

# Cutting edge research that will impact future oral health care

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One of the four missions of the FDI World Dental Federation is “to advance and promote the art, science and practice of dentistry”. Although FDI does not undertake any research on its own, the federation engages in the evaluation and synthesis of ongoing oral health research in order to present new and important findings to the practising dental community. The FDI has had a long working relationship with the International Association for Dental Research (IADR) in this context.

There are currently about 700 periodicals in circulation in dentistry, and the number of new journal titles is continually increasing. These journals contain an estimated 25,000 articles each year, which renders the principle of staying updated with scientific developments as a rather overwhelming task for the individual practitioner. Moreover, many articles do not present findings of primary research, can often be difficult to understand due to inadequate reporting, are lacking in research design or protocol, or may be difficult to interpret in terms of applicability to dental practice. ‘New’ results reported in periodicals can even be obsolete by the time of publication due to the length of time between submission, acceptance and publication, which may be up to two years.

Cutting edge research is usually first presented in scientific meetings for various reasons, but mainly to obtain (hopefully) constructive feedback for improvements from

peer researchers. The world's largest gatherings of dental presentations are the annual meetings of the International Association of Dental Research (IADR) and the American Association for Dental Research (AADR). During a few very busy days, several thousand research studies are selected from submitted abstracts to be presented, either verbally or on posters. All these submitted abstracts are scrutinised by individuals from one of 21 special groups in IADR. Acceptance for presentation at the meeting is granted if the abstract fulfils the minimum criteria of adherence to scientific research principles.

Thus, the true experts of the ongoing research in oral health can be identified as the officers in these 21 special groups who critically appraise all the submitted abstracts. With this perspective, the FDI approached IADR to establish a pragmatic concept for the transfer from these experts of the most up-to-date research within their specific research field that will impact on the future oral health care.

The first FDI-IADR science transfer seminar was organised during the IADR annual meeting in Göteborg in June 2003, and repeated in March, 2004 in Honolulu. This paper presents in a condensed format aimed for general practitioners the information provided by the special group representatives at these two seminars.

## Materials and methods

One representative from each of the 21 IADR special groups presented a five minute lecture on the activities within their group. The representative was instructed to address five questions that were considered to be of primary interest for the dental practice community:

1. Events during the past year that should be of concern for general dental practitioners (GDPs).
2. Planned activities for next year

in the research area that should be of interest to GDPs.

3. The hottest research issues in their specific research area.
4. Suggestions for a lecture topic targeted for GDPs at a future FDI World Dental Congress.
5. Suggestion for the need for one or more (systematic) reviews on a specific subject in the research area.

Some of the special groups provided information that suggests innovative research which overlaps specialties. However, the following summaries are presented without taking this into account, as this emphasises the importance/magnitude of this new research.

## Results

### *Behavioural Sciences Group*

The dental profession need to recognise Evidence Based Medicine (EBM) as a central and important concept for their practice. EBM has been the focus in many meetings for the health professions and is being embraced by large international organisations within biomedical fields. There is an initiative within IADR to establish an international collaboration for Evidence Based Dentistry (ICEBD). Furthermore, the International Cochrane Collaboration Oral Health group located in Manchester, UK is gaining support.

Professionals should be aware of, and continuously adopt their practice to, new systematic reviews based on EBD (e.g. The Cochrane Collaboration Oral Health Group and elsewhere). An especially appropriate example is the continuing series on the effectiveness of fluorides in caries prevention. It must also be recognised that systematic reviews identify not only the best research, but also often demonstrate large gaps in the evidence base for many procedures that relate to the mainstream of the practice of dentistry, for example, the true effectiveness of several forms of regular periodontal care

such as root planing or the validity of practical caries risk assessments.

The development of clinical guidelines is increasing on both a global and a local scale. It is important for the practitioner to recognise the differences between guidelines issued by different bodies. One needs to be able to differentiate between, and also critically appraise, evidence-based guidelines, good practice guidelines by consensus, guidelines produced by individual experts or 'expert groups', standards, and biased or politically motivated guidelines. Clinical questions that are facing practitioners, educators, and patients needs to be identified and workshops convened on both national and local levels to develop statements, protocols and guidelines for the profession.

More research carried out in routine clinical practices is required in dentistry to answer many questions on therapy effectiveness in actual clinical dentistry. Practitioners should seek contact with academics and discuss how best to conduct valid clinical research in general practices. There are ongoing research attempts to identify the most viable strategies to implement such research programmes amongst practitioners.

The quality of life (QOL) of people is affected by their general oral health, which is especially relevant for disadvantaged and special-needs patient populations. Adequate oral care and access to care is positively associated with high levels of quality of life. Dentists should discuss such aspects with their patients more often and be aware of QOL studies that demonstrate that our patients value oral health, perhaps more than we even realise.

Epidemiological studies continue to document large disparities in oral health and attempt to isolate the explanatory factors. The level of access to dental care appears to have a distinct impact on explaining disparities in oral health status.

### **Cariology group**

The US National Institute of Dental and Craniofacial Research/National Institutes of Health (NIDCR/NIH) *Consensus Development Conference on Dental Caries* held in Washington DC in 2001 can come close to being defined as a paradigm shift in cariology research. Several extensive systematic reviews presented were related to the aetiology, diagnosis, prevention, management and epidemiology of caries but there was also consensus that there are large voids of scientific evidence in cariology. This may hopefully generate new research that will conform to modern methodological standards of study design, implementation, analysis and reporting. Examples of identified needs are systematic epidemiologic studies of primary and secondary caries, information on the natural history, as well as treatment and outcomes of caries across different age groups. Moreover, clinical trials of established and new treatment interventions for various stages of caries lesions are needed. Studies of clinical practice including effectiveness, quality of care, outcomes, health-related quality of life and appropriateness of care are also required. Finally, genetic studies are necessary to identify genes and genetic markers of diagnostic, prognostic and therapeutic value.

Some of these issues were addressed in an international consensus workshop on caries clinical trials in Loch Lomond, Scotland in 2002. The mission of this workshop was to reach consensus about the designs of protocols for caries clinical trials which are scientifically acceptable as central evidence of the anti-caries efficacy of oral care products. The multidisciplinary forum produced and agreed on detailed consensus statements, and 25 reviews and the recommendations for actions based on these were published as a *Journal of Dental Research* supplement in August 2004, which is highly recommended.

### **Craniofacial Biology group**

While the core research in craniofacial biology is progressing very rapidly and potential uses are recognisable, clinical applications may not be available immediately. However, establishing the genetics of craniofacial growth and development of maxillofacial structures (including teeth) may lead to targeting specific growth abnormalities by interventions based on new technologies in the future. This should also provide a better foundation for appraising possible environmental effects on craniofacial growth and development in individual cases, as well as for demographic cohorts.

Understanding the basic mechanisms associated with cell signalling, growth factors, and craniofacial growth and development of, for example, the mandible, palate and teeth, provides information necessary for safe and predictable therapies based on biomechanical principles, such as tooth movements, dentofacial orthopaedics, use of micro screws and distraction osteogenesis. The last treatment option is gaining support as a surgical intervention prior to implant prostheses with less morbidity than alternative bone grafting methods.

Studies on the interactions between facial function, craniofacial growth and development, with or without dentofacial orthopaedics, and TMD continue to support the belief that TMD bears little relationship to any anatomical-morphological characteristics.

The potential benefits of using innovative imaging technologies, such as many new maxillofacial radiological techniques, for diagnosis and treatment of malocclusion and craniofacial anomalies remain uncertain. In many situations, the 'gold standard' to establish most diagnoses continues to be the comprehensive patient history combined with a thorough clinical examination and conventional radiography.

### **Dental Anaesthesiology Research Group**

The need and demand for sedation and anaesthesia services in dentistry is being established. For conscious sedation, there are rising concerns about the risk of harm versus benefit of enteral sedation and discussions are held to address questions such as the need for appropriate training and to recognise the limitations of paediatric sedation. Moreover, critical questions have been raised on the evidence of the efficacy and safety of titration of oral medications.

New analgesic agents are being studied as part of a balanced approach to anaesthesia in order to reduce the overall dose of sedative drugs being used. In addition, new analgesics are being introduced for improved post-operative pain control following dental surgery, in particular with respect to a reduction in adverse effects. New methods for topical anaesthesia are being introduced in the market. Examples are agents for periodontal treatments without the need for injection and agents with inherent vasoconstrictor abilities that may potentially lower the risk of side-effects compared, for example, to those containing epinephrine. Also, new agents consisting of single isomers in contrast to agents containing racemic mixtures may give fewer unwanted effects.

### **Dental Materials Group**

A wide spectrum of research problems are covered by this, the biggest special group of IADR.

#### **Tooth tissue replacement**

There appears to be a continuous demand for substitutes to metallic restorations and one avenue for research is the development of new active materials *vs.* the conventionally passive materials. It is believed that a controlled release of active agents such as fluoride or antimicrobials can enhance the clinical

performance of restorations. Materials have already been on the market for some years with mixed success.

### **Adhesive bonding**

Research on adhesive bonding to tooth structure and various materials aim to simplify procedures and enhance the predictability of using bonding materials. By using new nanofiller technologies for inorganic fillers combined with new organic resin combinations it is hoped that lower contraction stresses and consequently reduced polymerisation shrinkage can be achieved in the newer composite resins.

### **Light sources**

New light sources for polymerising light-activated composite materials continue to be developed, and apparatus based on light emitting diodes (LED) are being tested and compared. Research questions revolve around issues of overheating and curing energy use, effects of wavelengths and optimal intensity on curing of resins. Apparently, some LED curing lights have performances similar to the quartz-tungsten-halogen curing lights but there is still room for improvements for the LED systems.

### **Ceramics**

New high-strength ceramics have the potential of reduced fracture risk and are currently being tested for use in fixed partial dentures. Modern fracture mechanics experiments have led to an optimistic view of an enhanced clinical performance of these new ceramics, although most dental materials authorities today are still disinclined to advocate a general use of ceramics for this purpose.

### **CAD/CAM**

CAD/CAM processing of materials attempt to produce restorations with more predictable properties. Systems are being developed to be applied chairside, in laboratory settings and by industrial process-

ing, and a broad spectrum of ceramic and metal alloys are being tested. An exciting avenue is the potential to link the materials processing directly with radiography to simplify the restorative treatment.

### **Soft and hard tissue restoratives**

The integration of titanium to bone seems to be improved using nanotechnology processes. Moreover, the ongoing research on tissue growth and bonding to alloplastic materials, including hard and soft tissue implants, promises to enhance the predictability and speed of implant osseointegration and oral rehabilitation in the future (a research focus shared by the Implantology Group).

Tissue engineering of bone, enamel and dentine growth now helps maxillofacial surgeons to rebuild facial structures that to date have only been restorable with alloplastic materials. (This research focus is shared by the Craniofacial Research Group, the Oral Surgery Group and the Mineralized Tissues Group).

### **Tooth whitening**

In general all professionally monitored and most of the over-the-counter tooth whitening products are effective. However, the mechanisms of action and effects on tooth structure as well as on restorative materials differ somewhat, which is especially controversial when safety issues are contemplated. In addition, new technologies are continuously being developed, for example, based on using heat or light enhancement or a combination.

### **Diagnostics group**

Remarkable technological advances are revolutionising saliva/oral fluid-based diagnostics. A variety of pathogens and/or antibodies to them can today be detected from various oral samples, including saliva, gingival crevicular fluid, buccal swabs and mucosal transudate. The use of saliva as a diag-

nostic aid is a translational research success story, since saliva has emerged as an excellent solution for diagnosing and monitoring systemic health and disease states. Moreover, saliva can be also used to detect exposure to environmental, infectious and biological substances, for example for detecting protein biomarkers such as HER-2/neu in diagnosis and post-treatment monitoring of women with breast cancer.

Intraoral chips based on micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS) may serve as probes for ultrasensitive and specific detection of proteins in various oral fluids. Such portable 'lab on a chip' concepts may produce real-time data, are painless and non-invasive, and have the potential to initiate cost-effective disease screenings in large population samples. There are expectations that other innovative and inexpensive tests may reduce affordability and accessibility barriers to an early diagnosis of many health conditions in the general population.

### **Educational Research Group**

Training dental students in general dental practices as an alternative to, or complementary to the training in academic settings has become common in many countries. However, the expectations versus outcomes are unclear and the net benefits and losses of introducing such concepts remain to be appraised.

Also, continuing professional development (CPD)/dental education (CDE) is being introduced in more and more countries globally. The rationale is the hope and belief of a higher quality of care provided for patients. However, the optimal systems for the delivery of CPD/CDE remain uncertain. Conventional lectures for large audiences are not effective for changing professionals' behaviour or practice. Various collaborative international research initiatives have been estab-

lished to determine the 'effectiveness' of diverse types of CPD/CDE in different countries. Various creative concepts have emerged, such as providing CPD/CDE to dentists and their teams in their own practices.

Development of more research based in general dental practices is a major aim in dentistry. The questions remain as to how to apply the best strategies to persuade practitioners of the necessary, how it can be achieved in practice and how to educate general practitioners quantitatively and qualitatively as researchers. (This research focus is shared by the Behavioural Sciences Group).

### **Geriatric Oral Research Group**

The need for geriatric oral health research and treatment demands differs amongst populations in industrialised, non-industrialised and principally rural countries. In practice, research today is limited to the industrialised population group, a situation that should be addressed.

Xerostomia is a common problem for many older people and promising results have now been achieved by applying genetic engineering to re-stimulate salivary glands. The complexity of drug-induced salivary change remains an enigma. It is clear that relationships can be seen at a population level but that there are wide variations when trying to investigate each individual's response to drugs.

Root caries remains a common problem of this group, often associated with xerostomia, whether or not induced by medications. Several innovative methods have emerged for treating root surface caries, amongst them ozone therapy and other pharmaceutical approaches to reverse caries. So far, the evidence of efficacy is not strong. Guidelines need to be developed for clinical decision making for the frail and functionally impaired older adults and the impact of medica-

tion on clinical decision making. For example, poor adaptation to removable dentures in frail elderly is often an overlooked problem in treatment planning. It is suggested that gerodontology should have a stronger emphasis in undergraduate teaching than that which currently pertains in many dental schools.

Elders' quality of life is significantly affected by their oral health state, which also encompasses adequate oral functions and the relationship between compromised oral health and nutrition. Access to care for isolated populations and effective delivery of dental care for persons in long term care facilities is problematic in many countries and regions. It is important to determine innovative ways to reduce this problem and exchange knowledge across cultures and geographic borders.

The relationship between general health and oral health remains a focused research area. The potential association between oral infection and cardiovascular diseases attracts much attention. Robust epidemiological data have raised the awareness of a possible existing relationship. Further research needs to be conducted to establish possible biological explanations or identify the possible confounding variables.

There are many questions that remain unanswered in gerodontology and these differ for industrialised, non-industrialised or principally rural communities: In industrialised countries, unanswered questions are: How best to provide access to care and oral care for the homebound?; What are the oral health issues associated with end of life care?; What is the best root surface caries-diagnosis and treatment and what is the role of dentistry in palliative care? Necessary research in non-industrialising countries should address the following questions: Is the ART technique usable in ageing adult populations?; How does one develop preventive programmes which are culturally pertinent and sensitive?; Are there

cost-effective prosthodontic procedures for rural populations with limited means?; Can one develop programmes to teach preventive dentistry to medical and other health care personnel? Finally, in rural countries the questions are: What are the optimal methods of delivery of dental services to isolated populations?; How can one best teach oral health skills to persons who are illiterate?; What is the best strategy for teaching prevention to persons whose cultural beliefs are indigenous and may have conflicts with prevention?; What are the minimum requirements for the delivery of emergency dental services?

### **Implants Group**

The success of titanium and titanium alloys being used for implants is undisputed, but this does not stop the research into applying alternative biomaterials. Many new calcium-phosphate combinations are currently being developed and it is not unrealistic to expect other implant biomaterials to emerge in the next few years.

Tissue engineering or rather bone-tissue engineering-related research has become a very attractive area for implant researchers. Several different methods for 'priming' both the prepared bone as well as the alloplastic material meant to be implanted are being tested with the hope of achieving a faster and more predictable osseointegration. Some of these are now becoming commercially available, although the clinical trials to document the merits are more or less lacking.

Also, the implant surfaces are continuously being modified for the same purposes. Modifications on the micrometer scale are relevant, but it appears also that improvements may even be gained when changes are made on the nanometre scale. Recent studies indicate that the implant surface nanostructure elements may play an

important role in early stages of bonding to bone. So far, no implants have been promoted on the market that focus on this characteristic, but this can be expected in the future.

Immediate implantation/immediate loading trials are now very common as the implant system manufacturers seem to compete to provide the implants and procedures with the shortest osseointegration period. Although the relevance of a short healing time can be debated, it is almost rare nowadays to find new publications using the three and six month loading protocols first established two decades ago by the Brånemark group in Sweden.

### **Microbiology Group**

Microbial biofilms in dental unit waterlines remain a highly sensitive and controversial issue. Researchers are attempting to clarify the development of biofilms, how to remove them, their relevance for patient care in practice and their significance for the patient and possible work-environment hazards. Although several guidelines for dentists have emerged in the USA, UK and elsewhere these are based on general pre-emptive risk assessments and not on specific scientific evidence, since much research remains to be done.

The genome sequences for several oral pathogens have been completed, which open future opportunities to develop interventions specifically targeted against these pathogens. A future clinical use of this technology is likely to be in the management of active rapid periodontitis.

The hypotheses of an oral-systemic disease relationship have until recently mostly been based on epidemiological evidence. Ongoing research is now providing new and convincing data to also provide a biological basis to explain this relationship. Microbial analyses in diagnosis and treatment of oral diseases continue to advance and

practitioners should be aware that new methods have improved sensitivity and specificity compared to older conventional tests.

The future of antibiotic therapy to combat oral diseases is uncertain both regarding agents and approaches. Especially for the treatment of periodontal disease, research into host modulation (immunomodulators, etc.) has led to a more critical view of its effectiveness. Microarray technology in the characterisation of the host response is a technique that is increasingly being used to clarify disease progression. For periodontal infections one question is whether there really is a need to identify the microflora rather than host response factors before planning the management protocols for patients.

### **Mineralized Tissue Group**

Our understanding of basic mechanisms for bone, cartilage, dentine, enamel, cementum and pathological mineralisation is still far from complete. The research spans from the ultrastructural, e.g. crystal chemistry analyses of demineralisation/remineralisation to development, healing and regeneration of mineralised tissues using tissue engineering. Solving the complexities of tissue engineering raises some fascinating consequences for the future practice of dentistry. Examples of some intriguing developments that may be a reality within the near future are:

- Obtaining a complete tooth from stem cells may lead to the generation of new teeth and thus impact on the future for alloplastic material implants
- Regenerating bone and periodontal tissues will continue to impact on the future of periodontal treatments
- Repairing pulp tissue and inducing mineralising reparative dentine in the crown and root may end the need for conventional endodontic procedures

- Regenerating dentine and enamel by biomimetic materials instead of cytotoxic biomaterials will change restorative care.

Time will show whether the research and its funding will allow these valuable strategies to become clinical realities within the next few years or over a much longer period.

A very informative website containing extensive resource materials on mineralised tissues is the American Society for Bone and Mineral Research educational website (<http://depts.washington.edu/bonebio/ASBMRed/ASBMRed.html>)

### **Neuroscience Group**

Oral neuroscience includes research on the role of the nervous system in orofacial function and in the diagnosis and treatment of orofacial neural and muscular disorders.

The neural control of oral functions, such as mastication, swallowing, phonation, speaking, salivation, and of disorders that occur during sleep, such as apnea and bruxism, has been the research focus in several laboratories around the world. Research on the pathophysiology of bruxism includes studies on the role of cortical events in the genesis of this disorder and has challenged the old concept that bruxism is caused by occlusal interferences.

One of the most complex patient conditions found in the dental practice is orofacial pain, and especially if this is chronic. Studies on trigeminal pain mechanisms have provided the basis for understanding clinical phenomena such as pain associated with nerve injury, the spread of pain beyond the injured site, and its persistence after healing has taken place. There is emerging evidence supporting the role of sex hormones and genetic make up in the pathophysiology of chronic pain, and in the responses to pain medications. With trigeminal pain mechanisms being elucidated, clinical epidemiology has



provided evidence that questions the role of occlusion in the aetiology of orofacial pain.

Temporomandibular disorders (TMD) are extensively being researched, encompassing all aspects of epidemiology and diagnosis, pathophysiology, and patient management. Accumulating evidence seems to indicate a co-existence between TMD and chronic musculoskeletal pain in other body areas. While debates about the biological or psychosocial nature of gender differences in TMD pain continue, the answer is unlikely to be one or the other, since these aspects are undoubtedly interrelated. Recent imaging and jaw tracking studies of the temporomandibular joint (TMJ) have shed light into its structure, kinematics and function. Besides providing further clues on the aetiology of TMD, this information is also instrumental in tissue engineering research. While the aetiologies for TMD remain unclear, it is important that management strategies for patients are evidence-based.

### **Nutrition Research Group**

Improving health and preventing chronic disease through diet and nutrition has been identified by the World Health Organisation as an essential strategy for improving global health in general. The dental team has the potential of playing a pivotal role by virtue of their competencies and the close and regular contact they maintain with most segments of the population. Involvement of dentists in nutrition assessment and counselling may have a profoundly positive impact on overall health. Ongoing research attempts are identifying effective means of nutritional counselling and/or dietary intervention by members of the dental team both within and out of dental practice settings.

Numerous studies now demonstrate that tooth loss contributes to poorer dietary quality. New research

based on nutrition related biomarkers show that implant supported prostheses modify individuals' diets. It is a realistic expectation that patients fitted with good healthy prostheses may better adhere to dietary recommendations such as higher intakes of fibre rich foods and consume foods with higher nutrient quality.

The association between diet and dental erosion is still being elucidated. It has been known for many years that a simple relationship between the dietary pH and erosion is too simplistic; erosion is the end result for some individuals after a complex interplay between dietary intake, quantitative and qualitative salivary factors and many other unknown variables.

The oral manifestation of systemic diseases such as HIV and diabetes is influenced by the patient's nutrition status. This needs to be taken into account when new patients with an unknown prior patient history are being clinically examined.

A possible relationship between obesity and periodontal disease has been identified. This relationship may be related to increased oxidative stress and insulin resistance present in many obese individuals. Clarifying these associations will provide a better understanding of the progress and management of periodontal disease.

### **Oral and Maxillofacial Surgery Group**

The debate on the value and need of prophylactic wisdom tooth removal is not settled, and both clinical and epidemiological research is being carried out to provide better fundamentals for treatment decisions. More data are needed on the types, frequencies, and risk factors for complications after third molar extraction. Techniques can be used for regenerating bone in the extraction sites following third molar extractions and, for example, bone allografts and guided tissue regeneration can result in less

adverse effects on the distal teeth.

A sad fact of the contemporary epidemiology of surgical diseases is that today, violence has become a major aetiological factor for dental disease, at least in many urban environments. Surgeons therefore also need to be aware of potential development of acute post-traumatic stress disorders following orofacial injuries. It is important that appropriate counsel and support is provided to the patient at an early stage of the therapy.

While many studies previously focused on measurable outcomes when describing treatment outcomes of oral surgery, more emphasis today is directed and should be directed towards other outcome measurements such as psychological impact and other patient orientated measures.

Oropharyngeal cancer is still on the rise on a global scale. Early detection and chemoprevention is essential to reduce morbidity and survival prognosis. New tests based on saliva samples have emerged as very promising diagnostic tools in the detection of precancer.

The role of vascular endothelial growth factors, serum oncogenesis and IL-8 in wound healing has led to discoveries that may open avenues for genetic control of healing and provide a molecular explanation why some individuals develop unwelcome keloid scarring. Patients disposed to extensive scarring can now perhaps avoid this in the future.

How smoking affects the risk of failures in implant treatment remains unclear. There is evidence that smoking is associated with poorer treatment outcomes. However, the biological explanation for the relationship still remains obscure.

### **Oral Health Research Group**

The dental plaque biofilm is a central aetiological factor regarding tooth-borne diseases, and various interventions are being

evaluated to establish the most effective and efficient strategies for prophylaxis at the individual level and on oral health promotion at the community level. The scientific evidence is not substantial or methodologically strong. Examples are the debate about the relative merits of electric toothbrushes *versus* manual brushing in effective plaque control, and even questions with regard to minor details such as rotary *vs.* rubbing action of the electric toothbrushes.

Tobacco cessation models can be incorporated successfully in oral health promotion programmes. There are good reasons to suggest that the dental team can contribute effectively in targeted populations to reduce smoking.

An abundance of trials is continuously being published comparing differences between old and new oral health care products. These include different dentifrices, preventive agents, anti-plaque mouthrinses, fluoride solutions, malodour rinses, tooth stain removers, over the counter bleaching materials, etc. Many times these studies have not been conducted according to general guidelines set by, for example, the American Dental Association for testing such products and the results are highly confusing and often contradictory.

### **Oral Medicine and Pathology Group**

Micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS) have today been developed to detect multiple analytes in oral fluids. This is especially promising for detecting oral cancer and oral pathogens (particularly caries and periodontal disease). Oral fluids such as saliva can in the near future be the standard fluid for molecular diagnostics of various diseases. The great benefit of having new non-invasive approaches for biochemical and molecular detection of oral and systemic disease is currently generating much

attention from commercial enterprises that keep patenting new tests. One of the most important avenues is that oral precancerous and cancerous lesions can today be diagnosed at an early stage by specific biomarkers that are identified using non-invasive approaches. Another fascinating aspect with saliva is that it seems to contain anti-microbial components that researchers are attempting to apply to prevent HIV transmission through other mucosal routes.

New research efforts have focused on discovering cell mechanisms involved in the early precancerous stages as well as angiogenesis. This is important because the expression of integrin enhances the invasive behaviour of OSCC and cancerous cells utilise integrins to metastasise.

An interesting finding is that chemicals in green tea inhibit cancer growth, which may open up new pharmacotherapeutic interventions. There is evidence that the inactivation of superoxide dismutase by reactive nitrogen species is associated with the development of AIDS-Kaposi's sarcoma tumours and increasing evidence that human papillomaviruses contribute to the development of certain oropharyngeal cancers. It appears also that COX-2 inhibitors may have a role in the prevention of carcinogenesis.

Another emerging avenue for combating oral cancer is gene therapy. Although the possibilities are currently at the early stages, this appears to be a promising therapy since oral cancers are often readily accessible and adverse effects commonly associated with cancer treatment may be minimised by such an approach.

HIV, AIDS and opportunistic infections are important topics for research. Recent findings indicate that oral transmission is not as significant as was originally proposed.

Non-*albicans* yeasts play a significant role in oropharyngeal candidiasis in head and neck patients and

the complexities of the oral *candida* biofilm have become clearer. Both topical and systemic antifungal therapy seems not to eliminate candida colonisation as the yeast may transmute to withstand the new hostile environment.

A somewhat surprising finding is that disinfectant use in dental waterlines may select for growth of rare organisms found in the communal water supply. The consequences in terms of public health are so far unknown.

The role of dentists in bioterrorism has regrettably become a topic on the research agenda. In the case of a major outbreak where physicians are quarantined, dentists will be asked to provide vaccination and care for the general population. Contingency plans have been developed in some countries and are being discussed on an international level.

### **Periodontal Research Group**

Daily clinical experience continues to demonstrate that the patient resistance to pathogenic microbiota varies, but the exact mechanisms are unknown. Recent studies have indicated that such biomarkers may be on a molecular level, which opens up the possibility for tests to determine patients' risk for developing periodontitis. Non surgical disease treatment is a better therapy than surgical strategies for many patients, who experience less morbidity and risk of recurrent infections. There is debate as to whether added treatment effectiveness is gained by using local antibiotics, but the most common view is to be very restrictive with antibiotics.

The enigma between periodontitis and general diseases and especially cardiovascular diseases remain unclear. In addition to epidemiological evidence there is emerging evidence of possible biological explanations of such a relationship. The major problem is confounding variables and the self-evident



lack of possibilities of carrying out experimental studies on humans.

### **Pharmacology/Therapy/ Toxicology Group**

The tetracyclines have been widely used in medicine during the past 30 years due to their use as broad-spectrum antimicrobial agents. However, in the early 1980s, research revealed that the tetracyclines had unique and unexpected properties entirely independent of their antimicrobial characteristics. These findings opened up a range of novel uses for these 'old' compounds, and led to the development of a new class of pharmaceuticals with the potential to stave off tooth loss associated with adult periodontitis. By inhibiting collagen breakdown, the tetracyclines have also been shown to have an effect on the spread of cancer. Antitumour activity utilising these compounds was recently noted in the treatment of patients with AIDS-related Kaposi's Sarcoma. This therapy has also shown promise in preventing the underlying breakdown in osteoarthritis and rheumatoid arthritis.

A lack of efficacy of pharmacotherapy is sometimes observed for patients. There are reasons to believe that this may be caused by a genetic disposition of the individual, although the exact mechanisms have not been determined.

Analgesic therapy has been largely limited to local anaesthetics, opioids and aspirin-like drugs. The number of potential targets for analgesia, however, has grown from a traditional few dozen inflammatory mediators to millions of single nucleotide polymorphisms in humans. Analgesic clinical trials are based on relatively homogeneous patient samples in standardised clinical models, making it difficult to account for any molecular-genetic diversity or to provide a basis for extrapolating to heterogeneous populations. Utilising gene expression and the genomics of

pain, future therapies will focus on tailoring therapeutics to account for specific molecular-genetic diversity among subjects thus increasing efficacy.

### **Prosthodontic Research Group**

Although implant-supported prosthetics is regarded as a predictable therapy, some implants fail and this is usually unexpected. Ongoing research attempts to identify which factors can be associated with the prognosis for such restorations. Currently, apart from smoking, some drugs and perhaps radiotherapy little is known about why some implants fail. Although there is much focus on analysing the interface between materials and tissues, this conundrum remains.

A welcome trend is that clinical trials that are being conducted today are more concerned with measuring patient outcomes following prosthodontic therapy than previously. Several clinical studies have demonstrated the great impact prosthodontic treatment can have on patients' quality of life, functional capacity, and particularly emphasising improved nutrition and chewing ability and patient comfort.

### **Pulp Biology Group**

Basic studies on tooth morphogenesis and differentiation focus on issues such as signalling mechanisms in tooth development and the role of matrix proteins in dentinogenesis. This provides a better understanding of the mechanisms behind developmental disorders of teeth and opens up possible interceptive interventions and early diagnosis.

Our understanding of what causes and maintains pulpal pain can now be explained by trigeminal mechanisms. However, much remains to elucidate the relationship between dental pain and inflammation as well as how best to treat hypersensitive dentine.

Trauma to the tooth will create pulpal inflammation and often also peri-radicular inflammation. It is known that the dentine-pulp complex has a good potential for wound healing and regeneration. However, the value of pulp vitality testing and use of most appropriate diagnostic testing method in this context remains debatable.

The microbiology of infected pulp is rather complex, and involves immune cell responses and changes in the microcirculation. Future possibilities for regeneration involve stem-cell research and the use of tissue engineering.

### **Salivary Research Group**

Saliva is the fluid which maintains the health of the oral cavity. It contains numerous proteins, small molecules and ions. Their role is to maintain the integrity of both the dentition and soft tissues. Recent research has given a deeper understanding of the mechanisms involved, especially in relation to the structure and function of the proteins in saliva. The role of interactions between different molecules and bacteria in fulfilling this role is increasingly well understood.

Salivary analysis can now be performed easily at the chairside in order to assess caries risk. In addition to measuring flow rate, there are kits available for assessing buffering capacity e.g. Dentobuff (Orion Diagnostica), CRT Buffer (Vivadent) and Saliva Check (GC), as well as caries susceptibility e.g. Cario L-Pop (3M), and cariogenic bacteria e.g. Dentocult (Orion Diagnostica).

Saliva is becoming increasingly attractive as a non-invasive diagnostic fluid with many potential uses<sup>1,2</sup>. It can be used in the screening and diagnosis of systemic diseases (hereditary disorders, autoimmune conditions and malignancy). It can also be used for the monitoring of drugs of use and abuse e.g. cotinine in smokers, drug use in sport and whilst driving, and

patient compliance. It is also useful in monitoring steroid hormone levels.

Current research is centred around several topics. NIDCR is leading the task of identification of all of the proteins in saliva (the salivary proteome). Saliva has innate antimicrobial properties resulting from cationic polypeptides (e.g. defensins) which can be regarded as 'nature's own antibiotics'. The peptide sequences in some salivary proteins are homologous with anti-microbial peptides and are liberated on proteolytic degradation. Saliva also contains proteins with anti-viral activity. In addition to SLPI (secretory leukocyte protease inhibitor), basic proline rich proteins (PRPs) have been found to have antiviral activity; basic PRPs Ps1 and Ps2 inhibit HIV by binding to viral Gp120, a finding which may have considerable potential therapeutic use.

Gene therapy appears an attractive vehicle for future treatment of salivary gland disorders. An increasing problem facing clinicians however is xerostomia caused by polypharmacy and the management of this.

## Conclusion

Dentistry is not about just filling teeth, which, unfortunately, is a common stereotypical view of the public, physicians and health politicians. This resume displays that oral health – or using the historical term 'dental' – research is a fantastically complex environment involving

researchers working from nanosize levels right up to behavioural scientists targeting populations. It is difficult to imagine another part of the body that is so fascinating, so complex and which generates so much interactive and exciting research.

Society expects the dental profession to maintain a science-basis for oral health care. However, at times it seems like an overwhelming task to keep abreast of all this research. The sheer size of research output from the scientific literature, and reports presented at IADR and other meetings makes it very difficult to identify and to recognise the new research findings that have important consequences for general clinical practice. There has been a growing realisation that IADR and FDI need to complement each other, and cooperate to improve the translation of new and important dental research findings to the practising dental communities for the ultimate benefit of patients. The present paper has been written with this in mind and it is hoped that it may inspire each practitioner to seek further information on the research topics described.

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## Further publication

Because of its nature, we welcome publication of this paper in any official journal of a FDI National Dental Association member, after translation if required. In such cases acknowledgement of the original reference in the *International Dental Journal* should be made. However, comments by a national dental organisation, the editor or others may be added separately, but not included in the paper.