Interdisciplinary nature of oral diseases – clinical implications

Due to the progress in medicine and healthcare as well as the socioeconomic development in industrialised countries we have to deal with the flood of lifestyle diseases. The treatment of such diseases and in particular of complications thereof is the greatest economic burden on contemporary healthcare funding systems. Numerous studies prove the existence of interrelationships and cause-and-effect relationships among oral diseases and systemic illnesses. An analysis of risk factors for the occurrence of numerous systemic illnesses with a society-wide range has shown that the maintenance of oral health is one of essential elements which may considerably influence the modification of treatment outcomes for other general diseases.

W związku z postępem w medycynie i opiece zdrowotnej oraz rozwojem społeczno-ekonomicznym w krajach uprzemysłowionych, mamy do czynienia powodzą cywilizacyjnych. Leczenie tych schorzeń a zwłaszcza ich powikłań, najbardziej obciąża ekonomicznie współczesne systemy finansowania opieki zdrowotnej. Coraz więcej badań potwierdza istnienie współzależności i związków przyczynowo - skutkowych pomiędzy schorzeniami jamy ustnej a chorobami systemowymi. Analiza czynników ryzyka występowania licznych chorób układawodnych o zasięgu społecznym wykazuje, że utrzymanie zdrowia jamy ustnej jest jednym z istotnych elementów mogących znacząco wpływać na modyfikację wyników leczenia innych chorób ogólnych.

Introduction

More and more frequently, the contemporary medicine faces the problem of combating lifestyle-related diseases. Due to the progress in medicine and healthcare as well as the socioeconomic development in industrialised countries we have to deal with the ageing of societies. There are no disasters or high mortality rates in highly developed and developing countries, and the reproduction is mainly regulated by social determinants. At present, chronic systemic lifestyle-related diseases are becoming the primary cause of deaths in industrialised countries. Recent epidemiological studies have shown that the frequency of currently occurring chronic diseases is considerably higher than the frequency of acute conditions and infections [1]. The treatment of such diseases and in particular of complications thereof is the greatest economic burden on contemporary healthcare funding systems.

The oral cavity is an area where we can find numerous chronic pathologies with a complex aetiology. Frequently, their dramatic course is due to the coexistence of general diseases, the treatment and complications thereof. Moreover, the existence of many interactions among the conditions of teeth, oral soft tissues or bones of the stomatognathic system and selected systemic diseases was proven [2-5]. In 1994, the term of periodontal medicine [6] referring to studies on the influence of health of periodontal tissues on general health and the influence of coexistence of systemic chronic diseases on oral health was introduced into medicine by Offenbacher. This term also refers to the interaction of general and oral disease treatment effects because the existence of the so-called “vicious circle of disease” (lack of treatment effects related to a disease results from the coexistence of other diseases) which is the cause of very high costs of ineffective treatment was observed.

Treatment procedures in dental complications in the course of chronic systemic diseases

Diabetes is the most prominent example of a disease whose symptoms characteristically influence the oral health status, thus the treatment algorithm. The most significant pathomechanism responsible for the development and complications of oral diseases in the course of diabetes is the occurrence of irreversible micro- and macroangiopathic changes. In consequence of thickening of the endothelial layer of capillary vessels the oxygen flow to the tissues is hindered and the removal of products of metabolism is impaired [7]. The slower migration of neutrophils is the cause of an impairment of tissue immune response. It leads to the occurrence of reddening and the predisposition to oral mucosal bleeding and breaks as well as the occurrence of slow healing wounds and erosions more frequently than in generally healthy patients [8]. In addition, such condition exacerbates the impairment of neutrophil functions (chemotaxis, adherence
and phagocytosis), the impairment of collagen synthesis, maturation and homeostasis as well as slower mitotic cell divisions and fibroblast proliferation [9,10]. Therefore, the treatment of inflammatory gingival and periodontal conditions in diabetic patients is prolonged. Apart from routine procedures (oral hygiene instructions, supra- and sub-gingival scaling, polishing, rinsing with 0.2% r-rem chlorhexidine), the treatment plan should include highly specialised periodontal (e.g.: intraoral douches with radon waters) or periodontal surgical procedures connected with the application of local (applying minocycline ointment to the gingival pocket) or general antibiotic therapy (stimulating the host response by administering small doses of doxycycline: 20 mg 2 times a day for 3 months) [11-13]. It has been proven that modified treatment procedures considerably contribute to the decrease of glycohemoglobin concentration in blood serum. It has been demonstrated that the inclusion of the full-mouth disinfection (FMD, Tab. I) programme in standard treatment methods in connection with the nonsurgical periodontal treatment significantly contributes to the improvement of glycaemic management [14]. Procedures involving an interruption of tissue continuity need to be performed under antibiotic cover [15]. Moreover, the diabetics should undergo periodontal checkups more frequently (every 3 months) than healthy individuals because the prevention plays a key role in this case.

Caries occurs statistically more frequently in diabetics and has a more rapid course than in generally healthy individuals. There are several mechanisms responsible for that. On the one hand, a high concentration of glucose in the saliva and the gingival pocket fluid creates favourable conditions for the pH reduction in the oral cavity and the demineralisation of dental hard tissues [16,17]. It manifests itself in cavities, particularly in the periodontal region due to the coexistence of lesions in the marginal periodontium, and affects especially adults [16,17]. In addition, the occurrence of enamel hypoplasia in newly erupted permanent teeth which were mineralised before the occurrence of clinical symptoms of diabetes was observed in diabetic children [18]. The changes occurring in the saliva constitute the second caries risk factor in diabetic patients. The salivary gland ischemia causes an impairment of the function thereof. The phenomenon of „diabetic xerostomia” is a frequently encountered complication in diabetics, and the ethiopathology thereof has not been fully explained. Neuro- and angio-pathies as well as degenerative processes in the parenchyma of salivary glands are considered to be the primary causes of salivation disorders [19]. The mechanism of replacement of the secretory cells in salivary glands by the fatty tissue was described [20]. As a result, the salivary flow decreases, the viscosity of the saliva increases and its pH decreases, which entails a reduction of its buffering capacity [21]. All this leads to an accelerated dental plaque deposition as well as the development of caries and periodontal inflammatory conditions.

A complication of deep caries is an inflammatory condition of dental pulp (pulpitis) whose therapy in diabetics frequently involves complications resulting from an impairment of pulp tissue response to the action of odontotropic medication [22]. A frequent outcome in such situation, especially in patients with disturbed carbohydrate metabolism, is the pulp necrosis or gangrene. In consequence, it is necessary to use complicated and money-consuming endodontic treatment as the only alternative to tooth extraction. The procedure is performed under the antibiotic cover. A pattern of interconnected dental pathology mechanisms and the treatment thereof in the course of diabetes is shown in Figure 1.

One of the most frequent and severest diabetic complications is the diabetic kidney disease [23]. The epidemiological studies conducted in Poland showed that in nearly 30% of patients beginning the renal replacement therapy in 2005 the progressing and irreversible renal parenchymal atrophy was caused by diabetic complications [24]. Advanced chronic kidney disease is a cause of various pathologies which, by impairing the functions of organs and systems in the organism, indirectly affect the oral health status. It has been proven that in a group of chronic kidney disease patients a rapid deterioration of many clinical parameters responsible for the maintenance of health of dental, periodontal, mucosal and alveolar bone hard tissues may be observed [25,26]. Chronic kidney disease leads to the accumulation of uremic toxins in the blood with all the consequences it entails and the impairment of renal endocrine function. The causes of dental complications and the clinical image thereof in case of the coexistence of chronic kidney disease are described in Table II.

Dental diseases progress faster and more rapidly with the coexistence of chronic kidney disease in the course of diabetes. Together with chronic diabetic complications in the form of macroangiopathies, they become a real risk factor for the development of other inflammation based diseases such as vascular atherosclerosis, coronary heart disease, infective endocarditis or myocardial infarction [27-29]. This phenomenon is described by the so-called „pathogen burden” hypothesis – the theory of total infectious burden assuming that the development of adverse cardiovascular events is proportional to the number of microorganism infections [30,31]. Numerous epidemiological studies conducted among patients with cardiovascular diseases have confirmed a worse status of both teeth and periodontal tissues. Moreover, it has been proven that the inclusion of dental treatment has a characteristic influence on predictive markers of cardiovascular diseases and on the improvement of endothelial function (Tab. III).

Table I

<table>
<thead>
<tr>
<th>Procedure performed twice at the interval of 24 hours</th>
<th>Materials, instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgingival scaling</td>
<td>Universal (Columbia) and special (Gracey, Mini Graccy) curettes, hand, sonic and ultrasonic scalers</td>
</tr>
<tr>
<td>Root planing</td>
<td>Periodontal files, scalers with fine diamond coating, carbon curettes</td>
</tr>
<tr>
<td>Subgingival application of an antiseptic</td>
<td>1% chlorhexidine gel</td>
</tr>
<tr>
<td>Tongue brushing with antiseptic gel</td>
<td>1% chlorhexidine gel</td>
</tr>
<tr>
<td>Mouth and throat rinsing with an antiseptic</td>
<td>0.2-0.05% r-r chlorhexidine, 0.5-1% iodine povidone, 3% r-r H2O2, mouthwashes with essential oils</td>
</tr>
</tbody>
</table>

Figure 1

Figure 1

Metabolic disorders in diabetes.
Zaburzenia metaboliczne w cukrzycy.
with comorbidities. The allocation of limited modern medicine, in particular in patients medical directors the cost-effectiveness is to reduce morbidity and mortality of these preventive measures need to be introduced and clinical studies provides an insight importance. Evidence from epidemiological, and cardiovascular diseases (CVD) are of cardiovascular disease. Periodontal disease are associated with high burden before selected dental procedures. The danger of occurrence of cardiovascular incidents directly after a dental intervention is high [37]. An algorithm of procedure in bacteremia prevention after dental procedures in individuals with coexisting systemic diseases was created [38]. Table IV shows risk groups for the development of infective endocarditis and the latest guidelines concerning the use of antibiotic prevention before selected dental procedures.

Both diabetes and chronic kidney disease are associated with high burden of cardiovascular disease. Periodontal and cardiovascular diseases (CVD) are prevalent globally [39]. Epidemiological, pathological, microbiological and immunological studies show that infectious agents, such as periodontopathic pathogens and inflammatory markers in the blood have been correlated with increased risk of CVD [40]. Many studies provided strong evidence regarding relationship between oral/periodontal diseases to CVDs [41–44]. Poor oral health and CVD are major health problems worldwide and of significant public health importance. Evidence from epidemiological and clinical studies provides an insight into their potential association; therefore preventive measures need to be introduced to reduce morbidity and mortality of these chronic diseases.

Form the perspectives of payors and medical directors the cost-effectiveness is the most important issue. This problem is being more and more addressed in the modern medicine, in particular in patients with comorbidities. The allocation of limited available healthcare resources demands an agreed rational allocation principle and the consequent priority setting. Brandle et al. [45] assessed the median annual direct medical costs for subjects with diet controlregulated type 2 diabetes, BMI 30 kg/m², and no microvascular, neuropathic, or cardiovascular complications. They found that the costs were 1,700 dollars for white men and 2,100 dollars for white women. They also looked for reasons of increasing costs and found that a 10-kg/m² increase in BMI, treatment with oral antidiabetic or antihypertensive agents, diabetic kidney disease, cerebrovascular disease, and peripheral vascular disease were each associated with 10-30% increases in cost. In addition complication such as angina, and myocardial infarction as well as insulin therapy, were each associated with 60-90% increases in cost, while renal replacement therapy in a form of dialysis increased the cost 11-fold. From both perspectives payor and hospital directors the introduction of preventive programs and education is of utmost importance, as it decrease the number and costs of hospitalizations as well as ambulatory visits. In the personalized oral health education (POHE) during a free one-day interprofessional women's health promotion event Price et al. [46] showed that the participants' knowledge of oral-systemic health linkages had increased following this event. Moreover, it was the opportunity for dental faculty members and students to work alongside colleagues in other health professions in promoting women's health. Past research has indicated that similar projects have increased oral health knowledge in non-dental health care providers [47,48]. On the other hand, Catala-Lopez et al. [49] assessed the association between economic evaluations of healthcare interventions published in Spain (1983-2008) and the disease burden in the population. They included full-economic evaluations (e.g., cost minimization analysis [CMA], cost-effectiveness analysis [CEA], cost-utility analysis [CUA] or cost-volume analysis [CVA]) that evaluated interventions performed in Spain aimed at specific disease conditions.They found that oral conditions, as well as accidents and injuries, congenital anomalies, nutritional deficiencies and other neoplasms were the categories with a lowest number of studies (0.6% for each of them), while cardiovascular diseases (15.7%), infectious diseases (15.3%), malignant neoplasms (13.2%), and neuropsychiatric diseases (9.6%) were the conditions most commonly addressed. They also further contextualized our results within the National Health System. They stressed that examining discrepancies between the numbers of economic evaluations in particular diseases and the overall burden of disease helps shed light on whether there are potentially over- and under-investigated areas. Finally they concluded that establishing health priorities is a complex process where multiple circumstances interfere (e.g. such as political decisions, the economic situation, etc.), many times making decisions about the health problems to be prioritized is accomplished unclearly and for reasons not always reasoned adequately. Therefore, the reduction of the burden of disease is an explicit criterion that, in combination with others such as efficiency (cost-effectiveness) and social equity, can allow for issuing recommendations to guide the debates about setting research priorities and, therefore, improving population health.

Summary
In view of the increasing number of patients with coexisting general diseases

### Table II
Etiology of dental complications in the course of chronic kidney disease.

<table>
<thead>
<tr>
<th>Changes in kidneys in the course of renal insufficiency</th>
<th>Changes in tissues and organs of the organism</th>
<th>Dental complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Decrease in erythropoietin production in kidneys</td>
<td>- Anemia</td>
<td>- Atrophy of lingual papillae</td>
</tr>
<tr>
<td>- Decrease in rennin secretion</td>
<td>- Hemodynamic disorders</td>
<td>- Tongue pain, burning sensation and smoothing</td>
</tr>
<tr>
<td>- Decrease in prostaglandin secretion</td>
<td></td>
<td>- Mouth corner sores – cheliosis</td>
</tr>
<tr>
<td>- Inhibition of 1α-hydroxylase activity in cell mitochondria of proximal nephron tubule</td>
<td></td>
<td>- Burning sensation in oral cavity and oesophagus</td>
</tr>
<tr>
<td>- Increase in phosphate concentration in proximal nephron tubule cells</td>
<td></td>
<td>- Haemorrhages</td>
</tr>
<tr>
<td>- Impairment of renal PTH degradation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Decrease in glomerular filtration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Progressing renal parenchymal atrophy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Decrease in erythropoietin production in kidneys
- Decrease in rennin secretion
- Decrease in prostaglandin secretion
- Inhibition of 1α-hydroxylase activity in cell mitochondria of proximal nephron tubule
- Increase in phosphate concentration in proximal nephron tubule cells
- Impairment of renal PTH degradation
- Decrease in glomerular filtration
- Progressing renal parenchymal atrophy

Spain (1983-2008) and the disease burden in the population. They included full-economic evaluations (e.g., cost minimization analysis [CMA], cost-effectiveness analysis [CEA], cost-utility analysis [CUA] or cost-volume analysis [CVA]) that evaluated interventions performed in Spain aimed at specific disease conditions.
in our population, the interdisciplinary and multi-professional treatment should become a standard. More and more studies prove the existence of interrelationships and cause-and-effect relationships among oral diseases and systemic illnesses. An analysis of risk factors for the occurrence of numerous systemic illnesses with a society-wide range has shown that the maintenance of oral health is one of essential elements which may considerably influence the modification of treatment outcomes for other general diseases. Former U.S. Surgeon General Dr. C. Everett Koop emphasized the importance of oral health to overall health by stating, “You’re not healthy without good oral health” [50]. In 2000, U.S. Surgeon General Dr. David Satcher in a landmark report on the nation’s oral health described dental and oral diseases as a “silent epidemic,” which has serious ramifications for systemic health [51]. From the economic point of view, ineffective treatment is the most expensive form of treatment. In addition, the World Health Organization (WHO) advocates developing policies on oral health promotion and oral disease prevention, including development and implementation of community-based projects for oral health promotion and prevention of oral diseases and advocacy for a common risk factor approach to simultaneously prevent oral and other chronic diseases [52]. Therefore, it is important to finally recognise oral diseases as independent risk factors for the occurrence of systemic diseases. Reduction in the incidence of heart diseases in the world may be indirectly linked to improvements in personal hygiene, particularly oral hygiene, among the public, and this must not be forgotten by clinicians and the healthcare system [53]. Thus, the prevention and treatment of dental diseases would then become an element of prevention of other systemic lifestyle-related diseases.

References