ISTITUTO SUPERIORE DI SANITÀ

Conference

Dental setting as it stands with current procedures, materials and substances in use and related environment (indoor air quality)

Ospedale Odontoiatrico George Eastman
Rome, Italy
June 14, 2008

ABSTRACT BOOK

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This book includes 25 abstracts of contributions presented during the day Conference. Programmed communications presented at the Round Tables are also included as abstracts. This Conference has a dual aim: 1) to provide a refresher and updating opportunity on "dental setting as it stands with current procedures, materials and substances in use and related indoor air environment (indoor air quality)" directed to dentists, physicians, chemists, biologists and others involved in dental activity; 2) to provide researchers of different disciplines the opportunity to discuss relevant topics and outline factors that may affect the quality of the indoor air environment and measures (in terms of layout, air treatment systems, etc.) needed to prevent or reduce the chemical contamination which dentists and dental staff may be exposed to.

Key words: Dentistry, Dental material, Indoor air, Contamination, Volatile Organic Compounds (VOCs)

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Questo volume include 25 riassunti delle relazioni presentate durante la Conferenza. Sono inclusi anche i riassunti delle comunicazioni presentate nelle due Tavole Rotonde. La Conferenza ha un duplice scopo: 1) un aggiornamento sull'attuale assetto odontoiatrico con materiali, sostanze e procedure dentali in uso ed il relativo ambiente di lavoro (qualità dell'aria), diretto ad odontoiatri, medici, chimici, ed altri coinvolti nell'attività odontoiatrica; 2) un'opportunità per i ricercatori di differenti discipline per discutere gli stessi argomenti e le misure (sia in termini di layout dell'ambiente di lavoro che di sistemi di trattamento/contenimento concentrazioni dei contaminanti) per prevenire o ridurre l'eventuale contaminazione cui dentisti e staff odontoiatrico potrebbero essere esposti.

Parole chiave: Odontoiatria, Materiali dentali, Aria indoor, Contaminazione, Composti Organici Volatili (COVs)

Organized by: Dental Hospital Emergency Unit of Ospedale George Eastman - ASL-RM/A, Rome, Italy; with the cooperation of the Indoor Air Hygiene Unit of the Department of Environment and Primary Prevention, Istituto Superiore di Sanità, Rome, Italy; with the participation of: Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine of Dental Department; Department of Dental Toxicology, Walther-Straub-Institute of Pharmacology and Toxicology, of the Ludwig Maximilians University, Munich, Germany

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PROGRAMME

Saturday, 14 June, 2008

8.30 Registration of participants

9.00 Welcome messages from:
Carlo Saponetti
Director of ASL-RM/A

Stefano Pompili
Health Director of ASL-RM/A

Pasquale Marini
Health Director of Ospedale Odontoiatrico George Eastman of Rome

Opening address:
Luciana Gramiccioni
Director of the Department of Environment and Primary Prevention of Istituto Superiore di Sanità

Introduction of the coordinators of the Conference:
Emanuela Ortolani, Anna Santarsiero

Opening address of the honoured guest:
Reinhard Hickel
Director of the Department of Operative/Restorative Dentistry, Periodontology and Pedodontics Ludwig Maximilians University of Munich

LECTURES 1

Chairpersons: **Rudolf Schierl, Anna Santarsiero**

9.30 *Dental work and patients typology at the Dental Emergency Unit of Ospedale Odontoiatrico George Eastman of Rome*
Emanuela Ortolani, Anna Santarsiero

10.00 *Occupational hazards*
Crispian Scully

10.45 Coffee Break

LECTURES 2

Chairpersons: **Mario Seiss, Sergio Fuselli, Rossella Bedini**

11.05 In vivo *and* in vitro *metabolism of dental materials*
Mario Seiss, Reinhard Hickel, Franz-Xavel Reichl

11.35 *Occupational medicine - future needs for dental settings*
Rudolf Schierl

12.05 *Dental setting and related environment: the indoor air of the dental emergency ward of the Ospedale Odontoiatrico George Eastman of Rome*
Anna Santarsiero, Sergio Fuselli, Emanuela Ortolani

12.35 Discussion

13.00 Lunch

LECTURES 3

Chairpersons: **Emanuela Ortolani, Anna Santarsiero, Rosa Giordan**o

14.30 *Dental materials sampling*
Rossella Bedini

ROUND TABLE 1

15.00 *The mechanisms through which the dental materials, chemicals, procedures and the layout of the dentistry setting affects the quality of the environment and the health of ental staff*
Anna Santarsiero, Crispian Scully, Rudolf Schierl, Franz-Xavel Reichl, Mario Seiss, Gilberto Rinaldi, Peter Schmid, Gabriella Pal, Sergio Fuselli, Antonio Manieri, Giuseppe Viviano, Sergio Costantini, Maurizio Nazzicone, Fabrizio Maccari, Giorgia De Blasio, Simona Di Cicco, Rosa Giordano, Luca Cordaro, Rossella Bedini, Emanuela Ortolani

16.15 Coffee Break

ROUND TABLE 2

16.45 *Dentistry indoor air chemical contamination and exposure*
Anna Santarsiero, Crispian Scully, Rudolf Schierl, Franz-Xavel Reichl, Mario Seiss, Gilberto Rinaldi, Peter Schmid, Gabriella Pal, SergioFuselli, Antonio Manieri, Giuseppe Viviano, Sergio Costantini, Maurizio Nazzicone, Fabrizio Maccari, Giorgia De Blasio, Simona Di Cicco, Rosa Giordano, Luca Cordaro, Rossella Bedini, Emanuela Ortolani

18.00 Closure

INFORMATION FOR READERS

This book includes 25 abstracts of contributions that will be presented during the one-day Conference. The sequence of abstracts follows the order of the presented lectures. Programmed communications presented at the Round Tables are also included as abstracts. Contributions, referred to the round Tables 1 and 2, follow the order of the topics dealt with during the round tables.

PREFACE

This Conference is a follow-up of studies undertaken at the Dental Hospital George Eastman in Rome, Italy, on the Indoor Air Quality (IAQ) of the Hospital Dental Emergency Unit. A spontaneous scientific collaboration of the Indoor Air Hygiene Unit of the Istituto Superiore di Sanità with the Dental Emergency Unit George Eastman in Rome has grown, with the honoured participants of important health and dental institutions: Prof. Dennis Nowak, Director of the Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine; Dr. Rudolf Schierl, Head of the related Analytical and Monitoring Unit; Prof. Reinhard Hickel, Director of the Department of Restorative Dentistry, Periodontology and Pedodontics, Prof. Franz-Xaver Reichl, Head of the Department of Dental Toxicology, Walther-Straub-Institute of Pharmacology and Toxicology, of the Ludwig Maximilians University, Munich (Germany).

We are also honoured by the great interest and attention shown to the topic by Prof. Crispian Scully, Dean of the Eastman Dental Institute of London University College, University of London (United Kingdom). We also acknowledge the significant contribution made to the interdisciplinary character of the Conference by the Department of Chemical Engineering, Materials, Environment, Faculty of Engineering, University La Sapienza of Rome, Italy, through Prof. Gilberto Rinaldi; and the great interest and attention paid by Prof. Peter Schmid, Professor Emeritus of the Faculty of Architecture, Building, and Planning, Eindhoven University of Technology in the Netherlands, Eindhoven, Netherlands, that are attending the Conference. In the last few years, many meetings restricted to researchers involved in the study, both in Rome and Munich have been held. A meeting including also researchers from Hungary and Poland was also held at the Istituto Superiore di Sanità, as well. A need emerged: to understand the general trends in the dentistry field by collecting data from different countries.

Currently, available data on whether materials, products and chemicals of dentistry sector should be regarded as potential sources of contaminants of the indoor air of dental settings are sparse, lack details and comparability, thus representative only of the dental setting to which they are referred.

There is a need to collect representative samples of both dental settings and dentistry settings as well as to develop new monitoring methods for the collection of reliable data in order to define the scale of the problem that may derive from a possible question such as "to what extent does the dentistry work may affect the related indoor air quality, the health, the environment".

Through the analysis of the dentistry settings and legislation adopted by different countries in this field, criteria, methodologies and measures could be devised. With a sound database it will be possible to implement or update current regulations and safe work practices in order to keep any possible contaminant concentration as low as possible.

This Conference has been designed with a dual aim: 1) to provide a refresher and updating opportunity on "Dental setting as it stands with current procedures, materials and substances in use and related environment (indoor air quality)", directed at dentists, physicians, chemists, biologists and others involved in dental activity and related environment; 2) to provide an opportunity to discuss the same conference content with a

multidisciplinary approach; bringing together dentists, physicians, chemists, physicists, biologists, engineers and architects, together with environmental researchers having an interest in focusing factors (namely dental materials, substances, dental clinical procedures, equipment, apparatus and related dental healthcare facility environments) to be taken into consideration for any design aimed at keeping any impact as low as possible.

Scientific evidence indicates that the air inside residential and non-industrial buildings can be more seriously polluted than the outdoor air and people spend 80-90% of their time indoors (such as work places, home, commuting and others). The concern of the possible risks that may occur due to the combination of indoor contaminants and the long-term exposure, even to low air pollutant concentrations, prompted the scientific community and the involved organisations to discuss or update indoor air quality (IAQ) guidelines and standards. The increasing awareness of indoor pollution has led to a series of studies aimed at identifying the indoor air sources of pollutants, and measuring the related level of contamination and the emission rate from each pollutant source that could alter air quality in enclosed environments. Multiple external factors (an increase in outdoor pollution) and internal factors (building materials, furniture, occupant activities and cleaning products and so on) affect the indoor air quality (IAQ).

Apart from these factors, indoor air of dental environment deals with the inherent contamination produced by the dental activities performed, thus making the topic very intermingled.

The acquisition of data on indoor contaminant sources, dental activity patterns, dental setting layouts and related aeration and/or ventilation rate data, site data that would be used to develop a distribution model of contaminant levels in the different scenarios would be essential for any appropriate investigation aimed at optimizing or improving the management and operativity of the dental setting.

This book includes 25 abstracts of contributions, presented during the Conference, dealing with some of the aspects of this multifaceted topic. The variety of issues covered by the abstracts (going from patients categories, dental materials, substances and procedures used, to building and dental healthcare facilities design and related indoor built environment) dealt with in this conference gives ample evidence of the need for research in the field.

Anna Santarsiero

LECTURES 1

Chairpersons
Rudolf Schierl, Anna Santarsiero

DENTAL WORK AND PATIENT TYPOLOGY AT THE DENTAL EMERGENCY UNIT OF OSPEDALE ODONTOIATRICO GEORGE EASTMAN OF ROME

Emanuela Ortolani (1), Anna Santarsiero (2)
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(2) Department of Environment and Primary Prevention, Istituto Superiore di Sanità, Rome, Italy

A description of the dental activity at the dental Emergency Unit of the "Ospedale Odontoiatrico George Eastman" of Rome is presented. The patients referring to the Emergency Unit are quite numerous and heterogeneous both in terms of administered dental procedures and country of origin. Both factors - patient volume and required dental procedures - may constitute an interesting sample, that could be large enough to investigate correlations among the dental activities carried out, the number of patients and the possible contamination of the ward. Such an investigation may be helpful in a study aimed at characterizing the possible contamination in a dental setting and the related indoor contaminant sources.

The acquisition of data on indoor contaminant sources, dental activity patterns, dental setting layout and related aeration and/or ventilation rate data, site data that would be used to develop a distribution model of contaminant levels in the different scenarios would be essential for any appropriate investigation aimed at assessing contaminant levels and the consequent related measures to be taken also in terms of optimization or improvement of the management and operativity of the ward.

OCCUPATIONAL HAZARDS

Crispian Scully
Eastman Dental Institute, University College London, University of London, London, United Kingdom

The hazards to dental staff from their occupation were rarely considered in the past. Radiation burns and tumours had been recognised but no one seemed greatly concerned, nor they were about the toxicity of dental materials, mercury, or anaesthetic agents. Serious transmissible infection was almost disregarded and the possibility of occupational stress was only briefly considered. Further, the dental team received little or no training in recognizing or avoiding occupational hazards and safe work practices were neither defined nor implemented.

However, the perceptions of risk by the dental profession, and the public at large, were greatly sharpened, by the HIV/AIDS epidemic. In the United Kingdom, governmental concern and the defining of safe work practices and measures for implementing them by the Health and Safety at Work etc. Act (1974) and Regulations such as the Ionizing Radiations Regulations (1988) and Control of Substances Hazardous to Health Regulations (1988), brought the matter of occupational hazards in dentistry into sharper focus.

Overall, the major dangers now threatening clinical dental staff from the practice of dentistry are infections, particularly hepatitis B and C, and, to a much lesser extent as yet, infection with human immunodeficiency virus (HIV) and the acquired immune deficiency syndrome (AIDS) and prions. Viral hepatitis and HIV/AIDS are increasing worldwide. Currently the incidence of variant Creutzfeldt-Jakob disease (vCJD), infection with prions, is rising by an estimated 20-30% per annum, but it is still too early to know whether this trend is likely to be sustained or to forecast the ultimate size of the epidemic. There is a thus potential for transmission of various infections via the dental route. Dental equipment should where at all possible, be single use, and dental staff must pay considerable attention to avoidance of needlestick (percutaneous inoculation) infections/injuries the routine decontamination of all re-usable dental instruments. Manufacturers should work closely together with clinicians to develop more instruments that are either single use or can be made in a form that can be more easily and effectively decontaminated.

There are also lesser risks to dental staff from accidents, eye damage, irradiation, dental materials and drugs, stress and from the rapidly increasing scale of drug abuse.

However, accidents on the roads and in the home, or related to leisure activities or lifestyle are undoubtedly a far greater risk to dental staff than dentistry.

LECTURES 2

*Chairperson*s
Mario Seiss, Sergio Fuselli, Rossella Bedini

IN VIVO AND *IN VITRO* METABOLISM OF DENTAL MATERIALS

Mario Seiss, Reinhard Hickel, Franz-Xaver Reichl
Dental Department, Ludwig Maximilians University of Munich, Munich, Germany

Methacrylic (MA) acid-based monomers like BisGMA (Bisphenol-A-glycidyldimethacrylate) and comonomers like TEGDMA (triethyleneglycoldimethacrylate) are used in dental restorative materials in order to build up the three dimensional network of filling materials. In previous studies it was demonstrated that MA is a reactive intermediate in the metabolism of unpolymerized dental comonomer resulting in the formation of 2,3-epoxymethacrylic acid (2,3-EMA). Furthermore it was demonstrated that approx. 70-80% of applied (co)monomers are exhaled as CO_2

For that reason we started to investigate the metabolism of TEGDMA and BisGMA for both *in vivo* and *in vitro* situation.

In vitro formation and hydrolysis were studied in defined systems containing MA and human liver microsomes at 37°C. Samples were taken after 5, 30, and 60 min and analyzed by headspace-gas chromatography-mass spectrometry.

Investigations of the metabolic urine pattern of guinea pigs (n=4) were performed after oral application of TEGDMA or BisGMA (each dose=0.02 mmol/kg body weight), respectively. For these *in vivo* investigations BisGMA was pre-dissolved in DMSO and subsequently diluted with 0.9% NaCl solution (final DMSO concentration 1%) and TEGDMA was dissolved in 0.9% NaCl solution. The solutions were administered with a gastric tube; control animals received 0.9% NaCl or 0.9% NaCl solution with 1% DMSO solution, respectively, only.

For the reaction of MA to 2,3-EMA the average conversion rate was about 5% within 1 hour. It was found that the rate constant of enzymatic hydrolysis of 2,3-EMA at pH 7.4 was about 10 times higher than the rate constant of the formation from MA (k=8.3 *vs* 0.83 µmol/l min), indicating an instability and thus a high reactivity of 2,3-EMA. No formation was observed when heat-inactivated liver microsomes were used (controls).

Thus it was clearly demonstrated that 2,3-EMA is a product of dental material metabolisms in biological systems.

After 24 h in collected urine the following metabolites were identified: after administration of TEGDMA (mean (relative concentration of administered substances) ± s.d. [%]; n=4): unchanged TEGDMA: 12±1.5%, MA: 2.4±0.8%, and triethyleneglycole: 35±2.2%. After administration of BisGMA (mean ± s.d. [%]; n=4): unchanged BisGMA: 11.4±2.7%, MA: 2.2±0.6%, and Bisphenol-A-bis(2,3-dihydroxypropyl)ether: 60.1±5.2%).

No further metabolites like previously identified intermediate 2,3-EMA and derived reaction products were identified in urine. This indicates the high reactivity of 2,3-EMA *in vivo*. Possible reaction products are DNA adducts or mercapturic acids. These theses are currently under investigation.

OCCUPATIONAL MEDICINE - FUTURE NEEDS FOR DENTAL SETTINGS

Rudolf Schierl
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The principle role of Occupational Medicine is the provision of health advice to organizations and individuals to ensure that the highest standards of Health and Safety at Work can be achieved and maintained. Therefore, the protection of workers in their employment from risks resulting from factors adverse to health has to be done for each specific working-place. If hazardous exposures are identified, the classical instruments like banning, replacing, use of closed systems and at least personal protection equipment have to be brought in force.

In dental settings not only personnel (dentists, assistants, technicians) is exposed but also patients may be at risk. In this lecture the focus is set on chemical substances used for different tasks in dental settings. This involves well-known "old" problems like amalgam fillings, which are made from a silver/mercury mixture and are handled in closed systems. But during restoration processes there are still significant mercury exposures. Unknown exposure can also be relevant in case of unsafe waste management procedures. The various types of "new" composite fillings may cause health problems too. Especially those containing methacrylates could cause allergic reactions. But there may be also relevant future risks by nanomaterials. Although nano-sized particles (20-50 nm) are mainly fixed in the composites it is unclear up to now, if there is a significant release during manufacturing or drilling processes. Additionally, organic solvents and antibacterial ingredients of disinfectants can spread into the environment and cause health problems.

Up to now there is little published information on whether materials, products and chemicals should be regarded as potential sources of adverse effects on health for staff, patients or the environment. So there is an urgent need for developing new monitoring methods in order to evaluate potential risks by those substances. With a clear and sound database it will be possible to define regulations and good working practices in order to keep personnel exposures as low as possible.

DENTAL SETTING AND RELATED ENVIRONMENT: THE INDOOR AIR OF THE DENTAL EMERGENCY WARD OF THE OSPEDALE ODONTOIATRICO GEORGE EASTMAN OF ROME

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The aim of this study was to understand to what extent the total burden of chemical substances and materials used in dental health care facilities may contribute to poor indoor air quality (IAQ) in dental environments. The first part of the study concerns the selection of a suitable sample that would be representative of both current dental setting (as it stands with current dental area layout, spaces and apparatus) and dentistry setting (namely current dental care protocols, materials and substances in use in dental procedures).

The Dental Hospital George Eastman in Rome was selected and the emergency ward of the hospital was chosen for the investigation; being the only dental facility that operates 24 hours a day, treats about 38,000 patients per year. Initially in the study, walkthrough inspections were conducted in order to become familiar with indoor building characteristics (design layout, dimensions, number of wards and ventilation) as well as dental procedures.

The building predominately has natural ventilation, and the emergency ward is supplied with autonomous air conditioning and heating. Random measurements of the most important parameters for initial IAQ studies were carried out in the ward. Temperature, relative humidity, carbon dioxide and carbon monoxide were measured over different days and months with a handheld analyser Q-Trak Model 8551. Volatile organic compounds (VOCs) were also investigated and simultaneous samplings of ward indoor and outdoor air, using passive samplers, were performed.

The identification and determination of individual VOCs were based on retention times and confirmed by gas chromatography-mass spectrometry (GC6890 HP-MS 5973 HP) analyses. The obtained results of measured parameters were compared with the related guidelines and standards set by relevant Agencies and Institutions. VOCs were qualitatively identified and benzene, toluene, ethylbenzene, xylenes (BTEX) were quantitatively determined as they are the indicator compounds (markers) for the exposure to VOCs.

The obtained concentrations of VOCs were far below occupational exposure limits. Comfort parameters (temperature and relative humidity), were found to be within the standards ranges. Carbon dioxide (CO_2) never exceeded the value of 700 ppm, CO never reached the value of 1 ppm. Indoor CO_2 concentrations reflected outdoor air concentrations (averaging ~ 400 ppm), and indoor air concentrations of annexed areas (corridors, reception and so). In this regard, walkthrough inspections carried out during

the monitoring may suggest that the natural airing of the investigated dental area does not let the air movement be under control at any instant through it. Therefore, the movement of possible contaminants from one area to another may be possible; being subject to opening and closing of doors, windows and any other events or layout characteristics likely to affect airflows. In addition, possible contaminants may move from one area to another throughout the existent open spaces between dental chair partitioning.

LECTURES 3

Chairpersons
Emanuela Ortolani, Anna Santarsiero, Rosa Giordano

DENTAL MATERIALS SAMPLING

Rossella Bedini
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Dental materials used in dentistry practice are a small less than sufficient quantity for samples subjected to mechanical tests (tension, compression, flexural, bending, shear, etc.). The greatest problems about carry on mechanical tests of small samples are to hold them in the material testing machine during the test and apply the force in a correct way without any sample alterations. If it's no possible to obtain grips avoiding undesidered sample break, they will be then partially glued in resin.

Often, mechanical testing on manufactured sample follows the technical normative recommendations for test proceduring data (speed, loading, force to apply, sample position, etc.). If these information are unavailable in international normative, it'll be then possible to investigate among the literature data and use a procedure or a protocol that match the experimental future test.

To simulate thermical and chemical influence of oral cavity on dental materials it's possible to do sample conditioning before test. Thermo cycling simulate temperature's stressing with great and rapid temperature changes by means of almost two climate chambers. On the other hand, chemical stress artificial saliva or physiological solution samples requires dipping from 48 hours to 7 days.

These are the more used evaluating sample procedures in oral cavity environment simulation because it's very difficult to have a sampling of in mouth inserted materials, also for long time. Conservative restoration or endodontic reconstruction failure lead to no sufficient material or device portions for testing. When in dental surgery a mobilization of implants occurs, extracted fixture and abutment can represent right dimension samples for testing. So when possible, mechanical tests can be performed on in-vivo aged samples.

Round Table 1

The mechanisms through which the dental materials, chemicals, procedures and the layout of the dentistry setting affects the quality of the environmentand the health of ental staff

SAFETY OF DENTAL MATERIALS AND RELATED PERFORMANCE

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Dental materials used in the dental profession are indeed many, varied, and complex. The dental specialist who prepares and uses many of these materials in assisting the dental officer must know their composition, properties, uses, and manipulation. A thorough knowledge of dental materials and the skill to manipulate these materials is one of the important duties of a dental specialist.

Restorative materials are the metallic or non-metallic materials used to restore diseased or damaged teeth to health and function. Restorative materials have been greatly improved, although a universally ideal restorative material has not yet been developed. The corrosive nature of saliva and the expansion and contraction of tooth structure with changes in temperature make great demands upon a restorative material. The stress brought to bear on the restoration by chewing forces also makes great demands. Restorative materials must be compatible with living tissue. If used in the anterior region of the mouth, the materials must also be aesthetically pleasing. Restorative materials, used when and where indicated, help to ensure the placement of a successful restoration and preservation of the tooth.

Gold is frequently used in combination with other metals to produce alloys that can be used to fabricate various types of dental restorations where metal is indicated.

Dental amalgam is now used more than any other filling material for the restoration of posterior teeth, and is used more than any other material to restore carious teeth. It is easy to insert into the cavity preparation and adapts readily to cavity walls but it has many disadvantages as the colour that does not match with that of the teeth. If the amalgam is placed too close to the pulp, it may irritate the pulp.

All dental personnel must be familiar with the proper handling of mercury and the potential health hazard if exposed to concentrated mercurial vapours over an extended period of time, they must wear also masks when removing amalgam restorations.

Actually the goal of research and development is to develop the ideal restorative material. The ideal restorative material would be identical to natural tooth structure, in strength adherence and appearance. The properties of an ideal filling material can be divided into four categories: physical properties, biocompatibility, aesthetics and application. The physical properties include heat insulation, resistance to different categories of forces, and wear, bond strength, and chemical resistance. The material needs to withstand everyday forces and conditions on it without fatiguing.

Now composite resins seem to show excellent restorative materials because of their good mechanical resistance to wear and their excellent aesthetics.

Mechanical and 3D microtomography characterization of implanted and explanted amalgam and other dental biomaterials like composite, microcomposite, nanocomposite, hybrid and polyceramic biomaterials are going to investigate for assessing the material performance related to safety.

A BRIEF OVERVIEW ON SOME REGULATIONS IN DENTAL SECTOR

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Directive 93/42/EEC, related to Medical Devices (MDD) and adopted by Italy with Legislative Decree No. 46 of 24 February 1997, establishes that since 15 June 1998 the manufacturer of MDD can place products on the market only if they have a CE mark. As for the accomplishments of interest to dentists and orthodontists, some indications and clarifications on the application of the Directive, through the document DPS/VI/16AG/1493 of 12 June 1998, have been introduced. After the Directive came into force, the difficulties encountered in their practical application and a further deepening of the topic hinted the possibility to bring some changes and integrations. In particular, the orthodontist, as manufacturer, must guarantee that a specific MD is manufactured so that it meets the requirements foreseen by Annex I of Legislative Decree No. 24 of February 1997 No. 46 regarding the essential requirements of the MDD. Among other things, the orthodontist must define and document the procedures related to processing and analyse the risks linked to the use of the manufactured device, with particular reference to the biocompatibility of the materials used. Moreover, the medical device produced must have an adequate label and an instruction sheet reporting all the information necessary for a correct use of the MD.

A series of European regulations adopted in Italy have been issued for the dental sector, *i.e.* UNI EN 1639, 1640, 1641 and 1642, each of them referring to a series of other specific regulations. These regulations are very important for the market because they help to clearly define the characteristics, the requirements and the services that the various dental products should have and provide, besides contributing both to facilitate market exchanges and to keep high either the quality and the safety level of this field.

In this paper an overview of these regulations is given.

UPTAKE, DISTRIBUTION AND ELIMINATION OF DENTAL COMPOSITE COMPONENT BISGMA IN GUINEA PIGS

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Bisphenol-A-glycidyldimethacrylate (BisGMA) is used in many resin-based dental materials. It was shown in vitro that BisGMA was released into the adjacent biophase from such materials during the first days after placement. In this study the uptake, distribution, and excretion of [14C]BisGMA applied via gastric and intravenous administration at dose levels well above those encountered in dental care were examined *in vivo* in guinea pigs to test the hypothesis that BisGMA reaches cytotoxic levels in mammalian tissues. [14C]BisGMA was taken up rapidly from the stomach and intestine after gastric administration and was widely distributed in the body following administration by each route. Most [14C] was excreted within one day as 14CO2. The peak equivalent BisGMA levels in guinea pig tissues examined were at least one-thousand-fold less than known toxic levels. The peak urine level in guinea pigs that received well in excess of the body weight-adjusted dose expected in humans was also below known toxic levels. The study therefore did not support the hypothesis.

COMPOSITES AND NANOSTRUCTURED MODERN MATERIALS

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Concept of "composite" material: strength of the matrix, strength of the reinforcement, strength of the composite material; stress transfer from the matrix and the reinforcement; difference between particulate, short and long fibers; mechanical properties of a composite; anisotropy and isotropy of a composite structure; design and serendipity of the components, Fundamental aspects of the adhesion of the matrix to the reinforcing material.

Brief survey on the chemical, physical and mechanical characteristics of modern particulate composites and of their use in dentistry. Synthetic matrices (epoxy resins, polyesters, poliacrylics), fillers (inorganic oxides, glasses) and special additives (fluidifiers, coupling agents) to be employed for the obtainment of multipurpose complex materials (formulations) "tailored" for this special purpose. The use of particulate composites as a function of the "mechanical" environment they must endure; main properties of fiber-composites and their behaviours; short-fiber composites and their applications. Fracture toughness and durability of the composites as a function of the reinforcing material.

Resistance of a composite material under the action of "chemical" environment, above all wet air and solutions, under the action of impact and above all fatigue stress, under radiative environments.

Nanostructured composites are outlined as possible new tools for the future obtainment of a best performant and durable material. Carbon nanotubes, single and multiwalls and similar: obtainment, purification, risk and related technologies. Possible development of "new" composites.

CHEMICALS IN DENTAL CARE ENVIRONMENT

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Dentists, dental staff and patients may be exposed to several chemical contaminants from materials and substances used in the course of routine dental procedures. These include substances of restorative materials (for example mercury, acrylate compounds, etc.), organic and inorganic disinfectants, anaesthetic gases, and so on. For example, exposure to mercury and acrylate compounds occurs during the placement of amalgam or composite fillings, the finishing and polishing of fillings, and the removal of old fillings. Although the use of some materials (such as amalgam, etc.) has been recently reduced, exposure to them may take place during the removal of old fillings. Moreover, the use of composite materials (acrylic resins) as alternative materials has increased.

In addition to restorative materials, dentists and dental personnel may be exposed to substances that generally belong to the category of disinfectants (such as hydrogen peroxide, sodium hypochlorite, clorexidine, formalin, etc.).

Personnel may also be exposed to organic solvents and active (antibacterial) ingredients of disinfectants when they clean surfaces or instruments (with solvent-based disinfectants or water-based agents). Examples of active ingredients of the disinfectants used in dental environment are o-phenylphenol, benzoyl-p-chlorophenol and n-alkyl-n-benzyl-n,n-dimethylammonium chloride.

Dentists, dental staff and patients are also exposed to chemical agents that are used as topical antiseptics in the dental practice. For example, for caries cavities or root canals, zinc oxide is used as a pulp capping agent and a root canal antiseptic; hydrogen peroxide is used as a root canal irrigant; m-cresol, formaldehyde, and glutaraldehyde as root canal antiseptics; and iodoform as a root canal filling agent. Benzalkonium chloride, benzethonium chloride, chlorhexidine, and iodine are antiseptics directly administred to the oral mucosa. Carbol camphor, eugenol, guaiacol and thymol are endodontic medicaments used as pulp sedatives.

Most of the above chemicals (mercury, glutaraldehyde, formaldehyde etc.) are currently listed on either the European Union dangerous substances list - Annex 1 of the 67/548/EEC Directive or are designed as sensitizer by relevant Agencies or Institutions, such as American Conference of Governmental Industrial Hygienists (ACGIH) or German Senate Commission of the Deutsche Forschungs Gemeinschaft (DFG).

An overview of current legislation on chemical substances, of current classifications (used by relevant Agencies or Institutions such as the International Agency for Research on Cancer (IARC), the ACGIH DFG etc.), of relevant chemical substances as carcinogens, as toxics and sensitizers, and related data bases is given.

DISINFECTANTS IN USE IN HOSPITAL

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Disinfectants, in terms of regulation, are considered as medical surgical presidiums, thus included among the compounds intended to protect health and safety. For this reason their marketing is allowed only under the registration by the Health Ministry to be obtained after the product passed a series of exams about its effectiveness, toxicity, chemical stability, etc. This is why the information given by the manufacturer to the consumer must be authorized by the Ministry. The disinfectant reduces the number of micro organisms, though not being always effective on the spores; the effect is indeed always conditioned on a deep cleaning before its use. Heat is to be used when possible in order to obtain a good disinfection otherwise a broad-spectrum disinfectant is preferable since it acts even on spores such as hypochlorite. Disinfectants may be divided into the following two categories.

Inorganic disinfectants such as:

- Acids (tartaric acid, hydrochloric acid, solphochromic mixture, boric acid);
- Alkalis (sodium hydroxide, sodium carbonate, potassium hydroxide, calcium hydrate);
- Oxidants (peroxide, potassium permanganate);
- Inorganic halogens (chlorine derivates: calcium chloride, alkali hypo chlorites, potassium -chlorate, Amuchina, inorganic chloramines; iodine compounds: iodine tincture, iodine alcohol);
- Heavy metal salts (mercuric bichloride, mercuric ossicyanide).

Organic disinfectants such as:

- Alcohols (denaturated ethyl alcohol, isopropyl alcohol);
- Aldehydes (formaldehyde, glutaraldheyde) phenols (phenol, polyphenols, cresol, chlorine xylenol, chlorine cresol, dichlorine xylenol, esachlophene);
- Mercury organic compounds (mercurochrome, metiolato, Hg phenil nitrate);
- Chlorine organic compounds (chloramine, dichloramine);
- Iodine organic compounds (iodine povidone/betadine);
- Quaternary ammonium derivated (benzalkonium, benzoxonium and benzetonium chloride, cetrimide, tolitrimonio).

In the hospital workplace the workers might be exposed to chemical risks and disinfectants are the most important substance. These substances might be very dangerous because of their toxicological and physical chemical characteristics. For this reason it is necessary the risk assessment and the development of prevention and protection technical measures. Generally the primary contact for the health worker is the skin and the eyes (allergic and irritative dermatitis, ocular irritative diseases) with acute effects and sensitive

effects. While formaldehyde and glutaraldheyde have a known sistemyc effects: they are toxic for inhalation

An overview of the toxicological aspects of disinfectants in use in hospital workplaces and related exposure routes is given in this paper.

Round Table 2

Dentistry indoor air chemical contamination and exposure

INVESTIGATION OF INDOOR AIR CONTAMINATION MEASUREMENTS IN DENTISTRY ENVIRONMENTS

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There is a lack of data on the amount of contaminants in indoor air of dental settings as well as on the amount of contaminants that may occur during each dental procedure.

Currently, data available on indoor air contamination in dental settings are representative only of the specific dental offices/clinics investigated.

In order to get a general picture of this specific environment, research is needed in order to correlate the observed contaminant concentrations. The possible relevant concentration modifiers are the existent partitioned dental chairs, layout and ventilation design, number of patients admitted and the type of dental procedures carried out, apparatus used and related space in the dental settings.

The relevance of an accurate characterization of dental settings with the consequent possibility to make general statements about indoor air contamination is of vital importance especially for the health of dentists and dental staff that spend most of their time in such places.

Hence, in planning a study of indoor air contamination, it is important to determine what the sample experimental dental setting must comprise of, how the air sampling must be performed, and how many samples (both dental settings and related indoor air samplings) must be collected. It is important to provide the highest possible number of modifying factors. Going from type and number of dental procedures, to architectural design and building materials, ventilation system design and furniture that determine the indoor air quality, and could affect the contaminant concentrations.

In this paper an initial collection of data, from measured contaminants in investigated dental indoor air environments, are reported and the factors related to their representativeness are discussed.

DENTAL HOSPITAL EMERGENCY WARD INDOOR AIR VOLATILE ORGANIC COMPOUNDS

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The aim of this study was to understand to what extent substances and materials used in dental work as well as health care practices for the control of infection, could cause the presence of volatile organic compounds (VOCs) that dentists, dental staff, patients and visitors may be exposed to. VOCs are of great concern because of their adverse health effects. Exposure to low-level VOCs concentrations in indoor air is suspected in contributing to a variety of non-specific symptoms such as headaches, eye, nose and skin irritations. VOCs, for example formaldehyde and benzene, are classified as carcinogenic. VOCs were measured at the dental emergency ward and dental clinic activities were recorded. Simultaneous samplings of indoor and outdoor air over three different weeks were carried out. For sampling, the Radiello passive sampler (code No. 165) for aldehydes and the Radiello passive sampler (code No. 130) for volatile organic compounds were used. The identification and determination of individual VOCs were based on retention times and confirmed by gas chromatography-mass spectrometry (GC6890 HP-MS 5973 HP) analyses. The identification and determination of individual aldehydes were performed by reverse phase HPLC. Volatile organic compounds were identified; benzene, toluene, ethylbenzene, xylenes, and methyl methacrylate were quantitatively determined. Aldehydes such as formaldehyde, acetaldehyde, propionaldehyde, and benzaldehyde were also quantified. The obtained concentrations of VOCs as well as aldehydes were far below occupational exposure limits. The dentistry indoor and outdoor concentrations, for each volatile compound, quoted as ratios (ID/OD) resulted higher than 1, for aldehydes, benzene, toluene and methyl metacrylate pointing to higher concentration of such compounds in dental indoor air than in outdoor. While xylenes indoor and outdoor concentrations ratios resulted about equal to 1. For a detection limit of 0.01μg/m³ of the chemical method used, ethylbenzene and many other volatile compounds (such as 1,2-diclorobenzene, methyl cyclopentane etc.) were never detected both in indoor and outdoor air.

For a detection limit of 0.1μg/m³ of the sampling method used, glutaraldehyde was never detected. During the monitored periods, associations of dental procedures with the measured concentrations were inconclusive because of an inadequate number of observations. The obtained results do not permit us to draw any conclusion. However, in limiting our measurements only to indoor/outdoor air measurements, does not seem to be an adequate way to estimate the concentration level of VOCs in dental setting. Nevertheless, we need to increase the data on indoor air contaminants in dental settings and investigate the outdoor air quality since outdoor air quality represents a factor for the removal, dilution or both, of indoor contaminants that must be considered as a priority.

CURRENT LEGISLATION ON DENTAL HEALTH CARE FACILITIES DESIGN

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Matters regarding dental health care facilities operativity and design and related authorizations are currently the competence of local Health Authorities, and dental setting design and related indoor environments are approved and authorized by Regions (or Provinces) on the basis of the streamlines set forth in the Italian Legislative Decree No. 502 of 30 December 1992 and ammendments.

This means that each Italian Region regulates the requirements that a dental setting design (public or private) must meet for obtaining the authorization. As an example, we report Regional law No. 4 of 3 March of 2003 of the Lazio Region that (by means of its subsequent regional regulations) fixes the minimum requirements (as reported in the Regional Bulletin No. 25 - Supplement No. 7 of 9 September 2006) for a dental setting. Among others:

- minimum area required per dental chair partitioning;
- floor and internal walls of the dental partitioning must be built in materials that can easily be washed and disinfected;
- presence of a reception area or administrative office separate from the dental operativity room;
- toilets for patients and dental staff;
- a space for storage of clean materials;
- a space for storage of unclean materials;
- spaces or cubicles for drugs, products and instruments and toolbox, waste disposables.

If surgical operations are involved, standards of ventilation rates, of health and comfort parameters as well as a greater floor area of the surgery room must be met.

Products, substances, equipments and dental chairs in use in current dentistry practice are already regulated by other laws/directives (National law 626/94, EU Directive 93/42/EC, etc.).

In this paper, factors (such as the demand for dental care, care protocols and processes, and even new types of specialists) that may change the scenario of the activities that take place in enclosed dental environments and related indoor air quality are discussed.

VENTILATION DESIGN OF DENTAL AREAS

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The ventilation design of enclosed environments is central to the control of airborne contaminants. Specifically, the ventilation design of the dental area should be set to protect dental staff, visitors and patients from exposure to pollutants deriving from the specific dental activity (aerosols, particulate matter, nitrous oxide if used, odours from medications, sterilization fluids, cleansers and restorative materials) as well as from exposure to usual indoor pollutants (those from building materials, spaces layout and ventilation system design and furniture etc.) of enclosed environments. In most cases, guidelines and standards on ventilation design for dental areas are derived from the approaches used to design health care facilities for preventing the spread of infectious disease, of chemical and radioactive substances. Most of these guidelines limit mechanical ventilation to the principal medical treatment areas, such as operating theatres and associated rooms that must follow specific requirements such as high-efficiency particulate air-filters. Generally, patients wards are not required to be mechanically ventilated and natural ventilation through opening windows is often adopted. Ventilation in dental indoor settings has not received a specific deal of attention, possibly because it is often assumed that, except for some specific areas (areas in which nitrous oxide is used, sterilization area) the requirements of the comfort parameters are met by the sufficient airing through operable windows.

With mechanical ventilation the air flow within a building may be under control by means of pressure gradient in such a way the movement of air goes from clean areas outward in a cascading pressure regime towards the less critical areas and, ultimately, the unclean areas. The air may also be cleaned by removing contaminants through filtration. With natural ventilation, the movement of air is unpredictable, being subject to opening and closing of doors and any other events or features likely to affect airflows. Thus, with natural ventilation it is difficult to control the movement of contaminants from one area to another when they are not under effective pressure control. Other guidelines and standards on ventilation design for dental areas are derived from those created for non-industrial settings, such as offices and residences, which focus on acceptable comfort levels for occupant, whereas others guidelines and standards were developed for industrial settings (laboratories) and based on health concerns (nitrous oxide, chemicals etc.). In reality, dental ventilation rates (and related systems or devices) should be set on the basis of emission rates of all airborne pollutants of concern, of pollutant dynamics, of dental activity patterns and target levels for acceptable exposures to the resultant pollutant mixtures. In this paper, ventilation rates and systems intended for dental environments are discussed.

DESIGN FOR WELL BEING IN DENTAL CARE- INTEGRAL DESIGN SOLUTIONS FOR HEALTH AND WELL BEING

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The World Health Organisation (WHO) approved the need for building better environments and functional spaces supporting individual's health and disease prevention.

Integral design solutions are needed in hospitals, assuming a new outpatient focus. The goal is to identify the appropriate requirements for the design upgrading, on the background of the issues of World Health Organisation concerning health care and environment.

This is done by revisiting the traditional standards of hospital design and the indicators adopted in building to answer to the issues of the WHO.

Specific components, recurrent through the ages in the design of hospitals, have traced its course and influenced its development. Assuming these components as reference points, their origin and nature are investigated and put into relation with the above indicators. Based on the correspondence emerged, they are re-considered and re-valued in order to be re-introduced in design supplying the appropriate requirements for the upgrading of the dental care unit.

These and other traditional components, constantly adopted in dental care design, are taken as the indispensable design requirements for an integral design solution that answers to the issues of the WHO and is suitable for the upgrading of the dental care design.

This solution, promoting a therapeutic functional environment and configuration, is considered generally suitable for the upgrading of dental ambulatory care, outpatient diagnostic and treatment in hospitals. It includes the following components:

Bio-compatible building technologies and energy saving systems - Long lasting reproducible easy-to-substitute building material/features/details promoting safety and sanitation - Large small scale flexibility of design - Modularity of space and systems - Careful organization of space - Multipurpose and shared spaces - Horizontal lay-out minimizing distance - Identity and positive perception of design - View on landscaped outdoor spaces - Colours and light - Artwork and decoration - Well identified way - finding - Clearly visible reference points and signage - Familiar environment and comfortable atmosphere - Privacy and social life - Functional green areas - Diseases prevention and treatment information - Criteria for changing and methodical up-grading.

A HOME FOR HEALTH.
INTEGRAL BIO-LOGICAL ARCHITECTURE - IBA -
A CONTRIBUTION FOR HOLISTIC WELL-BEING

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Health and well-being (even good feelings) are two sides of one coin.

Our constitution and condition in relation with and dependent on life style influence our health. Movement and rest, food, and the complex natural, artificial, and social environment, including hygiene, and preventive/medical care, can have - physically, psychologically, and spiritually - significant impact on our well-being. The built environment, our habitat, especially for living, working, and curing or re-creating belongs importantly to the non-direct-medical, but also relevant treatments, as various old building traditions teach and the recent phenomenon of Sick Building Syndrome proofs. Already European Geomancy including Radiesthesy, Indian Stapathya Veda or Vastu Shastra, and Chinese Feng Shui contain many examples of an approach in architecture and town planning towards optimal dwelling conditions from the viewpoint of a sound and sane, wholesome, hale and hearty stay.

Based on these old and new insights the design follows the idea of selected natural processes and materials (with consideration to allergy risks) which can help in prevention as well as curing ill, sick, diseased, or indisposed states, if we give or even improve the possibility to freely develop. According this idea we can draw off guidelines for design of buildings for optimal living and good feeling in them.

The guidelines contain objectives on material and energy, space, shape, and building form including modular coordination, light and colour, structure and construction, indoor climate, and they are related to gross as well as subtle perception. More and more people seem to be extremely sensitive for negative influences, amongst others certainly also coming from a technically highly sophisticated environment.

This subject might be even of a higher importance and value for buildings in which therapeutic and medical treatment should be successfully supported. It is valid for preventive/prophylactic treatment, during medical treatment, and for convalescence, in which physiological, psychosomatic, and mental - holistic - well-being is aimed. Architecture should try to support this aim.

INDOOR EASE: SOME DESIGN PRINCIPLES OF COMFORTABLE COSY FRIENDLY AND SAFE DWELLING

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Recent and current research dealing with:

- statistics concerning physical and psychological well-being and safety of various related populations;
- measurement of indoor (air) quality in terms of temperature, humidity, draft, and light, noise, smell as well as extremely fine or micro dust, and allergens;
- check of toxicity, like chemical pollutants in or of building materials, building components, and cleansing agents, detergents, and objects within (hospital) interior;
- exploration of static electricity, electric, magnetic, electro-magnetic and other subtle field phenomena - after registration of more and more highly sensitive persons;
- survey of the complex appearance of the so-called Sick Building Syndrome as well as Sick Hospital Syndrome (also related to ecology and energy questions) …;

show a colorful picture, which at least proofs seriously that the built environment has significant influence on well-being and also on health of inhabitants of homes and work places as well as on patients and convalescents in hospitals and therapeutic buildings.

The insight in and the recognition of the relationship between quality of life and quality of the built environment, the building in which the occupant remains, is not new. It might be, that the rather subtle interchange was widely forgotten during some hundred years, now already behind us for a while. Neglecting this important old knowledge together with the sometimes "blind triumph" of so many new materials, technologies, and behavioral circumstances, nowadays we experience - like a boomerang - a heavy revenge of the past carelessness and negligence. We are confronted with an avalanche of difficulties concerning costly complains about inconvenient circumstances in buildings.

Some of Indigenous People of various cultures have knowledge about the best possible solutions how an abode should be optimal chosen and made. More over there are disciplines, how to build most beneficial, like traditional Geomancy and Radiesthesy in Europe, Feng Shui in China, Stapathya Veda or Vastu Shastra in India, and the same or similar precepts in other (Far and Middle) Eastern Countries. All of them focus on architectural and building concepts for highest possible well-being and happiness. It might be worth to investigate those traditions also for our current needs.

As a result of preliminary studies of the various old building rules and new holistic concepts for benefit and avoiding disadvantages within our build environment as well as from the recent and alarming complains about the ill-making influences from our built environment, we go to present some "integral bio-logical" design principles (and examples) in order to support the most sustainable and comfortable living circumstances.

MEASURING FORMALDEHYDE IN A DENTAL CHAIR PARTITIONING

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Formaldehyde (CAS No.: 50-00-0) has been classified by IARC as carcinogenic to humans (Group 1). Occupational exposure limits to formaldehyde have been set by relevant Agencies or Institutions such as the American Conference of Governmental Industrial Hygienists (ACGIH) or the German Senate Commission of the Deutsche Forschungs Gemeinschaft (DFG). For example ACGIH (2004) fixed a Threshold limit value (TLV) equal to 0.3 ppm (TLV: 0.3 as Ceiling value); DFG (2004) sets a Maximum Allowable Concentration limit value, expressed as MAK equal to 0.3 ppm (MAK=0.3 ppm, or equal to 0.37 mg/m³ as 1 ppm=1.23mg/m³).

Apart from its use in the production of phenolic, urea, melamine and polyacetal resins, formaldehyde is directly found in aqueous solutions (formalin), as disinfectant and preservative in many applications. In dental practice, formaldehyde is also an ingredient of chemical agents used as root canal antiseptics.

In order to gain information on the concentration level of formaldehyde in the dental indoor environment, a measurement was made at a dental chair partitioning operating 24 hours-a-day.

Simultaneous air samplings were collected over a week at the dental chair partitioning and at a far-away window, representing the indoor and outdoor air of the dental ward, respectively. Two passive samplers (Radiello Aldehyde Samplers, code No. 165) were simultaneously placed. One at the dental chair at about 1.70 m height in the breathing zone and about 0.50 m from the chin of the patient,the other at the outdoor window.

The samplers stood in place for seven consecutive days during which time occupants (dental staff, dentists etc.) were asked to ignore their presence.

Formaldehyde analyses were performed by reverse phase HPLC. A HPLC-(Agilent Technologies 1,100 series) equipped with Restek Ultra C18 HPLC column, 150 mm long, 4.6 mm diameter, 5 μm packing particle size, and UV detection.

The mean concentrations of formaldehyde obtained in indoor and outdoor air were 3.6±0.12 μg/m³ and 2.2±0.07μg/m³, respectively, in any case far below the above mentioned occupational exposure limits (e.g., TLV, MAK).

However, a systematic survey involving a great number of samples is needed to draw any conclusion on the obtained concentration of formaldehyde in the studied dental partitioning.

FORMALDEHYDE MEASUREMENTS IN A DENTAL SETTING

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The aim of this work was to gain information on the concentration level of formaldehyde in a dental setting that includes an open space, divided by panelled walls 1.40 meter high delimiting two spaces, each equipped with a dental chair, where the patients are visited or treated.

A continuous sampling was carried out over a week in August, September and October 2007. Simultaneous samplings took place in the dental setting and at a far away outdoor window. Formaldehyde was sampled using the passive system Radiello Aldehyde Samplers (code No. 165).

The samplers position in the dental space was set at a 1.80 m above the floor and at least 2 m away from the two dental chairs. The sampler at the outdoor window was placed 1.30 m above the floor. The samplers were left in place for 7 consecutive days during which time occupants were asked to ignore their existence.

After sampling, formaldehyde analyses were performed by reverse phase HPLC. A HPLC - (Agilent Technologies 1,100 series) equipped with Restek Ultra C18 HPLC column, length 150 mm, 4.6 mm diameter, 5 μm packing particle size, and UV detection.

The analysis procedure met the requirements of the US EPA Method TO-11A U.S. EPA. 1999a. US EPA IP-6A. ASTM D5197.

The following results of indoor/outdoor air concentrations of formaldehyde were obtained.

Week in August: number of patients visited = 988; mean concentrations of formaldehyde measured in indoor and outdoor air = 4.1±0.12 μg/m³ and 2.7±0.08 μg/m³, respectively.

Week in September: number of patients visited = 527; mean concentrations of formaldehyde obtained in indoor and outdoor air = 3.6±0.11 μg/m³ and 2.2±0.08 μg/m³, respectively.

Week in October: number of patients visited = 551; mean concentrations of formaldehyde obtained in indoor and outdoor air = 4.4±0.13 μg/m³ and 3.9±0.12 μg/m³, respectively.

The literature reports that levels of formaldehyde in outdoor air are generally below 0.02 mg/m³ (20μg/m³) in urban settings, and typically 0.02-0.06 mg/m³ (20-60μg/m³) in the indoor air of houses. Although the concentration we obtained is far below these values, a systematic survey involving a much greater number of samples is needed to draw any realistic conclusion on the actual level of formaldehyde in the studied dental setting.

GLUTARALDEHYDE IN DENTAL SETTING

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Glutaraldehyde is a chemical that may be used as a cold sterilant to disinfect and clean heat-sensitive medical, surgical and dental equipment. Routine exposure to glutaraldehyde is known to cause adverse health effects. For example, California's Division of Occupational Safety and Health (Cal/OSHA) sets and enforces workplace chemical exposure limits. Cal/OSHA has set a Ceiling Limit for the amount of glutaraldehyde in workplace air. The Ceiling Limit for glutaraldehyde is 0.2 ppm (about equal to 0.8 mg/m³ milligrams of glutaraldehyde per cubic meter of air). Glutaraldehyde usage is declining in dental setting. In order to gain information on any possible background concentration level of glutaraldehyde in a dental setting, that does not use glutaraldehyde, an air monitoring inside and outside a dental ward was carried out over four different weeks. A simultaneous consecutive 7-day sampling of glutaraldehyde took place during each week, at the dental area and at the outdoor window of a separate room, as follows:

- one sampler was positioned at the dental area equipped with two dental chairs at about 1.8 m height in the breathing zone;
- the other sampler was positioned at the outdoor window, at about 1.50 m height in the breathing zone.

For sampling, the Radiello passive sampler system: Radiello Aldehyde Samplers (code No. 165) was used.

The samplers were left for 7 consecutive days during which time occupants were asked to ignore the existence of the samplers.

After sampling, glutaraldehyde analyses were performed by reverse phase HPLC. A HPLC-(Agilent Technologies 1100 series) equipped with Restek Ultra C18 HPLC column, length 150 mm, 4.6 mm diameter, 5 μm packing particle size, and UV detection.

Gluteraldehyde was never detected in all monitored weeks. In this regard, there is to note that the detection limit of the used sampler system and sampling duration (a 7-day exposure) is 0.1μg/m³ for gluteraldehyde.

MEASUREMENTS OF METHYL METHACRYLATE AT A DENTAL CHAIR PARTITIONING

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Methyl Methacrylate (MMA), a monomer of acrylic resin, has a wide variety of dental applications. Indoor/outdoor air MMA concentrations were measured over a 7-day period. The Radiello passive sampler system (Adsorbent cartridge code No. 130) for volatile organic compounds was used for sampling. Simultaneous air samplings were carried out at a dental chair partitioning and at the outdoor window of a separate room.

Four passive samplers were simultaneously placed as follows:

- two samplers set aside at the dental chair at a height of about 1.80 m in the breathing zone and about 1.0 m away from the chin of the patient;
- two samplers at the outdoor window at about 1.5 m above the floor.

The samplers stood in place for 7 consecutive days during which time occupants (dental staff, dentists etc.) were asked to ignore their existence.

The sampling samplers were taken off after 7 days exposure time (a week) and two air samples for each sampling point (dental chair and outdoor window) were collected

The identification and determination of methylmetacrylate was based on retention time and confirmed by a gas chromatography-mass spectrometry (GC6890 Agilent Technologies -MS 5973 Agilent Technologies) with single ion monitoring (SIM).

Conditions of the GC/MS (SIM) analyses:

- Rtx-5MS capillary column, 60 m length, 0.25 mm diameter, 1.0 µm film thickness;
- injector temperature: 280°C;
- gas carrier flow (helium): 2.0 ml/min;
- temperature programme: 35°C (isothermal for 2 min), 1°C/min to 45°C (isothermal for 1 min), 5°C /min to 75°C (isothermal for 3 min), 10°C /min to 175°C (isothermal for 3 min),15°C to 250°C (isothermal for 3 min).
- detector temperature: 250°C.

The detection limit of the chemical method for MMA was 0.01µg/m³

The mean concentrations of MMA obtained in indoor and outdoor air were 1.8±0.06 µg/m³ and 0.10±0.07µg/m³ respectively.

Indoor air mean concentration of MMA was far below workplace standards and air toxics guidelines, e.g, the 8-hour threshold limit value time-weighted average (TLV-TWA) occupational standard for MMA is 100 ppm; 410,000 µg/m³ (OSHA and ACGIH).

CHEMICAL RISK IN HOSPITAL ENVIRONMENTS

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The hospital has always been a place intended to admit and heal unhealthy people, but is also a working place, where workers might be exposed to different kinds of risks, especially the biological, the physical and the chemical ones. We will now talk about problems related to chemical risks due to exposure to volatile substances.

In Italy, the chemical risk in work environments has been taken into consideration for several years by the current laws on safety and hygiene at work, starting from the DPR 303/56 (general rules on hygiene in work environments) and DPR 547/55 (regulations about accidents prevention).

The Legislative Decree 626/94 includes among the substances object of the study all those dangerous compounds (*i.e.* chemical, carcinogenic and mutagenic) which might either affect people's health for their toxicological characteristics or damage safety for their physical and chemical characteristics. In the chemical risk sphere we have in fact to underline the risk due to an exposure to carcinogenic (or such alleged) substances, or to chemical compounds which might be related to congenital malformations: the current regulations give particular attention to such aspects of the question, providing suggestions for a more precise protection about it. The chemical substances then have to be analyzed every time we happen to find their presence, even small, in any work production process, every time they cause an undesired effect; whether they are single or compound substances; whether they are specifically used or rubbish. Chemical products are to be taken into consideration not only when they are in their liquid or solid physical state, but even when they develop gases, vapors, fogs, smokes or powders. The change of a compound's physical shape can lead to a more dangerous situation in case of contact with the workers, enlarging the cutaneous surface (vapors, fogs). Another issue to be carefully considered concerns the concentration of the substance once in solution: the potential noxiousness of the contact with the workers can radically change acquiring for example a particular blistering effect, thus increasing the cutaneous and muculitic absorption. The analysis brings then to the identification of the minimum required which has to be granted for the health's protection of the workers towards possible damaging effects due to working activities that involve professional exposure to chemical substances. The next step is the organization of an intervention schedule which involves technical or organizational changes in order to limit the risk, and the definition of priorities to follow.

Risk assessment of exposure to chemicals in the workplace and enforcement of the laws are discussed in this paper.

AN UPDATING SURVEY ON THE INDOOR AIR POLLUTION

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In this short communication, a brief highlight of the state of the art of the techniques for the removal of the indoor air pollution is outlined.

Gas or air purification involves the removal of vapour-phase impurities from a gaseous stream; the processes which have been developed to accomplish this task vary from simple once-through wash operations to complex multiple-step recycle systems. In some cases, the process complexities arise from the need for recovery of the impurity or reuse of the material employed to remove it.

The primary operation of the gas-purification processes generally falls into one of the following three categories: Absorption into liquid, adsorption into a solid, chemical conversion to another compound. The designer of gas- or air-purification process units must, therefore, be particularly familiar with the principles of design of absorbers, adsorption units, and reactors.

The last system for the removal of impurities (chemical conversion) at this moment is in a stage of great development, owing to the results obtained by means of the so-called "photo-catalytic" conversion of pollutants.

The problem for the air-pollution, both outdoor and indoor is a little complicated in our times by the presence of particulate matter, the so-called PM (from "1,5" up to "10"), with the need of some type of "tailored" filters (physical or chemical).

Starting from both the "ordinary" civil and industrial air polluted environments and the abatement methods actually in use, the possible "transfer" of the ordinary techniques to the special environment of a large dental unit is examined.

The methods for the elimination of pollutants from mercury and acrylate compounds, organic solvents, chemical agents from antiseptics, zinc oxide, aldehydes, peroxides, iodoform, organic chlorides, iodine are discussed; the problem of microparticulate PM 10 and PM 2.5 is also examined.

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