

## THE PROBLEM OF USAGE OF DRUGS WITHOUT PRESCRIPTIONS BY THE YOUTH

Lucyna Szefczyk-Polowczyk, Agata Zygmunt, Malwina Respondek, Karina Wengel

Medical University of Silesia

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**Summary:** Introduction. Self-treatment, defined as application of drugs without prescription without consulting your doctor has become a common phenomenon. Easy access to this group of pharmaceutical. advertising campaigns and lack of awareness of adverse effects as a result of incorrect application makes drugs without prescription the medications which have become our first choice.

The aim of the study is to assess the problem of the use of over the counter (OTC) drugs by young people living in the Silesian Voivodeship.

Material and methods. The study included 180 persons from the Silesian voivodeship at the age of 18-30.

The research tool was an author's, anonymous questionnaire. The questions included within it concerned, among others: frequency, form and side effects of drugs applied without prescription.

Results. Despite the fact that the majority of respondents (57%) assess their health state as good, the overwhelming number of people (91%) report applying medications without a prescription. The most popular OTC pharmaceutical products include painkillers and vitamins. One in five respondents (20%) admits that he or she consumes more medication than it is recommended in the package leaflet.

Conclusions. Very good and good health state declared by the respondents does not exclude accepting their medication without prescription. In case of treatment of intermittent or mild symptoms, the use of medications without a prescription – saves patient's time and unburdens health care system. This phenomenon, however, is a challenge for the public health sector. Actions must be undertaken which are aimed at raising consumers-patients' awareness regarding the dangers posed by improper use of OTC drugs.

**Keywords:** non-prescription drugs, self-treatment, OTC

### Introduction

Drugs available without a prescription are pharmaceutical agents that can be applied without doctor supervision. Most often they are purchased in pharmacies, supermarkets and petrol stations (Roguska, Feliksiak 2010). Most people when buying these drugs do not realize that there are health-related consequences of improper use of such pharmaceuticals. The adverse health and life impacting effects may be caused not only by an overdose, but also there is a possible occurrence of side effects and interactions with other consumed drugs (Światowy 2006). The most common reasons for the use of medications without a prescription include: pain relief and improvement of health condition. The choice of a medicament by the consumer is influenced by many factors. The most important of them include: economic, demographic, social and cultural factors (Czerw 2008).

Every year Poland experiences a growing number of sold non-prescription drugs. It is considered that the market of over the counter drugs (OTC) is one of the fastest growing segments of the pharmaceutical market. K. Krajewski-Siuda believes that "the market of non-prescription drugs comprises as much as a quarter (26%) of the value of the pharmaceutical market and it is relatively the highest value in Europe" (Krajewski-Siuda 2012). The value of income from the sale of OTC drugs in Poland since 1996 has increased from 1 to 4 billion compared to 2006 (Krajewska-Kułał et al. 2011). Subsequent reports show that in the year 2012 the market of OTC products in our country reached 8.93 PLN billion (www.pmrpublications.com). Central Statistical Office reports that in 2006, only 2% of households did not buy this type of pharmaceuticals (GUS 2011).

**Address for correspondence:** Lucyna Szefczyk-Polowczyk, Medical University of Silesia, Department of Public Health, Chair of Emergency Medicine and Child Neurosurgery, Piekarska 18 street, 41-902 Bytom, e-mail: lucynka.szefczyk@gmail.com, phone: 690 433 169

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The phenomenon of the mass acquisition of OTC drugs is associated with an increase in the wealth of Poles as well as an increased awareness of their own health (Pączkowska 2008).

The promotional tool within the OTC market is primarily advertising, aimed at both patients-consumers of drugs, as well as intermediary agents in the process of purchasing these drugs. The decisions which drugs to purchase without a prescription are also affected by other factors such as the pharmacist's advice, as well as the effectiveness of the benefits offered in the form of lower prices or certain drugs and the possibility of obtaining free samples.

The wide availability of OTC drugs carries the risk of their excessive use, leading to the phenomenon of addiction to medication.

The pace of life in recent years causes the use of drugs without prescription by many people being an alternative to a visit to a doctor. Their excessive use is becoming a dangerous phenomenon for the health and life of people. The most frequently applied group of commonly available pharmaceuticals are non-steroidal anti-inflammatory drugs (NSAID). It is estimated, according to Kuźniar-Placek et al. (2012) that as a result of complications associated with the improper use of NSAIDs there are approx. 3 000 deaths per annum in Poland (Kuźniar-Placek et al. 2012).

The use of non-prescription drugs has become particularly threatening among young people. Sedatives and hypnotics used without prescription are – after cigarettes, alcohol, and marijuana -the most prevalent abusive substances among young people. Studies carried out so far regarding the use of non-prescription drugs mainly focused on the elderly, but there is little data on patterns of the consumption of these drugs by young people (Woynarowska, Mazur 2011).

The purpose of this study was to investigate the effects of the use of OTC drugs among young people from the voivodeship of Silesia.

## Material and methods

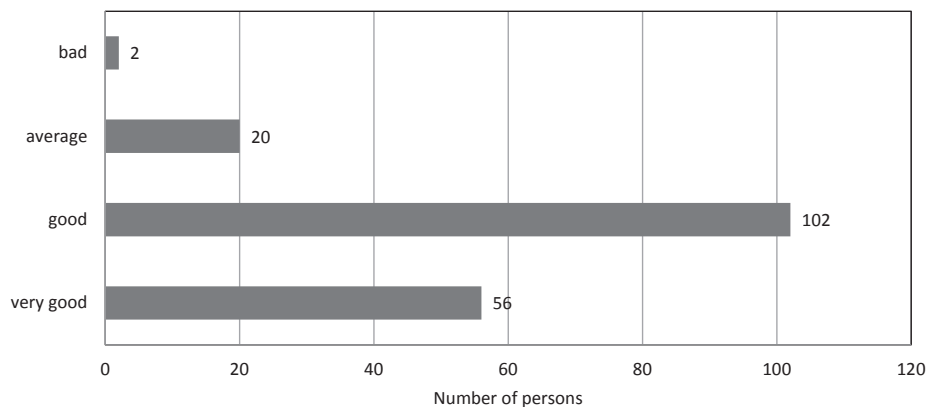
The study group consisted of 180 people aged 18 to 30 living in the Silesian Voivodeship. The conducted study involved 115 women and 65 men. Among the 180 respondents, 75% lived in the city, and 25% inhabited rural areas. Education of respondents is as follows:

- higher education: 100 people,
- vocational education: 50 people,
- secondary education: 15 people,
- basic education: 15 people.

The research method within this study was a survey, while the research technique-a questionnaire. The respondents covered by the author's anonymous questionnaire gave answers to questions about applying medications without a prescription.

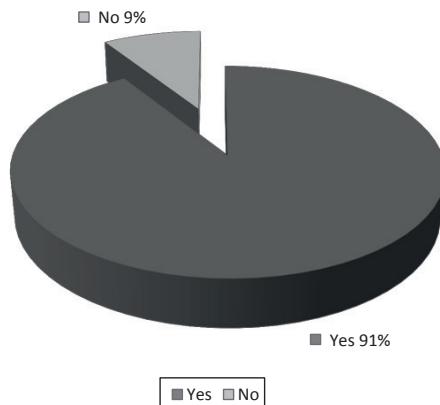
## Research results

Among those who took part in the study, 85% stated that they do not suffer from chronic diseases (153 people). Other people (15%) require continuous treatment (27 people). Very good health condition was declared by 31% of people, while a good condition was indicated by 57% of respondents (figure 1).



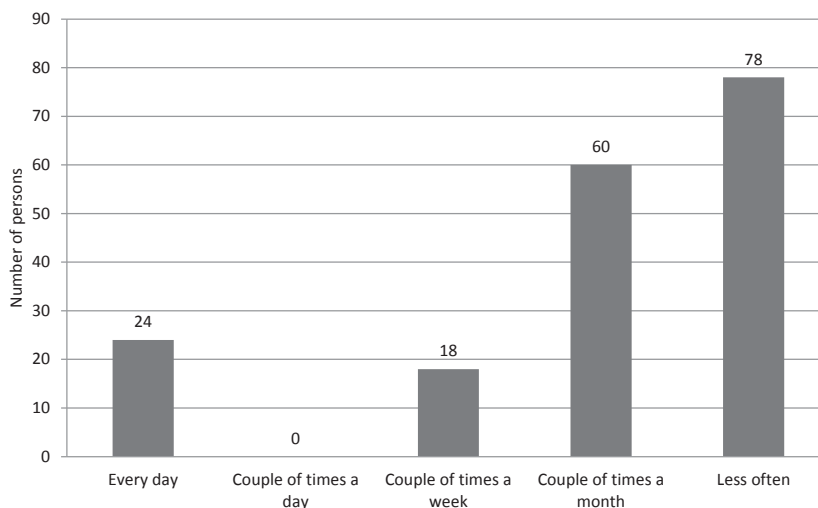
**Figure 1.** State of health of the respondents in their subjective opinion

Use of medicines without a prescription is declared by 91% of the respondents (164 people). Only 9% of those participating in the study acknowledges that they do not accept this type of medication (16 people) (figure 2).



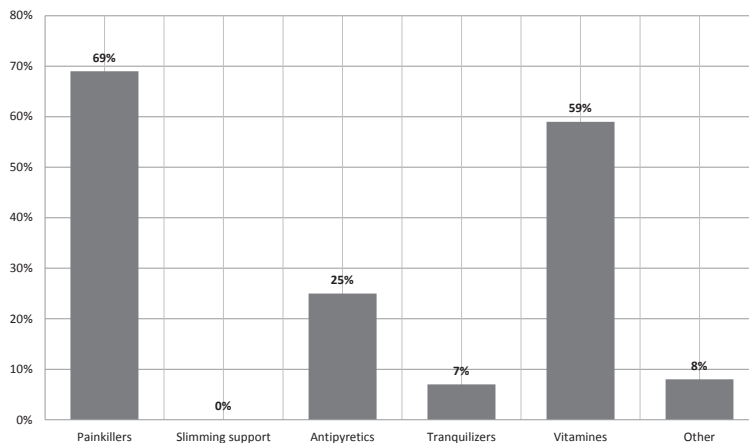
**Figure 2.** The use of medicines without prescription (OTC) by respondents

Frequency of use of medicines without prescription by the respondents is presented by figure 3.



**Figure 3.** Frequency of use of medicines without prescription by the respondents

Most often selected by the respondents groups of pharmaceuticals are painkillers (69%) and vitamin supplements (59%). The respondents were least likely to apply slimming preparations (figure 4).



**Figure 4.** Groups of drugs applied by the respondents

The most preferred form of drug among the recipients are the pills. This answer was selected by 86% of the researched (155 persons) (figure 5).

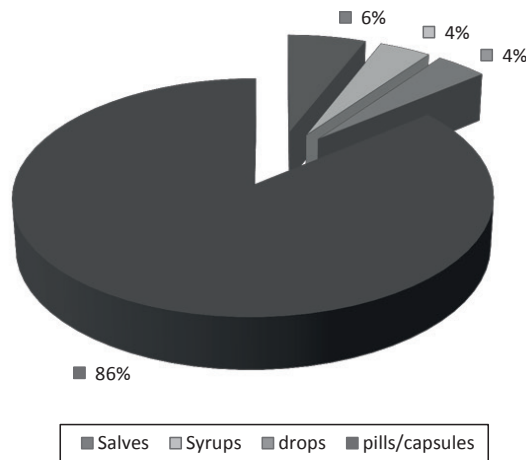


Figure 5. The form of drugs chosen by the respondents

The application of OTC medication in doses greater than it is recommended in the leaflet is indicated by 20% of the respondents (36 people). The vast majority of respondents (80%) do not exceed the recommended dose (144 people). 13% of respondents experienced side effects after taking the drug without a prescription (23 people). Other people have not experienced any negative symptoms after use of OTC drugs (87% - 157osób).

When analyzing the determinants influencing the decision to purchase OTC drugs by the respondents it was noted that the respondents are persuaded first by its effectiveness (48%). The opinion of the respondents is also a pharmacist is also important for the respondents (figure 6).

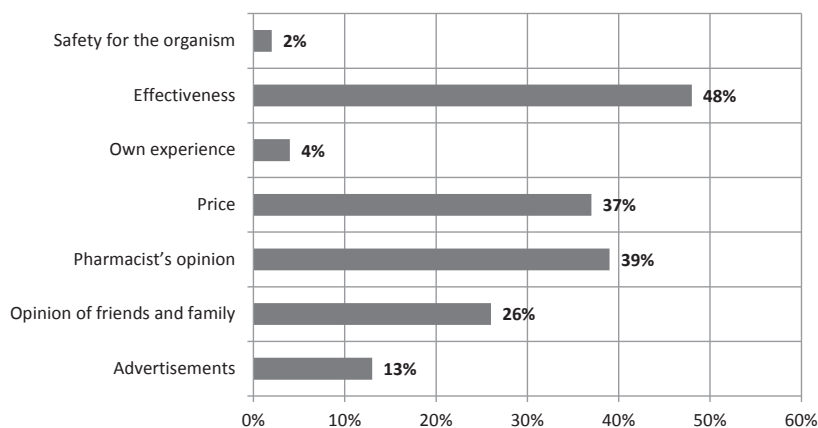


Figure 6. Determinants impacting the decision of purchasing OTC drugs by respondents

What raises concern is the fact that among half of the respondents there are individuals who feel that OTC medicines are safer for the body than prescription drugs purchased (figure 7).

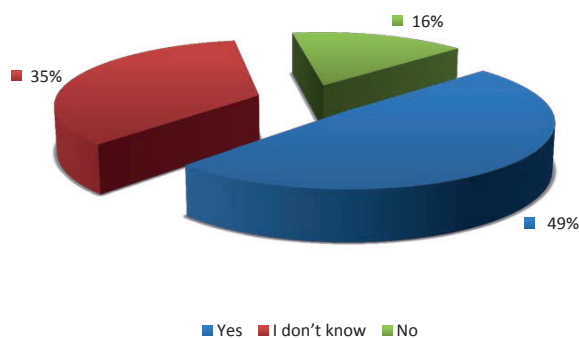


Figure 7. Answer of the respondent to the question „Do you think that medicines without prescription are safer for your organism than drugs prescribed by a doctor?”

## Discussion

The use of OTC is becoming a mass phenomenon. The researched persons are young people (18-30 years old) and their use of the drugs without prescription is quite common. Respondents admit that their health condition is satisfactory, and at the same time it is not a contraindication to the use of OTC drugs. It is difficult to compare the incidence of OTC medicines use by patients, as the authors of similar works differently define the concept of frequency. Work by Pączkowska contains a subjective term "often", "very often" (Pączkowska 2008). Whilst Wolano suggests that most respondents are taking medicines without a prescription once a month (45%) (Wolano 2012). In this study, respondents most frequently responded that OTC medication are used by them at least a few times a month (43%). When analyzing the results of the forms of drugs preferred by the respondents, it was noted that these were the tablets. This information is confirmed in the work of Kasperczyk et al. (2007).

A significant proportion of respondents considered applying pharmaceutical drugs without a prescription as less dangerous for the body than drugs prescribed by a doctor. Part of the respondents admit to exceeding the recommended dose. Side effects of using OTC drugs occurred in 13% of subjects, a similar result was obtained in the study of Wolano -15.71% (Wolano 2011).

The danger of OTC medication use involves the simultaneous adoption of preparations from the same class of drugs (even in the amounts indicated in the package leaflet). Patients often unknowingly exceed the acceptable amount of a particular substance. This is for example in the case of analgesics and antiphlogistics which contain ibuprofen, naproxen, acetylsalicylic acid or diclofenac applied also for self-treatment of colds. These preparations belong to the group of non-steroidal anti-inflammatory drugs (NSAID). Simultaneous use of several painkillers containing these substances most often does not produce synergistic effects, but it creates a huge risk of nephrotoxicity or hepatotoxicity and may lead to an imminent threat to the life of the patient. Extensive information is provided within the work presented by Woron J. (Woron 2012) and within the article by Hartman M. (Hartman et al. 2012).

In 2007, three people with severe bone marrow were admitted to the Katowice Hematology Clinic. Doctors confirmed that the health status of patients was the result of long-term, excessive use of analgesics. Patients who were admitted to the Clinic were all under 30 years of age, one of them died (Walewski 2010).

The above information is important due to the fact that according to the research carried out by the authors the respondents most often chose analgesics, antipyretics and vitamin supplements from the OTC groups of drugs. Similar results are provided by the work by Ruohola et al. (2009) as well as studies exploring the Polish market of OTC drugs (Pączkowska 2008, Wolano 2012; Wdowiak et al. 2006).

An important problem of the use of non-prescription drugs may be masking the fact of serious, life-threatening diseases. OTC formulations used are often effective to alleviate pain, which can be a symptom of chronic diseases, which unchecked, may lead to death (Szkolnicka 2005).

Despite the risks posed by improper use of OTC drugs, it is worth noting that, according to the WHO, their reasonable application effectively relieves the health care system, raises the level of use of vitamin supplements used prophylactically, thereby increasing the awareness of health prevention (WHO 2000).

Both drugs purchased without a prescription and those issued on prescription ought to be used in accordance with the product leaflet. An important and often underestimated role in case of doubt of the patient is played by the advice taken from the pharmacist.

## Conclusions

The phenomenon of medication use among the respondents is very common. Respondents admit to consuming higher doses of medication than it is recommended in the package insert of the drug, which may pose a threat to their health and even to their life.

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**DIZZINESS – PATHOGENESIS, DIAGNOSIS AND TREATMENT****Marek Tomaszewski<sup>1</sup>, Katarzyna Banakiewicz<sup>2</sup>, Krzysztof Jajko<sup>2</sup>, Roman Szypowski<sup>2</sup>, Paweł Zieliński<sup>2</sup>, Grzegorz Zalewski<sup>2</sup>, Grażyna Olchowik<sup>1</sup>**<sup>1</sup>Pope John Paul II State School of Higher Education in Biała Podlaska<sup>2</sup>Anatomic Group at the Chair and Department of Human Anatomy, Medical University of Lublin

Tomaszewski M., Banakiewicz K., Jajko K., Szypowski R., Zieliński P., Zalewski G., Olchowik G. (2015), *Dizziness – pathogenesis, diagnosis and treatment*. Health Problems of Civilization, 1 (9), p. 11-17

**Summary:** Dizziness is a symptom of many diseases. Patients very frequently come with such ailment to the hospital emergency department. It is a state which may last a few seconds or minutes and increase or recede with time. Therefore, the admitted patients frequently cannot assess their own illness in a precise and objective way. The dizziness definition is also quite ambiguous. Dizziness is defined as the sensation of one own's body movement or spinning and movement of the surrounding. It is very important to record the patient's medical history since the diagnostic procedure may depend on the symptoms' character. Dizziness may be a symptom of a serious disease, although it is not easy to find its cause. It appears not only in case of the labyrinth and nervous system disorders, but also in the systemic and functional diseases.

Dizziness and balance disorder are the direct cause of admitting one in every thirty patients. The symptom indicated the directly life-threatening disease only within the 3-8.5% of patients (cerebral circulation insufficiency - 6%, cardiac dysrhythmia - 1.5%, brain tumour < 1%). Analyzing the data concerning the problem of dizziness occurrence within the general population, it has been noticed that this symptom has been reported two or three times more frequent by women than by men.

Dizzinesses are classified pathogenetically and clinically into labyrinthine and non-labyrinthine, paroxysmal and permanent, acute and chronic.

Dizziness is hard to diagnose because the symptoms reported by patients are only their own subjective sensations. The data presented in the article implicate the increasing number of patients with such disorders. Apart from dizziness, the patients complain also about the hearing disorders and nausea, which make their proper functioning impossible.

It is inappropriate to start the treatment without knowing the cause. Establishing, on the basis of patient's medical history and physical examination, whether the dizziness is of peripheral or central origin, is essential for the further diagnosis. After establishing the main diagnosis, the casual and symptomatic treatment is implemented, in some cases - there is a vestibular rehabilitation or even a surgical treatment.

**Keywords:** dizziness, labyrinth, internal ear

**Introduction**

Dizziness is a symptom of many diseases. Patients come with such ailment to the hospital emergency department very frequently. It is a state which may last a few seconds or minutes and increase or recede with time. Therefore, the admitted patients frequently cannot assess their own illness in a precise and objective way. The dizziness definition is also quite ambiguous. Dizziness is defined as the sensation of one own's body movement or spinning and movement of the surrounding.

It is very important to record the patient's medical history since the diagnostic procedure may depend on the symptoms' character. Dizziness may be a symptom of a serious disease, although it is not easy to find its cause. They appear not only in case of the labyrinth and nervous system disorders, but also in the systemic and functional diseases.

Primarily, the neurology and laryngology experts are the ones who deal with the dizziness treatment, although, in many cases, it is an interdisciplinary problem due to its complicated aetiology. The dizziness treatment is based on casual and symptomatic treatment. Pharmacology, vestibular rehabilitation, and surgical treatment are applied.

**Address for correspondence:** Marek Tomaszewski, Pope John Paul II State School of Higher Education in Biała Podlaska, Sidorska 95/97 Street, 21-500 Biała Podlaska, e-mail: tomaszewski.marek@gmail.com, phone: (83) 344 99 18

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## Epidemiology

Dizziness and balance disorder are the direct cause of admitting one in every thirty patients. The symptom indicated the directly life-threatening disease only within the 3-8.5% of patients (cerebral circulation insufficiency - 6%, cardiac dysrhythmia - 1.5%, brain tumour < 1%) (Seemungal 2007; Kroenke et al. 2000).

According to the data collected and analyzed by the researchers of Medical University of Baltimore in the United States, the diagnosis of the patients experiencing dizziness in the emergency department becomes more and more expensive. The research conducted in 2003-2008 indicates that 4 billion dollars were spent averagely per year, which represent 4% of all the costs borne by those departments in the United States. It has been observed that increasing number of patients reporting dizziness has been admitted to hospital. At the same time, the frequency of doing the imaging tests has also increased (Saber Tehrani et al. 2013).

Analyzing the data concerning the problem of dizziness occurrence within the general population, it has been noticed that this symptom was reported two or three times more frequent by women than by men (Neuhauser, Lempert 2009). According to the British research covering the large population of people (2000) of working age (18-64 years old), dizziness is a problem concerning many adults. About 20% of people felt dizziness at least once in a month. Out of this group, nearly 1/3 of people suffered from the recurring dizziness for few years (Tacikowska, Kubiczek-Jagielska 2010).

Elderly people report the problems with balance and anxiety about falling down more frequently than any other age group (Colledge 1999). They occur in case of one out of five people over 65 years old. The serious cause of dizziness is found among 20% of patients over 50 years old (Lo 2013).

The disease concerns also the children. The research on the group of 1050 children conducted by Riina Niemensivu and et al. implied that 23% of the children suffered from dizziness, which considerably influences their comfort of life, 8% of them experienced dizziness at least once (Niemensivu et al. 2006).

## Dizziness classification

Dizziness classification into systemic and non-systemic, introduced by Hitz in the 19th century, is still applied in the clinical practice.

When the ailments are sudden and paroxysmal, the patients report the sensation of spinning and moving of the surrounding against their own bodies; it suggests the systemic, also known as peripheral, aetiology of dizziness (Domżał 2010). The above mentioned symptoms do not usually last longer than 3 weeks; they are often accompanied by hearing impairment, and head movements intensify the ailments (Storper 2005). This state is mostly caused by damaging the peripheral part of vestibular system. The patient is then able to point the direction of spinning and such type of dizziness is called "vertigo".

The less specific sensation of posture and walk instability, hardly determinable time of first symptoms, and chronic complaints indicate the dizziness of non-systemic, or central origin. Visual impairments, convulsion, and loss of consciousness are also typical for the described problem. Such ailments is usually of neurological origin (Janczewski 2000). The patients then has difficulty with pointing the direction of spinning. Such state is described as "dizziness". Such disorders can frequently be observed in case of elderly people, since the disorders are connected to the cognitive functions that decline with age (Pongrácz 2011, Maarsingh et al. 2010). The distinction between systemic and non-systemic dizziness is only the summary of medical history and the introduction to the further diagnosis (Table 1) (Prusiński 2011).

There is also a pathogenic and clinical classification of dizziness: labyrinthine and non-labyrinthine, paroxysmal and permanent, acute and chronic.

**Table 1.** Comparison of dizziness of central and peripheral origin

Clinical signs	Dizziness of central (non-systemic) origin	Dizziness of peripheral (systemic) origin
Character of complaints	difficult to define sensation of staggering, collapsing, instable posture and walk	illusion of circular movement
Beginning of symptoms	difficult to establish, gradual	sudden, paroxysmal
Intensity	moderate or low, symptoms of the same intensity continue to be chronic	the most intense symptoms at the beginning, getting lower with time
Single episode	lasting few seconds, may cause a fall	remaining for several minutes to several hours



Clinical signs	Dizziness of central (non-systemic) origin	Dizziness of peripheral (systemic) origin
Duration of complaints	months, years	few weeks
Head movement	small influence on the symptoms	intensifying the symptoms
Hearing disorders	none	there is often a hearing impairment, usually on the damaged labyrinth's side
Convulsion	possible	none
Disturbance of consciousness	possible	none
Headache	frequent	seldom
Visual impairments	diplopia, amblyopia, scotoma, reduced visual acuity	none
Symptoms of CNS damage	frequent limb and cranial nerves pareses	there may only appear a peripheral facial paresis
Nystagmus	spontaneous, high amplitude, possible nystagmus of low amplitude	horizontal, intensifying with every direction of fixation

Source: Prusiński 2011; Szczelik 2011; Litwin and Członkowska 2008.

### Terminology

It is worth to add that concepts of “vertigo” and “dizziness” mean something different in the United States, whereas in other countries they can be used interchangeably. In Poland, each disorder of this type is called “dizziness” (Narożny et al. 2010).

In 1972, Drachman and Hart introduced the following concepts connected to balance disorder (no equivalent in Polish) (Tacikowska, Kubiczek-Jagielska 2010, Narożny et al. 2010):

- *presyncope* - it is caused by the reduced blood flow to the brain, resulted from the emotions or pressure drop. The patients pal. sweat, have narrow visual field, feel that their legs are weak (“feel groggy”), and their ears tingle.
- *disequilibrium* - occurs in case of patients with ataxia and loss of proprioception. The patients have a sensation of posture instability.
- *lightheadedness* - a difficult to define sensation of befuddlement, imbalance, described by the patients as “having a heavy head”. The cause of symptoms is indefinable in case of those patients. It is suspected that this type of disorders is of functional origin.

### Causes of peripheral (systemic) dizziness

#### – Inflammation of vestibular neuron:

Aetiology is not completely understood, although this affliction is usually preceded by viral infection. Therefore, there is an assumption that the virus is the main cause. It was impossible to dissect the contagium, therefore vascular aetiology and autoimmune aetiology are also taken into consideration. Mostly, it is a circular, sudden, and extreme dizziness which intensifies in time; it is often accompanied by vomiting and nausea (Kaski, Bronstein 2012). There are no hearing disorders, however, there is a horizontal nystagmus or horizontally rotational nystagmus. The attenuation or lack of excitability of labyrinth is shown by electronystagmography, and caloric stimulation is usually positive. In some cases, giving a small dose of steroids in the acute stage improves the long-standing prognosis. The anti-histamine and cholinolytic medicines are also applied and the vestibular rehabilitation is recommended as well (Zaper et al. 2012).

#### – Benign paroxysmal positioning vertigo (BPPV):

The aetiology of this state is not completely explained, although it has been suspected that the essence of the disease is the inappropriate movement of otoliths in the semicircular canals as a result of traumatic and postinflammatory changes. The ailments are caused by a sudden change of position, from seating to standing position or the rotational head movement. The attack is very short; it usually lasts less than 1 minute and it occurs during making the movement or in the so-called “critical position” (Balatsouras, Korres, 2012). It is often accompanied by a vertically rotational nystagmus. The hearing test is without any aberration. It is treated symptomatically and rehabilitatively using the freeing manoeuvres. The anti-histamine and cholinolytic medicines are used in the chronic therapy, but usually, taking them does not equal a complete remission (Continuum 2012). According to

the Maslovara's research conducted on the patients with benign paroxysmal positioning vertigo, using the same pharmacotherapy of betanecol chloride for 8 weeks and introducing the rehabilitation for 8 weeks influenced the increase of negative caloric stimulation. Both types of treatment influences the improvement of this trial's results (Maslovara et al. 2012).

– **Ménière's disease:**

The aetiology is not completely understood. It has been assumed that the disease may be of autoimmune origin (Kozubski and Liberski, 2011). The symptoms are caused by an excess of endolymph in cochlea. Ménière's disease, also called the endolymphatic hydrops, appears as a result of increased pressure within the utricle (Janczewski 2000). There are three characteristic ailments: dizziness, tinnitus, hearing loss. After the attack, the hearing comes back to normal, although later there may occur a permanent damage of hearing. Nevertheless, it is rarely a severe hearing loss (Foster, Breeze 2013). The anti-histamine and cholinolytic medicines, giving medicines through the tympanum, and pressure therapy are applied in the attacks treatment. Limiting the sodium consumption is recommended prophylactically. The operational treatment is applied as the last resort. However, it affects the hearing disorder (Strupp, Brandt 2013). Ménière's disease concerns also the children. In Sweden, there were 4 cases of children aged 4-7 years old. Those patients were diagnosed with this disease, although it was impossible to get an objective description of hearing symptoms, which constitutes the criteria for the diagnosis (Brantberg et al. 2002).

- Other causes of peripheral dizziness (Prusiński, 2002):
  - injuries (damaging the semicircular canal. labyrinth concussion),
  - labyrinth stroke,
  - acute or chronic inflammation of middle ear,
  - diseases of external ear,
  - ototoxic medicines,
  - congenital defect
  - cancers.

**Causes of central (non-systemic) dizziness:**

– **Cerebral circulation disorders:**

The main disorders of blood supply within posterior cranial fossa (brain stem and cerebellum) as well as thalamus and cortex of temporoparietal area appear in dizziness. Circulatory insufficiency within the vascularity of vertebral artery and basilar artery causes not only the dizziness but also vomiting, nausea, visual impairment, dysarthria, dysphagia, and ataxia. Dizziness appears suddenly during the day or in the morning after getting up. The disorders of cerebral circulation appear frequently as the consequence of systemic disease, like hypertension, hyperlipidemia. Treatment is primarily concerned with the reduction of risk factors, normalization of pressure, rehabilitation, anticoagulants, anti-aggregation medicines (Prusiński 2002).

– **Epilepsy:**

Dizziness, connected to epilepsy, appears as paroxysmal disorders. They may precede a generalized epileptic seizure, be a part of partial seizure, or appear as an isolated seizure. It should be remembered that anti-epileptic medicines (e.g. carbamazepine) may cause the side effects, like dizziness (Prusiński, 2002). The electroencephalographic examination is very important, especially when dizziness appears as isolated seizure, i.e. vestibular epilepsy (Kozubski, Liberski 2011).

– **Migraine:**

Dizziness appears among the group of symptoms or it accompanies the pain in about 25% of patients suffering from migraine. The patients report the sensation of instability and collapsing. A slight dizziness appears as isolated symptom in case of migraine-related vestibulopathy (Neuhauser 2009).

– **Other causes of central dizziness (Kulma 2009):**

- a. cerebellopontine angle tumors and compression changes of the posterior cranial fossa, hemangioma, metastatic tumor,
- b. inner damage of brain stem (e.g. arteriovenous malformations),
- c. damaging the eighth cranial nerve in systemic diseases,
- d. paraneoplastic syndromes,
- e. hereditary familial afflictions (e.g. spinocerebellar ataxia),
- f. multiple sclerosis,
- g. brain and cervical spine injuries,
- h. atrophy of cerebellum.

### Central-peripheral dizziness

Ramsay Hunt syndrome type II, also known as herpes zoster oticus, and cancers are accompanied by the mixed, peripheral and central symptoms. At first, there is the peripheral dizziness. Then, other nerves are damaged and the central dizziness appears (Litwin, Członkowska 2008).

### Dizziness in systemic and functional disorders

The dizziness may be caused by viral diseases (flu, measles, mumps), metabolic diseases, and hormonal diseases (diabetes, sclerosis, menopause) (Szczeklik 2011). Cardiac dysrhythmia should be highlighted among the factors that cause the cardiovascular dizziness (Tacikowska, Kubiczek-Jagielska 2010).

The described disorders appear also in case of neurosis and depression. However, they recede as the mental state is healed. This is the so-called functional dizziness.

### Diagnostics

Collecting a precise medical history of the patient suffering from dizziness is crucial because the further diagnostic process depends on it. The patients should describe the beginning of ailments, whether they appeared suddenly or were gradually intensifying, the duration of attack, the frequency of recurrences, the causing factors (verticalization, change of head position, small amount of sleep, infections, hypertension, taking medicines). The patient, who describes dizziness as the sensation of staggering and collapsing, complaining about the posture and walk instability, should be referred to tests that confirm the central dizziness. However, if the patient has the illusion of circular movement, it indicates the peripheral nature of dizziness. Nevertheless, it is not the rule and the patient's sensations are subjective. Other symptoms accompanying the dizziness are also important, e.g. hearing loss, earaches, ailments connected to damaging other cranial nerves, disturbances of consciousness, symptoms of focal brain injury (Tacikowska, Kubiczek-Jagielska 2010).

The physical examination should include static-dynamic tests, i.e. the Romberg's test, the Babiński-Weil's test, and the Unterberger's test. The occurrence of nystagmus, its direction, amplitude, and duration can be examined by electronystagmography, videonystagmography, and caloric stimulation (Hallpike's test). It is important to examine the eye movement as the disorder may indicate the central damage. It is necessary to do the otoscopic examination, pure tone audiometry, and impedance audiometry, brainstem auditory potentials.

If the cause is still unknown, there is a need for neuroimaging examination (computer tomography/magnetic resonance), posturography, examination of blood flow in extracranial and intracranial arteries, and serological examinations (Litwin, Członkowska 2008).

### Therapeutic procedures

The condition and functioning of a patient with dizziness should be assessed in the hospital emergency ward after collecting the medical history and doing the physical examination of the patient. It should be decided whether the patients is able to keep the static and dynamic posture and whether there is a risk of fall (Tacikowska, Kubiczek-Jagielska 2010). The neurologist and otolaryngologist should decide on the further diagnostic process and put the treatment into practice after finding the cause.

The treatment of dizziness connected to the systemic diseases, migraine, epilepsy, or multiple sclerosis is based on the casual treatment and supportive symptomatic treatment. *Antivertiginosa* is a term defining the medicines which reduce the sensation of dizziness and accompanying symptoms, e.g. anxiety. Such medicines include the following groups: medicines inhibiting the CNS (neuroleptics, anxiolytics, first-generation antihistamines, cholinolytics), vascular medicines (calcium antagonists, nicotin acid and its methylxanthene derivative, medicines blocking the  $\alpha$ -adrenergic receptors), cytoprotective medicines (neuroprotective) (Litwin, Członkowska 2008).

Operational treatment concerns the cases when the cause of dizziness is known (e.g. otosclerosis, fistula, proliferative changes, some of the vascular disorders), when the improvement after the conservative treatment is insufficient and the vestibular symptoms are progressive (Tacikowska, Kubiczek-Jagielska 2010).

The vestibular rehabilitation is a very important element of therapy in case of many patients and it should be taken into consideration while planning the dizziness treatment according to the latest standards (Obrębowicz 2010). Currently, it includes: the movement therapy stimulating the processes of vestibular disorders compensation and the therapy of benign paroxysmal positioning vertigo (Józefowicz-Korczyńska 2010). The rehabilitation is based on two mechanisms that exist mainly in cerebellum and brain stem: adaptation and compensation (Shepard, Telian 1995).

The procedure concerning the particular disease entities has been described above, while discussing the causes of peripheral and central dizziness.

## Conclusions

It is extremely difficult to compare the examinations done in different parts of the world due to the unsystematic terminology concerning dizziness and unsystematic methodology of examining dizziness and balance disorders. The lack of normalized concepts may easily cause the confusion and it would be harder for a doctor to use the provided information.

As the article emphasizes, the neurologist and otolaryngologist are not the only ones who should demonstrate their knowledge concerning dizziness, since dizziness is a problem that patients report to doctors of various specialities. It is necessary to remember that the cause of dizziness always has to be found, although dizziness is usually mild and unrelated to excess mortality.

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**THE AIRWAY OBSTRUCTION – IMPORTANT ABRUPT CONDITION FOR PEDIATRICS****Marek Tomaszewski<sup>1,2</sup>, Katarzyna Banakiewicz<sup>3</sup>, Krzysztof Jajko<sup>3</sup>, Roman Szypowski<sup>3</sup>, Paweł Zieliński<sup>3</sup>, Grzegorz Zalewski<sup>3</sup>, Stanisława Spisacka<sup>2</sup>, Grażyna Olchowik<sup>2,4</sup>**<sup>1</sup>Department of Human Anatomy, Medical University of Lublin<sup>2</sup>John Paul II State School of Higher Education in Biała Podlaska<sup>3</sup>Anatomic Group at the Chair and Department of Human Anatomy, Medical University of Lublin<sup>4</sup>Department of Biophysics, Medical University of Lublin

Tomaszewski M., Banakiewicz K., Jajko K., Szypowski R., Zieliński P., Zalewski G., Spisacka S., Olchowik G. (2015), *The airway obstruction – important abrupt condition for pediatrics*. Health Problems of Civilization, 1 (9), p. 18-22

**Summary:** The ability of fast response in case of increasing health problems of a child which lead directly to life-threatening situations is a necessary condition for creating opportunity of child's survival until it will be transported to intensive care unit, where it will be provided with care by a specialist. In case of healthy children the most common cause of acute respiratory failure is obstruction of upper respiratory tract. There is an enormous variety of causes of upper airway obstruction, but the most important are the result of congenital defects, acute inflammation, anaphylactic reactions, foreign body aspiration and injuries. Consequence of the hypoventilation resulting from significant impediment of airflow through the obstructed airways is impaired gas exchange in the lungs. This leads to the increasing hypoxemia ( $PaO_2 < 60$  mmHg) and hypercapnia ( $PaCO_2 > 45$  mmHg). This condition is called the total respiratory failure. The persistence of hypoventilation leads to hypoxia of vital organs (heart muscle, brain), increased anaerobic metabolism, acidosis, and inevitably to cardiac arrest as a result of homeostasis disorders. Respiratory failure is defined as acute when developing suddenly and is potentially reversible. We can find such a situation in the fast-increasing stenosis of the larynx. Symptoms of severe dyspnoea occur in a short time, but can be interrupted by an effective airway patency. Acute respiratory failure is a state of direct threat to life, which is why it is crucial to give a prompt aid to the sick child. The aim of this paper is to discuss the signs and symptoms, knowledge of which is essential for rapid identification and initial differentiation of the causes of acute upper airway obstruction in children. The principles of first-aid for children with acute respiratory failure and above all the description of life-saving procedures will be presented.

**Keywords:** airway obstruction, hypoxemia, hypercapnia, respiratory failure

**Introduction - acute respiratory failure (ARF)**

One of the most common causes of ARF in previously healthy children is obstruction of the upper airways (UA). There is a huge variety of causes of obstruction of UA, but the most important ones are the result of congenital defects, acute inflammation, anaphylactic reactions, foreign body aspiration and injuries (Oleniacz 2008). Consequence of the hypoventilation resulting from significant impediment of airflow through the obstructed airways is impaired gas exchange in the lungs. This leads to the increasing hypoxemia ( $PaO_2 < 60$  mmHg) and hypercapnia ( $PaCO_2 > 45$  mmHg). This condition is called the total respiratory failure (Szczeklik 2010). The persistence of hypoventilation leads to hypoxia of vital organs (heart muscle, brain), increased anaerobic metabolism, acidosis, and inevitably to cardiac arrest as a result of homeostasis disorders. Respiratory failure is defined as acute when developing suddenly and is potentially reversible. We can find such a situation in the fast-increasing stenosis of the larynx (Daniel 2006; Kwong et al. 2007). Symptoms of severe dyspnoea occur in a short time, but can be interrupted by an effective airway patency. ARF is a state of direct threat to life, for this reason it is crucial to give a prompt aid to the sick child.

**Address for correspondence:** Marek Tomaszewski, Pope John Paul II State School of Higher Education in Biała Podlaska, Sidorska 95/97 Street, 21-500 Biała Podlaska, e-mail: tomaszewski.marek@gmail.com, phone: (83) 344 99 18

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### The anatomy of larynx in children

The larynx is part of the upper respiratory tract and the voice organ. It is composed of muscles, ligaments, connective membranes and skeleton made of cartilages. Cavity of the larynx consists of three sections: the upper vestibule of the larynx, middle - middle cavity of the larynx and lower - subglottic cavity. The larynx functions as a phonatory, respiratory and defence organ. There are fundamental differences between the larynges of a new-born, an infant, a young child, and an adult human larynx. 1 mm<sup>2</sup> of infant's glottis supplies 0.013 m<sup>2</sup> of oxygen to the body surface area, while in the adult-it supplies 0.009 m<sup>2</sup>. Delivery of oxygen in the infant appears adversely and it is drastically reduced during the oedema of the mucous membrane of the larynx. Oedema of subglottic area in infants and children is a threat to life far more often than in adults. This is due to the large accumulation of connective tissue with a number of lymph vessels, which becomes readily oedema as a result of activation by irritating factors such as infection, allergy, and injury.

Table 1 shows changes in cross-section of subglottic larynx, caused by the oedema of this area depending on the age (Baker et al. 2006; Maciejewski and Torres 2007).

**Table 1.** Changes of subglottic area caused by oedema

		New-borns	Children	Adults
Normal	Diameter of subglottis (mm)	4	8	14
	Surface of subglottis (mm <sup>2</sup> )	12	48	147
Result 1 mm oedema	Diameter of subglottis (mm)	2	6	12
	Surface of subglottis (mm <sup>2</sup> )	3	27	108
	Reduction of respiratory surface (%)	75	44	27

The high location of the larynx and undeveloped sufficiently in the early period of life mechanisms of local and systemic immunity are conducive to the spread of viral and bacterial infections of the upper parts of the respiratory system. During the infection the inflammatory oedema occurs, that narrows significantly the airway and impairs the respiratory airflow through the throat.

### Causes of narrowing of the airways at the level of the larynx in children

- Developmental disorders of the larynx (Bailey 2003, Baker et al. 2006, Chmielik et al. 2003, Daniel 2006, Yuen et al. 2006):
  - Congenital laryngomalacia is the most common cause of stridor and exhaust dyspnoea in infants - laryngomalacia cases represent 60% of congenital anomalies of the larynx. Symptoms appear at third week of age and disappear about the 18th month of age. The essence of the disease is collapse of slender cartilage and fibrous parts during inspiration to the interior of the larynx. Most cases of congenital laryngomalacia are mild and do not require treatment. In about 10% of cases Laryngomalacia is severe, with significant respiratory problems and requires surgical treatment including tracheostomy.
  - Congenital subglottic stenosis is about 10-12% of congenital larynx defects. Small and medium-sized stenosis may not be symptomatic until the infection of the upper respiratory tract, when even a slight swelling causes severe subglottic laryngitis.
  - Subglottis haemangioma is a congenital tumour occurring in the area of subglottis and trachea. It can be life-threatening due to the location at the narrowest point of the respiratory tracks. Some children require implementation and maintenance of a tracheotomy until involution of haemangioma.
  - Airway patency disorders can also result from other less frequent birth defects such as: total laryngeal atresia, fins, cysts and tumours.
  - Paralysis of the vocal folds (Daniel 2006)
  - Inspiratory stridor and expiration dyspnoea is observed in bilateral palsy which is often accompanied by defects of CNS such as Arnold-Chiari syndrome, hydrocephalus, meningocerebral hernia and others. Dysphagia with aspiration of food into the airways, which is an additional risk, appears in children with bilateral vocal cord paralysis. The severity of dyspnoea in these patients may require intubation or tracheostomy.

- Acute inflammation of the larynx (Szenborn et al. 2004):
  - Laryngitis occurs seasonally, mainly in the autumn-winter period and is a significant clinical problem.
  - Szenborn et al. in the conclusions to their study involving 632 children hospitalized with symptoms of acute laryngeal dyspnoea pay special attention to the two morbid entities. The first is the subglottic laryngitis, which was diagnosed in over 75% of hospitalized children. The second is a rare cause (3% of hospitalizations) - the acute inflammation of the epiglottis, but with the most serious prognosis.
  - Subglottic laryngitis is a disease which due to narrowing of the airway may be a threat to the life of a small child. The disease is frequent in childhood, and primarily concerned with children between third month of life and three years old. The boys get sick twice as often as girls. Etiological factors are viruses. The classic symptoms appear suddenly at night in a child previously healthy with normal body temperature or the slight fever state. The disease manifests itself in barking cough, inspiratory-expiratory stridor and inspiratory differently severe dyspnoea.
  - Acute epiglottitis inflammation is rapidly caused disease in which inflammatory oedema of the epiglottis occurs and significantly impairs the patency of the larynx. Etiologic factor is mostly Haemophilus influenzae type B. Predominantly, children between 2 and 7 years of age get sick. Classic symptoms include severe sore throat, dysphagia, high fever and rapidly growing inspiratory dyspnoea. The disease develops within a few hours leading to immediate danger of life by suffocation or the development of sepsis. Examination of the throat may intensify dyspnoea. In many cases require intubation and treatment in the ICU.
- Foreign bodies in the larynx (Szepter 2011):
  - Aspiration of foreign body is the most common cause of respiratory distress in young children and is one of the major causes of morbidity and mortality in this age group. The problem of foreign body aspiration affects the most children less than three years of age who put various objects into their mouth and in this way learn about the world. Most often these are nuts, popcorn, seeds, raw carrots, grapes, candies, coins, small parts of toys. Sudden onset of stridor in a previously healthy child should always be treated as caused by the presence of a foreign body, until it is excluded in the bronchoscopy. The foreign body of large size can get wedged in the larynx and in combination with reflexive contraction, often occurring in these cases, may lead to severe respiratory failure. It is always direct threat to the child's life. In this situation life-saving treatments may be application of percutaneous tracheotomy or cricothyrotomy.
- External laryngeal trauma in children (Zawadzka-Glos et al. 2013, Oleniacz 2008):
  - Injuries of the larynx represent about 1% of all injuries in children are more common than in adults. The vast majority of damage of the larynx occurs during play or as a result of traffic accidents. Direct manifestation of clinical status does not always correlate with the degree of airway damage of the child. This means that the patient with injury of the larynx showing even minor symptoms to be treated as a patient in critical condition. In these cases, the procedure always applies according to the scheme of first aid used in multiple accidental traumas which main points are: to control breathing disorders and bleeding as well as stabilize the cervical spine.
- Allergic swelling (Zielinska 2010, Lacket al. 2003):
  - After a foreign body aspiration, an anaphylactic reaction is the next most important reason explaining the sudden occurrence of respiratory distress symptoms in children. The most common cause of anaphylaxis in children is primarily food, drugs are the second cause and the third one is insect bites. An anaphylactic reaction is a response the body to contact with the allergen. The greatest clinical implications are changes occurring in the respiratory and cardiovascular system. The action of histamine-induced bronchospasm with increasing swelling of the mucosa of the larynx and trachea, causing dyspnoea inspiration - expiration. Vasodilatation leads to a sudden blood pressure drop and consequently to anaphylactic shock. It is accompanied by pallor of skin along with the rising swelling of the face, lips, neck. Rapid assessment of condition of a child with a rapidly developing anaphylactic reaction, if possible interruption of exposure to an allergen, securing airway patency and oxygen therapy, intramuscular adrenaline supply in age-appropriate dose, protection of intravenous access are necessary steps giving the child a chance to survive and transport to the ICU, where it will be provided with highly specialized help.

### **Symptomatology of increasing obstruction of the upper respiratory tract in children**

Clinical symptoms displayed by a child with upper airway obstruction, regardless of the reason are as follows: (Graczyńska 2007, Szczeklik 2010):

- Increasing dyspnoea, the child suffers from a lack of air, difficulty catching breath despite enhance respiration. The laryngeal dyspnoea resulting from the narrowing of air flow path at this level is an inspiration - expiration. It may occur suddenly and then have a dramatic course.



- Invalid path of breathing, tachypnea, much larger respiratory rate of a child than the average base of respiratory rate for the age. Breathing becomes shallower, breath elongates and pauses between inspiration and expiration is shortened significantly. Complete closure of the airway causes suffocation (asphyxia).
- Pulling sternum, intercostal space, abdominal and supraclavicular holes results from the mobilization of additional respiratory muscles. The child takes the apparently increased respiratory effort, moving flaps of the nose, the child sweats.
- Wheezing breath (stridor inspiratory, inspiratory - expiratory), with a tight stenosis of the airways at the level of the larynx. During inspiration, you can hear the high, monophonic sound like a whistle, called stridor. This sound is clearly audible, frequently without a stethoscope.
- Coughing is a natural defensive reflex. In the case of suspicion of foreign body aspiration into the respiratory tract you should first encourage your child to cough, because it is an effective way to remove the material obstructing the flow of air through the UA.
- Cyanosis of the skin is a symptom of hypoxic of body tissues and indicates persistent hypoventilation of a child with acute laryngeal dyspnoea.

### Principles of conduct in acute dyspnoea in children

Procedure mainly depends on the cause and degree of airway obstruction as well as the current condition of the child. It should be noted that the patient requires constant monitoring because its condition can suddenly get much worse. Most frequently this is due to the increasing laryngeal oedema or movement of a foreign body. In this study, we focused on the discussion of the principles of first aid in case of complete closure of the air flow through the upper respiratory tract in children, and especially identifying possible ways of unblocking it. In each case of an acute, life-threatening laryngeal dyspnoea coursing with cyanosis, unconsciousness, cardiac arrest without delay there must be performed life-saving treatment unblocking respiratory tract. The most frequently performed in such circumstances are intubation or tracheotomy. In the case where, for various reasons the above steps cannot be performed alternative life-saving treatments are trachea-oesophageal puncture or cricothyrotomy. Tracheopuncture is the introduction through the skin into the lumen of the trachea needle having a diameter of 1.6 - 1.8 mm. Tracheopuncture performed in the midline beneath the arch cricoid cartilage. Percutaneous (needle) Cricothyrotomy involves puncture of ligament - thyroid cricothyroid and introducing cannula into the lumen of the trachea, through which pressurized respiratory gases (oxygen) are blown. Tracheopuncture and cricothyrotomy needles are ad hoc, temporary life-saving treatments. After accomplishment of them full patency of the airway (intubation, tracheostomy) must be provided, as soon as possible. Child with established cannula must immediately be taken to the hospital. Due to insufficient ventilation after 30 - 45 minutes the hypercapnia and respiratory acidosis occur (Oleniacz 2008, Szeleter 2011).

### Summary

Acute laryngeal dyspnoea is a multidisciplinary problem. It requires careful diagnosis of causes and careful observation of a sick child, because the prognosis is always uncertain. Knowledge of the symptoms and causes of upper airway obstruction allows for efficient handling of the child in this dramatic health situation. Sharp course of inspiratory dyspnoea is always life-threatening condition. This requires undertaking by the rescue team immediate action restoring the patency of the upper respiratory tract.

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## SELECTED ELEMENTS OF THE ASSESSMENT OF EATING HABITS ON THE EXAMPLE OF 2<sup>ND</sup> and 3<sup>RD</sup> CLASSES OF HIGH SCHOOL

Dominik Olejniczak<sup>1</sup>, Karolina Pietrzak<sup>2</sup>, Urszula Religioni<sup>1</sup>, Beata Gawrońska<sup>3</sup>

<sup>1</sup>Medical University of Warsaw

<sup>2</sup>Warsaw University of Technology

<sup>3</sup>University of Warsaw

Olejniczak D., Pietrzak K., Religioni U., Gawrońska B., (2015), *Selected elements of the assessment of eating habits on the example of 2<sup>nd</sup> and 3<sup>rd</sup> classes of high school*. Health Problems of Civilization, 1 (9), p. 23-28

### Summary:

#### Aim

The aim of this paper is the assessment of eating habits of high school students from grades 2 and 3, including eating habits, self-evaluation of diet and the most common nutrition mistakes committed by the members of the studied group.

#### Materials and methodology

The study involved 333 high school students between the age of 17 and 19. The group consisted of 150 girls and 183 boys. Data was collected using an original survey which consisted of questions dealing with diet and respondent's particulars. The study was anonymous. The results have been subjected to statistical analysis using Pearson's chi-squared test. The statistical differences recognized as significant were those with probability of  $p < 0.05$

#### Results

The majority reaching nearly 40% of respondents declared that they eat 4 meals a day. Over 60% eat breakfast every day. The number of students who declared that they do not eat breakfast at all amounted to 48. Over 55% do not pay attention to their eating habits, whereas 45 students consider them unhealthy. About 60% of respondents declare that they do not drink energy drinks. Within the group of students who consume such drinks the most often declared frequency was 1-2 times a week. The answers, however, vary between the female and the male group ( $\chi^2 = 82.72121$ ,  $p \leq 0.05$ ); 75% of males do not consume energy drinks, among females the percentage amounts to mere 43%.

#### Conclusions

The students taking part in the study commit nutrition mistakes which might be a sign of insufficient level of health education within that field. The nutritional education of the youth should start in primary school and be adapted to the needs and possibilities of the target group. In the face of poor diet, it seems justified to analyze the sources of information on nutrition used by the youth in terms of their credibility.

**Keywords:** diet, youth, health promotion

### Introduction

One of the factors determining man's good health is a proper diet. It is particularly important in the case of children and the youth as they are still growing and their bodies need to be provided with a proper amount of energy and nutrients. Providing them in the right quantities influences the physical and mental development, including the process of learning. To satisfy the nutrient requirements, it is necessary to provide the body with a proper amount of products from different groups (Post-Skagegard 2002).

Due to the technological developments and socio-cultural conditions people lead a sedentary lifestyle and fail to comply with the principles of proper nutrition. The epidemiological data and multiple studies indicate a growing number of children with excess weight or obesity.

Malnutrition and lack of physical activity during childhood or adolescent years might be the cause of future health problems and increase the risk of civilization illnesses such as obesity or diabetes mellitus type 2 (Walicka-Cupryś 2010).

**Address for correspondence:** Dominik Olejniczak, Medical University of Warsaw, Faculty of Health Sciences, Public Health Department, Banacha 1a Street, 02-097 Warszawa, e-mail: dominikolejniczak@op.pl, phone: (22) 599 21 80

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The way children and adolescents eat is influenced by many factors. One of the most important ones is home environment, typically combining both positive as well as negative eating habits. The second one is school where children and adolescents often have easy access to the products offered by school shops and which largely consist of quick snacks and sweets - products which do not help with maintaining a reasonable diet (Jeżewska-Zychowicz 2003).

Shaping proper eating habits from an early age is crucial as these habits are usually replicated in adult life.

Therefore, it is important to learn about teenagers' eating habits so that appropriate steps can be taken to introduce positive health behaviour patterns (Szczerbiński, Karczewski 2007).

### Aim of the paper

The aim of this paper is the assessment of diet of high school students, grades 2 and 3, including the eating habits, self-evaluation of diet and the most common nutrition mistakes committed by the members of the studied group.

### Materials and methodology

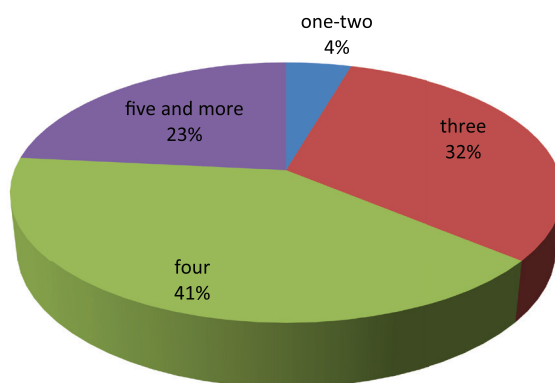
The study involved 333 high school students between the ages of 17 and 19. The group consisted of 150 girls and 183 boys.

The tool used in this study was an anonymous, original survey which consisted of general questions about age and sex as well as more specific ones dealing with diet. The questions were closed-ended and dealt with the amount and the type of meals and beverages consumed as well as the length of intervals between meals and the frequency of consuming them. Furthermore, the respondents conducted self-evaluation of their own diet.

The results were subjected to statistical analysis using Pearson's chi-squared test. The statistical differences recognized as significant were those with probability of  $p \leq 0.05$ . The statistical analysis of the results was conducted using STATISTICA v.10.

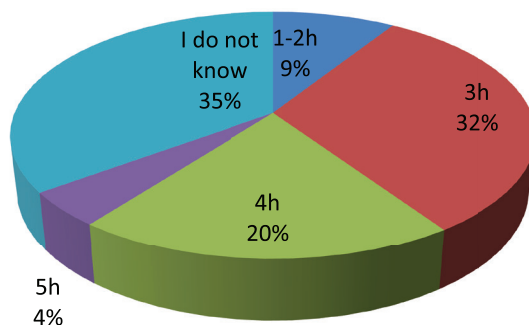
### Results

The first question dealt with the amount of meals consumed every day. The majority reaching nearly 40% declared that they eat 4 meals a day. The second place was taken by 3 meals. A small percentage of students stated that they eat up to 2 meals a day (Figure 1). The amount of meals consumed varies depending on the respondent's sex. Females more frequently indicated that they eat 3 meals, males - mostly 4 meals, and statistically it is a significant relationship between the sex and the amount of meals consumed every day ( $p \leq 0.05$ ).



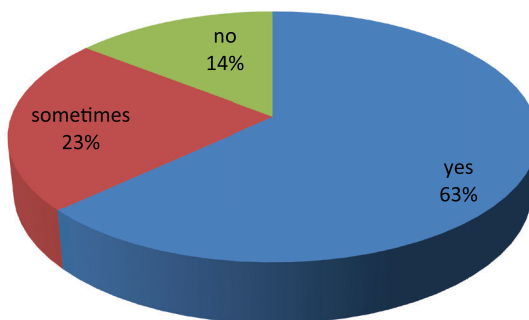
**Figure 1.** The amount of meals consumed by the respondents

The students were also asked about the length of intervals between meals. The majority of respondents does not pay attention to the length of intervals between meals. However, if they declare a specific number, the interval usually lasts around 3 hours - just over 30% of respondents have chosen this exact answer (Figure 2). Among the students who do not pay attention to the length of intervals between meals, males are predominant. Females most frequently indicated that they eat every 3 hours and statistically it is a significant relationship between sex and maintaining proper intervals between meals ( $p \leq 0.05$ ).



**Figure 2.** The length of intervals between meals

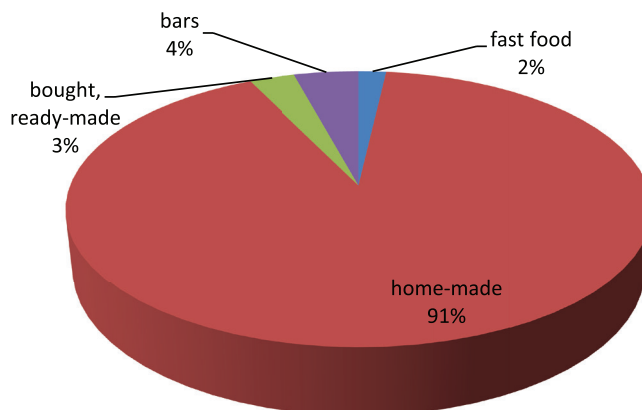
The respondents were also asked if they eat breakfast every day. Over 60% eat breakfast every day. The number of students who declared that they do not eat breakfast at all amounted to 48 (Figure 3). 94% of females indicated that they always eat breakfast. Among males the percentage amounted to mere 38%. This shows a statistically significant relationship between sex and regularity of eating breakfast ( $p \leq 0,05$ ).



**Figure 3.** Eating breakfast among the respondents

The answers to the question on the type and the amount of beverages consumed varied considerably. 44% of respondents consume 1 glass of carbonated sweet beverages every day and 46% consume 1 glass of fruit juice. When it comes to the amount of consumed water - the most common answer was 2-3 glasses a day chosen by nearly 30% of respondents. The amount of consumed coffee and tea usually varies between 1 to 3 glasses. The vast majority, for as much as 77% of students, declare that they do not drink alcohol every day.

Over 90% of respondents consume mainly home cooked meals (Figure 4). The answers in this case are differentiated by respondent's sex. Among females, home cooked meals are consumed by 98% of respondents, among males the percentage drops to 86% and the next most frequently checked answer is "bars" (7% of males). In this case, the differences are not statistically significant and there is no relationship between sex and eating home cooked meals ( $p \geq 0,05$ ).

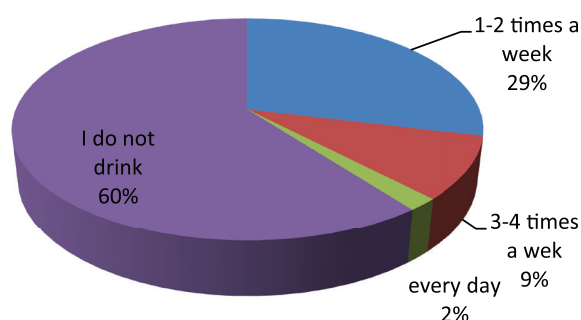


**Figure 4.** The type of meals consumed

The students were also asked about snacking between meals. The majority admits that they snack between meals. The largest group of females (48%) indicated that they often snack between meals. The most common answer indicated by males was "sometimes" (51%), thus there is a statistical relationship between sex and snacking between meals ( $p \leq 0,05$ ).

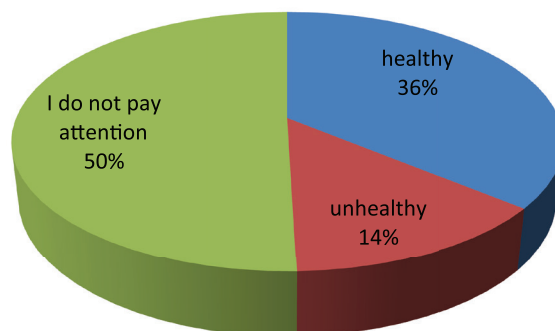
The next question dealt with the frequency of consuming products from different groups. 36% of respondents declared that they consume milk every day and nearly 49% consume dairy and cereal products. The consumption of animal fats varies between daily and 3-4 times a week. Sweets are consumed 3-4 times a week by nearly 29%. Fruits and vegetables are present in everyday diet of 36% of respondents. 62% of respondents declare that they rarely consume fast foods.

As regards the question about the frequency of consuming energy drinks such as Red Bull, about 60% of respondents declare that they do not consume energy drinks at all. Students who drink such beverages most frequently declared that they consume them once or twice a week (Figure 5). The answers, however, vary between the female and the male group and these are statistically significant differences - thus, there is a relationship ( $p \leq 0,05$ ). Nearly 75% of males do not consume energy drinks, whereas in the case of females, the percentage amounts to mere 43%.



**Figure 5.** The frequency of consuming energy drinks

In the last question the respondents were evaluating their own eating habits. Over 55% of respondents do not pay attention to their eating habits, whereas 45% of them consider them unhealthy (Figure 6). There is a statistically significant relationship between respondent's sex and the evaluation of their own eating habits ( $p \leq 0,05$ ). More than half of females believe they are eating healthy, while 85% of males indicated that they do not pay attention to this kind of behavior.



**Figure 6.** General self-evaluation of respondent's eating habits

## Discussion

Many studies conducted on students of primary school, middle school and high school show multiple nutrition mistakes which might have a negative influence on their health in the future.

According to a study conducted by B. Kołataj, W. Kołataj and Karwat (Kołataj et al. 2008) the largest group of students consume 3 meals a day - nearly 37%, 35% declared that they eat 4 meals and 19% admitted to having 5 meals a day. Only a little over 5% included 2 meals in their daily diet. A study conducted by Czarniecka-Skubina and Namysław (Czarniecka-Skubina, Namysław 2008) showed similar results. The largest group of students consumed 3-4 meals a day. Another study revealed that more than half of adolescents (54.5%) consumed 4-5 meals a day and about 1/3 of respondents consumed three or less meals a day (Gajda, Jeżewska-Zychowicz 2010). The study presented in this paper had similar results - the amount of meals consumed every day ranged between 3 to 4.

In the abovementioned study (Kołątaj et al. 2008) 3.5% of respondents declared that they do not eat breakfast at all and in a study on the "Eating patterns of a selected group of students finishing upper-secondary education in Warsaw" [Zachowania żywieniowe wybranej grupy uczniów ostatnich klas szkół ponadgimnazjalnych w Warszawie] 40% of respondents claim that they eat breakfast at home every day, a slightly larger percentage of which were females. Furthermore, the results indicated that the breakfasts consumed were monotonous and consisted mostly of sandwiches (Wojtaś, Kołajtis-Dołowy 2011). The results of the study presented herein revealed that more than 60% of respondents eat breakfast every day, 18 students declared that they do not eat breakfast at all. Not eating breakfast is a negative trend as it might have a negative influence on the process of learning.

The authors of "Selected elements of high school students' eating patterns" state that the majority reaching 84% of adolescents snack between main meals (Czarnecka-Skubina, Namysław 2008). According to the article "Eating patterns of youth residing in Świętokrzyskie Voivodeship – selected aspects" the majority of students taking part in the study declared that they snack during the day and as regards the frequency of doing so, the most commonly marked answer was "sometimes". It is worth noting that most of these studies point to a larger percentage of males who snack between meals (Gajda, Jeżewska-Zychowicz 2010). In the study presented herein, the majority of respondents claiming to snack describe the frequency of doing so as "sometimes" or "often". Frequent snacking between meals might lead to becoming overweight or obese, particularly if the products consumed are high in calories, e.g. crisps or sweets, which is why snacking is a negative phenomenon.

The abovementioned study revealed that more than 90% of students consumed their meals at home (Gajda, Jeżewska-Zychowicz 2010). The same results have been obtained in the study presented herein which revealed that nearly 91% of respondents consume mostly home cooked meals.

A study titled "Wrong eating habits among teenagers - preliminary study" [Nieprawidłowe nawyki żywieniowe u nastolatków – badania wstępne] indicated that 56.49% of respondents most frequently consume tea and slightly over 14% claimed they drink fruit juice (Czarnecka-Skubina, Namysław 2008). Also, the abovementioned study on the "Eating patterns of a selected group of students finishing upper-secondary education in Warsaw" revealed that water (64.5%) and carbonated beverages (73%) are on the list of 10 products most frequently consumed by students outside the home (Wojtaś, Kołajtis-Dołowy 2011). The study presented herein revealed that adolescents consume about 1 glass of carbonated beverages and fruit juice a day, and the consumption of water, coffee and tea ranges between 1 to 3 glasses a day.

Studies conducted by Czarnecka-Skubina and Namysław show that only a few students consume fruits and vegetables 4-5 times a day, usually they are only an addition to second breakfast or afternoon snack (Czarnecka-Skubina, Namysław 2008). In a study on "The significance of school education in shaping the nutritional awareness of secondary school students" conducted on students between the ages of 13 and 15 revealed that the higher the level of education of a mother, the bigger the possibility of snacking on fruits by a child. Nearly 44% of students whose mothers have higher education claimed they eat fruits between meals. As regards the students whose mothers have vocational or lower education, the percentage was significantly lower and amounted to about 29% (Łyszkowska 2002). Parents' influence on child's health behaviour when it comes to diet is crucial because usually it is home where most meals are consumed and family is the first one to shape child's preferences and habits when it comes to diet. Family is one of the influences of social environment (Story et al. 2002). The results of the study presented herein show that the majority of respondents consume fruits and vegetables on daily basis or 3-4 times a week.

In a study on the "Selected elements of high school students' eating patterns" a considerable percentage of respondents (slightly over 42%) believed that they do not maintain a proper diet, 36.7% of students claimed that they maintain a good diet and 21.1% could not determine whether their diet was healthy or unhealthy (Czarnecka-Skubina, Namysław 2008). Among the group of students involved in the study herein, 48% claimed that they do not pay attention to their eating habits and only 14 students firmly stated that they believe their habits to be unhealthy.

In a study published in the Volume of the National Institute of Hygiene in 2006 the assessment of the groups of products consumed by students was conducted. The results were compared with model-based daily food ratios suggested by Turlejska et al. for 19-25 year olds and divided into 9 groups of foodstuff. Among female students, low intake of cereal products was noted - only 7% consumed the recommended amount of cereal products, whereas in the case of male students the percentage amounted to 17.6%. Moreover, low intake of fruits and vegetables was noted - the average ratio among female students amounted to around 69% of recommended intake and among male students to slightly over 82%. About 40% of females consumed less than half of recommended daily intake of fruits and vegetables and 23.5% of males consumed 30-50% of recommended intake of fruits and vegetables. There was also insufficient intake of milk and dairy products - 52% of recommended daily intake in the case of females and 76.4% in the case of males. The intake of sugar and sweets reached nearly 90% among females and 99.3% among males (Wyka, Żechałko- Czajkowska 2006). In the study presented herein, the majority of the respondents claimed that they consume cereal products (over 50%) as well as milk and dairy products (nearly 40%) on daily basis.

The study conducted by Batyk (2012) from the University of Warmia and Mazury in Olsztyn on a group of 80 randomly selected students between the ages of 13 to 18 showed great popularity of fast foods among young people. According to the study, 56.3% of respondents use those products on daily basis. There was not one person in the studied group who had never consumed them before. In the study presented herein 62% of respondents claimed that they rarely consume products from this group which is a positive phenomenon as they are classified as products of the worst quality.

### Conclusions

1. Irregular meals and snacking indicate a poor diet.
2. The students taking part in the study commit nutrition mistakes which might indicate insufficient level of health education within that field.
3. In the face of poor diet, it seems justified to analyze the sources of information on nutrition used by youth in terms of their credibility.
4. The nutritional education of youth should start in primary school and be adapted to the needs and possibilities of the target group.

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## THE ROLE OF PHYSICAL THERAPY IN CANCER TREATMENT

Mirosława Sidor, Krzysztof Jeziorski

Pope John Paul II State School of Higher Education in Biala Podlaska

Sidor M., Jeziorski K. (2015), *The role of physical therapy in cancer treatment*. Health Problems of Civilization, 1 (9), p. 29-32

**Summary:** Cancer is a very important problem in both medical and social respects. In recent years, there has been a shift in approach to oncological prevention, diagnostics and treatment. As a result, oncology has become an interdisciplinary field. Factors relevant for successful oncological treatment are: sequence, type and scope of intervention, including diagnosis of the cancer, assessment of its progression, systemic treatment, surgery, radiotherapy, supportive therapy and rehabilitation. Rehabilitation addresses the realm of psychology (psychooncology), as well as somatic and social issues. Physical therapy is a notion inseparably related to medical rehabilitation and it encompasses a range of treatments which are based on the body's reactivity to stimuli.

The purpose of this article is to present the specific character, the methods and the role of physical therapy in oncology, as an increasingly popular strategy in medicine, which helps to improve performance and physical function in cancer patients. Physical therapy is essential in primary and secondary cancer prevention and it greatly contributes to improving the quality of life of patients and helps them recover quicker. Four basic kinds of intervention in oncological rehabilitation include: preventive interventions, restorative interventions, supportive interventions and palliative interventions. The main principle in rehabilitating a patient with an advanced cancer is progressing steadily but gradually. The primary and essential form of rehabilitation for cancer patients is movement exercise i.e. kinesiotherapy. Integration and cooperation during group exercise are also among the strategies that therapists seek to employ while working to improve the condition of patients diagnosed with cancer. Kinesiotherapy prevents pulmonary and thromboembolic complications in cancer patients. One method of physical therapy applied in cancer treatment is lymphatic drainage (massage), which improves circulation of lymph.

To sum up, physical therapy plays an increasingly important role in holistic care of cancer patients. It is indispensable and should become a standard approach, as a method of reducing the risk of complications, helping in faster recovery and limiting the economic and social costs of treatment.

**Keywords:** oncology, physical therapy, cancer rehabilitation, holistic care

Cancer is a very serious medical and social problem. In Poland, malicious cancers rank second as cause of death. In 2011, 26% of deaths in men and 23% of deaths in women were caused by cancer. In the same year, 154,000 people in Poland were diagnosed with cancer, while 320,000 other were living with cancer diagnosed within the past five years (Didkowska et al. 2013). Over the last few years, an evolution may be observed in the approach to oncological prevention, diagnosis and treatment and oncology has become a multidisciplinary field as a result of that. This holistic approach to the patient assumes a multi-dimensional care, which includes: health promotion, prevention stages I, II, III and IV, diagnostics, treatment, nursing, rehabilitation and palliative care, all based on co-operation of a team of specialists in different fields, including a doctor, a nurse, a physical therapist, a psychologist, a diagnostician, a chaplain (Pasek, Dębska 2010). For this reason, the work of physical therapist as well as their therapeutic options are based on the so called comprehensiveness, that is, a collaborative work of the specialists mentioned above, as well as working with patients and their families. Only a team of highly skilled, responsible experts working together can carry out the most difficult tasks one is faced with in treatment and rehabilitation of cancer patients (Kwolek 2009). Kamusińska argues that the composition and hierarchy of competence in such a team should depend on the specific situation of a given patient (Kamusińska 2008).

In such a system of cancer care, the goal is to attain the maximal effectiveness of treatment of cancer while maintaining safety requirements for any procedure potentially dangerous for patient's life. The following aspects are relevant in oncological treatment: sequence, type and scope of intervention, including diagnosis of tumour;

**Address for correspondence:** Krzysztof Jeziorski, Pope John Paul II State School of Higher Education in Biala Podlaska, Sidorska 95/97 Street, 21-500 Biala Podlaska, e-mail: krzysztof.jeziorski@wp.pl, tel. (83) 344 99 16

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assessing its progression, systemic treatment, surgery, radiotherapy, supportive treatment and rehabilitation (Warzocha 2014). Rehabilitation addresses patient's psychology (psychooncology) as well as somatic and social realms of life.

Physical therapy is a notion inseparably related to medical rehabilitation and it encompasses a range of treating methods, which make use of the body's reactivity to stimuli. Physical therapy includes the following kinds of therapy: balneotherapy, climatotherapy, hydrotherapy, kinesiotherapy, manual therapy, therapeutic massage, occupational therapy, remedial gymnastics. Physical therapy prevents progression and relapses of the disease and restores physical function. The goal of physical therapy is to prevent disease progression and relapse, remedy different ailments, and help in regaining physical function. According to Nowotny, by applying physical therapy one strives to prevent unwanted states and phenomena, to remedy or alleviate undesirable symptoms, or in case the former is impossible, to adapt the patient to functioning in everyday life in spite of the occurring disorders (Nowotny 2004, p. 30). The role of physical therapy is especially important in oncology. Its main purpose is to help patients regain self-confidence and realize that the rehabilitation is reaching its intended results, thus enabling them to achieve functional independence in life. According to Ostaszewska, physical therapy is of significant importance in primary and secondary prevention of cancer, and also greatly contributes to improving the patients' quality of life and accelerating their return to normal life (Ostaszewska 2013).

Four basic kinds of interventions are distinguished in cancer rehabilitation:

- preventive interventions aimed at reducing the negative effects of treatment,
- restorative interventions, which seek to help the cancer patient regain the original physical function and activity,
- supportive interventions, by which the patient learns to accommodate and accept the disease and the disabilities that result from it, for example learning to use prosthesis and items of daily use,
- palliative interventions, which are used in terminal stages of the disease. They are designed to alleviate different ailments and improve the patient's quality of life e.g. through pain control, preventing contractures or decubitus (Piechaczek, Kwolek 2007).

Rehabilitation for cancer patients is safe and does not have any negative effects on their health. A correctly designed programme of rehabilitation and physical therapy depends on the stage of the oncological treatment, the time passed since it ended, and the patients specific condition and needs. Existing dysfunctions or possible complications that might occur during oncological treatment must also be taken under consideration.

The main principle in rehabilitation of patients with an advanced cancer is to progress steadily but gradually (Gośliński 2011). The rehabilitation requires patience, prioritizing the goals set for it to achieve, adapt to the patient's needs, particularly in the terminal stage of the disease.

The primary and essential form of rehabilitation for cancer patients is movement exercise i.e. kinesiotherapy.

Almost every kind of exercise is used, especially passive exercise, breathing exercise, active and relaxing exercise. Kinesiotherapy should be started as soon as possible, adjusting the exercises to the patients abilities and taking regularity and correct posture into account. The exercises may be conducted individually or in group, while bearing in mind possible contraindications such as anaemia, dyspnoea, bone pain, acute nausea, elevated body temperature and cachexia. While conducting a kinesiotherapy session, a therapist should take those contraindications into account and adequately select exercises so as to achieve the intended results. In active exercises, general rehabilitation, breathing, loosening, and relaxing exercises one should always adjust the rhythm, speed and intensity to the whole group. Integration and cooperation during group exercise are also among the strategies that therapists seek to employ while working to improve the condition of patients diagnosed with cancer. Improvement in quality of life is significantly correlated to taking advantage of physical exercise during hospitalisation, and exercising may potentially shorten time spent in hospital (Kwolek et al. 2007).

A problem common for cancer patients is avoiding kinesiotherapy sessions, particularly group exercise. This results from poor psychological and physical condition of patients in that group. Among the reasons to avoid physical activity in cancer patients one might also find choosing a less demanding lifestyle, frequent and intense fatigue symptoms and decreased exercise capacity. Thus, the therapist should convince the patients that physical activity is by all means desirable in their cases. Kinesiotherapy prevents complications in the circulatory and respiratory systems, which result from prolonged immobilisation of the patient. Regular exercise under supervision of a physical therapist greatly contribute to improving the quality of life. A patient feels less tired, has a better control of their own behaviour, is less preoccupied with thoughts of fear, and does not experience anxiety about their condition too often.

Kinesiotherapy prevents pulmonary and thromboembolic complications occurring in patients diagnosed with cancer (Ostaszewska 2013). In that case, physical therapy should also be used in the form of breathing exercises, assuming drainage positions, chest clapping and applying inhalations. In antithrombotic prophylaxis, methods used should include the so called antithrombotic therapy, intermittent pneumatic compression, adequately elevated limb positioning.

One of the methods in physical therapy used for cancer cases is lymphatic drainage (massage), aimed at improving lymph circulation. It is a special kind of gentle manual massage. It should be stressed that lymphedema occurs in majority of cancer patients, due to lymph nodes being involved or pressed by the ongoing disease process, or as a result of surgical extraction of lymph nodes. Manual lymphatic drainage is one of the key elements of antithrombotic therapy (Piotrowicz et al. 2000).

A technique used increasingly often as a supplement for comprehensive antithrombotic therapy is *Kinesio Taping*. There are ongoing studies meant to verify effectiveness of this method. Other methods used in physical therapy to treat lymphoedema include: intermittent pneumatic compression, gymnastics, bandaging, using elastic sleeves and stockings (Paz 2010).

Among methods used for rehabilitation of cancer patients one should mention *Aquavibron* massage. It is a dry massage with the use of a device equipped with a vibrating membrane. The membrane vibrates as a result of water flowing through the device under pressure. *Aquavibron* is used in treatment of lymphoedema. Other physiotherapeutic methods for cancer treatment include exercise in water, especially *aqua aerobic* recommended in particular for women who underwent mastectomy (needless to say, only after their surgical wound has healed) after consultation with the oncologist. Another form of additional physical activity for women after mastectomies, which may contribute to improving their functioning is *Nordic walking*. Marching with poles engages large muscle groups of the upper body, which translates into improved physical performance in women after breast amputation.

A significant problem occurring in cancer patients is constipation. In such cases, it is recommended to use classical massage of the abdominal wall so as to improve peristalsis if no contraindications apply (Pyszora 2010). Additionally, physical therapy is recommended for dyspnoea commonly occurring in advanced cancer patients (Pyszora, Wójcik 2010). Breathing exercises are recommended in particular, as a method to increase inspiratory capacity, improve elasticity of chest muscles and hence improve the mechanics of the chest to facilitate breathing.

In discussing the place and role of physical therapy in oncology, one should not omit patients staying in palliative care facilities, home hospices or nursing homes, where occupational therapy is used along with music therapy which as a relaxation technique, which positively influences the psyche of patients suffering from cancer.

## Conclusions

Given the fact that the number of people suffering from cancer increases every year, one must bear in mind that it is possible, if not essential, to ensure comprehensive rehabilitation services for patients, especially in the initial stage following oncological treatment. One may safely argue that, as a result of progress in cancer treatment and developments of physical therapy methods for oncology, patients who have undergone oncological treatment may return to functioning as active members of the society. Application of physical therapy in oncology is the subject of numerous debates and studies. In the past, it was common to argue that exercise and physical therapy should be avoided in cancer patients. Today, physical therapy is seen as an essential treatment, which should become a standard approach (Woźniewski 2012). Its programme is based on experience and recommendations of medical personnel, whose goal is to restore the patients former quality of life and thus help him or her return to normal life in the society. It should be borne in mind that only cooperation of a whole team of doctors, nurses and physical therapists creates favourable conditions to attain the goal of ensuring the welfare of cancer patients and providing professional help much needed in this difficult period of their lives.

It should be stressed once again that physical therapy plays a significant role in cancer treatment and is dependent on the indications of a specialised doctor, formulated after close analysis of a patients case history.

In conclusion, physical therapy plays an increasingly important role in holistic care of patients suffering from cancer.

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## FOOD QUALITY CONTROL BY HYPHENATED SEPARATION TECHNIQUES

Justyna Walczak<sup>1,2</sup>, Paweł Pomastowski<sup>1,2</sup>, Bogusław Buszewski<sup>1,2</sup>

<sup>1</sup>Department of Environmental Chemistry and Bioanalytics, Faculty of Chemistry,  
Nicolaus Copernicus University

<sup>2</sup>Interdisciplinary Centre of Modern Technology, Nicolaus Copernicus University

Walczak J., Pomastowski P., Buszewski B. (2015), *Food quality control by hyphenated separation techniques*. Health Problems of Civilization, 1 (9), p. 33-38

**Summary:** Food as complex mixture of proteins, lipids, vitamins, etc. cannot be separated and identified by using in only one method. This article presents a revision on the hyphenated chromatographic techniques and methods used in food analysis and described main application in food science research, and determination of xenobiotics and their metabolites in environmental. Also article discusses applications of "omics" in food analysis (proteomics, transcriptomics, genomics, metabolomics) and new discipline of - foodomics.

**Keywords:** food analysis, hyphenated techniques, liquid chromatography, mass spectrometry

### Introduction

Food analysis is located within the scope of multidisciplinary food science and human nutrition, which used the achievements in areas, such as biology, chemistry, microbiology or mathematic. The main objective is to evaluate the quality of food, which is primarily determined by the chemical composition. In order to provide high quality of healthy food, all parts of the food chain (production, sourcing of raw material, purchase of raw material, processing and manufacturing), must be subject to strict supervision designed to find the factor which reduce the quality of healthy food and provide appropriate food safety. Knowledge of the methods for the determination of basic food ingredients, food additives, contaminants or changes during processing and storage of food is essential for specialists involved in the production and quality control of food. It is also useful for all people interested in understanding the relationship between food consumed and human health (Mcgorrin 2009).

Food analysis is a very hard task, due to the complexity of the matrix which is typical of food. In order to characterize and identify specific food components, hyphenated separation techniques are used. Such hyphenated techniques are of use in food analysis, pharmaceutical industry or medicine. Analytical techniques have been classified according to the methods of sample preparation (e.g., solid phase extraction (SPE); liquid-liquid extraction (LLE); purge and trap (PT); polymerase chain reaction (PCR)), separation techniques (e.g., high performance liquid chromatography (HPLC); gas chromatography (GC), capillary electrophoresis (CE); thin layer chromatography (TLC); two dimensional gel electrophoresis (2DE)), and identification methods (e.g., ultraviolet (UV); mass spectrometry (MS); matrix-assisted laser desorption/ionization (MALDI); nuclear magnetic resonance (NMR)) (Michel, Buszewski 2008).

This paper describes the most important applications of the hyphenated separation techniques in food science and technology. It describes analysis of food-related molecules, such as amino acids, peptides, proteins, lipids, vitamins, metabolites, toxins, pesticides, and antibiotics. Moreover, among environmental pollutants there can be found large group of xenobiotics. Xenobiotic is a natural or synthetic chemical compound which is not a product of biosynthesis. Compared to the naturally occurring organic substances, some xenobiotics and their metabolites are resistant to biodegradation.

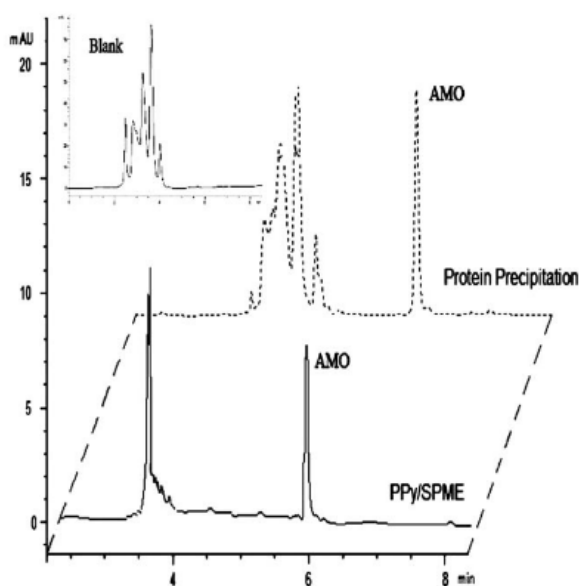
**Address for correspondence:** Bogusław Buszewski, Nicolaus Copernicus University, Gagarin 7 Street, 87-100 Torun,  
e-mail: bbusz@chem.umk.pl, phone: +48 56 611 43 08

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## Food analysis

Food quality is an important factor in determining the state of human health. The presence of toxic and harmful to health substances in food is an important issue and needs to project both remedies for the prevention of pollution, as well as methods of control to assess the degree of contamination of the final product. A particular group of food contaminants are pesticides. These substances in small amounts can cause acute poisoning, contribute to the formation of cancer and developmental defects, adversely affect the endocrine, immune and nervous systems. Analysis of food samples for the presence of pesticides is a multi-stage analytical procedure including collection and sample preparation in this extraction of analytes from the matrix, the purification of extracts and determination of pesticides (Kumar et al. 2010). Proper extraction of the sample and its proper preparation are crucial because they determine the quality and credibility of the result of the determination. Over the last decade there has been a significant growth and development of the extraction methods used for the isolation of pesticides from food, which has allowed to simultaneous extraction of the remains of many substances with different physicochemical properties. The new methodology for determining pesticides residues in food matrices is so-called QuEChERS (quick, easy, cheap, effective, rugged, and safety) - solvent extraction combined with purification of the extract (Payá et al. 2007). Liquid chromatography coupled with mass spectrometry (LC-MS) is currently one of the most common methods used for detection, identification and quantification of pesticides in food. This technology provides information about the structure of the analyte which does not demand thorough purification of a sample, and can do without derivatization of the analyzed compounds (Lehotay 2007).

Another very important issues is analyzing antibiotics residue in food samples (Moreno-Bondi et al. 2009). A wide application of antibiotics in animals husbandry makes it necessary to conduct the quantitative and qualitative control of residues of these medicinal substances in food. Antibiotics are also added to food or water, because due to this a positive effect on weight gain of animals can be observed. However, the antibiotic remaining in the tissues and organs of animals and their products - milk, eggs and honey are potential source of adverse effects on consumers of food of animal origin. Small doses of antibiotics taken with food for a longer period, may contribute to the emergence in human body of drug-resistant bacterial strains. Taken with food, even small amounts of antibiotics may cause allergic reactions or disturbances in the normal functioning of tissues or organs (mutagenic and carcinogenic effects) (Pejsak, Truszczyński 2005). The most popular extraction technique for determination antibiotics in food is solid phase microextraction (SPME). A great advantage of applying this technique is the small sample volume and low solvent consumption. Liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) is most often useful technique in this case (Szultka et al. 2014). Figure 1 presents the application of SPME coupled with HPLC-MS in determination of amoxicillin. The use of this technique allows efficient detection and confirmation of the presence of antibiotics and other antibacterial drugs in the products and foodstuffs of animal origin (Buszewski et al. 2011).

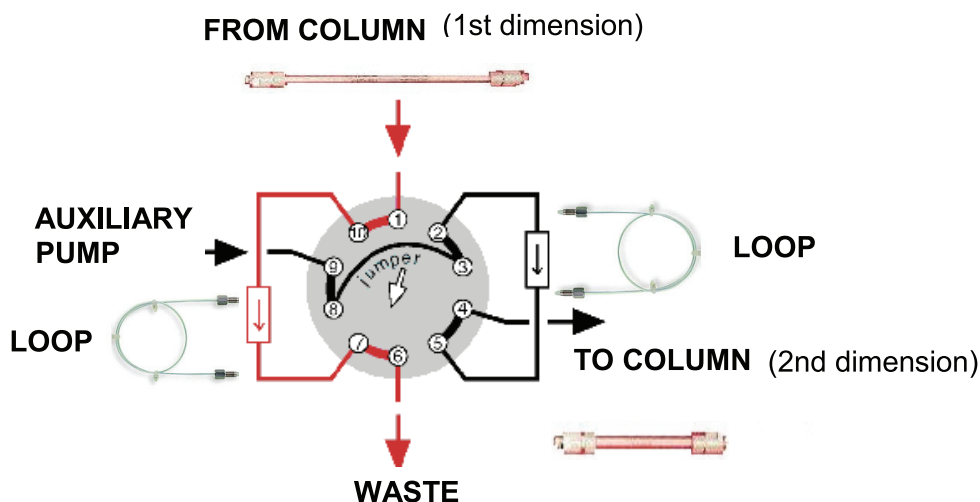


**Figure 1.** Chromatogram of amoxicillin extracted by PPy/SPME and protein precipitation (according to Buszewski et al. 2011)

High performance liquid chromatography (HPLC) or ultrahigh performance liquid chromatography (UHPLC) are the most frequently used techniques in analyzing food components. Gas chromatography is often used in an analysis of volatile compounds, such as fatty acids (Golay 2009). Liquid chromatography coupled with mass spectrometry

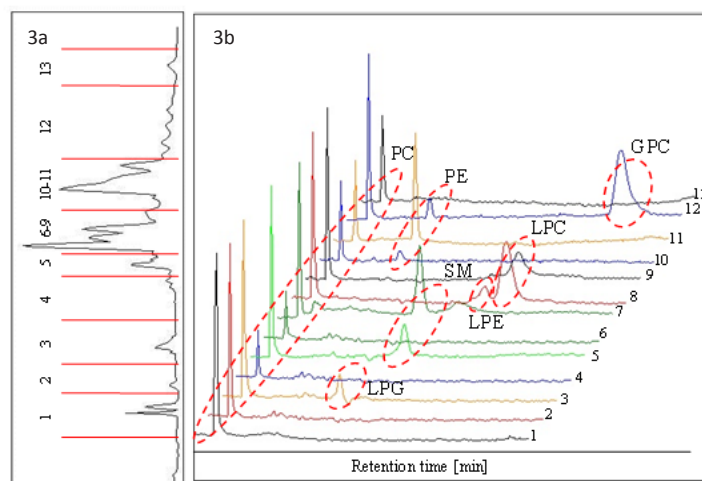
(MS) or tandem MS (LC-MS/MS) have been applied particularly to analyze antimicrobial residues in food of animal origin (Boglialli, Di Corcia 2009), and food allergen (Faeste et al. 2011). The essential oils (Jalali-Heravi, Parastar 2011) and food contaminations (Robledo, Smyth 2009) can be identified by using other hyphenated separation techniques: gas chromatography with mass spectrometry (GC-MS) or capillary electrophoresis-mass spectrometry (CE-MS).

Multidimensional chromatography techniques in *off-line* and *on-line* mode, such as LC×LC, GC×GC, LC×GC, are very useful techniques in analysis and separation of complex mixtures (Herrero et al. 2009, Welke, Zini 2011). Differences in columns properties (e.g. HPLC x HPLC system) change the selectivity and resolution of separation system drastically. In results of set-up combination (see Fig 2) in the first cycle (column No. 1) fraction from separated mixture (chromatogram) can be received, but in the second cycle (column No. 2) the interesting analytes have been obtained in pure form.



**Figure 2.** Two dimensional LC x LC set-up

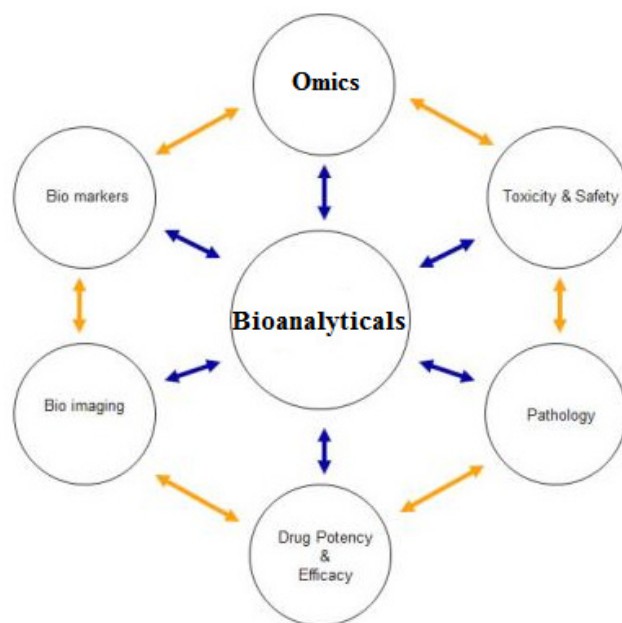
The combination of two systems can help to identify and separate phospholipids in egg yolk (Walczak et al. 2014). The Figure 3 show the chromatogram of phospholipids from egg yolk. Thirteen fractions of PLs obtained from the first dimension have been analyzed by RP-HPLC (Fig 3a) coupled with mass spectrometry. *N,O*-dialkylphosphoramidate (C18) (Fig 3b) stationary phase was used. In the first dimension separation is based on hydrophobicity of fatty acids/or hydrophobic interactions with stationary phase (differences in chain lengths and number of double bonds of acyl residues). In the second dimension (with the retention time on Fig. 3b) separation is based on the differences that take place in the polarity of the phospholipid "headgroups" take place.



**Figure 3.** Chromatogram of egg yolk phospholipids separation: a) first dimension; C18 column, mobile phase: 100% MeOH, flow 1 mL/min, b) second dimension; *N,O*-dialkylphosphoramidate (C18), mobile phase: 90% MeOH/10% H<sub>2</sub>O, flow 0.45 mL/min. The number of collected fractions in the chromatogram 3a corresponds to the number of chromatograms in the 3b (according to Walczak et al. 2014)

### Foodomics as a new approach in food analysis

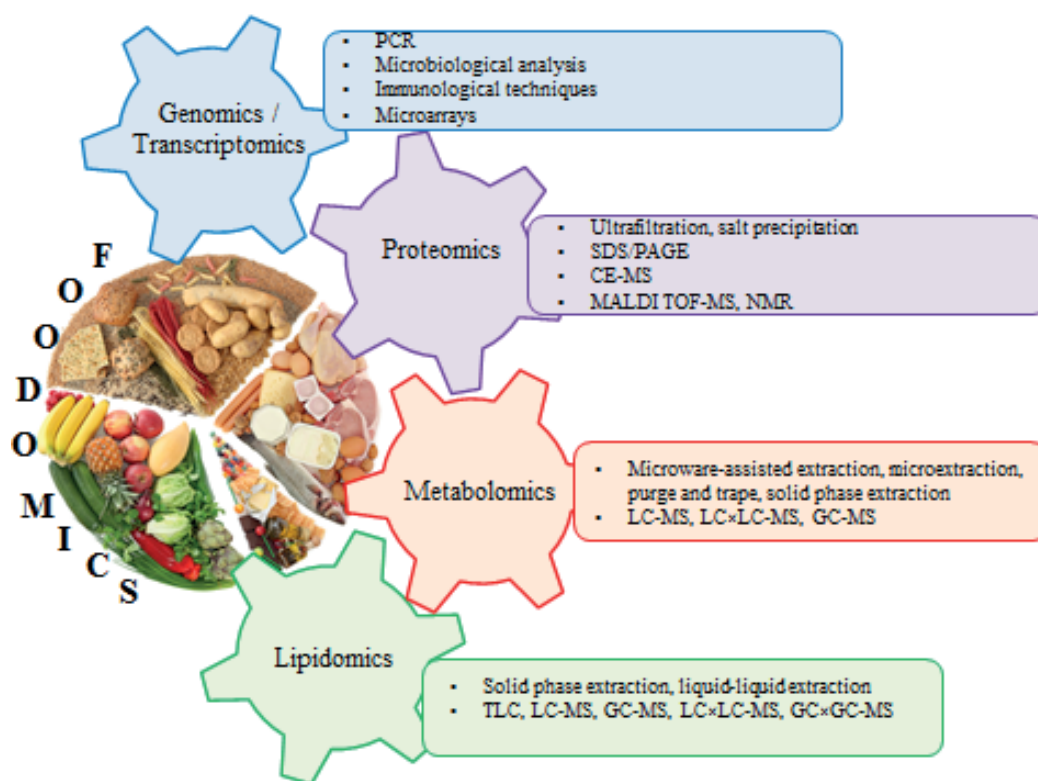
In recent decades, “bioanalytical chemistry” has become a very important and a rapidly developing branch of chemistry. The concept of bioanalytical chemistry comprises two aspects. In first meaning it refers to studies whose target are objects and/or biological phenomena. In the second case, bioanalytical chemistry is the study of the use of “bio-tools” whose devices are integrated with biomolecules. Figure 4 shows the relationship between bioanalytics and “omics”, and other specialty areas such as drug metabolism and pharmacokinetics, clinical chemistry, toxicology and safety pharmacology.



**Figure 4.** Relationship between bioanalytics and specialty areas

Foodomics is a new multidiscipline in “*omics*” technologies. We can define foodomics “as a discipline that studies the food and nutrition domains through the application of advanced omics technologies to improve consumer’s wellbeing, health, and knowledge” (Cifuentes 2009). Foodomics include transcriptomics, genomics, proteomics, and metabolomics, and a variety of *omics* sub-disciplines (epigenomics, lipidomics, metallomics, diseasomics, etc.). Genomics analysis investigates expression of genes, designation of RNA in a biological sample and the indication of genes mutations. Polymerase chain reaction (PCR) analysis facilitates forecasting and studying neoplastic diseases. The main purpose of proteomics is the detection, quantitative determination of protein and identification of biomarkers in the early stages of the disease. Proteomic studies use chromatographic and electrophoretic separation, mass spectrometry, immune reactions, protein and tissue microarray. Metabolomics studies are very complicated by the presence of hundreds or thousands of chemically labile metabolite present in the sample. Lipidomics as a new branch of molecular biology deals with the characterization of lipids present in living organisms, their interactions, and biological functions. Genomics with proteomics, metabolomics and transcriptomics are the main backbone of *foodomics* (Figure 5).





**Figure 5.** Scheme of foodomics platform, including analytical methodologies

## Conclusion

Over the last two decades the hyphenated separation techniques have significantly broadened their applications in many areas of science, industry, pharmacy. In the paper various hyphenated methods, e.g., LC-MS, GC-MS, CE-MS, etc. have been presented which are used in such processes as pre-isolation analyses of crude extract/fraction, isolation, detection, and identification of products.

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## TULAREMIA – SERIOUS ZONOTIC DISEASE

Marcin Weiner<sup>1</sup>, Maria Kubajka<sup>2</sup>

<sup>1</sup>Pope John Paul II State School of Higher Education in Biała Podlaska

<sup>2</sup>National Veterinary Research Institute in Puławy

Weiner M., Kubajka M. (2014), *Tularemia – serious zoonotic disease*. Health Problems of Civilization 1 (9), p. 39-46

**Summary:** Tularemia is an acute, infectious zoonotic disease caused by a small, aerobic, intracellular, gram-negative bacillus *Francisella tularensis*. Tularemia was firstly described towards the end of nineteenth century in Japan, however, the name *Francisella* comes from Edward Francis, an American researcher who in 1911 detected this bacterium in squirrels in Tulare County, California. In Poland tularemia in humans was recognized for the first time in 1949. In the years 1949 to 2009, over 600 tularemia cases were recorded in Poland, with one fatality in 1983. Initial work on the use of *F. tularensis* as a biological weapon was carried out in the 30s of the twentieth century simultaneously in the United States, Soviet Union and Japan. The natural reservoirs of the micro-organism are rodents and lagomorphs, which can be a source of infection for other animals and humans. Human infection occurs through direct contact with sick animal, inhalation of dust contaminated with feces of sick animals and it takes place mainly in the farms involved in the animal production, to a lesser extent as a result of contaminated food and water.

**Keywords:** *Francisella tularensis*, tularemia, bioterrorism, zoonosis

### Introduction

Tularemia is a zoonotic infectious disease, also called the “plague of rodents”, “wild hare disease” or “rabbit fever” (Kłapeć, Cholewa 2011). An etiological agent of this zoonosis is bacterium *Francisella tularensis*, which was isolated for the first time during an epidemic of tularemia in squirrels in Tulare County, California in 1912 (Hansen et al. 2011, Oyston et al. 2008). The name of the bacterium comes from the name of the researcher, Dr. Edward Francis, dealing with these pathogens (McCoy and Chapin 1912). Although the micro-organism is pathogenic to 190 species of “animals”, clinical symptoms occur mainly in lagomorphs and rodents (Glinski and Kostro 2005, Reed et al. 2014). The natural reservoirs are murine, muskrats, water rats, ground squirrels, voles and rabbits (Rastawicki and Jagielski 2005, Osiak et al. 2006). The given zoonosis is described as a disease with an acute course, but in many cases it can be mild or asymptomatic (Rastawicki et al. 2005). Most often the source of an infection is an arthropod, as well as direct contact with sick animal or biological material derived from infected animals (meat, water, contaminated dust) (Mierzyńska et al. 2002, Moniuszko et al. 2010). Tularemia in humans may take different forms depending on the route of entry into the body. This may be a direct contact through the skin and / or mucous membranes, aerogenic route as well as by mouth. Tularemia in humans may take various forms, depending on the route of entry, virulence, and the infectious dose. Depending on the route of entry, virulence and infectious dose different forms of this disease can be distinguished.

### Etiology

Etiological agent of tularemia is small (0.2-0.7 µm), gram-negative, aerobic, non-motile and not producing endospores, granulomatous bacterium *Francisella tularensis* (Ellis et al. 2002). Tularemia grows under aerobic conditions on alkaline substrate (pH 7.2) at 37±2°C. The growth occurs after 2 - 5 days in a form of small, mucilaginous and transparent colonies.

Taxonomic position of *F. tularensis* underwent frequent changes (Rastawicki and Jagielski 2005). According to the latest Bergey's taxonomy, the pathogen belongs to *Francisellaceae* family, genus *Francisella*, which includes two species of *Francisella*: *tularensis* and *philomiragia* (Brenner 2005). *F. tularensis* consists of four subspecies:

**Address for correspondence:** Marcin Weiner, Pope John Paul II State School of Higher Education in Biała Podlaska, Sidorska 95/97 Street, 21-500 Biała Podlaska, e-mail: m.weiner@dydaktyka.pswbp.pl, phone: (83) 344 99 18

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1. *Francisella tularensis* subspecies *tularensis* (formerly type A or subspecies Nearctic),
2. *Francisella tularensis* subsp. *holarctica* (formerly type B or subspecies holarctica),
  - 2.1. biovar I erythromycin sensitive,
  - 2.2. biovar II erythromycin resistant,
  - 2.3. biovar japonica,
3. *Francisella tularensis* subsp. *mediasiatica*,
4. *Francisella tularensis* subsp. *novicida*.

Those subspecies have been classified primarily on the basis of the genetic code, virulence, ability to produce acid from glycerol and citrulline ureidase activity.

*F. tularensis* subsp. *tularensis* is found mainly in North America and is highly virulent for humans and rabbits. This subspecies is responsible for approximately 70% of cases of *Francisella* sickness. The infectious dose is <10 CFU (*colony forming unit*) and can lead to life-threatening diseases, in particular when the respiratory tract is being infected. *F. tularensis* subsp. *holarctica* is more common and differs from *F. tularensis* in terms of biochemical properties and reduced virulence in humans and animals.

*F. holarctica* is primarily isolated from aquatic animals such as beavers and muskrats in the northern areas of North America, and is a major cause of tularemia in hares and small rodents in northern areas of Europe and Asia (Osiak et al. 2006, Pechous et al. 2009). *F. mediasiatica* has a similar virulence to the subspecies *F. holarctica* but its geographical distribution is limited to Central Asia and the former Republic of Soviet Union (Pechous et al. 2009).

Tularemia bacillus is sensitive to high heat, sunlight and UV radiation as well as to majority of the commercial disinfectants (Rastawicki and Jagielski 2005). In the environment with favorable conditions it can survive for up to several months (Tab. 1).

This microorganism is listed in the 3rd place after the Anthrax bacillus (*Bacillus anthracis*) and botulinum toxin (a neurotoxin produced by the bacterium *Clostridium botulinum*) as a microbiological factor applicable to bioterrorism (Glinski and Kostro 2005, Reed et al 2014).

**Table 1.** *Francisella tularensis* survival in different environments

Potential source of infection	Survival
Dried skins	~ 45 days
Dry hay and straw, pasturage	~ 120 days
Hare carcasses	~133 days
Hemolymph of ticks and insects	~240 days
Soil, silt	Few weeks
Water bodies, corpses of dead animals	~3 months
Frozen meat (e.g. rabbit)	Several years

### Source and route of infection

The main reservoirs of the germ are arthropods carrying bacteria and infected organism itself. The natural reservoirs are rabbits, hares, squirrels, nutria, mice, rats, however there are cases to eradicate the infection in cattle, horses, sheep, goats, or even pigs and dogs. Humans can be infected by mosquitoes, ticks, flies, or through the direct contact with contaminated environment or the inhalation of contaminated dust. There are cases of falling ill after the contact with material coming from sick animal. or after eating meat from rabbit or hare. Natural circulation of infection exists because of the circulation of the germ in the environment: rodent (donor) - arthropod (carrier) - rodent (recipient). During this stage new epidemics arise (Kłapeć, Cholewa 2011, Oyston 2008).

### Occurrence

The disease is widespread. The natural outbreaks of tularemia occurred in the USA, Mexico, Canada, Yugoslavia, Spain, Czech Republic, Slovakia, Scandinavia, Turkey, the former Soviet Union, Japan and many Asian countries. In the United States in the years 1981-1987 the cases of tularemia were reported in all states. In Europe, the first laboratory confirmed cases were registered in the USSR in 1926. In later years, great epidemic waves were observed, during which tularemia moved to the west and south of the continent. The first wave of epidemic reached Scandinavia (illnesses were reported in Norway in 1929 and in Sweden in 1931) and Central Europe - Moravia

(Austria and the Czech Republic in the years 1935-1937). The second wave occurred during World War II in the northern part of the Soviet Union. In the old endemic hotbed new epidemics broke out. This wave was characterized by a high expansiveness, it passed to remote areas previously free of tularemia. In this way, in the mid-forties, it reached the mouth of the river Neman and along the Baltic coast, to the west Europe (epidemics in East and West Germany, Belgium, France). Hereafter, in some parts of Europe, the germ created reservoirs among the native fauna (persistent infection of rodents and arthropods) - creating the so-called natural hotbed. In these areas the isolated cases of human illnesses were observed and cyclical epidemics were breaking out. Maximum increase of cases of tularemia in the world was recorded in the years 1930-1950. New cases of illnesses and epidemics, the source of which are not only hares, appeared in Turkey (Akalin et al. 2009, Gurcan 2007), Spain in 1997 (Anda et al. 2001), Georgia in 2006 (Chitadze et al. 2009) and Germany in 2005 (Hauri et al. 2010). More and more often the source of disease is water (spring water, water from recreation areas) and the food, in Italy in 1982 (Greco et al. 1998) and Bulgaria (Christova et al. 2004). In 2000, Sweden (Elliason et al. 2002) reported an outbreak of tularemia in areas previously not considered endemic. 270 people fell ill. Epidemiological analysis showed that the disease was caused by a mosquito bite, passively transferring germs. Data from the literature shows that in Sweden until 2000, 6,000 people died from tularemia (Elliason et al. 2002). In Poland, the endemic hotbeds of tularemia are present mainly in the north of the country (near Bialystok, Gdansk, Bydgoszcz, Szczecin) and near Poznan. In Poland tularemia in humans was diagnosed for the first time in 1949 in Lodz, where the source of infection was probably the skin of a hare. The first major epidemic outbreak was detected in the Olsztyn province in 1950 and the likely cause of the infection was a hare. The cause of the next cases were laboratory animals: in 1950, 4 employees of PZH (National Institute of Hygiene) were infected and fell ill, and following outbreak occurred in the Szczecin province in the years 1952-1953, where 70 cases of tularemia were recorded. Rabbit was considered to be the source of infection in almost all outbreaks (Malottke and Dominowska 1973, Skrodzki et al. 1954). Another outbreak of tularemia was registered in Warsaw, in a company being in the venison trade, where 18 employees fell sick. For that reason an approximate test was being carried out on the employees working in this type of enterprises in 10 provinces. A total of 526 persons were examined. Positive serological and allergic results were obtained in 10 cases, and 5 people were having symptomatic disease (Kicińska et al. 1954). Pacewicz and other contributors, in 1999 carried out tests on 716 forestry workers from the regions the north-eastern Poland for antibodies against *F. tularensis*. Only one employee had positive results. The tested person showed no signs of disease neither in the time of the test nor in the past (Pacewicz et al. 2004). In 2002 the same authors carried out another test on the 55 patients with enlarged lymph nodes, who have been admitted to clinic in order to establish a diagnosis - the results were negative. They have tested as well a group of 765 forestry workers from the same regions of Poland. 20 patients had positive results, but none of these persons showed symptoms suggesting of having tularemia in the past. The tests carried on 480 forestry workers in selected regions of Poland (province.: Podlasie, Warmia-Masuria, Kielce, Opole) in 42 cases (8.8%) showed the presence of antibodies for the antigens of *F. tularensis* (Rastawicki and Jagielski 2005). In the years 1949-2009, 614 people fell sick on tularemia; one fatal case was recorded in 1983.

## Pathogenesis

The infectious dose of *F. tularensis* for humans depends on the route of infection, and it ranges from 10 to 50 CFU when the pathogen was injected intradermally or by inhalation and 10 CFU after intake (Sjostedt 2007). *F. tularensis* have the ability to intensively multiply within macrophages. The virulent ability of the germ interferes with the resistance of the host organism, resulting in bacterial cell division in the cytoplasm (Carvalho et al. 2014). It can trigger off a cell death by apoptosis, releasing the bacteria to infect new cells (Glinski and Kostro 2003). Bacillus *F. tularensis* invade the lymphatic vessels using macrophages and can cause inflammation of the lymph nodes. When the body's resistance is broken bacteremia and then sepsis are being developed. After further multiplication they spread throughout the body by circulatory system occupying much of the internal organs and reaching to the lungs, spleen, liver and kidneys. At a later stage, an inflammatory condition develops resulting in local necrosis with infiltration. In the final stage, the secretory changes develop, which takes form of caseating granulomas characteristic of tuberculosis and sarcoidosis (Hansen et al. 2011, Moniuszko et al. 2010, Osiak et al. 2006). The organism fights the microorganism by creating multiple defense mechanisms. In the early stages of the infection PMNs leukocytes (polymorphonuclear leukocytes) destroys bacteria. TNF factor (tumor necrosis factor) and interferon gamma (IFN- $\gamma$ ), stops the infection process. Lipid rich capsule protects pathogen against complement lysis and as a result reticuloendothelial system is being populated by the microorganisms. Within 2 days of infection, the body's cellular immunity is dependent on neutrophilia: interleukin 10, interleukin 12, IFN -  $\gamma$  and TNF- $\alpha$ , but when the infection progresses, T-cells have an important role in combating infection (Kłapeć i Cholewa 2011 Moniuszko et al. 2010). ACP protein, which can be found in *F. tularensis*, demonstrates

acid phosphatase activity. Low pH is essential to the bacteria in phagosome macrophages to absorb iron and to multiply. Acidic environment result in the release of iron from transferrin host and may cause additional virulence factors. In the moment when the element is no longer available *F. tularensis* dies. The effects between macrophages and bacteria depend on the types of macrophages. Activation of peritoneal macrophages leads to the production of nitric oxide - NO, and alveolar macrophages (pulmonary) are activated by interferon -  $\gamma$ . The initial stage of bacterial cell multiplication within macrophages runs at a slow pace, but after 12 hours, it accelerates. In fact, it causes them to die off, and the released *F. tularensis* may take up subsequent cells of the host (Osiak et al. 2006). LPS (Lipopolysaccharide) of *F. tularensis* plays a significant role in the development of bacteria in macrophages. Protein 23-kDa fulfills important functions in intracellular multiplication and hinders post inflammatory cytokine actions.

## Epidemiology

Tularaemia occurs in a number of clinical forms. Its symptoms can be a bit different depending on what way the bacteria entered the organism. The illness can be undergone in various forms – from acute to mild or even asymptomatic. The beginning of the illness is sudden – 38-40 °C fever, headache, throat ache and pain of muscles. Sometimes diarrhoea, nausea and vomiting occur. As the illness progresses, the organism gets weakened and loss of body weight occurs. Incubation period takes around 3 to 5 days, but there occur extreme cases, in which symptoms appear very fast (during one day) or relatively late (even after twenty days from the infection).

In Europe 90% of cases of tularaemia are of the ulcerating-nodal form, which occurs usually after contact with a sick animal or after getting bitten by arthropods. After 3-5 days from exposition, in the place of bacterial penetration there develops a primary lesion in the form of erythematous pellet, which then becomes ulcer and heals fast. After a short incubation period (3-6 days), there appear flu-like symptoms in the infected person and local lymph nodes enlarge – which most often is the only reason why patients come to the doctor. Through the lymphatic system it comes to spreading of the bacteria to the internal organs, including lungs, liver, spleen and kidneys (Kłapeć, Cholewa 2011).

In around 5% of cases tularaemia is diagnosed in a tonsillitis form, which occurs after consumption of infected water or food. It courses with exudative inflammation of oral cavity, throat and/or tonsils and jugular lymphadenopathy. This can suggest streptococcal tonsillitis and in these cases the treatment is performed using potassium penicillin G, for which the *F. tularensis* bacteria are immune. This form can be hard to distinguish from ulcerating-nodal form if the patient was bitten by arthropod in the head or neck. Then the lymphatic nodes also get enlarged and the primary lesion can be unapparent (Rastawicki, Jagielski 2005).

Among other forms of tularaemia, the forms which occur much less frequently are listed below:

- pulmonary – caused by the penetration of microorganisms through respiratory tract or occurs as a complication of other forms of tularaemia. The symptoms are nonspecific: pains in the chest, dry cough, high fever. The most characteristic symptom is the enlargement of axillary lymphatic nodes. In the X-ray of the chest vesicular concentrations spanning over the lobe or segment of the lungs, granulomatous changes or abscesses can be visible. There can also occur the enlargement of the cavities and the exudation in pleura.
- ocular-nodal – occurring rarely. Courses with ulcerative conjunctivitis. The infection takes place in effect of rubbing the eyes with infected fingers.
- gastric-intestinal – occurs after consumption of infected water or food. Courses with mild diarrhoea or in severe form – with ulceration of intestines.
- typhoid – a historical name, very controversial nowadays. Concerns the cases of tularaemia coursing without primary lesions – primary lesions of skin, nodes, eyes, oral cavity and lungs. The sudden beginning, with high fever and muscle aches, is characteristic. In some cases there occur diarrhoea, dry cough and pain in the chest. The most common complications are rhabdomyolysis, inflammation of the liver, kidneys and joints. This form courses with high mortality rate reaching 50% of cases. The way of infection is unknown.

## Diagnosis

Identification of *F. tularensis* is hard and should take place in specialist laboratories of BSL3 class. The variety of laboratory methods of tularaemia analysis allows for a fast and precise diagnosis of the illness from the moment of infection to the recovery period, and even after death (Kłapeć, Cholewa 2011). In humans each material intended for identification should be delivered before the start of antibiotic therapy. Samples can include blood, serum, specimen of lymphatic nodes, saliva, material from digestive tract or respiratory tract, scrapings from places changed by illness, urine. If there is a suspicion of the occurrence of *F. tularensis* in animal, sample of serum, drawn

at least 14 days after the occurrence of symptoms, should be given to laboratory for diagnosis. In the case of dead specimen, [following parts of the body] the following can be analysed: lymphatic nodes, bone marrow, organs (lung, liver, spleen). In the case of epidemic outbreak environmental samples, like water, soil, rodent faeces as well as blood-sucking insects, are sent for analysis (Cavalho et al. 2014).

The methods of laboratory diagnosis of *F. tularensis* infection: microscopic, serological, bacteriological as well as molecular methods, are described in Table 2.

**Table 2.** Methods of laboratory diagnosis of *F. tularensis* infection

Type of analysis	Diagnostic method/ Nutrient	Description
Microscopic formulations	Gram Method or Giems Method colouring	In coloured Gram formulations, <i>F.tularensis</i> is coloured negatively in red-pink (taking the colour of the dye). Giems Method: formulation is coloured in pink – blue, taking form of a ball or a rod of various length
Histological formulations	Direct and indirect immunofluorencence reaction, Immunochromatography reaction, Immunoenzymatic reaction, Precipitation in capillaries reaction	Extremely sensitive and fast methods, which allow detecting the microbe already on the level below 10 <sup>3</sup> CFU/ml.
Serological analyses	Test tube agglutination reaction, Microagglutination reaction, ELISA reaction, Latex reaction	Serological methods allow detecting inherent antibodies for <i>F. tularensis</i> antigens after approximately 14 days from the occurrence of illness symptoms.
Cell cultures	Agar with the addition of blood, cysteine and glucose, Chocolate agar (cysteine agar enriched with 9% addition of ram erythrocytes) Cysteine Heart Agar with the addition of haemoglobin (CHA), Thayer – Martin Agar with supplement Mueller – Hinton bouillon with the addition of 0,025% iron pyrophosphate	<i>F. tularensis</i> colonies are round, smooth, a bit mucous, have 2 – 4mm diameter and greenish-white colour. On flat bases, the growth is observed after 18h, in the temperature of 37°C (some strains grow from 3 to 6 or even 10 days). Sometimes the temperature of 28°C is used, which is necessary in detailed identification of <i>F. tularensis</i> from <i>Yersinia pestis</i> , <i>F.tularensis</i> subsp. <i>novicida</i> , <i>F.philomiragia</i> .
Bioassay	Biological analyses are infection of mice, guinea pigs or rabbits with the material containing living, malignant <i>F. tularensis</i> germs. Infection is done by various methods: subcutaneously, intramuscularly, intravenously, through respiratory tract, through digestive tract, through instillation of the infected material to the conjunctival sac or nose.	Deaths occur from 2 to 10 days. [There are] haemorrhagic enlargements of lymphatic nodes, liver, spleen, multiple necrotic foci.
Molecular biology methods	Polymerase Chain Reaction (PCR) LR-REP-PCR and ERIC- PCR.	There is a search for fragments of genes coding protein of outer membrane. It allows distinguishing <i>F. tularensis</i> on the subspecies level.

### Tularaemia as a biological weapon

*F. tularensis* is a number 3 pathogen, after bacillus of anthrax and botulinum toxin, used as a potential biological weapon in bioterrorism on account of its biological properties (Mierzyńska, Hermanowska-Szpakowicz 2002). American Centers for Disease Control and Prevention (CDC) classified *F. tularensis* as a bioterrorist mean, because it is highly infectious, pathogenic, spreads easily, influences public health and probability of mortality rate(Chomiczewski 2003).

The multitude of ways of bacterial transmission makes counteraction, and also finding the source of infection, harder. In case of bioterrorist attack, *F. tularensis* can be spread by wind over long distances. Germs can also infect carriers (e.g. lice, fleas, mice, rats), from which the pathogenic microbes can move to people directly or to water and food (Chomiczewski 2003). First researches using *F. tularensis* were conducted already before World War II in

such countries as USSR, USA and Japan. It is supposed that these bacteria were used by Russians in the years 1942 – 1943 during the fights over Stalingrad. The proof for it were massive pneumonias among Russian and German soldiers and civilian population. In the years 1932 – 1945 Japan conducted intensive researches of biological weapons development in Manchuria. After the World War II USA and USSR still conducted researches at offensive use of this pathogen. Americans conducted the works until the end of the sixties, developing a technique of using tularaemia rods in the form of aerosol. During the Soviet programme, conducted in the nineties, a strain immune to vaccines and antibiotics was developed. In 1970 WHO experts made a simulation which suggested that spraying 50 kg of the aerosol suspension of tularaemia rods from the plane two kilometres over the area with 500,000 residents would cause 30,000 fatalities and 125,000 serious illnesses (Chomiczewski 2003).

## Treatment

Quick diagnosis of tularaemia and adequate treatment on the areas where this illness occurs relatively rarely is hard to achieve, because the symptoms of tularaemia are little specific and usually give rise to suspicion of other infectious diseases. The diagnosis of the illness relies mostly on the data from [medical] examination (Rastawicki i Jagielski 2005).

In most cases correct antibiotic therapy leads to full healing. In the treatment of this illness streptomycin is given to the diseased. The medicine is given in the quantity of 1g intramuscularly, two times a day over a period of 10 days. Gentamycin is an alternative and can be given intravenously in the quantity of 5 mg/kg, once a day over a period of 10 days. In case of an epidemic, relapses or immunity for the early treatment [these medicines] can be given:

- Doxycycline: 100 mg orally, two times a day, over a period of two weeks,
- Ciprofloxacin: 500 mg orally, two times a day, over a period of two weeks,

For children the same antibiotics are used (also in case of epidemic) in reduced doses:

- Streptomycin 15 mg/kg intramuscularly, two times a day,
- Gentamycin: 2,5 mg/kg intramuscularly or intravenously, three times a day,
- Doxycycline: for children weighing over 45 kg, 100 mg orally, two times a day, over a period of two weeks, For children weighing below 45 kg, 2,2 mg/kg orally, two times a day, over a period of two weeks,
- Ciprofloxacin: 15 mg/kg orally, two times a day, over a period of two weeks (Osiak et al. 2006; Dennis et al. 2001).

## Inherent prophylaxis

First attempts to create a vaccine against tularaemia did not give demanded results, because of very low immunity in people and animals for it. Next researches on acute, attenuated vaccine were conducted already before the World War II in onetime Soviet Union. In the beginning of 1940 new strain of *F. tularensis*, marked as 15, was isolated. [Strain] marked as 155 was another strain, obtained in the Gamaleja Institute in Moscow. Thanks to these strains the acute vaccine that was mass produced came into being. This vaccine was in turn given to the US Army Medical Research Institute of Infectious Diseases where, during another tests, acute vaccine strain LVS (Live Vaccine Strain) was obtained. Vaccine from LVS can be given the erogenous, oral, as well as subcutaneous way, which proved to be best. It does not give full protection against the inhalatory form of tularaemia, it just has a slight influence of making the course of the illness milder. Lately a mutated, attenuated strain Schu S4 has been discovered, which gives a much better protection against inhalatory infection (Kłapeć, Cholewa 2011, Osiak et al. 2006, Pechous 2009). Researches on creating a vaccine containing antigens capable of inducing humoral and cellular immunity are conducted. The only antigen inducing immunological reaction against *F. tularensis* is LPS (Lipopolysaccharide). At this moment there is no licensed vaccine against tularaemia on the market. The only available vaccine is attenuated LVS, which is available only to persons of high-risk group and the availability of which is limited.

## Administrative proceedings

Tularaemia is in the specification of infectious diseases and human infections covered by The Act on the Infectious Diseases and Infections of 31 January 2013 (*Ustawa o chorobach zakaźnych i zakażeniach z 31 stycznia 2013 r.*), and in view of the danger for human health the animals with tularaemia are recommended to be eliminated on the basis of The Act of 11 March 2004 on the Protection of Animal Health and Combating Infectious Diseases of Animals (*Ustawa z 11 marca 2004r. o ochronie zdrowia zwierząt oraz zwalczaniu chorób zakaźnych zwierząt*). Combating tularaemia relies on neutralizing the source of infection and cutting out the paths of spreading the disease. Preventing the illness relies on avoiding situations connected with the risk of contact with infected



material and on thermal or chemical preservation of carcasses of dead animal. eliminating of field rodents and complying with hygiene norms. The best method is not residing on endemic territories of occurrence of tularaemia, and when it is impossible, using appropriate prevention means. While residing on forest territories and meadows (work, tourism) the precautions which protect against biting by a tick should be kept. Extreme caution should be exercised while skinning of hares or rabbits (Magdzik 1986).

Despite the fact that in Poland tularaemia is so far not a serious problem, the occurrence of this illness in neighbouring countries and the rising number of infections both in neighbouring countries and in Poland cause that it [(tularaemia)] is to be taken into account during the microbiological diagnosis of infections. In conjunction with the geopolitical situation it should also be considered as a potential biological weapon.

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## THE IMPACT OF TOOTHBRUSH FILAMENT DESIGN ON GINGIVAL HEALTH DURING HEALING. A RANDOMIZED, CONTROLLED, INVESTIGATOR-BLINDED CLINICAL TRIAL

Eva Kovalová<sup>1</sup>, Bohuslav Novák<sup>2</sup>, Tatiana Klamárová<sup>1</sup>, Anna Eliašová<sup>1</sup>

<sup>1</sup>Clinic of Maxillofacial Surgery; Faculty of Health Care, University of Prešov in Prešov

<sup>2</sup>Department of Stomatology & Maxillofacial Surgery FM CU and OISE, Bratislava

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### Summary:

**Objectives.** The primary objective of the study was to test toothbrushes with different types of filaments (conical vs. rounded) with respect to cause gingival abrasion after surgical intervention of wisdom teeth. A secondary objective was to evaluate the efficacy of plaque removal and the improvement of gingival conditions to alleviate wound healing and to avoid gingivitis.

**Methods.** One hundred and seventy-three healthy subjects with surgical intervention of wisdom teeth participated in a randomized, single blind study and were randomly allocated to control group (standard ADA reference toothbrush) or test group (meridol® special toothbrush with conical filaments). Clinical examinations included gingival abrasion, plaque index and gingival index, and were conducted at baseline, 7 and 28 days.

**Results.** For the gingival abrasion the mean number of lesions of all sizes was after 28 days significantly lower in the test group (p-value <0.001) compared to control group. Plaque index was not significantly different between the two groups in the last visit. At day 28 the gingival index was significantly lower in the test group (p=0.031) compared to control group.

**Conclusions.** The toothbrush with conical filaments induced significantly less gingival abrasions than the standard ADA toothbrush and showed superior results in improving gingival health (gingival index). Both toothbrushes were comparable effective with respect to plaque removal.

**Clinical Relevance.**

Scientific rationale for study: Supra and sub-gingival biofilm leads to gingival inflammation. Post-surgical removal of the biofilm from gingival surfaces promotes healing after wisdom tooth extraction. Tooth brushing leads to gingival abrasion. Earlier investigations with toothbrushes having conical filaments suggest less gingival tissue damage.

**Principal findings:** The results showed that the toothbrush with conical filaments caused significantly less gingival abrasions than the toothbrush with rounded filaments.

**Practical implications:** Toothbrush filament design should be considered when choosing toothbrush for oral hygiene after oral surgery.

**Keywords:** conical filaments, toothbrush, gingival health, gingival abrasion, healing

### Introduction

Gingivitis is caused by substances derived from microbial plaque (biofilm) accumulating at or near the gingival sulcus. All other suspected local and systemic etiologic factors either enhance plaque accumulation or retention, or enhance the susceptibility of the gingival tissue to microbial attack. The evidence supports the conclusion that gingivitis is a disease, and that control and prevention is a worthwhile goal and a health benefit (Page, Gingivitis 1986). Following surgical intervention, the healing process invokes an inflammatory response and, subsequently, the presence of inflammation promotes the rapid formation of a biofilm. It has been shown that significantly more biofilm is formed in the presence of experimentally induced gingivitis than in a healthy environment (Dal. Highfield 1996). After dental extraction, in order to promote wound healing and to avoid gingival damage, the formation of this biofilm should be controlled, both mechanically and chemically, as a combined approach leads to optimal results. Toothbrushes remove biofilm and food debris and thus contribute to reducing inflammation (Saxer, Yankell 1997). Characteristics of an ideal toothbrush would therefore include reliable plaque removal and avoidance of gingival damage due to mechanical abrasion. These properties can be achieved by exploiting properties of the

**Address for correspondence:** Eva Kovalová, Clinic of Maxillofacial Surgery, Faculty Hospital, Hollého 14, 080 01 Prešov, Slovakia, e-mail: kovalova@nextra.sk, phone: +421 908 974 703

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filaments and the shape of the inserted handle segment (Drisko et al. 1995). Research that compared the tapered filament toothbrush to a ADA reference toothbrush has revealed that the two types were comparably efficacious in reducing gingivitis, while the toothbrush with tapered filaments was superior in preventing gingival lesions (von Bethlenfalvy et al. 2002). Furthermore, with respect to the Turesky plaque score (derived from the Quigley-Hein index), there was again a small but significant advantage of the tapered toothbrush (Dörfer et al. 2003). In a split-mouth design trial including 32 subjects, Versteeg *et al.* compared the tapered filament toothbrush to an ADA reference toothbrush. Here the focus was on gingival abrasion and gingival health following experimental gingivitis. Results showed that, while gingival health improved with both toothbrushes and the tapered filament toothbrush showed a tendency towards fewer gingival sites with abrasion, the ADA toothbrush was more effective in removing plaque and reducing bleeding (Versteeg et al. 2008). In a long-term trial lasting 6 months with 2x15 volunteers, the tapered filament toothbrush was again compared to an ADA reference toothbrush by Checchi et al. (2007). While both the gingival index and the plaque index were significantly improved during treatment in both groups, there were, in comparison, statistically significant advantages with the tapered bristles.

The present study's purpose was to test toothbrushes with different types of filaments (conical vs. rounded) with respect to cause gingival abrasion after surgical intervention of wisdom teeth and to evaluate the efficacy of plaque removal and the improvement of gingival conditions to alleviate wound healing and to avoid gingivitis.

## Materials and methods

### Study design and materials

The study was designed as an investigator-blinded, randomized, controlled trial with two parallel treatment arms. The subjects (healthy individuals aged 18-65) were recruited among patients undergoing surgical extraction of wisdom teeth at the Clinic for Maxillofacial Surgery and Dental Hygiene, Prešov, Slovakia. Study interventions took place between October 2011 and June 2012. The trial was approved by the local ethical committee in Prešov. All patients were informed about the study protocol and signed an informed consent form before beginning the study.

Inclusion criteria were as follows:

- healthy male and female adults aged 18-65 years,
- directly involved after the surgery intervention,
- written informed consent,
- acceptable compliance according to the investigators assessment.

Exclusion criteria were as follows:

- medication that may interfere with the study up to 3 months before study start and during the course of the study,
- allergies and idiosyncratic responses to study products' ingredients,
- teeth supporting structures with any other painful pathology or defects (rampant caries, cracked enamel...),
- systemic diseases,
- known pregnancy or breast-feeding during the course of the study,
- professional administration and home use of CHX or other antibacterial activity mouth rinses or toothpastes,
- fillings etc. within 4 weeks prior enrolment and during the whole study,
- participation in another clinical trial or receipt of an investigational compound/treatment at the same time and 4 weeks prior to inclusion.

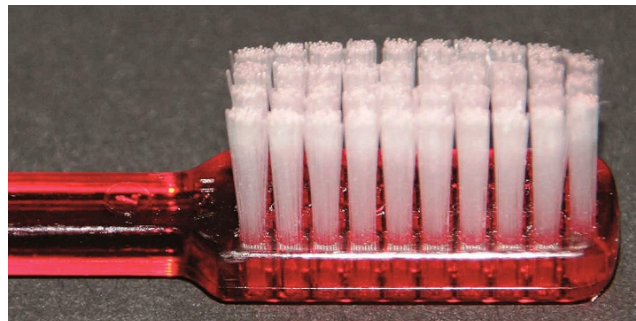
The 173 subjects, of whom 74 (42.8%) were males and 99 (57.2%) were females, were randomized into the trial's two treatment arms as follows:

Test group – toothbrush with conical filaments (meridol® special toothbrush - Figure 1): 84 patients (32 males, 52 females).



**Figure 1.** Meridol® special toothbrush with conical filaments

Control group – toothbrush with rounded filaments (ADA reference toothbrush - Figure 2): 89 patients (42 males, 47 females).



**Figure 2.** ADA reference toothbrush with rounded filaments

The study was performed under investigator-blinded conditions. Until the final examination of the last participant, the knowledge of the randomization list was limited to the persons responsible for their creation (statistician). In particular, the investigators had no knowledge of the treatment assignments until the blind data review meeting on June 4, 2012. At screening, participants were assigned to consecutive numbers (subject number) according to chronological entry in the study, starting at 20. All study participants were given the assigned toothbrush in anonymous packaging, same toothpaste (meridol® toothpaste) and same mouth rinse (meridol®). Toothbrush with conical filaments, toothpaste and mouth rinse were provided by the manufacturer. The subjects were instructed to brush their teeth twice daily and rinse in the evening with 10 ml mouth rinse.

### Clinical evaluation

The gingival abrasion was assessed at baseline, day 7, and day 28. In order to visualize gingival abrasion and plaque for assessment, a commercially available staining agent, Mira-2-Ton® solution (Hager Werken, Duisburg/Germany), was applied to the gums and dental surfaces. This preparation, which is marketed for the visualization of plaque, highlights abraded areas in a different color than intact mucosa.

Gingival tissues were classified as either marginal (cervical free gingiva), proximal (papillary free gingiva), or mid-gingival (attached gingiva). The size of the abrasions was measured using a periodontal probe (Deppeler) placed across the long axis of the lesions. The lesions were categorized as small (<3 mm), medium (3 - 5 mm), or large (>5mm) in all 4 quadrants.

The gingival index was assessed at all visits (baseline, day 7, day 28) of the treatment period, according to the scoring proposed by Löe (Löe H. 1967). The gingival assessment was performed after drying the teeth. Bleeding was provoked by running a blunt pocket probe along the soft tissue wall at the entrance of the gingival crevice.

Assessment always started with the vestibular sites (distal, buccal, mesial) in the maxilla, whereafter the palatal maxillary surfaces were assessed. The same procedure was performed with the teeth in the mandible (three vestibular and one lingual site). Each of the four sites of each tooth (buccal, mesial, distal and lingual) was assigned a score from 0 to 3. The sum of the scores divided by the number of investigated sites yields the index for the individual concerned. The average of the four scores per tooth represents the mean gingival index per tooth.

Plaque index was assessed at all visits (baseline, day 7, and day 28) of the treatment period according to the scoring proposed by Silness and L oe (1964). After drying the teeth with air, the staining agent (Mira-2-Ton® solution, Hager Werken, Duisburg, Germany) was applied. Assessment was performed with a dental probe run along the surfaces. Each of the four tooth surfaces was assigned a score from 0 to 3. Scoring started with the vestibular sites (distal, buccal, and mesial) in the maxilla and continued with the oral (palatal) surfaces. The same procedure was then performed with mandibular teeth (three vestibular and one lingual site).

### Study procedures

Patients were screened about three days before surgery. At baseline (Visit 1), inclusion and exclusion criteria were re-checked. After the assessment of gingival abrasion, gingival index and plaque index, the subjects underwent the surgical intervention and thereafter received the study products. Brushing started as instructed on the same day. Study parameters, adverse events, and compliance with study procedures were assessed on day 7 (Visit 2) and on day 28 (Visit 3), according to the study schedule.

The study was completed after day 28 and the patients received professional teeth cleaning.

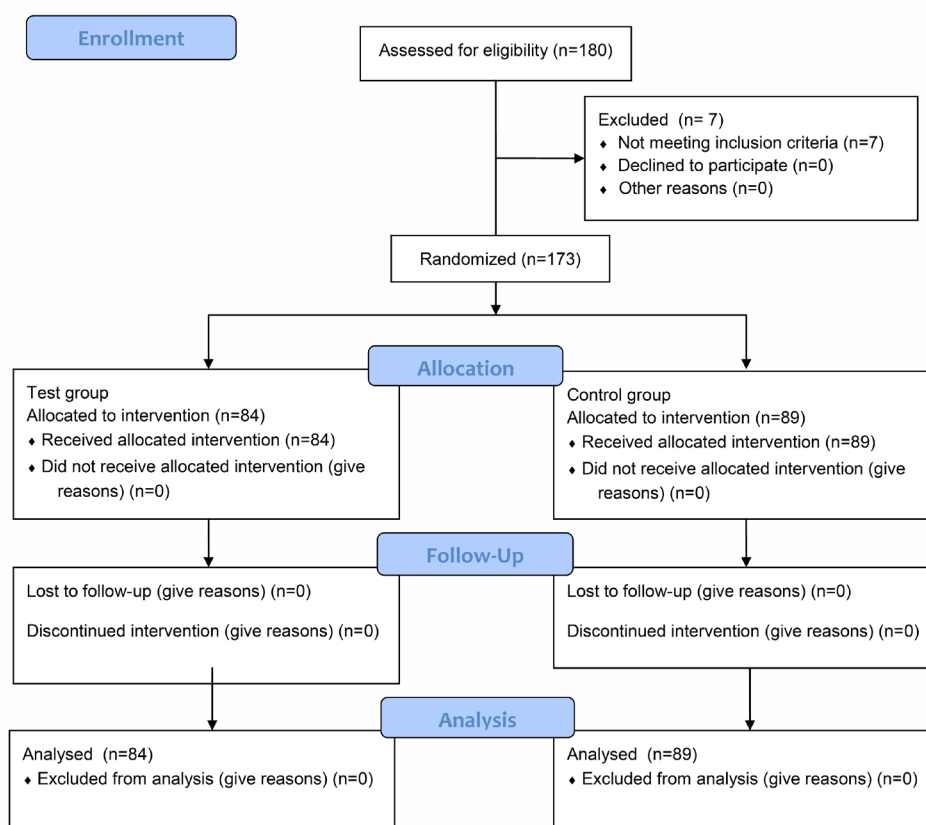
### Data analysis

Statistical comparisons between groups of gingival abrasion, gingival index, and plaque index on day 28 were effectuated by means of an analysis of covariance (ANCOVA) where the baseline values were used as covariates. For the comparisons between groups at Visits 1 and 2, Student's t-test has been used. SAS version 9.1 statistical software was used.

### Results

A total of 173 patients were included in the study, 84 in test group and 89 in control group. All the participants completed the study protocol.

A CONSORT-type diagram (Schulz et al. 2010) explaining the design of this study is presented in figure 3.



**Figure 3.** CONSORT-type diagram explaining the design of the study

## Gingival abrasion

Full details of gingival abrasion are provided in Table 1. Because of the small individual numbers, stratification by lesion size was not suitable for a statistical approach. Table 1 therefore shows the average number of lesions of all sizes for both groups at all three visits. While the average number of lesions was about 45% higher in the test group at baseline, this figure clearly and consistently decreased in the test group, and it increased in the control group at both later visits. The mean number of lesions of all sizes was after 28 days significantly lower in the test group (p-value <0.001) compared to control group.

**Table 1.** Mean number of gingival lesions per patient (mean  $\pm$  standard deviation)

		ADA (N = 89)	meridol® (N = 84)	p
Small lesions	Baseline	0.287 $\pm$ 0.387	0.375 $\pm$ 0.430	0.157*
	Day 7	0.264 $\pm$ 0.354	0.345 $\pm$ 0.360	0.137*
	Day 28	0.368 $\pm$ 0.395	0.161 $\pm$ 0.259	<0.001*
Medium lesions	Baseline	0.132 $\pm$ 0.287	0.238 $\pm$ 0.394	0.046*
	Day 7	0.256 $\pm$ 0.393	0.021 $\pm$ 0.124	<0.001*
	Day 28	0.214 $\pm$ 0.378	0.000 $\pm$ 0.000	<0.001*
Large lesions	Baseline	0.006 $\pm$ 0.053	0.003 $\pm$ 0.027	-
	Day 7	0.039 $\pm$ 0.188	0.012 $\pm$ 0.109	-
	Day 28	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	-
All lesions	Baseline	0.424 $\pm$ 0.417	0.616 $\pm$ 0.406	0.003*
	Day 7	0.559 $\pm$ 0.388	0.378 $\pm$ 0.365	0.002*
	Day 28	0.582 $\pm$ 0.382	0.161 $\pm$ 0.259	<0.001**

\* t test

\*\* Analysis of covariance with baseline values as covariates

## Gingival index

Numerical data are provided in Table 2. The gingival index was slightly lower in the test group at all visits; the difference reached statistical significance on day 7 (p = 0.021, t-test). At day 28 the gingival index was significantly lower in the test group (p=0.031, ANCOVA) compared to control group.

## Plaque index

Numerical data are provided in Table 2. The plaque index was slightly lower in the test group at all visits, but the difference did not reach statistical significance on any one of the visits.

**Table 2.** Gingival index and plaque index (mean  $\pm$  standard deviation)

		ADA		meridol®		p
Gingival index	Baseline	N = 88	1.212 $\pm$ 0.771	N = 85	1.072 $\pm$ 0.588	
	Day 7	N = 88	0.706 $\pm$ 0.589	N = 85	0.528 $\pm$ 0.409	0.021*
	Day 28	N = 87	0.424 $\pm$ 0.433	N = 84	0.281 $\pm$ 0.299	0.031**
Plaque index	Baseline	N = 88	1.325 $\pm$ 0.799	N = 85	1.277 $\pm$ 0.723	
	Day 7	N = 88	0.796 $\pm$ 0.550	N = 85	0.686 $\pm$ 0.391	
	Day 28	N = 87	0.515 $\pm$ 0.416	N = 84	0.417 $\pm$ 0.307	0.07**

\* t test

\*\* Analysis of covariance with baseline values as covariates

## Adverse events - tolerability

Adverse events and changes in hard and soft tissues in the oral cavity were recorded and documented at all visits (baseline, day 7, and day 28). No adverse events were reported.

## Discussion

The bacterial biofilm is commonly held responsible as one main reason for formation of both caries and inflammatory periodontal diseases (Axelsson, Lindhe 1978). Without brushing, plaque accumulates in the subgingival crevices of the teeth and causes gingival inflammation and bleeding (Addy 2008).

Rather the quality of tooth cleaning than the frequency is important for maintenance of oral health (Attin, Hornecker 2005). The use of the hard brush resulted in lower plaque scores and, at the same time, more gingival erosions than the use of the soft brush (Niemi et al. 1984).

The purpose of this study was to compare toothbrushes with differently shaped filaments with respect to cause gingival abrasion after surgical tooth extraction. Secondary endpoints were assessing the impact on general gingival health (gingival index) and plaque removal (plaque index).

The average number of lesions with gingival abrasion per patient slightly and consistently increased over the time in patients using the standard toothbrush with rounded filaments. This figure clearly decreased in patients using the toothbrush with conical filaments. The mean number of lesions of all sizes was after 28 days significantly lower in the test group (p-value <0.001) compared to control group. These findings are also supported by the study of Versteeg *et al.* (Versteeg et al. 2008).

The gingival index was slightly lower in the test group at all visits. At day 28 the gingival index was significantly lower in the test group (p=0.031, ANCOVA) compared to control group. Similar findings were demonstrated in the study of Sgan-Cohen *et al.* (Sgan-Cohen, Vered 2005) where the toothbrush with conical filaments showed highly significant statistical decrease of gingival index. This is in contrast with a study conducted by Versteeg et al. (Versteeg et al. 2008), where the toothbrush with conical filaments was less effective in the removal of biofilm and reduction of gingival bleeding than the toothbrush with conical filaments.

Plaque index was not significantly different between the two groups in the last visit. Both toothbrushes showed comparable effectiveness of biofilm removal. This is in contrast to a studies conducted by Dörfer *et al.* and Checchi *et al.* (Dörfer et al. 2003; Checchi et al. 2007), in which a groups using toothbrush with conical filaments had a statistically significant reduction in plaque index score to that of a toothbrush with rounded filaments.

Some limitations could be highlighted in this study. Both groups were using the same toothpaste and mouthrinse with amine fluoride and stannous fluoride. This could have influenced the formation of new biofilm and masked the differences between the two toothbrushes in case of plaque index.

This study raised no concerns regarding the safety and tolerability of either toothbrush.

Conclusion: The meridol® special toothbrush with conical filaments compared to the standard ADA toothbrush induced significantly less gingival abrasion and provides effective plaque removal and reduction of gingival index.

## Conflict of interest and source of funding statement

The authors have no conflicts of interest. The study was financially supported by GABA International AG (Therwil, Switzerland).

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