Why biochemistry is important for health professionals in rehabilitation?

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Povzetek
Telesna nedejavnost in slaba prehrana lahko neposredno vodita do patoloških stanj, ki so obsežen del fizioterapevtske obravnave, ali negativno vplivata na okrevanje po gibalni disfunkciji. Odnos med fizioterapevtom in posameznikom (klientom/pacientom) ponuja priložnost za preverjanje telesne nedejavnosti in slabe prehrane ter priporočanje in podpiranje gibalno in prehransko ustreznega načina življenja. Fizioterapevti so primer zdravstvenih delavcev, ki se ukvarjajo predvsem z razumevanjem vadbene fiziologije posameznikov s posebnimi zdravstvenimi težavami. Zato je nujno, da fizioterapevti poleg odličnega poznavanja anatomije, fiziologije, anatomije gibanja, patofiziologije poznajo tudi osnove biokemije za razumevanje celičnega ter sistemskega delovanja posameznika. Ključne besede: fizioterapevti, prehrana, metabolizem

Zakaj je biokemija pomembna za zdravstvene delavce v rehabilitaciji?

Abstract
Physical inactivity and poor nutrition can directly lead to pathological conditions managed by physical therapists or negatively influence recovery from movement dysfunction. The physical therapist/client relationship provides an opportunity for screening for physical inactivity and poor nutrition as well as recommending and supporting better practices by the clients under their care. Physical therapists are ~~the~~ examples of health workers mainly involved in understanding of exercise physiology of individuals with specific health problems. Therefore, it is essential that physiotherapists, in addition to excellent knowledge of anatomy, physiology, movement anatomy, pathophysiology, also know the basics of biochemistry to understand the cellular and overall functioning of an individual. Keywords: physical therapists, nutrition, metabolism

1. INTRODUCTION

Health rehabilitation practice in the 21st century outlines a health-focused strategy for physical therapists to lead in the assault on lifestyle conditions and global health care priorities. Consistent with contemporary definitions of physical therapy, its practice, professional education, and research, physical therapy needs to reflect 21st-century health priorities and be aligned with global and regional public health strategies. A proposed focus on health emphasizes clinical competencies, including assessments of health, lifestyle health behaviors, and lifestyle risk factors; and the prescription of interventions to promote health and well-being in every client or patient. Such an approach is aimed to increase the threshold for chronic conditions over the life cycle and reduce their rate of progression, thereby preventing, delaying, or minimizing the severity of illness and disability. The 21st-century physical therapist needs to be able to practice such competencies within the context of a culturally diverse society to effect positive health behavior change. The physical therapist is uniquely positioned to lead in health promotion and prevention of the lifestyle conditions, address many of their causes, as well as manage these conditions. Physical therapists need to impact health globally through public and social health policy as well as one-on-one care. This role is consistent with contemporary definitions of physical therapy as the quintessential noninvasive health care practitioner, and the established efficacy and often superiority of lifestyle and lifestyle change on health outcomes compared with invasive interventions, namely, drugs and surgery. A concerted commitment by physical therapists to health and well-being and reduced health risk is consistent with minimizing the substantial social and economic burdens of lifestyle conditions globally (Dean, 2009).

Rehabilitation and lifestyle conditions

Lifestyle-related conditions (ischemic heart disease, smoking-related conditions, hypertension, stroke, cancer, and diabetes) were leading causes of premature death across regions. Contemporary definitions of physical therapy support that the profession has a leading role in preventing, reversing, as well as managing lifestyle-related conditions. The proportions of practitioners practicing primarily in these priority areas and of the entry-level curricula based on these priorities were low. The proportions of practitioners in priority areas and entry-level curricula devoted to lifestyle-related conditions warrant being better aligned with the prevalence of these conditions across regions in the 21st century. A focus on clinical competencies associated with effective health education and health behavior change formulates the basis for The Second Physical Therapy Summit on Global Health (Dean et al., 2011) .

The example of obesity problem

Poor nutrition and obesity can directly lead to pathological conditions managed by physical therapists or negatively influence recovery from movement dysfunction. The physical therapist/client relationship provides an opportunity for screening for poor nutrition as well as recommending and supporting better nutrition practices by the clients under their care. As such, it is important for the physical therapy professional to understand optimal nutrition for healthy living and serve as a consultant for better nutrition for their clients. To achieve this end, this article addresses strategies for identifying nutritional trends for the specific groups of clients, screening for nutritional problems, assessing clients' readiness to change eating habits, providing useful information and resources concerning optimal nutrition, and recognizing the need for referral to nutrition professionals (Morris et al., 2009).

Nutritional rehabilitation background

Metabolism is the set of life-sustaining chemical reactions in organisms. The three main purposes of metabolism are (1) the conversion of the energy in food to energy available to run cellular processes; (2) the conversion of food to building blocks for proteins, lipids, nucleic acids, and some carbohydrates; and (3) the elimination of metabolic wastes. These enzyme-catalyzed reactions allow organisms to grow and reproduce, maintain their structures, and respond to their environments.

The word metabolism can also refer to the sum of all chemical reactions that occur in living organisms, including digestion and the transportation of substances into and between different cells, in which case the above described set of reactions within the cells is called intermediary (or intermediate) metabolism. Metabolic reactions may be categorized as catabolic – the breaking down of compounds (for example, of glucose to CO_2, H_2O and ATP by cellular respiration); or anabolic – the building up (synthesis) of compounds (such as proteins, carbohydrates, lipids, and nucleic acids). Usually, catabolism releases energy, and anabolism consumes energy. The chemical reactions of metabolism are organized into metabolic pathways, in which one chemical is transformed through a series of steps into another chemical, each step being facilitated by a specific enzyme. Enzymes are crucial to metabolism because they allow reactions to proceed with the required velocity in order to enable the organisms to drive the reactions that require energy and will not occur by themselves, by coupling them to spontaneous reactions that release energy. Enzymes act as catalysts. Besides to allow a reaction to proceed more rapidly, they also allow the regulation of the rate of a metabolic reaction, for example in response to changes in the cell's environment or to signals from other cells. The metabolic system of a particular organism determines which substances it will find nutritious and which poisonous. For example, some prokaryotes use hydrogen sulfide as a nutrient, yet this gas is poisonous to animals (Friedrich, 1998). The basal metabolic rate of an organism is the measure of the amount of energy consumed by all of these chemical reactions in the resting state of the organism. A striking feature of metabolism is the similarity of the basic metabolic pathways among vastly different species (Pace, 2001). For example, the set of carboxylic acids that are best known as the intermediates in the citric acid cycle are present in all known organisms, being found in species as diverse the unicellular bacterium Escherichia coli and huge multicellular organisms like elephants (Smith and Morowitz, 2004).

These similarities in metabolic pathways are likely due to their early appearance in evolutionary history, and their retention is likely due to their efficacy (Ebenhöh and Heinrich, 2001; Meléndez-Hevia et al., 1996). In various diseases, such as type II diabetes, metabolic syndrome, and cancer, normal metabolism is disrupted (Meléndez-Hevia et al., 1996). The metabolism of cancer cells is also different from the metabolism of normal cells, and these differences can be used to find targets for therapeutic intervention in cancer (Smith et al., 2018; Vander Heiden and DeBerardinis, 2017; Zorko et al., 2022).

Understanding the basics of biochemistry for effective rehabilitation

Many interrelated reactions take place in the organism. The entire system of reactions is called metabolism. It is a complex system of substance conversion accompanied by energy conversions. Energy is stored in a substance that is either food or stored in the body. Photosynthetic organisms obtain energy more directly from light. We get energy from the molecules that represent food or body stores by breaking them down into smaller molecules. The part of metabolism that performs this function is called catabolism (decomposition), which is an exergonic process. The energy of nutrients and reserves is mainly released during decomposition in the form of ATP molecules. Catabolism provides energy that is used up in anabolism. Catabolism and anabolism are energetically connected to other molecules and represent a set of chemical reactions, some of which are exergonic (flowing spontaneously towards products), and some of which are endergonic (do not provide enough products, flow spontaneously towards reactants) (Zorko, 2020). Life is possible because exergonic reactions coupled to endergonic reactions sustain life on expense of the energy obtained from the surroundings of the organism. Glycoproteins and glycolipids are embedded in the cell membrane, which enter with their oligosaccharide part into interactions with proteins on target structures, which specifically recognize and bind oligosaccharides. In this way, different cells and cells with viruses, toxins, bacteria and the like can connect with each other. The target structures must have proteins that recognize the oligosaccharide on their outer surface. In the case of cells and bacteria (these are also cells) they are embedded in the cell membrane, in the case of viruses in the virus coat, but the target can be the protein itself, as for example in the case of toxins or immunoglobulins (antibodies) (Zorko, 2020).

Life is a succession of transfers

From an energy point of view, life is a succession of transfers that obey the second low of thermodynamics, which states that the entropy of the universe is steadily increasing. However, living organisms are open systems, therefor the surroundings of the organisms should be always considered when applying the thermodynamic principles on their behavior. By definition, biosynthetic pathways would decrease the entropy of the newly synthesized biomolecules, at the expense of the universe free energy, through catabolism of nutrients. Unlike plants, animals, including humans, are unable to use light directly as a source of energy. Hence, these living organisms must use another source of energy, provided from the catabolism of nutrients, the synthesis of which is directly or indirectly permitted via plant photosynthesis. Our life is therefore indirectly but totally dependent on sunlight, as the unique energy source for plants, and on the complex, but highly regulated, pathways that link nutrient degradation to adenosine triphosphate (ATP) synthesis (Leverve, 2011).

The excess or deficit of nutrients and related pathologies

All kinds of biochemical reactions are linked to energy transfer, therefore each physiological function, as well as each pathological disorder or therapy, must have a consequence for biological energy. It is probable that further investigation of energy disorders in pathological states will lead to a better understanding of the underlying pathophysiological mechanisms and to new therapeutical tools. Living systems must be efficient in situations of both abundance and penury, therefore two distinct classes of disease can be proposed. On one hand are diseases of excess nutrients. For example, excess energy intake is associated with obesity, diabetes, hyperlipidemia ad atherosclerosis. On the other hand, diseases related to a deficit of nutrients can occur at the level of the whole body, individual organs or discrete cells. Diseases of scarcity include anorexia, cachexia, shock, hypoxia and ischemia, which can lead to acute or chronic nutrient imbalance. In addition, energy metabolism is mainly based on redox reactions involving molecular oxygen as the final electron acceptor, and reactive oxygen species (ROS) represent a major danger to many biomolecules and therefore to life. ROS are probably one of the major determinants of the process of ageing. In this view, understanding the mechanisms for sensing and transducing the surrounding oxygen concentrations, based on the flux of research for possible applications oriented towards new therapies for several diseases such as anoxia, ischemia, diabetes, atherosclerosis, cancer and degenerative pathologies (Leverve, 2011). ROS are probably one of the major determinants of the process of ageing. In this view, understanding the mechanisms for sensing and transducing the surrounding oxygen concentrations, based on the flux of research for possible applications oriented towards new therapies for several diseases such as anoxia, ischemia, diabetes, atherosclerosis, cancer and degenerative pathologies (Leverve, 2011). Besides, the understanding of xenobiotics (for instance ROS) elimination is an important subject of biochemistry, relevant to physiotherapists (Zorko, 2020).

The purposed knowledge for future physical therapists

Therefore, we conclude that future physical therapists would need to understand (1) the energy metabolism at the cellular level divided on (1) thermodynamics, (2) equilibrium, steady state, metabolic control, metabolic regulation, (3) cellular and mitochondrial aerobic energy metabolism, (4) mitochondrial metabolism and cell signaling, (5) cellular anaerobic metabolism, (6) adaptation to energy deficit, (7) energy metabolism in the body as a whole, (8) interplay between aerobic and anaerobic energy metabolism, (9) tissue anaerobic metabolism, (10) energy metabolism in the brain (neuron astrocyte cooperation), (11) role of lactate in ischemia-reperfusion injury, in more details.

The future of new therapeutical agents in physical therapy?

Several key questions regarding cellular energy metabolism are still poorly understood as yet and further investigations are mandatory for a better understanding of the pathogenesis of several diseases. So far, our view of the mechanisms and the consequence of the metabolic compartmentations is very limited. It is probable that this field of investigations will explode in the future. The relationship between cellular death and mitochondrial metabolism represents a new direction that might lead to significant therapeutic advances. Nevertheless, it is clear that the most difficult achievement is to obtain a real integrative view of the energy metabolism. How are the hierarchy and the priorities of the different ATP-utilizing pathways defined? Shall we be able to manipulate this hierarchy using new drugs in the future? (Leverve, from Lanham -New, Macdonald, Roche, 2011). Or new therapeutical agents in physical therapy?

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