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RISK ASSESSMENT AND CONTROL IN USING MODERN DENTAL MATERIALS

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Introduction. The use of new technologies and advanced nanomaterials (nanocomposites, bioactive coatings, etc.) in dental practice can increase potential risks for specialists of dental practice.

Purpose of the research was to assess a «nanospecific» risk in dental practice and develop tools for risk control.

Materials and methods of research. The risk was assessed at workplaces of a dental technician, dentist-therapist and dentist-orthopedist. The «nanospecific» risk was calculated using an approach of a «control stripe».

Results. It is found that the work of a dentist-therapist, dentist-orthopedist and dental technician is characterized by high occupational risk due to using modern dental nanomaterials. Measures to managing «nanospecific» risk at workplace were proposed (general and local ventilation, restrictions of access to premises for unauthorized persons, personal protective equipment, etc.).

Conclusions. The obtained results support necessity of further studies on nanomaterial toxicity in current dental practice.

Key words: risk assessment, control banding, composite materials, dental service

Introduction

The number of people, who contact professionally with nanosized substances and new materials, is constantly increasing. The use of new technologies and modern composite materials in dental practice, in particular, can increase potential risks both for different professionals (therapists, orthopedists, technicians) and patients. According to experts of The Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) one should distinguish situations, when traditional approaches to risk assessment are suitable or «nanospecific» risk assessment is necessary. In particular, «nanospecific» risk assessment is useful in cases, when production activity is followed by emission of particles sized 1–100 nm in the air of the working zone [5]. At the same time there are no clearly defined algorithms and computing models for the assessment procedure. The lack of information about toxicity of nanoparticles/nanomaterials and exposure levels at workplace as well as the lack of specific standards in many cases make it impossible to assess risks quantitatively [4]. At the same time an available and helpful alternative of the potential risk analysis with the further risk management is an approach of the «control banding». This simple, but effective approach is based on the use of the current information on the toxicity of materials and levels of exposure at workplace. Just this approach is recommended for cases, when traditional risk assessment is impossible due to lack of the data. Each «control band» is a result of the combination of

the calculated values of different toxicity aspects (both of the «parent» material and nanomaterial itself) and the exposure (dust levels, quantity and duration of production operations, number of workers, quantity of the used nanomaterial). It brings on the practical way of the risk control with the aim of the risk minimizing. The conservative approach that unknown risk is a high risk was taken as the basis of the «control bands». So, it was decided to use 75 % of the maximum value of the each analyzed factor for unknown factors [3, 6].

The last stage is a usage of the so-called «control band matrix» that helps to propose one or another engineer or management measures to decrease the risk.

Therefore, the aim of the work was to assess the «nanospecific» risk in the dental practice and develop tools for risk management.

Materials and methods of research

The risk assessment was made at workplaces of the dental technician, dentist-therapist, dentist-orthopedist at the Communal enterprise «Dentistry of the Sviatoshyn district of Kyiv». The «nanospecific» risk was calculated using the «control banding» tool [3, 6].

Results and discussion

In the earlier studies the exposure to nanosized fractions of the nanocomposite materials at dental workplaces was assessed. It was determined that the work

of the dentist, dentist-orthopedist, and dentist-therapist is followed by emission of nanoparticles to the air of the working zone [1]. The data on the exposure were used for risk assessment. The toxicity of materials, which were used in the orthopedic department and in the laboratory, was evaluated on the base of the literature data [2, 7].

Using of the «control banding» tool allowed to assess risk for workers of the therapeutic department, orthopedic department, and laboratory. In particular, in the therapeutic department calculations were made for three components of the nanocomposite dental restoration material Filtek Supreme XT (3M ESPE), consisting of the matrixes BisGMA, TEGDMA, UDMA, BisEMA and filling compounds:

- sintered nanoclusters of zirconium (5–20 nm);
- hydroxyapatite (10 nm, 50–100 nm);
- non-sintered particles of silicon (20 nm).

Based on the sintered nanoclusters of zirconium the toxicity results in 77,5 points, the non-sintered particles of silicon – 72,5 points, the hydroxyapatite – 67,5 points. The total sum, which was calculated by exposure indications, results in 55,0 points.

Therefore, when these points based on the toxicity and exposure, were assigned to the «control band matrix» (Table), the risk level 4 (RL4) was determined at the intersection of the obtained values for the sintered nanoclusters of zirconium. The RL4 («Seek specialist advice») corresponds to the highest risk nominally (whereas control band RL1 corresponds to the minimal risk) and requires broad decision making for the risk lowering, including measures which are specified for the RL1 («General ventilation»), RL2 («Fume hoods or local exhaust ventilation»), and RL3 («Containment») as well as administrative measures (shift duration, frequent wet cleaning, premise airing, nanomaterial change, etc.) and recommendations on individual protective equipment.

It is seen in the Table 1 that the RL3 («Containment») corresponds to the other components of the nanocomposite material Filtek Supreme XT (3M ESPE) – non-sintered particles of silicon and hydroxyapatite.

As usual, recommendation «Containment» may include modification of the production process (e. g. change of dry substance to wet one); automation or cancellation of some operations in the production process of the high risk; change of toxic or hazardous substances to less aggressive (reactive) ones; change of the equipment (including, obsolete one). For oper-

ations of the high risk the isolation of the equipment in the stalls as well as local ventilation system are proposed.

In the cases, when engineer's measures implementation is impossible, administrative measures are required: informing and learning of workers, hygiene at workplace (ban on eating, drinking, smoking); optimization of the production process, shortening of the working shift duration, in particular; reduction of the staff; entering only for the authorized staff; premise cleaning; storage of dry nanomaterials in closed containers.

At the same time, a notice that the RL4 is called «Seek specialist advice» for a reason, because only expert, who looks into a matter of nanosafety at workplace, can make a relevant decision about actual risk for workers and measures that have different effectiveness in the so-called ranking of the risk control (Figure). Therefore, considering that the dental nanocomposite materials are stored in separate containers and not milled in the storage conditions, the risk control in this case does not require their changeover.

In the therapeutic department the following risk control measures during the work with nanomaterials are recommended: limited access of unauthorized persons during manipulations with the material; providing of the appropriate level of ventilation; frequent wet cleaning; using the personal protective equipment (protection of the respiratory system, skin, and eyes).

Therefore, in the orthopedic department doctors use plastic materials Lucitone 199 (Dentsly), which contain multilayer carbon nanotubes. The total sum of the toxicity points, calculated upon this component was 75, whereas points, calculated upon exposure at workplace, come out at 72,5. This corresponds to the LR3 (Table). In this case the RL3 requires a limited access for the unauthorized persons during manipulations with the material; execution of instructions about Lucitone 199 storage and recycling; using personal protective equipment in manipulations with the material.

In the laboratory the risk was assessed based on the disk NanoZR of the CAD/CAM systems (Panasonic), which contains nanoparticles of the tetragonal zirconium oxide and nanoparticles of aluminium oxide. The total sum of the toxicity points was 67,5, whereas that of the exposition points – 90, that corresponds to the RL4 (Table). It should be noted that the previous study showed that among dental

Table

Matrix for determination of the control band on the base of the nanomaterial toxicity and exposure at workplace

Probability	Extremely Unlikely (0–25)	Less Likely (26–50)	Likely (51–75) (55 – TD*) (72,5 – OD*)	Probable (76–100) (90 L*)
Severity				
Very High (76–100) (77,5 – zirconium – TD*)	RL 3	RL 3	RL4	RL 4
High (51–75) (75 – OD*) (72,5 – silicon, 67,5 – hydroxyapatite – TD*) (67,5 – L*)	RL 2	RL 2	RL 3	RL 4
Mean (26–50)	RL 1	RL 1	RL 2	RL 3
Low (0–25)	RL 1	RL 1	RL 1	RL 2

Note. *OD – Orthopedic Department, TD – Therapeutic Department, L – Laboratory, RL 1 – General Ventilation, RL 2 – Fume hoods or local exhaust ventilation, RL 3 – Containment, RL 4 – Seek specialist advice.

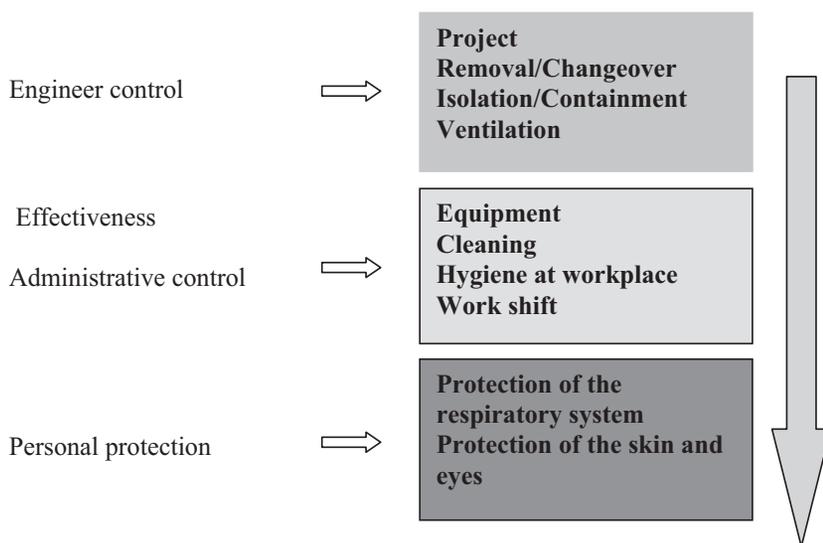


Figure. Risk control ranking

service workers just the work of the dental technician is followed by the maximum emission of nanoparticles in the working zone air [1]. Thus, in the laboratory it is reasonable to pay maximum attention to both common and local exhaust ventilation, hygiene at workplace, conditions of the storage and recycling of materials, limited access for unauthorized persons as well as to the use of the personal protective equipment during the whole shift.

Therefore, work of the dentist-therapist, dentist-orthopedist, and dental technician is characterized by the increased risk due to using modern dental materi-

als. This work requires 'nanospecific' risk control measures.

Conclusion

1. It is determined that the work of the dentist-therapist, dentist-orthopedist, and dental technician is characterized by the increased risk due to using modern dental materials and requires 'nanospecific' risk control measures.
2. The obtained results prove the necessity of the further deeper studies on the toxicity of modern nanomaterials in the current dental practice.

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ОЦІНКА ТА КЕРУВАННЯ РИЗИКОМ ПРИ ВИКОРИСТАННІ СУЧАСНИХ СТОМАТОЛОГІЧНИХ МАТЕРІАЛІВ

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Вступ. Використання нових технологій та сучасних наноматеріалів (нанокомпозити, біоактивні покриття та ін.) у стоматологічній практиці може підвищувати потенційні ризики для фахівців стоматологічної служби.

Мета дослідження – оцінити «наноспецифічний» ризик в стоматологічній практиці та розробити засоби щодо керування ним.

Матеріали та методи дослідження. Оцінку ризику здійснено для робочих місць зубного техника, лікаря стоматолога-терапевта, лікаря стоматолога-ортопеда. «Наноспецифічний» ризик розраховували за допомогою підходу «контрольних смуг».

Результати. Встановлено, що діяльність лікаря-терапевта, лікаря-ортопеда та зубного техника характеризується підвищеним професійним ризиком через використання сучасних композитних матеріалів. Запроновано заходи щодо керування «наноспецифічним» ризиком на робочому місці (загальна та місцева вентиляція, обмеження доступу до приміщення сторонніх осіб, засоби індивідуального захисту та ін.).

Висновки. Отримані результати свідчать на користь проведення поглиблених досліджень щодо токсичності сучасних наноматеріалів у стоматологічній практиці.

Ключові слова: оцінка ризику, смуги контролю, композитні матеріали, стоматологія

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ОЦЕНКА И УПРАВЛЕНИЕ РИСКОМ ПРИ ИСПОЛЬЗОВАНИИ СОВРЕМЕННЫХ СТОМАТОЛОГИЧЕСКИХ МАТЕРИАЛОВ

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Введение. Использование новых технологий и современных наноматериалов (нанокомпозитов, биоактивных покрытий и др.) в стоматологической практике может повышать потенциальные риски для специалистов стоматологической службы.

Цель исследования – оценить «наноспецифический» риск в стоматологической практике и разработать средства по управлению им.

Материалы и методы исследования. Оценку риска проведено для рабочих мест зубного техника, врача стоматолога-терапевта, врача стоматолога-ортопеда. «Наноспецифический» риск рассчитывали с помощью подхода «контрольных полос».

Результаты. Установлено, что деятельность врача-терапевта, врача-ортопеда и зубного техника характеризуется повышенным профессиональным риском из-за использования современных стоматологических наноматериалов. Предложены меры по управлению «наноспецифическим» риском на рабочем месте (общая и местная вентиляция, ограничения доступа в помещение посторонних лиц, средства индивидуальной защиты и др.).

Выводы. Полученные результаты свидетельствуют в пользу проведения углубленных исследований токсичности современных наноматериалов в стоматологической практике.

Ключевые слова: оценка риска, полосы контроля, композитные материалы, стоматология

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