Physiological Parameters of Aging

Part 1*

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Presently the number of persons 65 years of age or older approaches 23 million, or more than 10% of the total population. This number can be compared to the 1900 figure of three million people or 3.1%. Though 65 years has been designated by social and governmental agencies as indicative of old age, biological factors are far more significant than chronological ones in determining the vitality of the person. Aging is a “wearing out” process that affects virtually every system, organ, and cell in the body to a varying degree. An understanding of the age related effects upon body systems is an integral part of the scientific basis for nursing care of the elderly person.
Nervous System

Some of the most frequently discussed changes that occur with aging focus upon the neural structures. The most dramatic alterations occur in the central nervous system as compared to the peripheral motor neurons or autonomic nervous system whose functions remain relatively unimpaired throughout life. The most readily recognizable feature of the aged central nervous system is a diminished brain weight. Cerebral cellular loss begins in the early 30s and continues steadily thereafter though functional ability may not be significantly affected as a result of the compensatory activity of reserve cells. However, a possible consequence of decreased brain mass, particularly interneurons, may be a reduction or weakening of signal strength. Approximately 99% of all nerve cells that originate and terminate within the central nervous system are interneurons. These small neurons function in amplification, divergence, and refinement of signal input. Complex processes such as learning, memory, language, and mentation involve thousands of interneurons.

In addition to the reduced cell number, electrophysiological alterations such as a decrease in conduction velocity and a diminished activity of the enzymes associated with synaptic transmission occur with aging. A consequence of these biological changes may be manifested in a progressive slowing of response. Electroencephalographic data indicates that the cerebral activity of the aged is characterized by long-lasting "after effects" following stimulus input. The result of persistent "after effect" activity is to obscure subsequent stimuli, impede short-term memory and hinder learning. Long-lasting "after effects" may also be involved in increased response time. Simple tasks may be delayed until signal strength is increased sufficiently through the reinforcing effect of simultaneous "after effect" input.2

Short-term memory loss is frequently a problem for the elderly person, though long-term memory may remain intact. Two distinctly different physiological processes are involved in recent and long-term memory storage. Short-term, recent memory storage is a limited depository process contingent upon stimulus input into a closed reverberating neuronal circuit. Maintenance of the circuitous electrical activity, which is dependent upon adequate tissue oxygenation, is necessary for retention of the mental impression of the input. The aging brain may be considered to be chronically hypoxic. The diminished oxygen supply is due in part to atherosclerosis as well as a decreased cellular respiratory activity which may be ascribed to an intracellular accumulation of metabolic end products. Thus the elderly person may experience difficulty remembering what he had for breakfast that morning but may recall childhood experiences with ease. Long-term memory storage, which is not affected by chronic cerebral tissue hypoxia, may be attributed to permanent structural alterations of the neuron. These changes may be morphological, involving dendritic processes and new synapses, or molecular with the establishment of the nucleotide sequence of ribonucleic acid and other cellular proteins.3

Other neurologic parameters that exhibit age related alterations include temperature regulation, pain perception, and tactile discrimination. The elderly person has a low tolerance for extremes in temperature which may be attributed to a diminished vascular tone. The diameter of the vessel lumen is dependent in part upon the nervous system. Research may also reveal an age related alteration in the hypothalamic temperature setpoint, though evidence for this at the present time is lacking. Pain and tactile perception involve peripheral sensory receptors, a relay pathway and cortical integration. A decrease in the number and sensitivity of sensory receptors, dermatomes and neurons in the central nervous system contributed to a general dulling of these sensations.

Since the neurological changes characteristic of aging occur gradually, the elderly person is often able to compensate by an avoidance of new, stressful situations and temperature extremes, and by the accomplishment of tasks at a leisurely pace. Any stressor, such as illness or a new environment, may seriously interfere with these compensatory mechanisms contributing to confusion and disorientation.

Respiratory System

Tests of pulmonary physiology have revealed a number of age related alterations in lung function. The effects of environmental toxins, which increase over

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The respiratory changes that occur as a result of aging are significant and can impact respiratory function. Arterial oxygenation may be decreased with aging, affecting the efficiency of oxygen transport to the tissues. The alveolar-capillary membrane becomes less permeable, leading to reduced oxygen diffusion into the blood. The respiratory muscles become less efficient, requiring increased effort to maintain ventilation. The respiratory system's response to stimuli is also altered, with decreased sensitivity to stimuli and reduced cough reflex, which can lead to decreased clearance of secretions.

Aging also affects the cardiovascular system, leading to decreased cardiac output and reduced blood flow to the lungs. This can further reduce oxygen delivery to the tissues. The respiratory center's response to hypoxic stimuli is also altered, with decreased respiratory drive and slower respiratory rates.

The respiratory changes associated with aging can significantly affect the overall health and quality of life of the elderly. Understanding these changes is crucial for the development of appropriate interventions and management strategies to promote respiratory health in the elderly.
band. The constant hemodynamic challenge induces endocardial alterations. Aging results in the development of whitish patches, fibrosis, and sclerosis in the endocardium which lines the cavities of the heart and aids in forming the valves. The anatomical areas of the heart subject to high pressure are most affected. The right ventricle, which is a low pressure chamber, is generally spared. Histologically these changes are characterized by alterations in the insoluble collagen of the myocardium associated with an increased stabilization of body collagen. This rigidity in the myocardium could lead to a decrease in myocardial contractility, distensibility, and a decline in a number of physiological parameters of cardiac function.

A lifetime of hemodynamic stress is reflected in alterations in all the heart valves, however, the mitral and aortic are the most seriously affected. The valves become rigid because of nodular thickening and fibrosis. The aortic valve, located at the exit of the left ventricle, prevents a regurgitation of blood from the arterial system. The three cusps of the aortic valve are functionally important not only in the closed state but also in the open position. The coronary orifice is located in a widened portion of the aorta just above the aortic valve ring. The position of the aortic cusps is important in the maintenance of coronary blood flow. Eddy currents, a swirling motion of flowing liquid, are generated when fluids flow from a small orifice into a large vessel. The eddy currents in the aorta swirl about the cusps in such a manner that they prevent apposition of the cusps and aortic vessel wall, thereby preventing blockage of the coronary orifice. Distortion of the aortic valve, as occurs with aging, may result in blockage of work load of the heart. A clinically measurable parameter of the arterial rigidity is the nature of the pulse and the pulse pressure. With aging the pulse assumes a forceful character and the pulse pressure widens. By 70 years of age, the systolic blood pressure increases to approximately 150 mm Hg and the diastolic to 90 mm Hg. The reason for this is that aging results in decreased hemodynamic reflexes from the mechanoreceptors of the carotid sinus located in the aortic arch and the carotid sinus region. These baroreceptor reflexes are decreased as a result of an inelasticity of the vessel wall and possibly an altered setpoint of the mechanoreceptors. These factors are responsible for the common occurrence of persistent arterial hypertension in old age.

The resting cardiac output, which is the amount of blood pumped by the heart each minute, decreases 30 to 40% between the ages of 25 and 65 years. The diminished cardiac output reflects a decreased heart rate and a decreased stroke volume. Despite the diminished cardiac output, cerebral blood flow is maintained. Other organ systems, such as the liver and kidneys, receive a diminished blood supply. However, because of reduced function even the lessened blood supply is generally adequate for functional integrity. A challenge such as exercise may compromise this balance. At rest, skeletal muscles have a relatively small blood flow requirement; exercise increases the perfusion need several fold. Inability to meet this need is apparent in the ischemia induced intermittent claudication evident in some elderly persons following exercise of the lower extremities. On a cellular level, the aging heart has a decreased capacity to utilize oxygen.