The authors concluded that this small sample demonstrates the valuable and vital role that a highly skilful dental therapist can play in the multidisciplinary management of paediatric patients with hypodontia. All of the initial treatment prescribed in this small cohort could have been carried out by a dental therapist. There is therefore value in the dental therapist being actively involved in the model care pathway and in the early management of this group of patients to assist in maintaining and stabilising the patients' existing dentition, hence ensuring that long term treatment planning and options are not compromised.	Ranka, M.S., Parveen, T. & McKaig, S. (2010). The role of dental therapist in the management of paediatric patients with hypodontia. *Vital,* 37-40.

No.	Description	Reference
2	For one week, three dental assistants assigned to the 81st Dental Squadron, Keesler Air Force Base, Mississippi, experienced forensic dentistry first-hand. Three members of a newly established Air Force Medical Forensics Sustainment Support Team, acquired 39 hours of Medical Examiner Education Training provided by the Armed Forces Medical Examiner System, a component of the Armed Forces Institute of Pathology. Their training included a combination of didactic instruction and actual human remains identification at the Charles C. Carson Center for Mortuary Affairs at Dover Air Force Base, Delaware. The 70,000-square-foot Carson Center is the Department of Defense's largest stateside mortuary. The Keesler dental assistants served as members of a muitidisciplinary team consisting of an oral pathologist, dentist, a pathology technician and three radiology technicians. Their mission was to assist in identifying through scientific means the human remains of fallen members of the Armed Forces, government officials and civilians who die on exclusive federal jurisdiction. The identification process was accomplished via nine stations, including explosive ordinance detection, full body photography, bar-coding, fingerprinting, full-body digital radiography and computed tomography, digital dental radiography and examination, autopsy, wrap and dress, and transportation. A positive identification is made only after obtaining two scientific confirmations. The primary scientific tools utilized are fingerprinting and dental examination. DNA testing is also used, but due to the expense involved, only when other means fail.	Hanks, J. (2008). Air force dental assistants in forensic dentistry. *The Dental Assistant* January/February, 38-39.
3	Introduction: Head and neck cancer is the sixth most common malignancy in the world. Fifty percent of the patients can be cured by surgery, radiotherapy or a combination approach. Head and neck cancer is life-threatening, and treatment may leave the patient with visible facial disfigurements and impairment of functions such as speech and eating. This affects not only the patient, but may arouse difficult feelings in the treatment staff. Dental personnel are involved in all facets of treatment, yet they have no specific training in cancer care. In Sweden, dentists, dental hygienists and dental assistants work in hospitals and provide conventional dental treatment to disabled and medically compromised patients. In county and regional hospitals of Sweden offering specialised treatment of head and neck cancer patients, these hospital dental personnel work together with the medical staff in caring for these patients before, during and after radiation therapy. Advances in reconstructive surgical techniques and dental implant technology have dramatically changed the reconstruction of oral defects and provide patients with more reliable means of retaining intra-oral prostheses. As a result, specialists in oral and maxillofacial surgery and prosthetics, along with other dental personnel, become involved in the patients' rehabilitation. Whilst the contribution and participation of dental personnel in helping the patient cope during rehabilitation has been mentioned in literature, there is little knowledge today devoted to how dental personnel experience their role in the treatment of these patients. Background: The aim of this study was to describe the variation in ways dental personnel understand and experience the encounter with head and neck cancer patients, as the way of understanding a certain phenomenon is judged to be fundamental to the way we act and form our beliefs. Methods: Twenty members of hospital dental teams were interviewed. The interviews focused on experiences of the encounter with head and neck cancer patients. A qualitative research approach, phenomenography, was used in analysing the interviews. The encounter was perceived in three qualitatively different ways: as an act of caring, as a serious and responsible task and as an overwhelming emotional situation. Results: The results indicate that hospital dental personnel are not able to lean on education and professional training in finding ways of dealing with situations with strong emotional impact. This has implications for the treatment of patients with head and neck cancer, as well as education of dental personnel.	Röing, M., Hirsch, J.M. & Holmström, I. (2006). Ways of understanding the encounter with head and neck cancer patients in the hospital dental team - A phenomenographic study. *Support Care Cancer* 14, 1046–1054.

No.	Description	Reference
4	This article discusses the dental considerations for disabled adults discussing access issues, demographics, utilization of medical and dental services, the need for special dental care, dental treatment considerations, etc. In particular, the author notes that dental management of patients with disabilities, at all levels of severity, demands an interdisciplinary approach. Not only does special patient care call for a team effort by the dentist, dental hygienist, and dental assistant, but the dental team must work closely with other health care providers, family members, and social service agencies to facilitate therapy and home care. Dental and other health professionals and caregivers must be aware of the patient's special needs, be motivated, and have the skills to provide the requisite oral care. This requires special training at various levels of education for all disciplines involved, from advanced, predoctoral, and undergraduate professional training, to periodic in-service instruction of direct caregivers. Multidisciplinary education models have been tested and proven effective. The author concludes that adults with disabilities are a part of the population that has extensive oral health needs but limited access to dental services. The principal barriers to care are the inadequacy of public and private dental insurance, a lack of dental professionals qualified and available to meet the need, and a general lack of awareness of the importance of oral health to total health. To address the urgent oral health problems of this growing segment of the community requires a collaborative effort by the various health disciplines, social service agencies, makers of public policy, and the private sector.	Stiefel, D.J. (2002). Dental care considerations for disabled adults. *Spec Care Dentist* 22, (3), 26S-39S.

Table 7: Literature on Emerging Techniques and Technologies

No.	Description	Reference
	Articles in Peer-Reviewed Journals on Emerging Techniques and Technologies	
1	Cone Beam Computed Tomography (CBCT) is a relatively new three-dimensional imaging technology, which has been specifically developed for imaging of the teeth and jaws. The aim of this paper is to acquaint the dental team with various forms of this technology and its potential applications. An understanding of the underlying principles will allow the users of this technology to tailor the imaging protocol to the patient's individual needs to achieve appropriate imaging at the lowest radiation dose. The current UK Ionising Radiation (Medical Exposure) Regulations 2000 (IRMER) places a duty on all practitioners to ensure that radiographic images are fully evaluated, with abnormal or pathological findings recorded into the patient's notes. The law also requires anyone using X-ray equipment to be 'adequately trained' for the role they play. In the case of radiographic exposures the law recognises different roles; the 'referrer', the 'IRMER practitioner' and the 'operator'. Each has a specific role and needs to be prepared by suitable training to fulfil that role. Rather uniquely, a dentist may find he or she fulfills all these roles. The 'referrer' initiates the process; this is the dentist or doctor who prescribes or requests a radiograph. Their responsibility is to provide sufficient clinical information for the next person in the chain – the 'IRMER practitioner' – to be able to *justify* the radiograph. Training should help these clinicians select appropriate cases for CBCT examination, understanding the risks they seek to expose the patient to, the likely yield from the examination. These dentists should also know how to manipulate and interpret the resulting imaging dataset to extract the required diagnostic information. The 'IRMER practitioner' is the key person in the chain and they take responsibility in law for the radiographic exposure. This is normally a radiologist within a hospital setting but it may be a dentist in a dental practice. Their role is to *justify* the exposure, weighing the risks against the benefits and considering the necessity of CBCT and its imaging alternatives. Here training in CBCT capabilities and risks is essential to allow a balanced decision. The 'operator' is anyone playing any practical role in the radiographic exposure or reporting on the images and must be 'adequately trained' for the role they undertake. The central person here is the person taking the radiograph - this may be a radiographer, dentist, dental nurse or other DCP with a Certificate in Dental Radiography. Training should enable them to carry out the required CBCT examination safely, accurately and with maximum *dose optimisation* for the intended diagnostic role. The 'as low as reasonably achievable' (ALARA) principle applies here as much as in conventional dental radiography. The referring dentist also must have a responsibility to ensure that they are making the best possible use of the resulting data and that they are correctly trained and properly supported to do so. Training is therefore crucial for the whole dental team. It should comprise of training from the manufacturer's CBCT applications specialist on how to use the particular machine, an update on radiation hazards and imaging pitfalls relevant to CBCT, selection criteria for CBCT imaging and how to approach interpretation of cross-sectional and three-dimensional images. The authors conclude that CBCT technology is increasingly accessible in dental practice. It hugely expands diagnostic and treatment possibilities for patients. However, CBCT should only be used after careful consideration, where conventional two-dimensional imaging techniques are not sufficient or where access to the technological processes such as guided surgery will improve patient management. When selecting the best CBCT examination for an individual, it is important to minimise X-ray dose while striving for an image that enables appropriate diagnosis and management. This requires an understanding of the concepts behind CBCT and related technologies, making appropriate training essential for every member of the dental team.	Dawood, A., Patel, S. & Brown, J. (2009). Cone beam CT in dental practice. *British Dental Journal* 207, 1, 23-28.

No.	Description	Reference
2	This summary provides selected text from a "Viewpoint" article which discusses the issues of cone beam computed tomography in the dental office. The author, Dr. Perschbacher, is an Oral and Maxillofacial Radiologist and a member of the editorial board of Oral Health. She notes that new technology often enables us to do things better or more efficiently than we could before. Many of us are eager to embrace the potential of the latest tool placed in our hands. As dental professionals, however, we have been taught to resist the temptation of the glossy brochures and promises of salespeople and to use our best judgement when considering the application of new technology to our practice. We must consider how our patients will benefit, how the new instrument compares to other available methods and how our practices profit in terms of efficiency and economy. Cone Beam computed tomography (CBCT) is an example of such a new technology and some of the factors involved in deciding to adopt the use of CBCT in our practices are discussed here. CBCT is the newest modality available for imaging the maxillofacial region. It is a powerful instrument that can provide radiographicimages through any plane of the jaws as well as three-dimensional reconstructions. This ability to view the anatomy from limitless perspectives has not been readily available to the dental profession in the past and has great diagnostic implications. Dentists planning implants for patients can now clearly visualize the buccal and lingual dimensions and contours of the alveolar ridges, which can only be completely assessed by cross-sectional imaging. Vital anatomic structures, such as the inferior alveolar nerve canal, maxillary sinuses and bony fossae, can be localized with great accuracy and the internal bone pattern can be appreciated. The osseous structures of the temporomandibular joints can be studied and impacted teeth can be localized with respect to adjacent teeth or vital structures. These are just a few examples of the uses for which CBCT is being adopted. There is no doubt, that when applied appropriately, CBCT has the potential to benefit dental patients. So, why then is there concern about the use of this modality that has resulted in regulation of its use in the province of Ontario as well as in other jurisdictions? This is because some governments or regulators consider CBCT to be more complex than other dental imaging modalities and have concerns for patient safety if it is misused. Three major factors can be considered to be required for the appropriate use of CBCT; appropriate application of the modality, appropriate image acquisition protocoling and appropriate handling of the acquired data set. CBCT is a wonderful new technology with many potential applications that benefit our dental patients. As with any new technique, however, we must proceed with professional and evidence-based judgement. Given the complexity of this modality and the many factors involved in its appropriate use, it just might be that regulations are the best way to achieve this and ensure that the well-being of our patients remain our primary concern.	Perschbacher. (2009). Making the most of cone beam CT... responsibly. July. Available at: http://www.oralhealthjournal.com/issues/story.aspx?aid=1000333738 Last accessed: November 2010.

No.	Description	Reference
3	This article focuses on the general practice environment and the critical role a dental assistant can play in streamlining a dentist's day and providing quality of care to the patients. It also discusses ways to become more efficient and skilled with the most common new procedures and dental materials in general dentistry. Procedures performed by dental assistants can vary greatly depending on state guidelines and many parameters related to the overall focus of the individual dental practice. Many practices are classified as general dentistry practices; yet, the actual procedures performed from practice to practice can vary greatly and will influence the skills required from the assistant. For example, the introduction of rotary endodontic systems has expanded the number of endodontic procedures being performed by general dentists. When a general dentist incorporates endodontic procedures into his or her practice, the assistant is required to develop not only the traditional skills unique to that discipline, but also a set of skills to help integrate the new rotary instruments into the practice. While thought of as routine, even basic restorative procedures bring with them significant learning curves for auxiliary personnel, especially the assistant. The neverending introduction of new restorative materials, each with unique handling characteristics, requires a constant change in procedures that assistants must keep pace with. Consider the adhesive bonding systems associated with direct and indirect composite resin-based restorative procedures. The newly introduced self-etching adhesive systems vary from brand to brand with respect to application. These new systems are extremely technique sensitive, and the technique varies from product to product. With these new technologies, the dental assistant is key to proper preparation and application. In terms of impression materials, the authors note that while a number of factors depend on the skills of the dentist, a greater number of factors that may influence accuracy of the impression are under the direct, control of the assistant. The proper mixing procedure of the material, either with a mechanical device or by hand, influences the working time of the impression material and the accuracy of the final impression. Pouring impressions is another critical task often given to dental assistants in a busy general practice. Additionally, the cementation material (GC FujiCEM) a resin-reinforced glass isonomer, has gone through several modifications over just the past few years. While its method of delivery has changed, the clinical working characteristics need to be correct and consistent to obtain quality care. The rheological, or flow, characteristics obtained during mixing and final film thickness must meet clinical specifications. The dental assistant must maintain accuracy of mixing and dispensing to ensure the proper paste/paste ratio and film thickness during seating of the restoration. Also, the working time and setting time necessary to allow proper clean-up after seating of the restoration is dependent on this ratio. General dentistry practices contain a broad spectrum of equipment as a result of the different procedures in the daily routine. The proper operation of the equipment can require continuous monitoring and calibration activities that are conducted by the dental assistant (e.g., light polymerization units). The authors conclude that keeping up with new procedures and materials is an important part of keeping a general practice running smoothly. If current trends continue, the duties dental assistants will legally be able to perform will expand significantly. With expanded duties will come expanded needs for training. Through continuing education courses, working with new systems before using them chairside, and reading product reviews, the dental assistant can keep pace with these continuous changes and meet these new challenges.	Carlson, K. & Duke, E.S. (2007). Your assisting skills: New materials, new equipment, new challenges. *Contemporary Dental Assisting* March/April, 30-34.

No.	Description	Reference
4	Radiography has long been an essential diagnostic tool in managing patients' oral health in the dental practice. Dental auxiliaries play a vital role in obtaining and processing radiographs; their skills in radiographic technique render diagnostic images and their records management role ensures that those images are available to the dentist whenever they may be needed. In the past ten years, computer and digital record management has become integral in dental practice. Some offices are entirely digital, also referred to as "paperless," while many others rely on various digital records as well as more traditional hard copy records. Dental radiography is also being fundamentally changed by the evolving digital age. Digital radiographs are becoming more and more prevalent in dental practice. New dental offices are often designed to use digital radiographs, while others are converting from film radiography to digital. Digital radiographs can be viewed on any computer screen, manipulated to enhance contrast and detail and transmitted electronically without loss of quality. Basic knowledge of digital radiography is essential to the dental assistant, even if he or she is not currently using the technology in their daily work routine. Chances are, at some point in the future, the assistant will come into contact with and possibly need to master basic digital radiography. The purpose of this article is to introduce basic concepts of digital radiography and contrast that information with the more familiar information about film radiography.	Ng, V.M., Sidhu, G. & Wood, A.J. (2007b). Digital radiography for the dental assistant. *The Dental Assistant.*. September-October. Available at; http://findarticles.com/p/articles/mi_m0MKX/is_5_76/ai_n27421555/ Last accessed: November 2010.
5	This is a commentary on dental assistants and the use of new impression technologies. The author notes that dental practice was once heavily focused on traditional methods but now is slowly embracing technology that not only improves the patient experience, but also increases daily productivity and efficiency within the practice. For instance, consider physical impression taking for dental restoratives. While physical impression methods have been the most common option for dental restoratives, digital impression technology is an exciting alternative. This article describes the dental assistant's role with a new system that eliminates physical impression taking for crowns, bridges and other dental restoratives, improves work flow, saves time for the practice and provides a positive dental experience for the patient. As cutting-edge technologies are integrated into the dental practice, the benefits of these tools quickly spread to all aspects of day-to-day activities. One example is Cadent iTeroT™ a digital impression system that replaces physical impressions with an innovative technology that utilizes a hand-held intraoral scanner to capture an impression of the patient's teeth. Digital technology such as iTero will revolutionize the way that restorative procedures are performed by improving the patient experience and adding a new level of efficiency within the dental practice. Much needed space for storage of other important dental supplies is freed up. Reduced chair time, due to minimal retakes, prep and cleanup, enables more patients to be scheduled throughout the course of the day. The role of the dental assistants will also adapt to this efficient dental restorative procedure, enabling them to become an essential part of new technology. Dental assistants must be ready, prepared and willing to embrace what looks to be a very bright future.	Garvey, P. (2007). The dental assistant's role in integrating digital impression technology in the dental practice. *The Dental Assistant* November-December, 12-14.

No.	Description	Reference
6	Presurgical infant orthopedics has been employed since the 1950s as an adjunctive neonatal therapy for the correction of cleft lip and palate. Nasoalveolar molding represents a paradigm shift from the traditional methods of presurgical infant orthopedics. One of the problems that the traditional approach failed to address was the deformity of the nasal cartilages in unilateral, as well as bilateral, clefts of the lip and palate and the deficiency of columella tissue in infants with bilateral clefts. The Nasoalveolar Molding (NAM) technique utilizes wire and acrylic nasal stents attached to an intraoral denture. This appliance is used to mold the nasal cartilages, premaxilla, and alveolar ridges into normal form and position during the neonatal period. In effect, this presurgical management of the cleft infant is intended to reduce severity of the oronasal deformity prior to surgery. This technique takes advantage of the malleability of immature nasal cartilage and its ability to maintain a permanent correction of its form. In addition, the authors demonstrate the ability to nonsurgically elongate the columella in bilateral cleft lip and palate through the application of tissue expansion principles. This is performed by gradual elongation of the nasal stents and the application of forces that are applied to the lip and nose. Utilization of the NAM technique has eliminated surgical scars associated with traditional columella reconstruction, has reduced the number and cost of revision surgical procedures, and has become the standard of care in this Cleft Palate Center. The authors conclude that clinical skills in NAM develop over time. Efficiency in treating patients increases as these clinical skills improve, and these skills may be advanced by the training of a dental assistant or laboratory technician to make adjustments to the molding plate under direct supervision of the practicing clinician.	Grayson, B.H. & Maull, d. (2005). Nasoalveolar molding for infants born with clefts of the lip, alveolus, and palate. *Seminars in Plastic Surgery* 19, 4, 294-301.
7	Lasers are fast becoming the instrument of choice for many dental procedures and the role of laser safety officer (LSO) is paramount for incorporating this technology in a safe and effective manner. As a partner in the delivery of dental care, the dental assistant has an opportunity to assume the expanded role of appointed LSO for the dental practice. A trained LSO can help pave the way for successful implementation, primarily by overseeing safety but also in understanding the technology in order to train staff and educate patients. The Academy of Laser Dentistry (ALD) adopted the C*urriculum Guidelines and Standards for Dental Laser Education'* and maintains the training and certification programs ready lo help the dental assistant achieve the status of LSO. The certification program is the same as for the dentist except for simulating treatment with the laser device. There is also an Advanced LSO certificate. The rest of the article discusses the fundamentals of lasers, types of lasers, laser tissue interaction, laser safety, and laser safety officer responsibilities. In conclusion, the author argues that the LSO is a vital role for dental assistants and one that will expand as laser use increases. The author concludes that dental assistants can and should provide this vital role in the safe and effective delivery of this technology so that the best care is delivered.	Hatcher Rice, J. (2005). Laser safety officer: A vital role for dental assistants. *The Dental Assistant* January-February, 26-27.

No.	Description	Reference
8	Background: Despite a significant reduction in the prevalence of caries within some population subgroups in the Western world, this problem remains significant at the clinical and public health levels. Diagnostic devices have been developed with claims of detecting the earliest signs of enamel demineralization and thus affording the opportunity to intervene with aggressive therapies (mainly fluorides) at an incipient stage, arrest the lesion, encourage remineralization and avoid the need for restorative intervention. The extent of the epidemiological problem, along with this battery of new diagnostic tools, poses a challenge for the dental practitioner attempting to address the former while maximizing the scope for using the latter. An examination of the applications of these tools, and of the information they reveal, is in order. Objective: In this paper, the authors examine techniques for detecting caries that are intended for, or currently available to, general dental practitioners. This information is presented in the context of the larger framework of diagnostic tests and management strategies discussed in the current series of articles. Before the techniques are discussed in detail, however, we should define the clinical context into which they have been introduced. Table 1 summarizes the evidence for the more conventional methods of detecting caries: visual, visual and tactile, and radiographic. This summary is based on two highly recommended reviews of the subject by Bader and others. Although they are commonly used in dental practice and are reasonably reliable by today's standards, these conventional techniques leave room for improvement. This paper assesses whether any of the new systems fill that need. A glossary, with concise definitions of terms, is available for the entire series (see Appendix 1, Glossary of epidemiology terms, at http://www.cda-adc.ca/jcda/vol-70/issue-4/251.html). Discussion: Parts five and six of this series examine innovations in diagnostic and management procedures and assess their potential to become everyday tools of the dental clinician. This paper examines some of the diagnostic tools supporting a philosophical shift in mainstream dental practice from concern with extensively decayed teeth to a focus on detecting incipient demineralized tissues. With the latter approach, the incipient carious process can be reversed by promoting enamel remineralization and thus eliminating the need for restorative intervention. Numerous methods and devices have been developed to detect, diagnose and monitor such lesions, and several have been produced in versions that may appeal to dental practitioners. This paper considers three of these methods and devices: the DIAGNODent laser device, quantitative light-induced fluorescence and the Digital Imaging Fiber-Optic Transillumination device. Each technique is illustrated, the research on its effectiveness is assessed to determine usefulness to the practitioner, and the comparative advantages of the three adjunct tools are discussed. Conclusion: The DIAGNODent, DIFOTI and QLF devices may improve decision making by affording more sophisticated diagnostic and management capabilities (through more detailed information) and by providing a clearly stated measure of longitudinal lesion activity that can be incorporated into a diagnostic heuristic (thus making consultation patterns closely relevant to the natural history of dental caries). However, responsibility for making the "right" decision (i.e., correctly combining the various pieces of information into a treatment plan that satisfies the patient's personal preferences, attends to sociobehavioural aspects and takes care of the patient's biomedical needs) will continue to rest with the clinician.	Pretty, I.A. & Maupome, G., (2004). A closer look at diagnosis in clinical dental practice: Part 5. Emerging technologies for caries detection and diagnosis. *J. Am Dent Assoc.,* 780,(8), 540.

Table 8: Literature on Care Settings/Models of Care

No.	Description	Reference
	Articles in Peer-Reviewed Journals on Care Settings/Models of Care	
1	This commentary discusses the dental assistant apprenticeship program within the Unites States Disciplinary Barracks (USDB) at Fort Leavenworth, the only maximum-security prison in the Department of Defense. Many of the qualified inmates at USDB take advantage of the many treatment and vocational programs available. To be accepted into the dental assistant program, the inmate must express an interest in being part of the program and submit the appropriate paperwork. This request then goes through and approval process from the inmate's current detail supervisor, to an academic committee, to the director of treatment programs and then to the Non-Commissioned Officer in Charge of the dental clinic. Once accepted into the program the inmates receive clinical training. The training includes 200 hours of record keeping and charting, 400 hours of diagnosis and armamentarium, 300 hours of sterilization procedures, 100 hours of x-ray technique and safety, 200 hours of dental specialities and instruments, 300 hours of care of dental equipment and supplies, 300 hours of mixing of dental materials and 200 hours of dental hygiene and oral health.	Diaz-Cruz, A.A. (2006). Dental assistant apprenticeship program within the U.S. disciplinary barracks. *The Dental Assistant* January-February, 28-29.
2	According to the author, the versatility of the United States Dental Assistants was displayed during Operation Arctic Care 2005 held in the frozen tundra of the Alaskan peninsula from March 19th to April 1st. This major exercise is designed as a unique medical/dental training opportunity for members of the military while at the same time providing hard to get care to native American Indians throughout the peninsula. Operation Arctic Care is an annual multi-service readiness exercise that offers training in moving Army, Navy, Air Force, Reserve, Guard, U.S. Public Health Service and native health personnel and their equipment/materials to remote locations in providing health care under realistic conditions. The locations served this year were the Kodlak Area Native Association and the Tanana Chiefs Conference villages of Ouzinkie, Port Lions, Larsen Bay, Karluk, Akhlok, Old Harbor Hughes, Huslia, Ruby Kaltag, and Nuiato. Working side by side with dental officers from different services, the dental assistants helped in performing dental care to a combined total of 1,477 native Indians.	Orona, R. (2005). Army dental assistants perform in Operation Arctic Care. *The Dental Assistant* July/August, 36-37.
3	Purpose: This study was undertaken to determine what smoking cessation services dental professionals in Ontario's Wellington-Dufferin-Guelph Health Unit (WDGHU) provide before disseminating a smoking cessation information package. Methods: Data were collected with 540 self-administered questionnaires mailed to 60 local dental offices. Replies were requested from all dentists, dental hygienists, dental assistants and other dental staff working in each dental office. Results: Completed responses were obtained from 126 dental personnel in 28 (47%) of the 60 dental offices surveyed. The proportion of dental offices, dentists and hygienists providing cessation services to most patients was as follows: asking patients about tobacco-use status, 46%, 31% and 32%; advising tobacco users to quit, 46%, 32% and 29%; assessing tobacco users' interest in quitting, 46%, 25% and 19%; and assisting interested patients to quit, 25%, 6% and 13%, respectively. Conclusion: This survey indicates that most dental professionals in the WDGHU do not provide proven smoking cessation services. An opportunity exists to increase the proportion of dental professionals providing proven smoking cessation interventions as part of routine patient services.	Brothwell, D.J. & Armstrong, K.A. (2004). Smoking cessation services provided by dental professionals in a rural Ontario health unit. *J Can Dent Assoc* 70,(2),94–98.

No.	Description	Reference
4	This article discusses age limits to publicly subsidized dental care in Finland that were abolished by the amended provisions of the Primary Health Care Act and the Health Insurance Act. Even though most health centers have been able to provide dental care to those seeking their services, putting an end to the age-based prioritization of care as from December 1, 2002 has involved problems in quite many larger cities. As a part of securing the access to labour force and know-how, a preparation work concerning the mutual division of labour was started within the framework of the National Health Project. The division of labour must be reassessed in regard to oral health care as well. In improving the division of labour, a common view and will are needed to develop, in collaboration, the best possible practices. The authors note that dental assistants are another important part of care teams. A particular area for them is the health promotion work done at schools and child daycare centers and institutions, as well as supporting the self-care of clients. A dental assistant works in close cooperation with the dentist of the team. Dental assistants are most often those responsible for taking care that the dental clinic or unit is ready for service and for its hygienic conditions. They create cooperation networks with other professionals and maintain them. In accordance with the act on health care professionals, the profession of a dental assistant is registered with a protected title. The education usually lasts two and a half years. Working life places increasing demands on dental assistants as well as on dental hygienists. Table 1 on page 27 of the article also provides information on the dental workforce (i.e., dentists, hygienists, assistants) at health care centers in Finland, 2002.	Nordblad, A. (2004). Challenges for leadership of oral health care in Finland. *Journal of Dental Education* 68, 7 Supplement, 26-27.
5	Background: Nearly 20% of the U.S. population has some type of disability, with approximately 12% of the population considered to have severe disabilities. The provision of dental care to such patients requires consideration beyond routine approaches. Overview: This article discusses techniques, such as establishing a relaxing treatment environment that can be used to accommodate special-needs patients in the general dental practice. It provides background information on the current special needs population in the United States, and it describes the oral care approaches used in a residential care facility vs. a general dental practice. The article concludes with tips for integrating this special patient population into a general dental practice. Discussing his own dental team, the author notes that the team (including a dentist, a hygienist and two dental assistants) is trained in dentistry for disabled people and in providing supportive care for such patients' other needs. In describing a typical appointment, the author also notes that head and neck massage also may be given by the dental assistant, if he or she is trained in massage. If the patient requires sedation, the patient is not left alone once sedated. The dental assistant remains in the operatory and monitors the patient's vital signs. Rinsing and suctioning by the dental assistant are essential. The clients may have enlarged tongues and/or swallowing difficulties, which may cause them to react unexpectedly when fluids are in the mouth. Some clients may not have gag reflexes and can be silent aspirators, which places them at risk of developing pneumonia after dental care. Other clients regurgitate on a regular basis or may self-induce emesis. In all these cases, responsive suctioning is critical to the provision of safe care. Conclusions and Practice Implications: As the U.S. population with special needs increases, more general dentists are likely to find that such patients require their services. While the prospect of accommodating the needs of patients with disabilities may seem daunting initially, such treatment actually can be incorporated into a general dental practice easily. The practitioner treating patients with disabilities likely will find that he or she needs special equipment less than compassion and tolerance.	Lawton, L. (2002). Providing dental care for special patients: Tips for the general dentist. *J Am Dent Assoc* 133,1666-1670.

No.	Description	Reference
6	Societal trends and medical advances have resulted in increased numbers of physically and/or psychologically challenged individuals living within our communities. For some of these individuals, hospital dentistry with general anesthesia provides the only means by which general dental services may be provided. This paper presents considerations of significance to the general dentist wishing to incorporate outpatient hospital dentistry into his or her private practice. The authors note the importance of staffing issues for providing services to physically and/or psychologically challenged individuals within hospital dentistry. The authors state that all hospital auxiliary surgical staff are well-trained in instrumentation and procedures associated with medical surgical services performed in their respective surgical suites. However, their education and training includes nothing relevant to general dental instrumentation or procedures, which render them unqualified to assist the general dentist with the provision of those services. It is essential that trained dental assistants be available to assist the general dentist in the operating room. The most qualified auxiliary person to utilize in the hospital operating room is the general dentist's usual chairside dental assistant. Circumstances within the teaching hospital environment may also allow for the utilization of hospital-employed dental assisting staff from the in-house general residency program. Therefore, when evaluating the possible affiliation with a specific hospital, it is important to inquire about policies regarding the utilization of dental assisting personnel within the operating room.	Sani, R.J. & Spencer, R.O. (2001). Integrating hospital dentistry into the general dental practice. *Journal of the California Dental Association.* June. Available at: http://www.cda.org/library/cda_member/pubs/journal/jour0601/hospital.html Last accessed: November 2010.
Grey Literature on Care Settings/Models of Care		
7	This website of the Manitoba Dental Association outlines information on the dental assistant career (e.g., what they do, the advantages of the profession, where they work and other career opportunities). This summary focuses on these last two topics. *Where do Dental Assistants work?* Since many dentists employ two or more dental assistants, employment opportunities in this field are excellent. The types of practice settings available to dental assistants include: • solo dental practices (practices with only one dentist); • group practices (practices with two or more dentists); • specialty practices, such as oral and maxillofacial surgery (removal of teeth and correction of facial deformities), orthodontics and dentofacial orthopedics (straightening teeth with braces or other appliances), endodontics (root canal treatment), periodontics (treatment of gum problems), prosthodontics (replacement of lost teeth) and pediatric dentistry (treatment of children); • public health dentistry, including settings such as schools and clinics which focus on the prevention of dental problems within entire communities; • hospital dental clinics, assisting dentists in the treatment of bedridden patients; and • dental school clinics, assisting dental students as they learn to perform dental procedures. *Other career opportunities for Dental Assistants include:* • insurance companies, processing dental insurance claims; • vocational schools, technical & community colleges, dental schools and universities, teaching others to be dental assistants (which may require associate or baccalaureate college degrees); and • dental product sales representatives.	Manitoba Dental Association [MDA]. (2010). Careers in dentistry: Dental assisting. Available at: http://www.manitobadentist.ca/index.cfm?tID=1070 Last accessed: October 2010.

No.	Description	Reference
8	This American Dental Association brochure on dental assistants (DAs) briefly discusses what DAs do, the advantages of a dental assisting career, where they work, other career opportunities, education/training requirements, and earning potential. This summary focuses on the section regarding where dental assistants work. *Where do Dental Assistants work?* Since many dentists employ two or more dental assistants, employment opportunities in this field are excellent. The types of practice settings available to dental assistants include: solo dental practices (practices with only one dentist); group practices (practices with two or more dentists); specialty practices, such as oral and maxillofacial surgery (removal of teeth and correction of facial deformities), orthodontics and dentofacial orthopedics (straightening teeth with braces or other appliances), endodontics (root canal treatment), periodontics (treatment of gum problems), prosthodontics (replacement of lost teeth) and pediatric dentistry (treatment of children); public health dentistry, including settings such as schools and clinics which focus on the prevention of dental problems within entire communities; hospital dental clinics, assisting dentists in the treatment of bedridden patients; and dental school clinics, assisting dental students as they learn to perform dental procedures. *Other career opportunities for Dental Assistants include:* insurance companies, processing dental insurance claims; vocational schools, technical institutes, community colleges, dental schools and universities, teaching others to be dental assistants (which may require associate or baccalaureate college degrees); and dental product sales representatives.	American Dental Association. (2010b). *Dental assisting: Word of Mouth – Careers in the dental profession.* Available at: http://www.ada.org/sections/educationAndCareers/pdfs/brochure_dentalassisting.pdf Last accessed: October 2010.

No.	Description	Reference
9	This is an American Dental Association fact sheet on dental assisting. What does a dental assistant do? • Assists the dentist with a variety of treatment procedures—works with dental instruments and materials; • Helps patients feel comfortable before, during and after dental treatment; • Takes and processes x-rays; • Prepares and sterilizes instruments and equipment; • Communicates with patients, other health professionals, dental suppliers, business contacts and insurers; and • Performs a variety of office management tasks. Where do dental assistants work? • Dental offices of general dentists and dental specialists; • Dental schools; • Private and government hospitals and clinics; and • State and local public health departments. What training is needed? • College-level education is encouraged, but careers can begin without college-level courses through on-the-job-training in a dental office or high school work study programs. • There are approximately 270 ADA accredited dental assisting education programs in community and technical colleges in U.S., a minimum of one academic year in length. What are future opportunities? • The demand is currently excellent. • Flexible work schedules are often available. • Dental assisting offers excellent career opportunities for nontraditional students including individuals who are over 23 years of age and those seeking a career change. • Compensation depends on responsibilities, geographic location and other factors.	American Dental Association. (2010c). *What can a career in dental assisting offer you?* Fact sheet. Available at: http://www.ada.org/sections/publicResources/pdfs/assistant_fact.pdf Last accessed: October 2010.

Table 9: Literature on Access, Outcomes, Productivity

No.	Description	Reference
	Review Articles on Access, Outcomes, Productivity	
1	**Objectives:** This review identifies the challenges to oral health in rural America and describes areas of innovation in prevention, delivery of dental services, and workforce development that may improve oral health for rural populations. **Methods:** This descriptive article is based on literature reviews and personal communications. **Results:** Rural populations have lower dental care utilization, higher rates of dental caries, lower rates of insurance, higher rates of poverty, less water fluoridation, fewer dentists per population, and greater distances to travel to access care than urban populations. Improving the oral health of rural populations requires practical and flexible approaches to expand and better distribute the rural oral health workforce, including approaches tailored to remote areas. Solutions that involve mass prevention/public health interventions include increasing water fluoridation, providing timely oral health education, caries risk assessment and referral, preventive services, and offering behavioural interventions such as smoking and tobacco cessation programs. Solutions that train more providers prepared to work in rural areas include recruiting students from rural areas, training students in rural locations, and providing loan repayment and scholarships. Increasing the flexibility and capacity of the oral health workforce for rural areas could be achieved by creating new roles for and new types of providers. The authors identify solutions that increase the flexibility and capacity of the oral health workforce, including support for expanded function dental auxiliaries (EFDAs) and dental assistants. The scopes of practice of EFDAs and dental hygienists vary by state, but in general dental assistants work under the close supervision of dentists and provide supportive clinical services in direct relationship to treating a patient, and EFDAs perform dental assistant duties and also provide limited restorative functions. These dental professionals expand the capacity of dentists, which may allow them to see underserved patients more efficiently. Dental assistant and EFDA occupations may also provide entry points on a career ladder that leads to more advanced oral health professions, and as a result enhances professional satisfaction. The authors also discuss the proposal of new providers being considered in the US: the community dental health coordinator (CDHC) and the oral preventive assistant (OPA). CDHCs, whom the ADA expects would come from the underserved communities in which they will serve, would receive 18 months of post–high school training to provide educational, care coordination, intraoral assessment, and limited intraoral treatment services in safety net facilities. OPAs would provide a very limited set of preventive services in dental offices or safety net settings, and would receive training much like that of the CDHC and would still require supervision of a dentist. Solutions that overcome distance barriers include mobile clinics and telehealth technology. **Conclusions:** Rural areas need flexibility and resources to develop innovative solutions that meet their specific needs. Prevention needs to be at the front line of rural oral health care, with systematic approaches that cross health professions and health sectors.	Skillman, S.M., Doescher, M.P. Mouradian, W.E. & Brunson, D.K. (2010). The challenge to delivering oral health services in rural America. *Journal of Public Health Dentistry* 70, S49–S57.

No.	Description	Reference
2	Background: To date, no trials have been published that examine whether four-handed delivery (i.e., the use of an assistant) of dental sealants increases their retention and effectiveness. In the absence of comparative studies, the authors used available data to explore the likelihood that four-handed delivery increased sealant retention. Methods: The authors examined data regarding the retention of autopolymerized resin-based sealants from studies included in systematic reviews of sealant effectiveness. The explanatory variable of primary interest was the presence of a second operator. To examine the unique contribution of four-handed delivery to sealant retention, the authors used linear regression models. Results: Eleven of the 36 studies from systematic reviews met explicit criteria and were included in this analysis. The high level of heterogeneity among studies suggested that multivariate analysis was the correct approach. According to the regression model, the presence of a second operator increased retention by nine percentage points. Conclusions: For this group of studies, four-handed delivery of autopolymerized sealants was associated with increased sealant retention. Clinical Implications: Using four-handed delivery to place resin based sealants may increase retention.	Griffin, S.O., Jones, K., Kolavic Gray, S., Malvitz, D.M. & Gooch, B.F. (2008). Exploring four-handed delivery and retention of resin-based sealants. *JADA* 139, 3, 281-289.
Articles in Peer-Reviewed Journals on Access, Outcomes, Productivity		
3	This brief commentary discusses the role of dental assistants in addressing shortage areas and access to care issues in the US. The Academy of General Dentistry (AGD) has long been a proponent of the dental team. The AGD stated in its white paper *On Increasing Access to and Utilization of Oral Health Care Services,* that auxiliaries play the key role in patient education and preventive care within the dental team. Dentistry focuses on preventive care, which is why the AGD supports the dental team concept as the best approach to providing the public with quality comprehensive dental care. Further, the AGD recommends the advanced training of auxiliaries to provide greater expertise of preventive care and treatment within the dental team concept under the direct supervision of a dentist. One of the barriers to care is the capacity of the dental office. Some areas of the country have insufficient capacity to meet demand. The Health Resources and Services Administration (HR5A) has defined shortage areas for many years. Dental assistants have a unique position in addressing shortage areas and access to dental care. As noted in the "February 2010 AGD Workforce Report of the Dental Practice Council" expanded function dental assistants (EFDA) under the direct supervision of a dentist doing only reversible dedicated procedures is one of the most cost-effective, safest, and fastest ways to increase capacity, and therefore reduce the cost of dental care while also increasing access to care. Dental assistant laws vary significantly from state to state. Many states, like Tennessee, have already addressed access in a very substantial way with EFDAs. Tennessee enacted a law in 2002 that provided for their EFDAs (TCA 63-5-108) and has seen a substantial increase in the number of registered dental assistants since this regulatory change took effect. EFDAs, under the supervision of the dentist, reduce the cost of care by freeing the dentist to perform irreversible surgical procedures. This increases access to care by increasing capacity and it reduces office overhead, thereby reducing inflationary pressures on fees. Dental assistants play a critical role in educating patients. Dentists who have worked in rural or underserved settings know this, as they have seen first-hand how vulnerable populations, especially young mothers, need dental assistants working within the dental home to educate them about the infectious nature of caries and encourage them to seek and keep regular preventive appointments for themselves and for their families. However, that is just one example of the need for the dental assistant, and moreover, the EFDA, within the dental home concept, is key to solving the access to care problem. In that vein, both the AGD and the American Dental Assistants Association (ADAA) must continue to support the advancement and growth, in education, numbers, and distribution, of dental assistants working side-by-side with dentists as part of the dental home, to truly further prevention and access as cornerstones of oral health care in our society.	Halpern, D.F. (2010). Team players. *The Dental Assistant* May/June, 41-42.

No.	Description	Reference
4	Objective: Productivity (output per unit of input) is a major driver of dental service capacity. This study uses 2006-2007 data to update available knowledge on dentist productivity. Methods: In 2006-2007, the authors surveyed 1,604 Oregon general dentists regarding hours worked, practice size, payment and patient mix, prices, dentist visits, and dentist characteristics. Effects of practice inputs and other independent variables on productivity were estimated by multiple regression and path analysis. Results: The survey response rate was 55.2 percent. Dentists responding to the productivity-related questions were similar to dentists in the overall sampling frame and nationwide. Visits per week are significantly positively related to dentist hours worked, number of assistants, hygienists, and number of operatories. Dentist ownership status, years of experience, and percentage of Medicaid patients are significantly positively related to practice output. The contributions of dentist chairside time and assistants to additional output are smaller for owners, but the number of additional dentist visits enabled bymore hygienists is larger for owners. A 10% increase in number of assistants and hygienists is associated with an increase in visits of less than 1.0 and 0.4%, respectively. The findings suggest that the dentist's own time is the key determinant of dentist productivity. The effect of assistants and hygienists is less overall and is more strongly associated with the output of nonowners. This likely reflects differences between owners and nonowners in utilization of dental auxiliaries. The survey measures in this study reflect availability of auxiliaries, but not their specific use by the individual dentists. If more fine-grained measures of personnel skill level, auxiliary utilization, and dental technology were used in lieu of our general measures of labor and number of operatories, it is possible that findings regarding input effects on dentist output might be different. Also, this study focused on individual dentist visits, not total practice visits, so the estimated effects of dental auxiliaries capture only the effects of the availability of assistants and hygienists on the dentist's own output. Conclusion: As in earlier studies of dental productivity, the key determinant of dentist output is the dentist's own chairside time. The incremental contributions of dentist time, auxiliaries, and operatories to production of dentist visits have not changed substantially over the past three decades. Future studies should focus on ultimate measures of output –oral health – and should develop more precise measures of the practice's actual utilization of auxiliaries and their skill and use of technology.	Conrad, D.A., Shuk-Yin Lee, R., Milgrom, P. & Huebner, C.E. (2010). Estimating determinants of dentist productivity: New evidence. *Journal of Public Health Dentistry*, 1-7.
5	Although four-handed dentistry is routine in most dental practices in the United States, solo unassisted clinical practice is the norm for students at many North American dental schools. The objective of this study was to compare the clinical productivity of fourth-year dental students practicing in a four-handed model to the clinical productivity of those same fourth-year dental students practicing in a solo, unassisted mode at the University of Iowa College of Dentistry for the three academic years 2005–08. Students averaged 2.62 patient visits per day in the four-handed Dental Auxiliary Utilization (DAU) Clinic and 1.74 visits per day in the regular Family Dentistry Clinic. Charging fees that are approximately 50 percent of prevailing local private practice fees, the mean daily charges for services provided by individual students averaged $329 in the DAU Clinic and $190 in the Family Dentistry Clinic. The mean daily productivity differentials were 0.88 patient visits and $139. While students averaged 51 percent more patient visits and 75 percent higher charges daily in the DAU Clinic as compared to the regular Family Dentistry Clinic, the increased revenues might not be sufficient to offset increased expenses incurred in the four-handed clinical operation.	Holmes, D.C., Squire, L.J., Arneson, S.K., Doering, J.V. (2009). Comparison of student productivity in four-handed clinic and regular unassisted clinic. *Journal of Dental Education* 73, 9, 1083-1089.

No.	Description	Reference
6	Using all-inclusive data from 126 U.S. Department of Veterans Affairs health care facilities that provide dental services, this study identified the staffing infrastructure under which the Veterans Health Administration can provide graduate dental education (i.e., staffing dental offices with residents who assist and learn from dentists) without compromising dental clinic productivity. From regression analyses, the authors found that teaching residents has a negative impact on staff dentists' productivity; however, when the dental assistant to provider ratio is greater than or equal to 1.0, dental residents' workload contribution can offset the negative impact on overall clinic productivity. In the presence of dental residents, the dental assistant, front-desk personnel, and dental treatment room to provider ratios have a positive impact on productivity. The optimal ratios were calculated as 1.5 for dental assistants, 2.1 for dental treatment rooms, and 0.57 for front-desk personnel.	Lam, H-T., C. Ward, T., O'Toole, T.G., Arola, P.E. & Chang, B.K. (2009). Impact of infrastructure on graduate dental education and dental clinic productivity *Journal of Dental Education* 73, 2, 184-191.
7	Background: The greatest unmet health need for US children is dental care. School-based sealant programs (SBSP) target low-income, high-risk second graders and are effective in preventing caries for as long as the sealant material remains in place. However, it is not clear whether such programs make efficient use of available resources and staffing. . Dental practice acts cover a range of topics, including licensure requirements, examination procedures, and standards of conduct. One of the components of dental practice acts is to determine who can prescribe and apply sealants in SBSP. These acts vary greatly by state and can also vary for private and public health settings. There are four possible levels of supervision: ''no dentist supervision'' (N) allows dental hygienists to both prescribe and apply sealants, ''general supervision'' (G) allows hygienists to apply sealants without supervision to students who have been screened and prescribed sealants by a dentist, ''indirect supervision'' (I) requires dentists to screen and prescribe the sealants and be present in the building during all sealing (though they do not need to directly supervise), and ''direct supervision'' (D) requires the dentist to screen and prescribe, to be present in the building while sealing is going on, and to inspect the sealant when it is completed. Methods: The authors used discrete event simulation to determine the optimal combinations of staffing levels and sealant stations for school-based sealant programs. Using data provided by state programs and the literature, they modeled different-sized programs under different practice act constraints and determined times and associated costs. A detailed economic analysis was done for Wisconsin Results: For general, direct, or indirect supervision, it is optimal to have only one dentist or no dentists for no supervision. For general supervision, it is optimal to have the dentist and dental assistant to come on separate days to screen. The cost savings for adding an assistant and chair averaged over all of the program sizes and travel distances ranged from 4.50% (SE=0.89) to 10.94% (SE=0.56). Significant cost savings also result from reducing the required supervision level (8.72% [SE=1.61] to 29.96% [SE=1.67]). The cost of the practice act for the state of Wisconsin for 2003 was from $83,041 to $346,156, significantly more than its annual budget. Conclusions: States could save money by relaxing restrictions on the type of personnel who can deliver sealants in public health settings and by productivity gains through proper consideration of staffing. The savings could be used to improve access to sealant programs and further reduce disparities in oral health.	Scherrer, C.R., Griffin, P.M. & Swann, J.L. (2007). Public health sealant delivery programs: Optimal delivery and the cost of practice acts *Med Decis Making* 27, 762-771.

No.	Description	Reference
8	The purpose of this article is to provide a brief genesis and current status of one of the US Army Dental Command's (DENCOM) most cost-effective strategic initiatives, the Expanded Function Dental Assistant (EFDA) training program. This article provides a historical perspective, describes the needs that drove the program's establishment, and presents a background on how the program was organized and funded. This article also addresses the return on investment of the initiative and discusses a number of lessons learned. EFDA-trained personnel are completely embedded in several key army dental initiatives. EFDAs are used extensively in Dental Care Optimization (DCO). DCO is an initiative aimed at increasing access to care by using best clinical practices. The First Term Dental Readiness Program ensures that newly accessed Soldiers from all three Army components receive dental care that will allow them to be deployable upon graduation from Advanced Individual Training. EFDAs are also used extensively to expedite the surge requirements for dental care generated by mobilizations. The authors conclude that all three Department of Defense (DoD) dental services face the twin challenges of preparing large numbers of service members for deployment with a shrinking pool of general dentists. The DENCOM's EFDA program has been and continues to be a proven, highly successful method for leveraging the productivity output of general and comprehensive dentists to better meet the needs of service members.	Luciano, W.J., Rothfuss, L.G. & von Gonten, A.S. (2006). *Army Medical Department Journal* January-March, 16-20.
9	Background: Many poor, medically disabled and geographically isolated populations have difficulty accessing private sector dental care and are considered underserved. To address this problem, public- and voluntary-sector organizations have established clinics and provide care to the underserved. Collectively, these clinics are known as “the dental safety net.” The authors describe the dental safety net in Connecticut and examine the capacity and efficiency of this system to provide care to the non-institutionalized underserved population of the state. Methods: The authors describe Connecticut’s dental safety net in terms of dentists, allied health staff members, operatories, patient visits and patients treated per dentist per year. The authors compare the productivity of safety-net dentists with that of private practitioners. They also estimate the capacity of the safety net to treat people enrolled in Medicaid and the State Children’s Health Insurance Program. Results: The safety net is made up of dental clinics in community health centers, hospitals, the dental school and public schools. One hundred eleven dentists, 38 hygienists and 95 dental assistants staff the clinics. Safety-net dentists have fewer patient visits and patients than do private practitioners. The Connecticut safety-net system has the capacity to treat about 28.2% of publicly insured patients. Conclusions: The dental safety net is an important community resource, and greater use of allied dental personnel could substantially improve the capacity of the system to care for the poor and other underserved populations. The authors note that if safety-net clinics had the same allied health staffing levels as those of private practices, the authors estimate that the output of the safety-net clinics in Connecticut would increase by at least 80%, a substantial expansion over the present system.	Beazoglou, T., Heffley, D., Lepowsky, S., Douglass, J., Lopez, M. & Bailit, H. (2005). The dental safety net in Connecticut. *J Am Dent Assoc* 136, 1457-1462.

No.	Description	Reference
10	Different service models have emerged in Canada and the United States to address the issue of senior citizens' lack of access to comprehensive dental care. Over the past decade, one such model, the use of mobile dental service units, has emerged as a practical strategy. This article describes a mobile unit, operated as an adjunct to the general practitioner's office and relying mainly on existing office resources, both human and capital, to deliver services at long-term care institutions. The essential components of a profitable geriatric mobile unit are described, including education, equipment, marketing research and development, and human resource management. Issues related to patient consent and operating expenditures are also discussed. Data from one practitioner's mobile dental unit, in Hamilton, Ontario, are presented to demonstrate the feasibility and profitability of this approach. In particular, the authors note that the selection and management of staff is central to a successful mobile practice. Not everyone is able to cope with the problems and disabilities of elderly patients, so the support staff chosen to work in the mobile clinic must have a demonstrated ability to treat frail and elderly patients with compassion and care. Clinic staff must also be able to communicate effectively with nursing home staff to facilitate access and efficient delivery of dental care during clinic hours. All of the staff must be adaptable and self-motivated for the practice to run smoothly. Good clinical support, such as a dental assistant, is invaluable in a mobile practice. Like the dentist, the assistant must be able to work in unfamiliar surroundings and a less than ideal environment. The position of assistant involves many responsibilities including overseeing charts and supplies, replenishing supplies, sterilizing instruments, developing radiographs and staying informed about patients' medications. After each patient completes treatment, he or she must contact the appropriate person to take the patient back to his or her room. For patients who have undergone extractions, the assistant ensures that instructions are sent to staff on the floor and that the bleeding has been controlled before they are returned to the floor. The dental assistant also checks that charting is complete and that appropriate information is placed in the chart so that care providers in the nursing home understand the treatment and can follow any postoperative instructions, such as specific oral hygiene procedures.	Morreale, J.P., Dimitry, S., Morreale, M., Fattore, I. (2005). Setting up a mobile dental practice within your present office structure. *J Can Dent Assoc* 71, (2), 91-91g.

No.	Description	Reference
11	Purpose: The purpose of this 10-year, retrospective, cohort study was to evaluate the success of permanent molar sealants by comparing the effectiveness of sealants placed by dentists, dental hygienists, and dental assistants in a private dental practice, with all operators using an identical, standardized, application technique and four-handed dentistry. Methods: From 810 patient records that met entry criteria, the long-term follow-up records of 3,194 permanent first molars were evaluated. Data were collected and evaluated by survival analyses methods for: (1) time to first failure (caries or restoration of the sealed surface); (2) fluoride history; (3) caries experience; (4) operator type; (5) behaviour at sealant placement; (6) tooth type; (7) age at placement; and (8) patient gender. Results: Cumulative survival probability for 10 years in this practice was 87%, using Kaplan Meier analyses. The factors associated with an increased risk of failure included: (1) age (P<0.001); (2) decayed, missing or filled teeth (dmft) (P<0.003); (3) no fluoride (P<0.001); (4) dentist (P<0.001); and (5) registered dental assistant (P<0.001). While all operator groups had success rates equal to or exceeding previous studies, dentists and registered dental assistants showed three times and two times the risk of failure, respectively, compared to the registered dental hygienists. The no-fluoride group showed almost twice the risk of failure as compared to the optimal fluoride group. Behaviour showed a slightly higher risk of failure that approached significance. Age and dmft were highly significant, with slight increased risk of failure. Supplemental fluoride showed a protective effect, but this was marginally significant. Gender and tooth-type were not significant in this model. Major variations in success rates were observed in the dental assistant group, with two individuals accounting for most of the failures. Conclusions: This study supports delegation of sealant delivery to auxiliaries, since dental assistants and dental hygienists were equal to or better than the dentists in long-term sealant effectiveness.	Folke, B.D., Walton, J.L. & Feigal, R.J. (2004). Occlusal sealant success over ten years in a private practice: Comparing longevity of sealants placed by dentists, hygienists, and assistants. *Pediatr Dent.* 26, 426-432.
12	Objective: Dental Readiness Training Exercises (DENRETEs) are the military form of dental humanitarian missions. Most dental humanitarian missions focus on extractions and the provision of oral hygiene instructions. This paper describes a dental humanitarian mission, sponsored by the US Army Dental Command (DENCOM), to Honduras in 2003 and how expanded function dental assistants can increase the provision of care. Materials and Methods: The US Army Southern Command requested a DENRETE for fiscal year 2003. A site visit revealed the absence of water fluoridation, high levels of dental disease, and a desire to have an American dental team perform the mission at the Escuela Lempira, a low-income elementary school in the Honduran capital city of Tegucigalpa. Results: DENCOM in conjunction with dental personnel performing a six-month rotation with Joint Task Force Bravo performed a Pediatric Humanitarian mission in Tegucigalpa from 1 to 9 April 2003. During 6.5 treatment days, there were 416 patient encounters totalling 1,490 treatment procedures. Over $90,000 in dental services were provided. Conclusion: The 2003 Honduran DENRETE represented a changing paradigm from extraction-based dental missions toward providing comprehensive care aided by maximizing the use of dental assistants trained in expanded functions. With this philosophical shift in focused care, dental humanitarian missions have the ability to enhance the oral health of more children.	Chaffin, J., Spadaro, S. & Pirofsky, T. (2003). Maximizing care through dental assistant expanded functions in a humanitarian mission. *The Dental Assistant* May-June, 28-33.

No.	Description	Reference
13	Frustrations over the difficulty of improving health care in the United States often reflect a sense that the system's overwhelming complexity is our worst enemy. This overview of the state of the nation's oral health, suggests that even in a relatively simple subdomain of the health enterprise, the preference for harnessing private institutions to the pursuit of public goals brings success only at the price of endless tensions and trade-offs. The authors find that better preventive care and patient habits have helped improve oral health "for many parts of the population." At the same time, the number of dental hygienists in the workforce has grown steadily and is expected to increase by 37% between 2000 and 2010. But the U.S. dentist-to-population ratio declined during the 1990s, and the amount of time that dentists spend with patients every week has also been declining—partly a result of the increasing use of hygienists. This apparent signal of market equilibrium is misleading. The authors find "abundant evidence that a sizable segment of the population does not have access" to private care, while the dental safety net is "poorly defined and underdeveloped." Dentists' participation in Medicaid is not robust; community health centers and public health facilities have scant dental capabilities; and Medicare offers no dental coverage. "Radical steps" will be needed to correct "a growing disconnect between the dominant pattern of practice…and the oral health needs of the nation," the authors write, including new practice settings for dental care, integration of oral and primary health care, and expanded scope of practice for hygienists and other allied professions. In terms of dental assistants, the authors state that dental assistants work chairside with the dentist, in the business office, and in the dental laboratory. Many states do not require formal training or licensure for dental assistants. However, there are many certified dental assistant training programs, mostly at the community college level, as well as expanded practice dental assistant certifications in many states. The Bureau of Labor Statistics (BLS) estimates that there were 175,160 dental assistants employed in the United States in 2000, with an average salary of $24,130. In their discussion of alternatives to current practice, the authors also suggest that expanded practice for dental hygienists and assistants is another option being explored as a way to increase access to preventive services and education. Pilot studies have shown the expanded practice models to be safe and effective, and these practices have been successful in reaching underserved populations. Regulatory change around scopes of practice is a slow process, and few states have implemented major changes. Expanding the roles of allied oral health practitioners could increase the contact points for oral health information and care for numerous populations.	Mertz, E. & O'Neil, E. (2002). The growing challenge of providing oral health care services to all Americans. *Health Affairs* 21, 5, 65-77.
14	Access to oral health care continues to be a problem in the United States. Research has called for innovative approaches to improve access to oral health care and reduce oral health care disparities. Successful alternate approaches have been reported. In 1998 the Kansas Legislature passed a proposal to enhance access to care and manpower needs by allowing dental assistants to provide supragingival scaling, a service traditionally assigned to dental hygienists. In 2000, Mitchell et al. investigated the perceptions of Kansas dental hygienists and scaling dental assistants in relation to House Bill 2724 (HB 2724), which allows dental assistants to perform coronal scaling. The intent of the study was to collect baseline data in relation to HB 2724. The purpose of the present study was to follow up on the impact of HB 2724 six years after legislation. Both groups report satisfaction with their professions: scaling dental assistants believe the delivery of care in Kansas has changed, and areas of Kansas previously noted as dental health professional shortage areas are now served by either a registered dental hygienist or scaling dental assistant. Viewed at this level, it appears that HB 2724 was successful in achieving the goal of increasing the delivery of oral health care to rural Kansas. However, it is illustrative to consider that, of the sixteen counties previously unserved, two (12,761 people) are now served by scaling dental assistants only; twelve (61,457 people) are now served by dental hygienists only; and two (6,111 people) are now served by both scaling dental assistants and dental hygienists.	Villalpando Mitchell, T., Peters, R., Gadbury-Amyot, C.C., Overman, P.R. & Stover, L. (2006). Access to care and the allied oral health care workforce in Kansas: Perceptions of Kansas dental hygienists and scaling dental assistants. *Journal of Dental Education* 70, 3, 263-278.

No.	Description	Reference
15	Objective: The aim of this study was to evaluate outcomes in young children of risk-based management of dental caries in comparison with routine prevention. Methods: The study was carried out in two municipal health centers in Central Finland. The risk-based prevention group consisted of 299 children from Vanha Korpilahti, and the routine prevention group of 226 children from Saarijärvi. The children were two years old at baseline, and they were followed up for three years. All children received regular annual oral health care. In the risk-based prevention group, the presence of mutans streptococci (MS) in plaque (Dentocult-SM strip mutans-test, Orion Diagnostica, Espoo, Finland) and incipient caries lesions were the screening criteria. Additional prevention was targeted at MS positive subjects twice a year, consisting of health education and application of fluoride varnish. For those who had incipient lesions, 'the high-risk category', additional prevention was given four times a year and this included also chlorhexidine varnish treatments. Results: The screening and the preventive measures were successfully carried out by specially trained dental assistants. The proportion of children with cavitated caries or fillings was significantly lower in the risk-based than in the routine prevention group. The treatment effect was strongest within the high-risk category: two subjects had to be treated with intensive care for three year to avoid restorative treatment of dental caries by the age of five year in one subject (number needed to treat (NNT) = 2.0; 95% CI 1.4–3.8). The accuracy of screening was evaluated in the routine prevention group and found acceptable. Conclusions: The results indicate that in young children, risk-based management of caries seems practical, and prevention of caries can be targeted efficiently to individuals at risk.	Pienihäkkinen, K. & Jokela, J. (2002). Clinical outcomes of risk-based caries prevention in preschool-aged children. *Community Dent Oral Epidemiol* 30,143–150.
Grey Literature on Access, Outcomes, Productivity		

No.	Description	Reference
16	Dental and public health organizations recommend that dental care for children begin within six months of the eruption of the child's first tooth, or no later than the first birthday. However, for high risk families, the American Academy of Pediatrics recommends that care begin much earlier by identifying and working proactively with pregnant women and establishing a dental home before children reach the age of one. Serving more young children and pregnant women will present a host of challenges, as the current system of financing and delivering dental care is fragmented and inadequate even without expanding the target population. This paper focuses on those financing and workforce challenges, describes promising models of care, and discusses options for policymakers seeking to improve access to oral health care for young children. The authors note that state scope of practice rules have been loosening gradually for dental assistants, so that in many states they can perform some services that were once only done by hygienists or dentists. Dental assistants with extra training have a variety of names in state dental practice acts, and in most states, they must complete a training program that leads to certification or registration. Washington state allows specially trained dental assistants to apply fluoride varnishes and sealants in schools under general supervision. Massachusetts, Michigan, New Mexico, and Nebraska also allow trained or certified assistants to apply fluoride varnishes and/or sealants under general supervision. Expansions that involve restorative work are controversial. Six states explicitly bar dental assistants from placing amalgam restorations, 14 and bar them from carving restorations. No states allow dental assistants to perform complete hygiene services. However, expanding the scope of practice and loosening supervision requirements for preventive services could assist in public health efforts targeted at young children in pre-school programs or day care centers. In particular, the authors discuss EFDAs - Expanded Function Dental Assistants. They identify them as an example of a dental professional that states could use strategically to expand the workforce for young children. EFDAs (sometimes called registered dental assistants in expanded function) are licensed and in practice in 17 states. They work under the direct supervision of a dentist to prepare or finish up restorations, take x-rays, apply sealants and fluoride varnishes, and polish teeth. They also can perform limited cleanings, called "toothbrush cleanings" with a rubber cup or brush, that are well-suited to young children. EFDAs can greatly expand the productivity of dentists and make serving Medicaid and SCHIP patients more profitable. Unfortunately, in many states, EFDAs are in short supply and dentists aren't accustomed to working with them. Pennsylvania has gone the farthest in integrating EFDAs into dental practices. An innovative program funded by the Robert Wood Johnson Foundation has allowed the state to expand training for and use of EFDAs.	Gehshan, S. & Wyatt, M. (2007). *Improving oral health care for young children.* National Academy for State Health Policy. Available at: http://www.oralhealthamerica.org/pdf/NASHPImprovingOralHealthofYoungChildren.pdf Last accessed: October 2010.

No.	Description	Reference
17	This report discusses the problem of dental care for those with poor access to dental services in Quebec, with a view to making suggestions to deal with that problem. This report is not intended to be a systematic review of the problem or any potential interventions or programs to deal with that problem. Rather, this document summarises previous detailed reports of the oral health of Quebec's adults and children and describes a number of programs developed to address the problem of access to dental care for the under privileged in Quebec and elsewhere. These brief descriptions of selected programs are intended to inform discussion of potential solutions in Quebec rather than be detailed analyses of each program. In summary, this document aims to: • describe the oral health of the population of Quebec; • describe the determinants of poor oral health in Quebec; • describe the impacts of poor oral health; • describe dental care utilisation in Quebec; • describe the determinants of dental care utilisation in Quebec; • describe existing programs in Quebec and elsewhere in North America that provide • dental care for the under privileged; and • summarize the information and make recommendations for future work to address the problem. In the final section of the report, the authors emphasize those issues that need to be considered explicitly when deciding what sort of program to organize. Consideration of the advantages and disadvantages of all of these elements is essential if a successful program is to be developed and maintained. The elements are presented in no particular order and no attempt has been made to prioritize the issues as different organizing groups will have different priorities. The focus here will be on the types of staff required. When considering what types of staff are required for the program, it is essential to consider, among other things, the goals of the program, the versatility of the staff to be engaged (i.e. their ability to perform more than one role) and whether any of the staff types are already installed at centres or in organizations that one envisages using in the planned program. In terms of the dental assistant, the authors note that the role of dental assistant in these programs is very important, especially as often, the dental treatment is performed at sites and using equipment and materials concerning which the dentist performing the dental treatment is not familiar. There is no doubt that a dental assistant increases enormously the efficiency with which a dentist can work, therefore increasing the number of patients that can be cared for, if that is desired. People who are knowledgeable in disinfection and sterilisation procedures are also essential for all services and again this is important when the dental care being provided is so in a non-dental and/or non-clinical site, as is often the case when mobile dentistry is used. However, the role of dental assistant can be fulfilled by dentists and dental hygienists and appropriately trained dental students.	Allison, P., Allington, C. Stern, J. (2004). Access to dental care for under-privileged people in Quebec: A description of the problem and potential means to address it.. Available at: https://www.mcgill.ca/files/dentistry/Access_to_Dental_Care.pdf Last accessed: October 2010.

No.	Description	Reference
18	As health care costs continue to increase at rates higher than the general inflation rate, there is increased focus on controlling health care expenditures in the public and private sectors. In particular, there is a compelling need for more creative and informed allocation decisions for limited government public health funds. This thesis suggests several methods for better forecasting the demand for health care and allocating health care resources more efficiently. First, productivity of dental sealant programs is studied and suggestions are made for increased efficiency. Using simulation and data from several states' programs, guidelines are offered for optimal programs based on program size, distance to site, and practice act requirements. The author finds that under most conditions, it is better to carry an extra dental assistant to every program. Table 2.2 on page 13 of the article describes savings from adding an extra dental assistant for various program sizes. The cost of satisfying practice act requirements is also quantified. Second, a model for allocating health resources to Community Health Centers (CHCs) is provided. Using the state of Georgia as a prototype, local estimation is used to forecast county insurance types, disease prevalence, and likelihood of using a clinic. Then, the optimal locations and service portfolios to be offered under financial constraints are determined using a developed mixed-integer programming model. Finally, shortcomings in current Markovian modeling of chronic disease are analyzed. Common forecasting techniques can overestimate or underestimate the population in need of care, as illustrated by analytic results and an example with lung cancer data. Suggestions are presented for improving such modeling. Each of these issues affect the planning models for scarce resources in health care, and improving those models can positively impact utilization of those services. Through this research, models are presented that can positively impact public health decisions in coming years, particularly those for growing high-risk and low-income populations.	Robinson Scherrer, C. (2004). *The allocation of scarce resources in public health.* PhD thesis. School of Industrial and Systems Engineering Georgia Institute of Technology. Available at: http://etd.gatech.edu/theses/available/etd-07182005-151142/unrestricted/scherrer_christina_r_200507_phd.pdf Last accessed: October 2010.

Table 10: Literature on Demographics and Trends

No.	Description	Reference
	Articles in Peer-Reviewed Journals on Demographics and Trends	
1	This article provides updated information for dental assistants that were members of the American Dental Assistant Association (ADAA). Seventy-five percent of members are involved principally with clinical work, but few of them are exclusive to clinical duties. They double in administrative areas such as: Staff supervision (37%); Scheduling (90%); Assisting patients with financial arrangements (30%); and Purchasing (61%). Fifteen percent report administration as their principal occupation and one-third of those are practice managers. Five percent are full-time educators and the balance is employed in sales, insurance or lab tech work. Specialty offices involved only 28 percent of the respondents and of those, here's where they work (Table 2 on page 41): 32% Orthodontics; 24% Oral and maxillofacial surgery; 23% Pediatrics; 21% Periodontics; 11% Endodontics; 9% Prosthodontics. ADAA members practice in offices employing between one and three full-time clinical dental assistants. Twenty-four percent work in an office with three assistants and 19% with two assistants. Half of our members' offices include two part-time clinical assistants and one-fourth includes three part-time clinicals. On average, two of the assistants in each office are members of the ADAA and have been for 16 years. Half of the respondents' offices include one full-time administrative assistant; 22% report two fulltime administrative assistants. In addition, 17% employ two part-time administrative assistants. A total of 86% of ADAA member respondents are graduates of accredited dental assisting programs. All but three percent of these respondents attended schools accredited by the American Dental Association: 36% have attended college; 36% more have graduated from two year-community college programs; 5% earned a four-year degree; 3% have pursued post-graduate studies; 4% hold advanced degrees; 56% have attended radiology courses; 52% have attended expanded function courses; 19% attended specialty practice courses. In addition, 99% of our respondents are female and 80% are married; 37% have minor children at home and 92% are owners of the home they live in. Not too many of them wait for the bus because 99% own cars. The "mean age" (as many older as younger) is 45 and the average number of years as an ADAA member is 16.	McDonough, D. (2009). Demographics for the decade. *The Dental Assistant. September/October,* 40-43.

No.	Description	Reference
2	The escalating number and size of dental practices mean greater dependency on a ready supply of allied dental personnel. However, despite the increasing number of entry places in allied dental training programs, many places remain unfilled and large numbers of individuals do not complete the course of studies. A review of the changes in dental practice sizes and dental assistant, dental hygienist and dental laboratory technician programs raises concerns as to whether there will be enough allied dental personnel to meet the future needs of the profession. The need for increasing attention to this potential eventuality is stressed. The focus of this summary is the discussion of dental assistants in the article. Dental Assistants: There were comparable increases in the number of students enrolled in dental assistant programs, from 6,534 in 1997-98 to 8,279 in 2006-07. Throughout these years, first-year capacity of dental assistant programs far exceeded the actual enrollment. In 2006-07, while the dental assisting programs had sufficient facilities for about 13,150 students, somewhat fewer than 8,300 students were enrolled in these programs. The annual enrollment ranged from 7,300 to almost 8,300 students in the first half of the decade (Table 2, page 29 of the article). However, many students do not complete the course of training. For example, of the 5,629 students originally enrolled for the graduating class of 2005, 4,634 (82.3%) completed their training—a loss of almost 1,000 students. Nevertheless, since 2001, there has been an annual increase in the number of dental assistant graduates, reaching 5,951 in 2006 (Table 3, page 30 in the article). In 2006, 65% of the graduates from dental assistant accredited programs were white females. The graduates included 268 males, 489 Hispanics, 200 Asians, 662 blacks and 64 Native Americans. It should be noted that many individuals employed as dental assistants have received on-the-job training rather than as students in formal training programs. Concerns: A review of education program capacity indicates that each of the allied dental fields has many unfilled positions. In addition, in each of the programs, whether because of job/family care responsibilities (as reported in 2006-07 by 81% of dental assistant and 60% of dental hygiene students), the need for financial assistance (as reported by 72% of dental assistant and 65% of dental hygienist students, the vast majority of whom did receive financial aid) or other factors, significant numbers of enrollees do not complete the course of training. Will there be enough allied dental personnel to meet the needs of the increasing numbers of large dental establishments? Maybe not, unless there is increasing attention to: determining the actual short- and long-term needs for allied dental personnel; studying the factors that attract individuals to, or deter them from, an allied dental career; developing methodologies based on these findings to attract and retain young men and women to the allied dental fields.	Waldman, H.B. (2008). Allied dental personnel: Will there be enough? *NYSJD* November, 28-30.
3	Background: The authors examined the labour market for registered dental hygienists (RDHs) and dental assistants (DAs) in California from 1997 to 2005 to determine whether there was a shortage in either market. Methods: This analysis used economic indicators interpreted within an economic framework to investigate trends in labour force numbers and market-determined wages for RDHs and DAs. Rising inflation-adjusted mean wages indicated a labour shortage, while declining inflation-adjusted mean wages indicated a labour surplus. Results: From 1999 to 2002, the wages for RDHs increased 48% and then stabilized, indicating a shortage had occurred, after which the market achieved equilibrium. Wages for DAs increased 13.9% from 1997 to 2001, but then declined from 2001 to 2005, indicating a shortage that then became a surplus. The market for DAs may not have stabilized. Conclusions: Wages increased for RDHs and DAs, suggesting that labour shortages occurred in both markets. The large supply response in the market for DAs resulted in wages declining after their initial rise. Practice Implications: Tracking the local labour markets for RDHs and DAs will enable dental professionals to respond more efficiently to market signals.	Brown, T.T., Finlayson, T.L. & Scheffler, R.M. (2007). How do we measure shortages of dental hygienists and dental assistants? Evidence from California: 1997-2005. JADA 138, (1), 94-100.

<table>
<tr><th>No.</th><th>Description</th><th>Reference</th></tr>
<tr><td>4</td><td>Background: Educational programs play an important role in preparing a qualified dental work force. This article reviews the current status and trends in dental, advanced dental and allied dental education programs in the United States and examines their impact on the dental work force. Overview: This analysis focuses on survey data collected by the American Dental Association during the past 10 to 15 years and compares recent patterns in applications, enrollment and graduation with previous trends. The numbers of educational programs, applicants, enrolees and graduates have increased in dentistry, dental hygiene and dental assisting, while dental laboratory technology has declined in all measures. The proportion of women in dentistry has increased, while the ethnic profile of dental and allied personnel has shown little change. Both the cost of dental education and student debt continue to increase. Conclusions: Despite increases in the number of educational programs and overall numbers of graduates from dental and allied dental education programs, the proportion of underrepresented groups still lags behind their representation in the overall population, and the number of allied personnel falls short of practice needs. Practice Implications: Patterns in applications, enrollment and graduation are important determinants of the dental and allied dental work force. The cost and funding of education significantly affect the attractiveness of dental careers and the sustainability of educational programs and should be monitored carefully by the profession.</td><td>Neumann, L.M. (2004). Trends in dental and allied dental education. JADA 135, 1253-1259.</td></tr>
<tr><td colspan="3">Grey Literature on Demographics and Trends</td></tr>
<tr><td>5</td><td>On the Canadian Dental Assistants' Association (CDAA) website, the CDAA provides information on dental assistant salaries, this is summarized below. Dental assisting pay varies widely between regions and within communities. The following are results from the CDAA national online survey conducted in 2009:

General Practice Work Setting
<table><tr><th>National</th><th>BC</th><th>AB</th><th>SK</th><th>MB</th><th>ON</th><th>QC</th><th>NB</th><th>NS</th><th>PE</th><th>NL</th></tr><tr><td>$20.98</td><td>$22.11</td><td>$25.53</td><td>$20.36</td><td>$19.48</td><td>$19.79</td><td>$16.79</td><td>$17.19</td><td>$17.71</td><td>N/A</td><td>$14.24</td></tr></table>
Specialty Practice Work Setting
<table><tr><th>National</th><th>BC</th><th>AB</th><th>SK</th><th>MB</th><th>ON</th><th>QC</th><th>NB</th><th>NS</th><th>PE</th><th>NL</th></tr><tr><td>$22.47</td><td>$23.94</td><td>$27.52</td><td>$20.70</td><td>$20.67</td><td>$20.82</td><td>N/A</td><td>$19.94</td><td>$19.46</td><td>N/A</td><td>$17.61</td></tr></table></td><td>Canadian Dental Assistants' Association. (2010). Salary guide.

Available at: http://www.cdaa.ca/e/index.asp?l=/e/memberservices/salary.html

Last accessed: October 2010.</td></tr>
</table>

No.	Description	Reference
6	This information is from the US Bureau of Labor Statistics on Dental Assistants in the United States. This summary will focus on details regarding employment, job outlook, employment change, job prospects and earnings. Significant points for all the information presented were: • Job prospects should be excellent. • Dentists are expected to hire more assistants to perform routine tasks so dentists may devote their time to more complex procedures. • Many assistants learn their skills on the job, although an increasing number are trained in dental-assisting programs; most programs take one year or less to complete. • More than one-third of dental assistants worked part time in 2008. Employment: Dental assistants held about 295,300 jobs in 2008. About 93% of all jobs for dental assistants were in offices of dentists. A small number of jobs were in the Federal, State, and local governments or in offices of physicians. Job Outlook: Employment is expected to increase much faster than average; job prospects are expected to be excellent. *Employment change:* Employment is expected to grow 36% from 2008 to 2018, which is much faster than the average for all occupations. In fact, dental assistants are expected to be among the fastest growing occupations over the 2008–18 projection period. Population growth, greater retention of natural teeth by middle-aged and older people, and an increased focus on preventative dental care for younger generations will fuel demand for dental services. Older dentists, who have been less likely to employ assistants or have employed fewer, are leaving the occupation and will be replaced by recent graduates, who are more likely to use one or more assistants. In addition, as dentists' workloads increase, they are expected to hire more assistants to perform routine tasks, so that they may devote their own time to more complex procedures. *Job prospects:* Job prospects should be excellent, as dentists continue to need the aid of qualified dental assistants. There will be many opportunities for entry-level positions, but some dentists prefer to hire experienced assistants, those who have completed a dental-assisting program, or have met State requirements to take on expanded functions within the office. In addition to job openings due to employment growth, some job openings will arise out of the need to replace assistants who transfer to other occupations, retire, or leave for other reasons. Earnings: Median annual wages of dental assistants were $32,380 in May 2008. The middle 50% earned between $26,980 and $38,960. The lowest 10% earned less than $22,270, and the highest 10% earned more than $46,150. Benefits vary substantially by practice setting and may be contingent upon full-time employment. According to a 2008 survey conducted by the Dental Assisting National Board (DANB), 86% of Certified Dental Assistants (CDA) reported receiving paid vacation from their employers, and more than half of CDAs received health benefits.	US Bureau of Labor Statistics. (2010). Dental Assistants. Occupational Outlook Handbook, 2010-2011 Edition. Available at: http://www.bls.gov/oco/ocos163.htm Last accessed: October 2010.

No.	Description	Reference
7	This report is on the dental workforce in New Zealand. The focus is on the summary on other oral health practitioner groups and more specifically, dental therapists. The Dental Therapist Workforce: New Zealand dental therapists are still predominantly a group of older, New Zealand European women, but the representation of other ethnic groups and younger practitioners continues to increase, with 16.7% reporting their 'primary ethnicity' to be something other than New Zealand European (an increase of 2% on the previous year). The proportion of therapists working full-time has dropped to 69.0% from 73.9% the previous year, with almost all working in the District Health Board (DHB) sector. Almost three-quarters of dental therapists are now able to provide radiography, but there remains considerable variation across the DHBs, as with the proportions able to provide pulpotomies and stainless steel crowns. For example, only two of 34 therapists in Hawke's Bay are able to perform pulpotomies, and only one is able to treat teeth using stainless steel crowns; however, in Otago, over half are able to do so. Across the country, some 11 dental therapists were registered in the scope of Adult Dental Care. There appears to be a variation in the therapist-to-population ratio by area: it remains highest in Northland and the Bay of Plenty and lowest in the Greater Wellington region and South Canterbury. A total of 682 dental therapists were listed on the Dental Council of New Zealand (DCNZ) register who first registered prior to the 2008 reporting period, and 648 held a current APC. A total of 27 therapists had their registrations on hold (REGN), while a further seven were pending removal from the register (REMPEND). Therapists' ages ranged from 22 to 70 years, with a mean age of 48.9 years (SD, 10.9) and a median of 51 years. Over half of the active dental therapists are now aged 50 or over, with 42.6% in the 50-59 age band in 2008 compared with 40.2% in 2006. Therapists aged 40 and younger comprised one in four in 2007, but this was back to one in five in 2008. In 2008 there were 15 male therapists (1.4%). Of this number, 10 were in the 20-29 year age group, three were in the 30-39 year age group, and two were the 40-49 year age group. Full-time practice was reported by 447 dental therapists (69.0%, down from 73.9% the previous year). Of the 201 (31.0%) who reported part-time practice: nine (4.5%) were doing non-dental work; six (3.0%) reported that there was not enough dental work available; one (0.5%) reported they were seeking dental work; two (1.0%) was semi-retired from practice; 47 (23.4%) cited parental responsibilities; 74 (36.8%) did so by personal choice; and 62 (30.8%) indicated other reasons, including management, teaching, or study responsibilities as well as health reasons or dual dental therapy/hygiene work. A total of 20 were not currently practising; of those, one was practising overseas, one was overseas but not practising, and 18 were in New Zealand. Among the latter, six (37.5%) were working in another health profession, eight (50.0%) were full-time students, and two (12.5%) were not working due to parental duties. None of those who were working in another health profession recorded any hours worked in dental hygiene. Of the 18 who reported a second employment type, five were in private practice (four were self-employed), eight worked in the DHB sector, one was employed by the University's dental school, one was employed by an Iwi organization, and the remainder reported other forms of employment. The total hours worked by therapists ranged from 0 to 75 hours per week, with a mean of 33.9 (SD, 9.1) among the 600 therapists who reported working one or more hours per week. A total of 32 dental therapists (4.9%) reported they were currently undertaking postgraduate training, and 28 of those expected to practise in New Zealand at the completion of that training. The numbers of therapists registered in the various SOPs were: 648 (100.0%) in general dental therapy practice; 458 (70.7%) in diagnostic radiography in dental therapy practice (up from 59.9% in 2007); 44 (6.8%) in radiography in dental therapy practice; 237 (36.6%) in pulpotomies in dental therapy practice; 122 (18.8%) in stainless steel crowns in dental therapy practice; and 13 (2.0%) in adult dental care in dental therapy practice. Large differences are reported in the treatments that therapists from different DHBs are able to provide. In 2008, 96.1% of dental therapists (N=623) had completed at least 15 hours of CPD during the previous year. This is up from 88.2% in 2007. Of those 18 who were in New Zealand but not practicing, three quarters (N=14) had maintained CPD hours of at least 15 hours while the remaining quarter (N=4) had not done so (a turnaround from the year before).	Broadbent, J.M. (2009). *2008 Workforce analysis.* Dental Council of New Zealand. Available at: http://www.dentalcouncil.org.nz/Documents/Reports/Workforce Analysis2008.pdf Last accessed: October 2010.

No.	Description	Reference
8	Background: Much of the rural population, especially children, has inadequate access to dental care. The aim of this study was to investigate and report on rural dentist issues (e.g., demography, training, practice characteristics, staff, and job satisfaction) in four states. Methods: All rural dentists were surveyed in Alabama, California, Maine, and Missouri. Four mailings of the four-page questionnaire were performed, with a resulting combined response rate of 75%. Major Findings: Generally, dentists and their work patterns were similar across the four states. Dentist practices varied dramatically across states regarding staffing patterns. Vacancy rates for dental hygienists varied greatly from state to state, ranging from 35% to 6%, while dental assistant vacancy rates varied from 12% to 4%. Dentist Medicaid participation and volume differed widely across the states. The majority of dentists in the four states were satisfied with their professional life, but the percentage who felt they were too busy or not busy enough varied widely among the states. More specifically regarding dental assistants, the report found that in the four states, virtually all general dentists reported that they employed at least one chair-side dental assistant. Additionally, dentists across the states employed a larger number of dental assistants than dental hygienists. Rural dentists employed an average of 1.7 dental assistants per dentist in Alabama and California. In Maine, there were 1.4 dental assistants employed per dentist, and in Missouri, dentists employed an average of 1.8 chair-side dental assistants. In all four states, the vacancy rates for chair-side dental assistants were lower than the vacancy rates for dental hygienists. Using the same method as described above for dental hygienists, chair-side dental assistant vacancy rates ranged from 4.1% in Alabama to 5.7% in California. Rates for Missouri and Maine were nearly identical at 4.2 and 4.3% respectively. The average hourly wage of chair-side dental assistants ranged from $11.09 in Missouri to $14.35 in California. There were no statistically significant differences in the wages of chair-side dental assistants. As with dental hygienists, without considering the difference in the cost of living across states, this wage comparison is not meaningful, making direct comparisons of the dollar values problematic. Policy Implications: Rural dentists suggested many ideas to better meet unmet oral health needs. Because the issues are complex and the situations are so different in the survey states, creating general federal policies that work in all states is a daunting challenge. There are dental professional shortages in many rural areas. While training more dentists and dental hygienists is critical, it is not sufficient to provide the population with adequate oral health care. Many other strategies to enhance access, including increasing the ability to pay for dental services, are also needed.	Andrilla, C.H.A., Lishner, D.M. & Hart, L.G. (2006). *Rural dental practice: A tale of four states.* WWAMI Rural Health Research Center. Working Paper #107. Available at: http://depts.washington.edu/uwrhrc/uploads/RHRC_WP107_Andrilla.pdf Last accessed: October 2010.

<table>
<tr><th>No.</th><th>Description</th><th>Reference</th></tr>
<tr><td>9</td><td>The following two tables are from a PhD thesis. The first table (Table 4 in the thesis) provides a breakdown of the total dental care personnel for Canada by province (excluding Federal dental therapists) for 2006. The focus here is on the number of dental assistants. The breakdown for total number of dental assistants per province are as follows:
<table>
<tr><td>BC</td><td>6,390</td></tr>
<tr><td>AB</td><td>4,800</td></tr>
<tr><td>SK</td><td>750</td></tr>
<tr><td>MB</td><td>960</td></tr>
<tr><td>ON</td><td>11,000</td></tr>
<tr><td>QC</td><td>3,900</td></tr>
<tr><td>NB</td><td>106</td></tr>
<tr><td>NS</td><td>925</td></tr>
<tr><td>PEI</td><td>160</td></tr>
<tr><td>NF/LA</td><td>260</td></tr>
<tr><td>NU</td><td>Unknown</td></tr>
<tr><td>NWT</td><td>Unknown</td></tr>
<tr><td>YK</td><td>Unknown</td></tr>
<tr><td>Total</td><td>29,251</td></tr>
</table>
The second table (Table 8 in the thesis) provides the breakdown of dental assistants (Full-time equivalents, FTEs) for seven provinces for 2005 in the public sector. They are:

• BC: 23.9
• Alberta: 40.46
• Saskatchewan: 9.5
• Manitoba: 6
• Ontario: 140.47
• PEI: 13.4
• Newfoundland/Labrador: 7.32</td><td>Quiñonez, C. (2009). The political economy of dentistry in Canada. A thesis submitted in conformity with the requirements for the Degree of Doctor of Philosophy Graduate Department of Dentistry. University of Toronto.

Available at: http://gradworks.umi.com/NR/59/NR59133.html

Last accessed: November 2010.</td></tr>
</table>

No.	Description	Reference
10	This document provides guidelines to assist District Health Boards (DHBs), the Dental Therapists Board and private employers on the recruitment, staffing expectations and competencies of dental therapists in providing dental services. The Dental Therapy Technical Advisory Group (TAG) on the Recruitment and Practice of Dental Therapists was formed in October 2003 to provide recommendations on strategies for dental therapy workforce issues such as recruitment and retention, staffing expectations, educational opportunities, career structures, and the assessment of overseas dental personnel. New Zealand has a long history of providing school dental services to children and adolescents. Since the early 1990s, however, there have been significant changes to the education and training of dental therapists, and to their recruitment and retention in the public dental service. In March 2001 a former Dental Therapy TAG reported on the future organisation of dental therapy in relation to legislative arrangements to introduce the Health Practitioners Competence Assurance (HPCA) Act 2003. That report identified a number of issues that required immediate and long-term action. Some of the recommendations from the report have been actioned and others are still under consideration. At the time of the review the University of Otago was the only provider of dental therapy education and training. Since then the Auckland University of Technology (AUT) has also introduced a dental therapy programme. Both institutions now offer a three-year dental therapy education and training programme at the bachelor level, and the University of Otago also offers a two-year diploma qualification. In the past these courses have fallen short of their target student intakes. This has been attributed to the uncertainties surrounding long-term career opportunities in dental therapy. In addition, a postgraduate course offered by the University of Otago has failed to attract any applicants. Data available from surveys and audits conducted in the 1990s indicate an acute shortfall in the supply of dental therapy services. The dental therapy workforce is ageing, and there will soon be very few dental therapists available to deliver the current levels of care, unless there are career development opportunities to provide incentives to enter the occupation. The recruitment of overseas-trained dental therapists and dentists has been suggested as a short to mid-term solution to recruitment. However, the variability of overseas courses and programmes and the requirement to compare them to New Zealand courses has made it difficult to recruit appropriately and quickly. Workforce development is a critical factor in being able to deliver on government priorities and in contributing to improving oral health outcomes. A well-educated and sustainable workforce is required to ensure a safe, high-performing and efficient health system. Such a system is necessary to reduce the inequalities in health for Mäori, Pacific and low-income people, to contribute to equitable and affordable access to services, and to maintain a public health and primary care focus. In particular, the report to the Minister of Health, Improving Child Oral Health and Reducing Child Oral Health Inequalities, identified that increasing the recruitment of dental therapists is essential. The report also highlighted the disparity in the ethnic composition of the present dental workforce, the requirement for a larger Mäori and Pacific workforce, and the need for a culturally competent workforce. In 2001 the Health Workforce Advisory Committee undertook a stocktake of the health workforce. The resulting report (Health Workforce Advisory Committee 2002a) highlighted the fact that the expected development of publicly funded oral health will have workforce implications for the number of dental therapists needed, and will require a reversal of the trends that show the capacity of the dental therapy workforce declining. Under the HPCA Act 2003 the present Dental Council of New Zealand (DCNZ) will be replaced in September 2004 by a combined council comprising representatives from the various dental professions. Individual professional workforce boards will operate under this 'umbrella' DCNZ to manage the regulatory matters of each profession. Changes to the legislation will allow dental therapists to provide services to patients through both private and public dental clinics. There is, therefore, the potential for dental therapists to shift from public sector employment into the private sector and for the role of dental therapists to expand into a more primary care role for a wider range of patients. The impact of this change has not been fully explored, but it brings with it the need for a broader range of employing agencies to understand and appreciate the role of dental therapy and its relationship to other aspects of dental practice. Also, because of workforce shortages the consequences of the possible movement of dental therapists out of the School Dental Service into the private sector would seriously impact on the ability of the School Dental Service to retain the present level of service delivery. Clear, professional career outcomes for current dental therapists and young New Zealanders considering careers in this area of dentistry are required. The novelty of changes within the profession requires broad stakeholder and consumer agreement to the educational and philosophical aspects of dental therapy. These need to be in keeping with the dental service needs and demands envisaged by the New Zealand community.	Dental Therapy Technical Advisory Group. 2004. *Recruitment and practice of dental therapists.* Wellington: Ministry of Health. Available at: http://www.moh.govt.nz/moh.nsf/0/7CE13CF8E1D35AB0CC256EDE000D1045/$File/RecruitmentandPractice.pdf Last accessed: October 2010.

No.	Description	Reference
11	This review covers dentists and professionals complementary to dentistry (PCDs) and was undertaken at a time when major changes in the contractual and remuneration arrangements for the general dental services are in train in the UK. Team working in dentistry is also taking root as a result of extensions in the range of duties that dental therapists and dental hygienists may carry out; and as a result of the General Dental Council's plans for the registration of other PCDs including dental technicians and dental nurses. As the full implications of these changes for future dental workforce requirements are not yet clear, this review provides a best estimate of future demand and supply based on the data currently available. The review concentrates on the primary care dental services. The review has been carried out under the guidance of internal and external reference groups drawn from all the main stakeholders in dental care. It is also informed by six workshops that were held. The Department of Health has carried out detailed modelling of demand and supply for the dental workforce in England. The review's modelling team produced future projections of both demand and supply expressed in terms of 'clinical time' (i.e. direct contact time between a patient and a dental professional). Adult and child demands were modelled separately based on population projections for the next 20 years. A crucial part of this work was the assessment of the treatment mix. Key outputs from the demand modelling were: the projections of adult demand suggest a slight increase between now and 2011, followed by a levelling-off between 2011 and 2021, and the projection of child demand shows no significant change over the next 20 years. Total demand at present is estimated at around 30 million clinical hours per year. The 'higher' projection suggested that this could rise to top 33 million hours in 2011 and would remain at that level to 2021. The 'lower' projection suggested that demand could increase to 31 million clinical hours by 2011, and return to just above current levels by 2021. Supply models were based on registration data held by the GDC for dentists, dental therapists and hygienists. These are the three professions that can treat patients directly. Each of them contributes to the supply of 'clinical time'. The dental technician and dental nurse workforces are not included in the current models. The models used registration data (with age/sex/place of qualification breakdowns as needed) and reflected patterns of working hours, career breaks, and numbers of new entrants and retirements. The following factors that have implications for the number of working dentists and the 'whole-time equivalent' workforce were also included: more demanding requirements for the registration of dentists from countries in the 'Old Commonwealth', a decrease in dentists' working hours (often in combination with a switch from NHS to private dentistry), a 'step change' reduction in the time dentists spend on clinical work, resulting from specific pressures on clinical time (i.e. clinical governance, issues such as decontamination, clinical audit, etc.), the effect of women being a greater proportion of dental school graduates than previously, changing working patterns for both sexes. To assess the gap between demand and supply the 'baseline' supply projections were run as projections of existing trends. Key outputs from the 'baseline' supply modelling were that on current trends: the number of practising dentists in England is projected to fall by around 2,400 (WTE) between 2001 and 2021. However, the number of practising dental therapists is projected to increase by 870 (WTE) and the number of practising hygienists by 330 (WTE), and the total supply of clinical time on a 'dentist equivalent' basis is estimated to be around 28.6 million hours in 2001 (approximately 27 million in 2003). This is projected to decline to 26.4 million hours by 2011 and 24.6 million hours by 2021.	UK Department of Health (DoH). (2004). *Report of the primary care dental workforce review.* Available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4086050 Last accessed: October 2010.

Table 11: Literature on the History of the Profession/Recent Evolutions in Education and Training

No.	Description	Reference
	Articles in Peer-Reviewed Journals on Profession/Recent Evolutions in Education and Training	
1	This editorial provides a brief overview of the history of the dental assistant. In the history of dental assisting, Dr. C. Edmund Kells is attributed the honor of having hired the first dental assistant. The facts supporting this claim are not so absolute. It seems that men were the first assistants. Kells is said to have seen or heard of colleagues in the metropolitan areas of New York and Chicago who advertized a "lady in attendance" to reassure women of the propriety of seeking dental care in such an office. In 1885, Mrs. Kells was his assistant and he could advertize a "lady in attendance" in his office. By 1895, Dr. Kells hired another female assistant. Eventually, Dr. Kells hired Malvina Cueria, who is considered, by some sources, to be the first female dental assistant of modern history. Kells recognized the need to overcome the prevailing social norms to make dental care accessible for women who could not be accompanied by a chaperone. His move to incorporate women into his practice was an example of his innovative thought. He was using the assistant to bridge a gender gap just like many practices use assistants today to bridge cultural and linguistic gaps. The obvious economic advantage of increasing the patient base for his practice did not go unnoticed. Initially, the senior Dr. Kells found his son's working alongside a woman inappropriate, but, like his other colleagues, he soon realized the advantages and also hired female assistants. Dr. Kells went on to become a great advocate for the incorporation of dental auxiliaries into the dental practice. He recognized the efficiencies that auxiliaries could facilitate. He is quoted as having said, "The lady assistant is one of the dental institutions of the day and is due to survive as long as dentistry lives. The lady assistant is absolutely essential to the modern dental office." During 2003 to 2007, the average number of chairside assistants per dentist in the primary private practice of independent dentists hovered around 1.6. (Specialists during that same time employed an average of 2.6 chairside assistants.) One comparison of gross billings per practice hour showed that the mean figure for those dentists with no assistant was $169.70. The mean for those dentists with one chairside assistant was $300.51; for those with two chairsides assistants, the mean figure was $427.35. The obvious improvements in efficiency in the dental delivery system resulted in grants to dental schools to promote dental auxiliary utilization, DAU. Even in this economic downturn, a recent Internet posting of the 20 fastest-growing occupations included dental assistants. Productivity aside, the increased emphasis on universal precautions and recognition of the need to maintain sterile techniques make practicing without an assistant almost as difficult as performing surgery in the operating room without a surgical nurse. Some say the relationship we enjoy with the members of our practice team is the single, most important element in a successful practice. Efficiency, productivity, issues of sterilization, and bridging the cultural gap are of major importance but working with great assistants simply makes my life much nicer. Their ability to anticipate the dentist's needs, eliminate schedule log jams, make patients comfortable, and take the initiative in improving office team work are skills that the author appreciates every day.	Carney, K.K. (2010). Ladies in attendance. *CDA Journal* 38, 6, 369, 372.

No.	Description	Reference
2	This commentary discusses expanded duties and dental assistant education in Tennessee, US. The Health Resources and Services Administration (HRSA) provides comprehensive data concerning Health Professional Shortage Areas (HPSA). The Tennessee Dental Association (TDA), in collaboration with many other stakeholders, worked to improve the workforce situation. According to the HRSA definition, a dentist using up to four properly trained auxiliaries can produce as much as 1.5 Full Time Equivalents (FTE). This is especially significant for inner city and rural areas where distribution problems are more likely to exist. The key is to educate more auxiliaries and to expand their training as they work under the supervision of a dentist. The 2001 House of Delegates of the Tennessee Dental Association convened in May and considered two resolutions that many dentists believed would help alleviate workforce shortages. Resolutions EDDA-01-1 & 2 were passed by a substantial majority to seek legislation that would change the Tennessee Dental Practice Act to allow dental assistants and dental hygienists, with proper education, to place and carve restorations and to take final impressions for dental prostheses as Expanded Function Dental Auxiliaries (EFDAs). Indeed, there was widespread support throughout the dental team to pursue this statutory change. In 2002, the Tennessee General Assembly enacted changes in TCA 63-5-108, which provided for these new expanded duties based on consensus by all parties of interest. The dental profession and state policy makers moved forward together in a continued effort to answer questions surrounding the access to care issue. In October of 2005, the new rules associated with the statutory change became effective; however, there was still much to be done. A task force was formed in 2005 by the TDA to study the problems associated with dental assistant utilization in Tennessee and to make recommendations for solutions. A myriad of issues were identified, including a sluggish bureaucratic registration process, lack of or inadequate educational programs, restrictive regulations and a host of additional concerns. Solutions were brought to fruition which included standardized training and examination for advanced duties, re-established utilization of practical dental assistants, more efficient registration of assistants, alternate pathways for dental assistant education such as in-office clinical training as well as allowing a more consistent process for registration of out of state applicants with proper credentials. In addition support for existing dental assisting educational programs was encouraged along with seeking new programs where and when possible. Advanced duties for registered dental assistants now include radiology, coronal polishing, nitrous oxide monitoring, sealant application and expanded functions, both restorative and prosthetic, which allow a well-trained registered dental assistant or dental hygienist to place and carve both amalgam and composite restorations and take final impressions for dental prosthetic devices (EFDAs). The first EFDA class was held in March 2006 at the University of Tennessee College of Dentistry in Memphis. Since that time there have been more than 240 graduates of the program. By August of 2010, the University of Tennessee in conjunction with Meharry Medical College will offer an expanded function program in Nashville as well. Additionally, dental hygienists with further education can administer nitrous oxide and provide local anesthesia. The Tennessee Board of Dentistry and the State Legislature have partnered with Tennessee's dentists to provide for the public welfare through the mitigation of barriers to access to dental care by greatly increasing the productivity of the dental team while focusing on quality care and dental office safety for all patients.	Stanislav, L. (2010). Expanded duties and dental assistant education. *Journal of the Tennessee Dental Association* 90, 1, 14.

No.	Description	Reference
3	Teamwork is essential for the provision of contemporary, high quality oral health care. Teamwork skills need to be taught and learnt and therefore ought to be one of the core competencies in all dental education programs: dentistry, oral health therapy, dental technology and dental assisting. Currently, lack of opportunities for collaborative learning and practice within educational establishments, and in the practising professions, hamper the development of effective teamwork. For students across oral health care, 'learning together' requires positive action for teamwork skills to be developed. Interprofessional curricula need to be formally developed, based on evidence from the wider education literature that demonstrates how to maximise the engagements needed for teamwork in practice. Rigorous study of interprofessional education within dentistry and oral health is in its infancy. Anecdotal evidence indicates that dental technology students who experience an interprofessional curriculum are better prepared for collaborative practice. Formalised interprofessional education is posited as an effective strategy to improve interactions among oral health professionals leading to improved patient care. This paper reviews the extant literature and describes the approach currently being trialled at Griffith University.	Evans, J., Henderson, A. & Johnson, N. (2010). The future of education and training in dental technology: Designing a dental curriculum that facilitates teamwork across the oral health professions. *British Dental Journal* 208, 5, 227-230.
4	Health, education and social services are placing increasing emphasis on preventing abuse and neglect by early intervention to support families where children and young people may be at risk. Dental hygienist and dental assistants, like all other health professionals, can have a part in recognizing and preventing children from those who would cause them harm. They should be aware of the warning signs, recognizing what to consider as abuse or dental neglect and know how to deal with these young patients, and to fulfil their legal and ethical obligation to report suspected cases. The purpose of this report is to review the oral and dental aspects of child abuse and dental neglect thus helping the dental team in detecting such conditions. In particular, this report addresses the evaluation of bite marks as well as perioral and intraoral injuries, infections, early childhood caries and diseases that may be indicative of child abuse or neglect. Emphasis is placed on an appropriate protocol to follow in the dental practice to best treat and protect children who may have suffered abuse, helping the team in the diagnosis and documentation. In elaborating on the role of the dental assistant, the authors note that scientific literature offers little in the line of guidance as to what a dental hygienist can perform in specific areas of forensic science. The dental hygienist's role may be described as a set of defined functions in the field of oral health. This is not to suggest that the role involves no more than the execution of limited responsibilities. The same could be said of the dental assistant. In fact, dental hygienist and dental assistant can play an important part in the complex area of child abuse and neglect. One reason for this is the likelihood that they are one of the first health professionals to come in contact with the presumed victim of the abuse and help create an atmosphere of trust in which the patient feels able to 'open up'. This is mainly because they are able to spend more time with the patient than the dentist. Dental hygienists and dental assistants are key health professions in the effective management of the dental patient, especially in the initial stages (prevention) and subsequent to the intervention of the specialist (maintenance). They may also be involved in supporting medico-legal investigative activities of a forensic odontologist. This is not to say they can act unilaterally in the area of medico-legal activities. However, the obligation to submit a report to law enforcement authorities remains. In particular, non-accidental skin lesions such as bitemarks may constitute the first key step of a procedure designed to record the injury in time as evidence. This is particularly crucial given the nature of bitemarks and less severe injuries.	Nuzzolese, E., Lepore, M.M., Montagna, F., Marcario, V., De Rosa, S., Solarino, B., Di Vella, G. (2009). Child abuse and dental neglect: The dental team's role in identification and prevention. *Int J Dent Hygiene* 7, 96–101.

No.	Description	Reference
5	The first national recommendations for radiation protection were given by the British Roentgen Society (1915) and American Roentgen Society (1922). The basis for modern radiation protection was given in the recommendations of International Commission on Radiological Protection (ICRP 26) in 1977. Dental education in all Nordic countries takes five years and leads to the competence of performing intraoral radiography in Sweden and intraoral standard and panoramic radiography in Norway and dentomaxillo-facial radiography in Denmark and Finland. There is obligatory special training before using standard panoramic units in Sweden. For performing cone beam CT examinations and interpreting the images, a specialist degree in maxillofacial radiology is required in Sweden and Norway. Dental assistants and hygienists can perform intraoral radiography under the responsibility of a dentist. In Sweden, Norway and Denmark dental hygienists may also record caries lesions and periodontal disease, although in Sweden and Finland all radiographs must be shown to the dentist. In Denmark and Norway the dental hygienists may be responsible for a dental x-ray unit, and they can refer the patient for a radiographic examination. Updating education is mandatory only in Finland according to EU guidelines. The demands for dental radiographic units are very similar in all countries. Quality assurance programs are regulated by law in Finland, Sweden and Denmark. The programs comprise daily, monthly or yearly checks of radiographic procedures. Regulations for digital dental radiography are still under construction, though some are available in Denmark. The article provides some information on dental assistant education and changes. This is summarized below. Finland: The curriculum of dental assistants takes three years; it includes oral radiography, which may be performed by a dental assistant under guidance of the dentist. All radiographs must be interpreted by the dentist. Norway: The dental assistant education in Norway is one year including radiography. They have the competence to take intraoral radiographs. All radiographs must be submitted to a dentist for diagnosis. As in Denmark all dental auxiliary personnel may take radiographs and perform other dental procedures under the responsibility of a dentist. Denmark: A dental assistant has a two-year education and may take radiographs and perform other dental procedures under the responsibility of a dentist. The dental assistant may not be asked by the dentist to assist in holding the film in the patient's mouth during exposure. In Finland, government regulation no. 423/2000 and STUK directive ST 1.7 (following the EU directives) assign that all dentists and dental assistants who take radiographs must take part in updating training. The need for this training is 0.75 ECTS-points during every five-year period. In Sweden, Norway and Denmark there is at current no mandatory updating training. The Norwegian Dental Association arranges a highly recommended, systematic updating training for its members, »Tannlegenes systematiske etterutdanning« (TSE), which also includes a theoretical and practical course in oral and maxillofacial radiology (together with oral surgery and oral medicine). TSE courses are partially net-based. In Denmark, mandatory yearly updating for all dentists will be initiated in 2009.	Peltola, J.S., Petersson, A., Svanaes, D. & Wenzel, A. (2009). Regulations in the Nordic countries concerning oral and maxillofacial radiographic imaging technologies and their use. *Andlægebladet* 113, 2, 81-90.

No.	Description	Reference
6	Over the last five years, there have been major changes in the training, numbers recruited and regulations pertaining to the work of dental therapists. UK opportunities are rapidly expanding as schools and numbers in training increase. The range of treatment competencies taught has expanded. Since 2002, General Dental Council (GDC) regulations have enabled extension of the range of clinical activities or 'permitted duties' that can be performed by therapists, as long as they have received the appropriate training. The range of clinical settings allowed has also increased. Following the personal dental service (PDS) pilots in England, which were established to test alternative ways of delivering dental services (through local contracting arrangements) including the employment of dental therapists in dental practices, and the introduction of the new dental contract in England and Wales in 2006, therapists may now work in general dental practice (GDP) as well as the salaried and hospital services to which they were previously limited. Therapists are now referred to under the term 'dental care professional' (DCP), which also includes dental hygienists, dental nurses, dental technicians, clinical dental technicians and orthodontic therapists, all of whom must now register as DCPs with the GDC. Further clarification regarding the roles of DCPs was given by the GDC in 2009 in a document entitled *Scope of practice*, which details the skills that each DCP will have been trained to carry out and additional skills they may develop during their careers. Irrespective of whether a therapist has a diploma in dental therapy alone or combined with dental hygiene or a BSc, they will be trained and competent to carry out all the duties of a therapist in addition to those of a hygienist as described in *Scope of practice.* The extent to which dentists have seriously considered the possibility of adding dental therapists to their practice teams in the UK has changed over time. Objectives: To conduct a survey of current working practices of UK dental therapists following the changes in permitted duties, allowed clinical settings and the introduction of the new dental contract in England and Wales. Methods: A piloted postal questionnaire was circulated in 2006 to all GDC registered therapists and those on the hygienists register possessing a dental therapy qualification. Two subsequent mailings were used to boost the response rate. Results: There was an 80.6% response rate (n = 587). Ninety-eight percent of respondents were female. Average time since qualification was 17 years. Eighty percent (n = 470) of respondents were currently working as a dental therapist, 53% part-time. Of the 470, half were engaged entirely in GDP, one third in the salaried dental services (SDS), while others worked across different settings. Only 39% claimed to spend most of their time treating children. Recently qualified therapists more often worked in GDP ($p < 0.001$). Overall, a wide range of clinical duties were performed, although there was concern about maintaining skills across all the competencies since qualification, while emphasis on hygiene work was a limiting factor for some. On the basis of the continued professional development (CPD) activities described over one year, only half would have met the GDC CPD requirements from August 2008 for DCPs. Conclusions: More than half of therapists now work in GDP, compared with none six years previously. Many undertake a full range of duties. However, there was concern that some dentists use them for hygiene skills rather than across the whole range of their competencies, risking deskilling, while others reported their inability to gain employment as a therapist.	Godson, J.H., Williams, S.A., Csikar, J.I., Bradley, S. Rowbotham, J.S. (2009). Dental therapy in the United Kingdom: Part 2. A survey of reported working practices. *British Dental Journal* 207, 9, 417-423.

No.	Description	Reference
7	New Zealand has a long history of dental care provided by school dental nurses, now known as dental therapists. The nature of their training courses, although delivered in different centers, had remained relatively constant until 1999 when educational responsibility was transferred to the universities. Dental hygienists were not trained in New Zealand until 1994, with the exception of the New Zealand Army hygienists. Since 2001, the education of both dental therapists and dental hygienists has been the responsibility of the universities. Significant and progressive changes in educational delivery have occurred since then, which have culminated in three-year degree qualifications for dual-trained oral health professionals. Factors influencing this change included increased professionalism associated with the new legislative requirements for registration, workforce shortages, and enhanced educational and clinical practice requirements. The Bachelor of Oral Health degree at the University of Otago has an added emphasis on social sciences and incorporates aspects of learning relating to New Zealand's cultural heritage. We explore in this article the rationale for the introduction of a Bachelor of Oral Health in New Zealand and how it is designed to equip graduates as professionals in oral health.	Coates, D. E., Kardos, T.B., Moffat, S.M., Kardos, R.L. (2009). Dental therapists and dental hygienists educated for the New Zealand environment. *Journal of Dental Education* 73, 8, 1001-1008.

No.	Description	Reference
8	The number of students entering training for dental therapy has been increasing rapidly over the last few years. In practice, the scope of their work has increased, both in terms of permitted duties and their range of clinical settings. The possibilities for dental practitioners to work with therapists is therefore increasing. This paper traces the history of dental therapy together with the development of therapists' training opportunities and emerging competencies, up to the present. Dental therapists could be considered by the general public and dental profession as a new additional team member since their introduction to general dental practice in 2002. However, historical evidence reveals that there were 'dental dressers' performing equivalent roles almost a century ago and local authorities as early as 1909 laying the foundations for a School Dental Service. The introduction of dressers was met with substantial opposition from the dental profession and in 1932 and the government restricted the scope of the dressers' work to scaling and polishing, although they were not completely abolished until 1942. With the possibility of disintegration of the School Dental Service, the government looked to New Zealand for inspiration (i.e., the dental nurse model). There was a significant degree of controversy and opposition from dentists to the idea of introducing this type of clinical worker into the UK but the Dentists Bill was passed in 1957. The newly created General Dental Council (GDC) was then instructed to carry out an experimental scheme and it was the GDC itself that was to set the conditions under which the newly emerging 'dental auxiliaries' would work. The new dental auxiliaries (as they were originally known) would only be allowed to work in the public services (for example, salaried – hospital and school dental service) but not in general practice. They also had a limited scope of practice (e.g., carry out 'simple fillings' and extraction of deciduous teeth.) In 1959 the first school for dental auxiliaries was opened at New Cross Hospital in South London. The school admitted 60 female students per year for a two-year course. By 1965 it was considered that the new dental auxiliary was making a valuable contribution to the dental service and the Ancillary Dental Workers Regulation established them as part of the dental team. During the 1980s employment opportunities for dental therapists were limited as they were restricted to employment within hospitals and community placements and few positions were available. However, there was plenty of demand for dental hygienists, who could also work in general dental practice. A number of 'New Cross' therapists therefore took the opportunity of attending shortened courses to obtain the hygienist qualification. This gave them the option of working in general practice as a hygienist where potential earnings were far greater. In 1993, The Nuffield Report into the Education and Training of Dental Auxiliaries was published. The report made significant recommendations for all clinical dental auxiliaries, including dental therapists, dental hygienists and dental surgery assistants, later called professionals complimentary to dentistry (PCDs) and more recently, dental care professionals (DCPs). With regard to dental therapists, the report recommended that they expand their remit and, most importantly, that the restrictions regarding workplace should be lifted and therapists permitted to work in general dental practice in the future. Expansion in therapy training began in 1996 when Cardiff Dental Hospital started a dental therapy course funded by the Welsh Office. Since 1996, the remaining dental hygiene schools have gradually begun to offer dental therapy as a combined course or as a separate qualification. A major change for the training establishments occurred around this time. Many therapy schools have now made a successful move to a full university course. The GDC recommended that therapists be permitted to work in all sectors of dentistry, including general dental practice, in 1999. This was approved from 1 July 2002. At the same time, extended duties were added to their potential remit. The latest developments to impact on dental therapist working practice occurred in July 2006. The new GDC standards, 'Principals of dental team working' state that DCPs can carry out treatment if they are sure they are trained and competent to do it. Hence, therapists are no longer required to work to a specific remit, but as long as they are trained and competent, they can carry out any specific procedure. This has caused a lot of confusion among the dental profession as a whole and more clarity is needed regarding the context of any extra training to develop additional competencies. As part of the government initiative to improve access to NHS care, a number of therapists were employed within personal dental service (PDS) schemes. The PDS was initiated to test an alternative delivery system of dental services, including the employment of dental therapists within dental practices. A published review of four PDS pilots in the North West of England representing a range of practice profiles found that none of the practices were able to cover the cost of the salary of the dental therapist, dental nurse and practice overheads on the basis of the then current general dental service fee scale. This calculation could not take account of the longer-term potential health gain associated with the preventive role of the therapist or the increased productivity of the dental team. However, the payment arrangements in NHS general dental practice have now changed. A new dental contract was introduced in the NHS in England and Wales in April 2006.	Rowbotham, J. S., Godson, J. H., Williams, S. A., Csikar, J. I. & Bradley, S. (2009). Dental therapy in the United Kingdom: Part 1 Developments in therapists' training and role. *British Dental Journal* 207, 8, 355-359.

No.	Description	Reference
9	This is a commentary on dental assistants in Canada and their role in prevention. In Alberta, dental assisting became a regulated profession in 2006 under the *Health Professions Act*. By this act and its accompanying regulations, dental assistants registered by the College of Alberta Dental Assistants (CADA) and certified with additional training (Preventive Dentistry Module) were permitted to provide scaling procedures to patients with pockets up to 4 mm under the direction of a dentist or dental hygienist. Although not all reactions to this decision were positive, dentists, specifically those in rural areas, were pleased because it meant they would have qualified professionals to help provide preventive care to patients. The shortage of dental hygienists in Alberta is particularly acute in rural areas; dental assistants could provide an extra hand to dentists who found it difficult to attract hygienists to these areas. Dentists and dental assistants felt that having dental assistants perform this service would address care issues related to efficiency, effectiveness, demand and costs. Having the right provider provide preventive services to the appropriate patients within a suitable time frame met the goal of efficient oral health care. In a 1976 Ontario program at George Brown College, a 16-week scaling module for dental assistants was implemented; all students in that program failed the practical examination conducted by the Royal College of Dental Surgeons. (The reason given in the press was that the training had been too short.) In Saskatchewan, the Dental Assistants' Association released a statement that scaling is not an appropriate duty for dental assistants. The College of Registered Dental Hygienists of Alberta opposed proposed legislative changes to the province's *Health Professions Act* that would increase dental assistants' scope of practice (even with additional training and registration) because they were concerned that there would be inadequate instruction and insufficient practical training to ensure safe practice by dental assistants performing scaling procedures on patients with pockets of 4 mm. Although tensions exist among the oral health professions in Alberta, key leaders in the province profess a desire to reduce these tensions over this issue to benefit the public. In 2006, a Preventive Dentistry Module curriculum designed by the CADA and the Alberta Dental Association and College was provided to an urban polytechnic institution (SAIT Polytechnic) for delivery as a pilot project. Since then, the curriculum has been delivered by the two public schools in the province, with excellent results. One private dental assisting program has also been approved to offer the curriculum, although no sessions have been delivered to date. What is the impetus for dental assistants to undertake this additional training? Graduates wanted to expand their skill set, contribute more effectively and efficiently as a team member in their practices and increase their remuneration. Other motives included seeking to rejuvenate their interest in the profession, fulfillment and variety in their careers; wanting the challenge of learning; increasing employment opportunities; and improving the status of the profession within the range of oral health care providers and with the public. The authors conclude by noting that dental professions have tended to take a conservative view of innovation and role expansion. The ongoing challenges attributable to territoriality and "turf tension" serve only to maintain the status quo at a time when oral health is on the decline and diseases that are exacerbated by periodontal disease are on the rise. To improve access to preventive oral health care, more dental professionals are needed who are trained to provide preventive services, such as scaling teeth in patients without existing periodontal disease. Alberta dental assistants who are registered with the Preventive Dentistry Module are able to provide preventive care and counselling safely, effectively and efficiently in collaboration with dentists and dental hygienists. This model could be expanded across the country to improve the oral health status of Canadians. However, there must be collaboration among the dental professions and a reduction in the tension that exists if the end goal is the public good.	Vollman, A.R. & Wood, R. (2009). Going beyond dental assisting to prevention. *JCDA* 75, 9, 647-648. Available at: www.cda-adc.ca/jcda/vol-75/issue-9/647.html Last accessed: November 2010.

No.	Description	Reference
10	The incidence of eating disorders has increased substantially over the last forty years. Primary care physicians and dentists share a parallel challenge for secondary prevention of anorexia nervosa and bulimia nervosa. The dentist, in particular, has a uniquely important and valuable role with respect to assessment of oral and physical manifestations, patient communication, referral, case management, and restorative care. Despite this crucial role, few dentists are engaged in eating disorder-specific secondary prevention. The purpose of this study was to explore beliefs, attitudes, and experiences of general dentists regarding eating disorder-specific secondary prevention behaviors using focus group methodology. Three ninety-minute focus groups were conducted with twenty-one general dentists (seventeen male, four female) recruited from the 2004 Academy of General Dentistry Leadership Conference. Data from the focus groups were analyzed to identify two overarching themes and associated subthemes with regard to supports and barriers to eating disorder-specific secondary prevention practices. Analysis of data revealed that training, network, and dental professional contingencies emerged as places of influence for increasing capacity among dentists with regard to secondary prevention of eating disorders. This exploratory assessment identifies leverage points where strategic interventions including curriculum development, policies, and practices can be developed to support and sustain secondary preventive clinical behaviors among dentists. It is important that support mechanisms be maintained and strengthened. As such, it is crucial that the role of the dental assistant and dental hygienist with regard to secondary prevention of eating disorders be discussed as part of established protocol. Furthermore, all members of the dental treatment team should be aware of other health care providers in their area who treat eating disorders.	DiGioacchino DeBate, R. & Tedesco, L.A. (2007). Increasing dentists' capacity for secondary prevention of eating disorders: identification of training, network, and professional contingencies. *Journal of Dental Education* 70, 10, 1066-1075.

No.	Description	Reference
11	The U.S. surgeon general defined the national oral health care crisis in 2001 in *Oral Health in America: A Report of the Surgeon General.* The report concluded that the public infrastructure for oral health is not sufficient to meet the needs of disadvantaged groups and is disproportionately available depending upon certain racial, ethnic, and socioeconomic factors within the U.S. population. Now, several new workforce models are emerging that attempt to address shortcomings in the oral health care workforce. Access to oral health care is the most critical issue driving these new workforce models. Currently, three midlevel dental workforce models dominate the debate. The purpose of this report is to describe these models and their stage of development to assist the dental education community in preparing for the education of these new providers. The models are 1) the advanced dental hygiene practitioner; 2) the community dental health coordinator; and 3) the dental health aide therapist. The article also discusses the oral preventive assistant (OPA) model, which is designed to create a dental assistant with a background in providing patients with oral health education and information and with the basic elements of preventive care. The OPAs may be utilized to provide preventive services for uncomplicated patients, permitting dental hygienists to focus on more complicated patients. OPAs can also fill a role in public facilities such as community health centers and schools. The community dental health coordinator (CDHC) is a new dental team model that, like the OPA, in nearly all cases (from a scope of practice perspective) outlines many duties that can be done today by dental assistants and dental hygienists. The ADA plan calls for the CDHC to be trained under an entirely new academic program to help organize community programs, function in remote locations, and provide service to patient groups and areas that are underserved. He or she would be employed by federally qualified community health centers (FQCHC), the Indian Health Service (IHS), state or county public health clinics, or private practitioners serving dentally underserved areas. The CDHC would be supervised by a dentist. Working in facilities without the continuous presence of a dentist, the CDHC could perform palliative temporization of conditions (limited to hand instrumentation only) for later diagnosis and treatment by a dentist. Conclusion: The United States spends more money per capita on health care than any other country in the world. Yet there are still many underserved groups that do not have any access to oral health care. In a handful of states, the need for oral health care is so great that other medical professions are being utilized to provide services traditionally provided by oral health care professionals. To address the complex circumstances facing our dental workforce, solutions will almost certainly involve a broad spectrum of interests that include oral health and public health care professionals, representatives from minority interests, insurers and other payers such as businesses, consumers, and, most importantly, federal and state legislatures. Dental educators, including those in dental schools, allied dental programs, and advanced education programs, must work together to strengthen and build partnerships within these communities to ensure their seat at the table as broader discussions about our nation's health care workforce ensue. It is only by working together with one voice that dental education will have the means to meet the challenging diversity of oral health needs facing our nation and to maintain a viable and strong academic dental education system.	McKinnon, M. Luke, G., Bresch, J., Moss, M. & Valachovic, R.W. (2007). Emerging allied dental workforce models: Considerations for academic dental institutions. *Journal of Dental Education* 71, 11, 1476-1491.

No.	Description	Reference
12	Traditionally, the education of dental assistants, dental hygienists, and general dentistry residents takes place in separate clinic areas and in separate curriculums with limited or no interaction among the disciplines. In contrast, dental assistants, dental hygienists, and dentists are expected to practice in a cohesive and efficient manner upon graduation. Recognizing this as a problem, a facility was designed and built to integrate the dental assisting and dental hygiene programs with the general dentistry residency program for didactic and clinical education. The students are educated in the team concept of providing patient care. The clinic facility is modeled on a private practice office with a common reception area; the dental hygiene treatment area is immediately adjacent to the dental resident operatories. Dental assisting students assist in the dental hygiene and resident operatories. Each dental hygiene student, dental assisting student, and dental resident is grouped into a treatment team. Patient treatment is planned and coordinated by the team with faculty supervision. Responsibilities of dental hygiene students include the patient's initial periodontal therapy, oral hygiene instruction, post-surgical management, and post-care maintenance. Dental assisting students provide chairside assisting for dental hygiene students and residents, schedule appointments, and monitor patients' progress through treatment. Dental residents are team leaders and are responsible for providing patient treatment and monitoring the dental hygiene and dental assisting students. Meetings provide the members and the supervising faculty the opportunity to review each patient's progress. All team members participate in case presentation seminars. This collaborative program is a work in progress to determine the educational value of having dental hygiene, dental assisting, and general dentistry residents train together in preparation for the team concept of providing care. Evaluation of the program will be done through conventional assessment processes to include review of national and clinical board exam scores to compare student scores to those of other dental hygiene and dental assisting schools, and the review of graduate student and employer surveys to determine if students are judged better prepared to enter the workforce.	Gore, C., Solovan-Gleason, D., Schobert, K., Porter t. & Johnson, S. (2006). *Journal of Dental Hygiene* 80, 1. *Abstract only*

No.	Description	Reference
13	In 2003, the Minnesota Dental Practice Act was modified to allow dental hygienists and assistants to place amalgam, composite, glass ionomer, and stainless steel crowns. The concept of utilizing allied professionals to perform expanded functions has been suggested as a way to increase access to care and productivity. As legislated changes occur in state practice acts, so must the curriculum of dental hygiene and dental assisting education. In Minnesota, restorative functions training is offered via continuing education (CE) courses for dental hygienists and dental assistants who are currently licensed, in addition to incorporation of training related to restorative functions into the curriculum of traditional dental hygiene baccalaureate degree programs. The concept of training allied professionals to perform expanded functions as a viable way of increasing productivity and increasing the availability of dental care is not new. Numerous articles have supported the idea that oral health care personnel other than dentists may be trained to provide some of the patient care services traditionally performed by dentists. However, the expanded function duties included in previous research primarily involved placing pit and fissure sealants, polishing amalgams, rubber dam application, local anesthesia administration, and other duties of that nature. The objectives of this study were to examine confidence levels and effectiveness of the continuing education program. Pre- and post-course restorative content knowledge, along with confidence levels in knowledge, technical skills, and the ability to implement skills were measured. A continuing education course was offered to provide required certification for interested dental practitioners (N=12). The restorative functions CE course was a sixty-four credit, eight-day course over the span of three weeks in the summer of 2005. The first five days involved didactic and laboratory experience, and the remaining three days involved clinical experience during which course participants directly treated patients. Participants in the course were three licensed dental hygienists and nine licensed and registered dental assistants. Four dentists, two with academic backgrounds, provided the instruction and evaluated the participants during the eight-day course. The two dentists with academic backgrounds were individually approached by the investigators to consider involvement in this CE course. They, in turn, contacted two well-respected dentists in the area, one a pediatric dentist and one a general dentist, to lend their expertise. They agreed to involvement in this CE course as they felt positively toward the concept of expanded restorative care for dental auxiliaries. A matched pairs t-test found a significant increase in participants' restorative content knowledge ($p < 0.001$). Wilcoxen signed rank tests revealed an increase in confidence in all content knowledge ($p < 0.01$) and technical skill ($p < 0.05$) categories. Participants did not significantly increase in confidence to implement restorative functions skills into practice ($p < 0.7$). Interview data revealed that participants remain unclear about ways to incorporate restorative functions into the schedule. Findings in this case study suggest that content knowledge and confidence levels increase following completion of a restorative functions course. To improve education and training, research is needed to identify why participants' confidence in implementation did not increase.	Cooper, B.R. & Monson, A.L. (2007). Allied restorative functions training in Minnesota: A case study. *Journal of Dental Education* 71, 3, 373-377.

No.	Description	Reference
14	This paper focuses on the dental hygienist/dental assistant dichotomy in Alberta in particular, but also in the greater context of the political climates of dental professions in Canada and the United States. Both dental assistants and dental hygienists are vital and dynamic members of the dental health team. Both assistants and hygienists expose radiographs, take impressions for study models, polish teeth, give topical fluoride treatments, and apply pit and fissure sealants under the supervision of a dentist. Dental assistants perform other duties, in particular with respect to assisting the dentist during dental procedures, which dental hygienists do not routinely perform. However, recent legislation drafted for the Health Professions Act allows for a pilot project for expansion of the Dental assisting role into limited scaling, thus blurring further the boundaries between dental assisting and dental hygiene. Dental assistants, with additional training and education, will now have the potential to perform the majority of the technical skills that dental hygienists perform. It is the position of this paper that the acquisition of these technical skills does not constitute the entirety of the dental hygiene scope of practice, and that public awareness as to the breadth and depth of dental hygiene education and clinical skills needs to be heightened in order to ameliorate the common misconceptions about dental hygienists and dental assistants. Variance in academic credential among the respective disciplines is another source of confusion between dental assisting and dental hygiene. Dental assisting programs range from basic certificate to associate degree programs, and dental hygiene programs range from basic diploma programs to baccalaureate degrees and a handful of masters programs in the U.S. Dental hygiene and dental assisting are both taught in technical institutions in some provinces, however dental hygiene has a greater emphasis on scientific theory and critical thinking in the curricula. Dental assisting seeks to expand by adding restricted scaling activities to its skill-set, and dental hygiene seeks to expand through the advent of independent dental hygiene practice. For dental hygiene, this expansion signals to many the need for a national standard of baccalaureate education for entry into dental hygiene practice. A majority of the requisite knowledge for patient safety pertains to the ability of hygienists to ascertain whether invasive dental hygiene treatment is indicated or contraindicated with respect the patient's medical status and dealing with emergency situations should they arise. For dental assisting, the expansion signals to many the need for more comprehensive scientific background knowledge of the oral tissues to be manipulated in limited scaling as well as lengthy and intensive training programs to ensure competency. For both disciplines, these strides for better education have been progressing at a sluggish pace, as indicated by recent events in the University of Alberta Faculty of Medicine and Dentistry. As previously mentioned, the Alberta government has approved the implementation of a pilot study of a continuing education scaling module for dental assistants. This proposal sparked controversy and protest amid the Dental Hygiene department, particularly with dental hygiene students. Petitions and letters alarmed at the apparent paradigmatic conflict between the emphasis on scientific background information, critical thinking, and intensive supervised instruction of clinical skills promoted, advocated, and required by the dental hygiene program and the emphasis on technical preceptorship promoted and advocated by the proposed scaling module. How can one institution train two different disciplines the same skills under completely different paradigms – one academic and the other technical? Issues like this one underscore both the distinction between dental hygiene and dental assisting and a progressive trend towards confounding this distinction. Certainly if dental assistants were to train at the University in the very skill for which dental hygienists are known, public perception of the difference between assistants and hygienists would be more difficult to ascertain. This challenge will not befall Alberta dental hygienists, however, as the Faculty of Medicine and Dentistry declined implementation of the module due to the protests of dental hygiene students. Although the dental assisting scaling module is not yet a part of assisting curricula in the province, the role of the dental assistant has more legal definition than the role of the dental hygienist. If the role of dental hygienists is not clearly and legally defined, it is understandable that the public may not understand precisely what a dental hygienist does – especially if dental assistants are trained to perform similar technical skills. It is clear that dental hygiene needs to continue to improve and impress upon the public the education background in scientific theory and clinical assessment and decision making skills in order to both progress to professional status, and to ensure public understanding of dental hygiene practice. It is also clear from the proposed scaling module that dental assistants need to lobby for more comprehensive and improved education to complement their expanded skill set.	Rosmus, L. (2005). Dental Hygienists and Dental Assistants: Their roles in the Dental Team. *UAHSJ* 2, 44-45.

No.	Description	Reference
15	Many changes are occurring in the delivery of dental care to patients as a result of the implementation of a series of Government initiatives to improve the services to patients throughout the National Health Service (NHS). Dentistry is no exception, and the whole dental team should benefit from new opportunities that have opened up as a result of these changes. This paper outlines a number of these initiatives, and describes some of the potential opportunities that may develop for each group within the dental team. Many of these changes are already in the pipeline, many depend on funding, and many depend on a change in the mindset of established organisations and institutions to think 'outside the box'. The author believes that none of the changes outlined or discussed in this paper challenge the position or status of any group; however, they do require all members of the dental team to examine the way in which they work, to look at the evidence base for these ways of working, and then perhaps look for innovative solutions to the employment, training and development of all members of the team. The authors note that dental therapists probably have the greatest potential of all of the PCD (professionals complementary to dentistry) groups. This is especially so now that they are dually qualified as hygienist and therapist. Now able to work in all areas of dentistry (including general practice), there is considerable scope and opportunity for this group to help solve many of the manpower issues facing the profession, except that at present their numbers are too small. Dental therapist training is currently 27 months, but the number of hours of training undertaken (because training is not based upon traditional academic terms) would enable a university to award a degree at the end of the training, providing it is formally included in the National Education Framework (rather than currently being 'only' a professional qualification). There are just seven schools with a total annual output of only 54 dental therapists. In the period 1st August 2002 to 1st August 2003, the GDC added 52 new names, restored 49 and removed 31 for non-payment of fees. This amounts to a net increase in the year of only 70 dental therapists and this during a year when because of changing legislation, it would be expected that the maximum number would return to practice. Currently, dental therapists are only trained in the established dental schools; however, the University of Portsmouth is opening a new school for PCDs, which will include provision for the training of therapists in early 2005. Their model includes substantial outreach training, and is being designed as a modular course. Initially, students will only be able to gain their outreach experience in Community Dental Services and Personal Dental Services clinics because of the problems of indemnity for students working in general dental practices. Other institutions are beginning to take an interest; the University of Derby and the University (and new Medical School) of Brighton for two. An innovative approach is also being taken by Salford PCT, which is attempting to put together its own training program for therapists (eight at a time) and hopes to begin early in 2005. There is considerable scope for running courses for immigrant dental therapists, and conversion courses for dental hygienists to become therapists. In New Zealand, where the dental therapist profession was originally the school dental nurse, therapists are trained in the same way as in the UK but they are allowed to diagnose and carry out their own treatment plans. There would seem to be little good reason why this should not be the case in the UK, with the medical model of referral upwards when anything is seen outside of the treatment capabilities (and training) of the dental therapist. Furthermore, the question arises: does the dentist really need to be on the premises?	Lambert-Humble, S. (2005). Opportunities for the dental team arising out of the new arrangements for primary dental care. *Primary Dental Care* 12, (1), 15-19.

No.	Description	Reference
16	Background: The American Dental Association conducts surveys of educational programs in dental assisting, dental hygiene and dental laboratory technology. The 2002-2003 survey included questions about enrollment, graduates, program information and trends. Methods: The ADA Survey Center mailed the Survey of Allied Dental Education to 548 program directors of dental assisting, dental hygiene and dental laboratory technology educational programs. Results: The number of applications to, first-year enrollment in and number of graduates in dental hygiene and dental assisting educational programs have increased during the last five years. During the same period, the number of applications to, and graduates of, dental laboratory technology educational programs decreased, but first-year enrollment increased slightly. Dental assistants: The duties of a dental assistant are among the most comprehensive and varied in the dental office, requiring both interpersonal and technical skills. As of the 2002-2003 academic year, a total of 259 dental assisting programs had been accredited by the CDA. These programs were located in 48 states and Puerto Rico. Most (88.0%) of the institutions offering dental assisting education in 2002-2003 were classified as public institutions, while 10.0% were private and 1.9% were other types. For 29 dental assisting programs that opened since July 1998, settings included 11 community or junior colleges, 11 technical colleges or institutes, four vocational schools, two universities or four-year colleges and one "other" setting. Of these 29 programs, 17 (59%) offer certificates and 12 (41%) offer diplomas on completion of the entry-level dental assisting program. In 2002-2003, dental assistants received accredited education through academic programs at 132 community/junior colleges, 71 technical colleges/institutes, 31 vocational schools, 10 universities/four-year colleges, four dental schools and 11 other kinds of settings. Graduates of these programs usually receive certificates or diplomas. Although the majority of academic dental assisting programs take nine to 11 months to complete, some schools offer accelerated training, part-time educational programs or training via distance education. The number of applications to dental assisting programs increased from 11,105 in 1998-1999 to 11,954 in 2002-2003. The number of students accepted into dental assisting programs increased slightly, from 8,043 in 1998-1999 to 8,260 in 2002-2003. First-year enrolment increased from 6,162 in 1998-1999 to 7,304 in 2002-2003 (an 18.5% increase). The number of graduates increased from 4,720 in 1998 to 4,822 in 2002 (a 2.2% increase). The majority (89.8%) of 2002 graduates of dental assisting programs were U.S. citizens. About 62.9% of the 2002 graduates were 23 years or younger, with 84.7% younger than 30 years. *Costs:* The most recent Survey of Allied Dental Education reported the costs involved in attending dental assisting courses. Mean costs for tuition and fees in dental assisting programs (including textbooks, laboratory fees, supplies, instruments, uniforms, clinical fees and other fixed costs) were highest for out-of-state students, averaging $7,765 in 2002-2003. In-district students paid a mean of $4,334 for tuition and fees, and out-of-district students paid $4,816. (Tuition costs provided here are first- and second year costs combined, where applicable, and exclude costs of subsequent years for programs of more than two years.) *Graduation:* A high school diploma/general educational development (GED) certificate was the minimum requirement for admission to almost all (96.9%) dental assisting programs in 2002-2003. On graduation, most students (4,454 [92%] of 4,822) received a diploma or certificate, 261 (5%) were awarded a certificate and an associate degree, 97 (2%) received an associate degree and 10 (less than 1%) received an unclassified award in 2002. In 2002, about 266,000 dental assisting jobs existed in the United States, and about 12.5% of dental assistants were certified by the Dental Assisting National Board (DANB). *Certification:* Dental assistants can become certified by passing an examination that evaluates their knowledge. Most dental assistants who choose to become nationally certified take the DANB Certified Dental Assistant examination. Dental assistants are eligible to take the examination if they have completed a dental assisting program accredited by the CDA. Students who have been trained on the job or have graduated from nonaccredited programs are eligible to take the national certification examination after they have completed two years of full-time work as dental assistants. Some states also recognize passage of components of the Certified Dental Assistant examination, such as the Radiation Health and Safety examination or the Infection Control examination, for licensing and regulatory purposes. State regulations vary, and some states offer registration or licensure in addition to this national certification program. Information on employment, salaries and benefits is also available. Conclusions: Results from these surveys help address the concerns of the public and the profession regarding allied dental manpower levels. They also provide information for those interested in applying to individual allied dental educational programs. Practice Implications: Private dental practices employ the majority of graduates of allied dental educational programs. Recent graduates of dental assisting and hygiene programs continue to supply the office staff members needed to support the delivery of dental care.	Jackson Brown, L., Schaid Wagner, K., Mikkelsen, M.C. & Munson, B. (2005). A look at allied dental education in the United States. *J Am Dent Assoc* 136, 797-804.

No.	Description	Reference
17	Abstract: The use of computed tomography for dental imaging procedures has increased recently. Use of CT for even seemingly routine diagnosis and treatment procedures suggests that the desire for 3-D imaging is more than a current trend but rather a shift toward a future of dimensional volume imaging. Recognizing this shift, several imaging manufacturers recently have developed 3-D imaging devices specifically for dental purposes using cone-beam computerized tomography. This technology allows for 3-D imaging similar to CT, but at lower equipment cost, simpler image acquisition and lower patient radiation dose. Herein, an overview of these devices is provided such that potential users can be better informed about this emerging technology. Summary: Four CBVT 3-D imaging systems have been recently developed for dentistry. Multiple image views, various measurement analysis, and computer generated patient models, all of which allow the diagnostician to better visualize in a "spatial plane concept" potential therapeutic procedures before they are actually rendered is perceived as the next progressive step in dental imaging. While primarily intended for dental implant imaging, Figures 4 and 5 (of the original article) show the different aspects of dental diagnosis that could benefit from 3-D imaging. This progressive step does not mean 3-D imaging will replace traditional radiology. There are some factors to consider when deciding whether or not 3-D imaging should be used. Image resolution for 3-D imaging is less than film. The machines are expensive ranging from $200,000 to $300,000 and are generally available only in imaging centers or larger dental practices. This reduces patient access and the cost of the imaging examination is usually greater than for film. Patient radiation dose is lower than for conventional medical CT, but is similar to that for standard dental radiology. This would be an advantage for dental implant patients but not necessarily for others. Not all imaging examinations will be successful. No patient movement is critical for success and patients unable to comply are not candidates for 3-D imaging. Also, there will be a learning curve for dentists unfamiliar with reading multiple plane images. Despite these limitations, there is a role for this technology. CBVT imaging can provide a much-needed 3-D perspective in certain cases that require more information than can be obtained from traditional radiography. Examples of applications of CBVT in diagnosis and treatment planning are in dental implant placement, temporomandibular joint (TMJ) conditions, jaw tumours, airway analysis, impacted teeth, periodontal or endodontic problems. This article provides a brief introduction to these emerging machine so that any potential user can be better informed about the differences between these and traditional CT.	Danforth, R.A., Dus, I. & Mah, J., (2003, Dec). 3-D volume imaging for dentistry: A new dimension. *J Calif Dent Assoc.* 31(12), 890.
18	Allied dental healthcare providers have been an integral part of the dental team since the turn of the 19th century. Like dental education, allied dental education's history includes a transition from apprenticeships and proprietary school settings to dental schools and community and technical colleges. There are currently 258 dental assisting programs, 255 dental hygiene programs, and 28 dental laboratory technology programs according to the American Dental Association's Commission on Dental Accreditation. First-year enrolment increased 9.5% in dental hygiene education from 1994/95 to 1998/99, while enrolment in dental assisting programs declined 7% and declined 31% in dental laboratory technology programs during the same period. Program capacity exceeds enrolment in all three areas of allied dental education. Challenges facing allied dental education include addressing the dental practicing community's perception of a shortage of dental assistants and dental hygienists and increasing pressure for career tracks that do not require education in American Dental Association's Commission on Dental Accreditation accredited programs. The allied dental workforce may also be called upon for innovative approaches to improve access to oral health care and reduce oral health care disparities. In addition, allied dental education programs may face challenges in recruiting faculty with the desired academic credentials. The American Dental Education Association is currently pursuing initiatives in these and other areas to address the current and emerging needs of allied dental education.	Haden, N.K., Morr, K.E., Valachovic, R.W. (2001). Trends in allied dental education: An analysis of the past and a look to the future. *Journal of Dental Education* 65, 5, 480-495.

No.	Description	Reference
Grey Literature on Profession/Recent Evolutions in Education and Training		

No.	Description	Reference
19	This information is from the Ontario Dental Assistants' Association (ODAA) website and provides the history of the Ontario dental assistant and the ODAA as well as information on education. History: The Ontario Dental Assistants Association or ODAA (then the ODN & AA) was formed by Marion Edwards in 1927—just two years before women got the vote. A woman well before her time, Marion saw the value in developing an organization that recognized the power of dental assistants networking, bonding and uniting. Up until 1960, dental assistants learned on the job. They were not formally educated, and their skills and abilities were only as good as the person who was training them. In 1960, a committee of dental assistants, spearheaded by the late June Cook—a member of the organization since 1946—made a presentation to the Royal College of Dental Surgeons (RCDS) outlining the need for formal training for Ontario dental assistants. The RCDS agreed and it was decided that the ODAA be the certifying body for the curriculum. The Ontario Dental Association (ODA) and the Toronto Academy of Dentistry helped the committee to prepare an outline of the curriculum for certification. Evening classes started, and the Certification Program for dental assistants was born. From the first presentation of Certification Certificates in November 1961 to present day, the education and status of the dental assistant have been elevated to a new high. Dental assistants in Ontario are not yet recognized as "Regulated Health Professionals" under the Regulated Health Professions Act (RHPA). This means that untrained staff may be hired to work as dental assistants. This is of concern because dental assistants are responsible for infection control in the dental office. Formally educated dental assistants have been extensively trained in the disinfection of operatories, sterilization of instruments and management of infectious and hazardous waste. According to the website, the ODAA is working with the Ontario government to have dental assisting become a regulated profession. They believe that regulation is the best way to protect the public with regard to infection control issues, and ensure that all people working in a dental office are trained, licensed and committed to their profession. In 2009, the Ontario Dental Assistants Association marked its 75th anniversary of incorporation. This significant milestone represents 75 years of support, but also of pride and determination among their members. Backed by a solid history, they stand proud - poised to shape their own future. Education: Ontario dental assisting educational programs are offered at both Community Colleges and Private Career Colleges and are generally 10 months in length. The national standard for dental assisting educational programs in Canada is the Level II intra-oral program. However, some Ontario institutions have formal programs for both Level I (chairside) and Level II dental assistants. Admission requirements may vary from college to college but generally applicants must have the Ontario Secondary School Diploma with Grade12 English, Biology and Chemistry. There are approximately 574 hours of academics and 172 hours of pre-clinical and clinical practice. Students complete an 80-hour placement as part of the curriculum. Community colleges receive public funding from the Ontario government. Most community college programs are accredited by the Commission on Dental Accreditation of Canada (CDAC). This is an important consideration for two reasons: accreditation identifies a program that meets predetermined national requirements and facilitates labour mobility if the individual wants to work as a dental assistant in another province. Community Colleges offer only Level II dental assisting programs. Students divide their time between theory and practical experiences. The taking of radiographs on patients is not done until their required clinical placement in a dental office. Other intra-oral duties are practised within the community college clinic. Private career colleges (PCCs) are independent organizations. PCCs must be registered and have their programs approved by the Ministry of Training, Colleges and Universities under the Private Career Colleges Act, 2005. This act ensures that private career colleges meet certain standards for the programs they offer as well as advertising, refund policies and instructor qualifications. In some private colleges, there is a differentiation between Level I programs and Level II. Students complete the Level I program and then apply for the Level II component. If students are entering a private career college, make sure that the college is approved by the Ministry of Colleges, Training and Universities and that the radiography component is approved by the HARP Commission. It is important to note that if the students enrol in an unregistered college or an unapproved program, they will not be covered by the protections provided by the government under the Private Career Colleges Act, 2005, and their program will not be recognized for certification. Presently, no Ontario private career colleges are accredited by the Commission on Dental Accreditation of Canada (CDAC). Should graduates of Level II private career programs want to work outside of Ontario, they will be required to write both the written NDAEB exam and successfully complete the NDAEB's Clinical Practical Evaluation (CPE). Information on the recommended wages of DAs depending on level of experience and type of assistant.	Ontario Dental Assistants' Association. (2010). ODAA Website. Available at: http://www.odaa.org/ Last accessed: November 2010.

No.	Description	Reference
20	This information is from the British Association of Dental Therapists (BADT) and provides a history of the dental therapist in the UK. The history of the dental therapist begins long before 1960 when New Cross first opened its doors. In 1917 'Dental Dressers' were established in some counties in England – they were the first dental therapists in the world and their duties were based on the American hygienist with the addition of 'filling those cavities without pulpal involvement' and 'the extraction of 'temporary teeth in school clinics'. There was at the time a desperate shortage of school service dental officers and the Armed Services were recruiting registered (University trained) dentists for the First World War. Until the Dental Act of 1921 apprentice trained dentists were not registered - once this came into being there were enough dentists to work in the service and the dresser's duties were reduced to that of a hygienist, for whom there was little demand in the school services. In 1920 New Zealand established a School Dental Service and the training of Dental Therapists began – they were called Dental Nurses. As they worked in rural communities they were the first contact point for patients with an onward referral to a dentist if necessary. This scheme continues today and has been copied by many countries in the world where there is a rural population. In the UK, by 1950 there was once again a desperate shortage of dentists in the school services and children's dental health was worsening. Following visits to New Zealand the Dentist Act of 1956 was changed to allow the training of Dental Auxiliaries; however the New Zealand scheme was not adapted in its entirety. In 1960 the first school for training Dental Auxiliaries was opened at New Cross Hospital in south east London – using a former isolation unit which was ideal for individual surgeries. Sixty students a year followed an intense two year training course. This continued until 1983 when the school closed. They were trained to carry out restorations in primary and secondary dentition, Black Cavity Classifications Class I-V, to extract deciduous teeth, give infiltration anaesthesia, and take and develop x-rays, scaling and dental health education. In fact this remit did not change until 2002. Their patient base came from local schools following school dental examinations. Parents would sign the consent form and the children would arrive from school in a coach – escorted by two students. Escort and waiting room duties were part of the second year training. Early patient management and people skills. At this time the Dental Act would only allow Therapists to work in community dental services, hospital and the armed forces. Although able to carry out hygiene treatment they could not work under the title Dental Therapist in general practice so in order to do they had to study a further three months on a hygiene course (hygiene courses at the time varied between nine months and a year depending on the training school) so that they could register as a Hygienist. In 1983 New Cross was closed but that wasn't the end of Dental Therapists. Supporters argued and battled with the government for the training to continue. Evidence in support of dental therapists by a review group was finally examined and the first training of Dental Therapists at Barts and the London Hospital began with just eight students. The length of the course was extended to include the extra three months so that students came out with the dual qualification. Since then training schools have opened their doors all over the country. Many schools now offer a Degree course as well as the Diploma course. All courses give dual qualifications. In 2002 after years of pressure from the British Association of Dental Therapists, the Dental Act was finally reviewed and amended and Dental Therapists were allowed to work in general practice and along with that the remit finally changed and what became known as 'extended duties' were added. These included the long awaited administration of ID Blocks, pulpotomies on deciduous teeth and impression taking. August 2008 saw compulsory continuous professional development come into being with the requirement of 150 hours over a period of five years.	British Association of Dental Therapists. (2009). History of the dental therapist. Available at: http://www.badt.org.uk/public/history-dental-therapist.html Last accessed: November 2010.

No.	Description	Reference
21	This is a commentary written by the President of the American Dental Assistants' Association. Selected text from the commentary is provided below. In 1885, Dr. C. Edmund Kells hired the first "lady in attendance" for his dental office. Over the next 100 years, the dental assistant's role was to assist the dentist chairside, clean, set up and maintain the operatory while answering the telephone and making appointments - all with a smile! Then came dental insurance, OSHA, infection control regulations, and practice management concepts that changed the way dentists practiced. The days of the "one assistant" office are gone. Today, the average dental office has a business assistant and office manager to handle the financial side of the practice, while the chairside assistant and patient coordinator handle the clinical side. The dental assisting profession is changing rapidly and the opportunities are endless, if we are ready to accept a new paradigm. Many states have some type of expanded duties for dental assistants and many dental offices are hiring dental administrators to manage their practices. Last year, the American Dental Association completed The ADA Report of the Workforce Task Force which outlined ways that dental assistants could be utilized to increase access to care for all Americans. The ADA has proposed two new categories called an Oral Preventive Assistant (OPA) and the Community Dental Health Coordinator (CDHC). The ADA will be piloting the CDHC position in the future (www.ada.org). There are over 270,000 dental assistants in the current workforce, but the duties for the dental assistant vary from office to office and state to state. With all states having different dental practice acts and levels of education for assistants, it is difficult for a dental assistant to move from one state to another and know what is required. There is a need for a national standard of education and a standard credential that all states would recognize. The American Dental Assistants Association and the Dental Assisting National Board studied the core competencies that a dental assistant should meet and proposed a career ladder for dental assistants that would include the entry level assistant, the Dental Assistant, the Certified Dental Assistant, and the Expanded Functions Dental Assistant, with different levels of education required for each category. In 2005, the ADAA/DANB Alliance published a position paper on "A Uniform National Model for the Dental Assisting Profession" (www.danb.org). It is time for dental assistants to make a difference in their profession. We have a great opportunity to expand our profession in many areas. The ADAA provides many home study courses on advanced duties, such as placing rubber dams and fabricating temporary crowns. The ADAA "Learning in the Round" seminars showcase new products, materials, and techniques with the opportunity for dental assistants to provide feedback on these materials. With many dental materials, proper manipulation and handling are very important to the success of the procedure. Dental assistants can contribute to the quality of their patients' treatments by knowing the materials and procedures well. The author urges all dental assistants to learn what allowable duties can be delegated in their state and work with the ADAA and their state dental assistant association to bring the dental assisting profession to the attention of the state legislators and state dental boards. With dental assistants forming the largest portion of the dental workforce, using Expanded Functions Dental Assistants to help alleviate some access-to-care issues makes sense. Recently, the author had the privilege to attend a PennWell symposium on the oral-systemic connection called "The Scottsdale Project." The author represented dental assistants at this meeting featuring a panel of dentists, physicians, educators, and researchers discussing the link between oral health and overall physical health. This is another area where dental assistants will be a valuable part of the team, teaching patients about the importance of oral health and the effects of periodontal disease in relation to heart disease, diabetes, and stroke. We must be ready to take on new challenges and skills to advance the dental assisting profession.	Roberts, C.J. (2007). The changing role of the dental assistant: Are we ready? *Dentistry IQ*. Available at: http://www.dentistryiq.com/index/display/article-display.articles.dental-office.volume-12.issue-3.departments.news-notes-from-the-adaa.the-changing-role-of-the-dental-assistant-are-we-ready.html Last accessed: October 2010.

No.	Description	Reference
22	The purpose of this Executive Summary is to highlight seminal points of the Strategic Plan for Interdisciplinary Faculty Development; the summary describes how the Plan was developed and outlines the critical role of health professionals in substance use disorder (SUD) prevention and treatment. It summarizes the content of the two major sections of the Strategic Plan. The first section consists of a set of eight papers that review the scientific evidence in support of the Plan; the second section, consisting of 11 papers, presents a discipline-specific perspective on health professions training in SUD. The summary then lists the core knowledge, attitudes, competencies, and skills needed by health professionals in all disciplines in order to effectively identify, intervene with, and refer patients with SUD. It concludes with 12 comprehensive recommendations for improving health professionals' training in SUD. Each recommendation is accompanied by a rationale and a list of responsible agents. In terms of tobacco-cessation treatment for dental patients, for example, the authors note that dental assistants or even receptionists can be instructed to perform selected tasks. A number of hygienist and/or assistant programs now include tobacco education and cessation in their curricula. However, they also note that generally, substance abuse education in dental school is isolated, fragmented, and incomplete. Although the American Dental Educational Association's curriculum guidelines in substance abuse education for dental educators are valid, no consensus has been reached concerning the specific clinical competencies that should be required for substance abuse faculty and academicians. It is difficult to mandate a specific level of education and training for these educators because they will be teaching such a wide variety of students (dental assistants, hygienists, undergraduates, and graduates).	Haack, M.R. & Adger, H. (2002). *Strategic plan for interdisciplinary faculty development: Arming the nation's health professional workforce for a new approach to substance use disorders.* Association for Medical Education and Research in Substance Abuse (AMERSA). Available at: http://www.projectmainstream.net/newsfiles/1134/SPACdocfinal.pdf Last accessed: October 2010.

No.	Description	Reference
23	The Dental Assisting National Board, Inc. (DANB) has researched job titles for dental assistants across the entire United States to develop a single chart to view the landscape of the profession. Without a single, nationally-accepted set of guidelines that govern the practice of dental assisting in the country, it is difficult to execute a concise overview of this dental team member. A chart is provided that illustrates the various job titles given to different job function levels across the United States. Some job titles are directly from the state's dental practice act. Others are from a state's administrative rules, noted specifically, implied by definition, or used in practice. In an effort to see a pattern, there is an overlay column on the left-hand side of the chart entitled, Standardized National Job Titles from the *Position Paper of the ADAA/ DANB Alliance: Addressing A Uniform National Model For the Dental Assisting Profession* that was distributed throughout the oral healthcare and legislative communities in September 2006. By positioning a standardized job title structure as a ruler, per se, one can attempt to discern if a national view of career ladder patterns for dental assistants might exist. Attempting to view a "national road map of job titles" by referencing this chart is misleading, however. The difficulty in such a chart is that a dental assistant's job title varies, even if he or she is allowed to perform the same duty, depending on the state in which the dental assistant is employed. For example, to be considered qualified to perform coronal polishing procedures, here are some of the various titles a dental assistant must be qualified to hold, depending on the state in which this coronal polishing procedure was being performed: Advanced Dental Assistant (ADA)—SD; Certified Ohio Dental Assistant (CODA)—OH; DANB Certified Dental Assistant (CDA)--MA, MO, NC, OH; Dental Assistant II (DA II)—NC; Dental Assistant Qualified in Coronal Polishing (DA Qualified in Coronal Polishing)--AZ, KY, NE, NM, KS, IL; Dental Assistant Qualified in Expanded Functions (DAQEF)--MO, NH. While a national study of job titles and defined or implied career ladders for dental assistants is fascinating and often frustrating due to the many variations, it is more importantly critical for dental assistants to know what job titles their state dental practice act defines and allows, and what duties are legally allowed to be delegated to qualified dental assistants so they can perform them in their role on the dental team. It is unfortunate that the work load of the office may lead to a situation where a dental assistant is asked to perform, or makes a decision to perform a function that he/she may not be qualified or legally allowed to perform. Accessing the other state-specific resources on DANB's website to identify state-specific dental assisting titles, required qualifications, and allowable duties is a way to promote safe and legal dental assisting practice.	Dental Assisting National Board. (2010). *National overview of dental assisting job titles.* Available at: http://www.danb.org/PDFs/Job Titles.pdf Last accessed: October 2010.

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