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Deleterious effects of prolonged bed rest on the body systems of the elderly - a review

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Abstract

Objective: to describe the deleterious effects of prolonged bed rest on the body systems of the elderly. *Method:* an integrative-narrative review was carried out, with the following research question: *What are the effects of prolonged bed rest on the body systems of the elderly*? The PubMed and Virtual Health Library databases were searched with the following terms: "bed rest" and "elderly" with the Boolean operator "and". *Results:* a total of 1,639 articles were found. After application of the established criteria, nine articles remained, and 20 were added to maintain the citation of the primary source, giving a total of 29 articles. *Conclusion:* the immobility associated with prolonged bed rest is detrimental to the health of the elderly, as it affects several systems, such as the cardiovascular, pulmonary, gastrointestinal, musculoskeletal and urinary systems, which may lead to the onset of diseases in addition to those that led to bed rest.

Keywords: Health of the Elderly. Bed Rest. Comorbidity.

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INTRODUCTION

The human body usually remains in the orthostatic position, or seated, for approximately 16 hours each day, without great suffering. Prolonged time spent in bed, however, can generate several physiological disorders. There is a fear that lying down in bed may mean not being able to get up again[1]. Going to bed is a universal response to falling ill.

For almost a century, from the mid-1860s until 1950, bed rest was highly recommended for recovery from various illnesses and diseases[1,2]. From 1940, the usefulness of bed rest in the treatment of varying conditions began to change, mainly because of World War II. Wounded soldiers were treated and released faster, as there were many injured and few beds. It was observed that soldiers who spent less time in bed recovered from injuries and infections more quickly. From the 1950s onwards, the study of the effects of bed rest by the aerospace industry began, as it reproduces the condition of absence of gravity[3]. These studies concluded that long periods of immobility are detrimental to the health of all body systems, and also that inactivity is an important factor in the development of chronic-degenerative diseases, and is highly prevalent among the elderly[4].

Problems resulting from immobilization can complicate a primary disease or trauma and become a more serious problem than primary disorders[5]. The elderly are susceptible to other complications which are not directly related to the disease that led to hospitalization or a specific treatment, as they have reduced physiological reserve and are less able to adapt to stressors[6]. Studies have shown that 25% to 35% of elderly persons admitted to hospital because of a disease will lose functional independence in one or more activities of daily living, with the main losses being the ability to shower and dress, which can appear in only three days of hospitalization[7]. Due to the loss of such abilities and the deterioration of body systems caused by age and, especially, prolonged periods in bed, many elderly persons reside in long-term care facilities following hospitalization[8].

This review aimed to identify the deleterious effects of prolonged bed rest on the various body systems of the elderly.

METHOD

An integrative-narrative review was performed to survey the state of knowledge about the subject under study – disorders in the various body systems of the elderly relating to prolonged bed rest – through a broad analysis of multiple published studies. The narrative review seeks a qualitative analysis of a broad issue[9].

The research question was: *What are the effects of prolonged bed rest on the body systems of the elderly*? Articles were searched in the PubMed and Virtual Health Library (VHL) with the following terms: *bed rest* and *elderly* with the Boolean operator *and*.

The inclusion criteria were: articles that addressed the effects of bed rest with a target population of elderly persons over 60 years old, hospitalized or institutionalized without delimitation based on the disease or cause of hospitalization. We also selected articles that dealt with the two forms of prolonged bed rest, considering that excessive rest in hospital/hospitalization and its consequences may lead to extended institutionalization. Institutionalization increases the chance that bed rest will last longer, with ulcers being one of the consequences. The exclusion criteria were articles that were not in English, Portuguese or Spanish and were published more than five years ago, except for those used to maintain citations for the primary source.

RESULTS AND DISCUSSION

A total of 1,639 articles were found. After the application of the established criteria, nine articles remained, and 20 were added to maintain the citations of the primary source, giving a total of 29 articles.

The cardiovascular system undergoes deterioration with prolonged bed rest[11], as when the supine position is assumed, there is a redistribution of blood from the lower limbs to the thoracic cavity, leading to the redistribution of up to one liter of fluids in 24 hours of bed rest[1]. This redistribution of blood causes 11% of the total volume of blood to be redistributed from the vessels of the lower limbs to the thorax, with approximately 80% of this

volume entering the circulation, initially increasing the cardiac output, as a reduction in total plasma volume will occur later[10]. These same authors further claim that the cardiac workload increases by 20% when the body is recumbent, a rate which doubles in patients with pre-existing heart disease.

The review by Knight et al.[1] explains that when lying down, increased venous return leads to the stretching of the right atrium, which results in the release of atrial natriuretic peptide, a powerful diuretic that generates increased urine production, decreasing blood volume. This decrease in blood volume and consequently blood pressure is detected by the baroreceptors of the aorta and carotid arches, which then stimulate the release of the antidiuretic hormone which leads to water reabsorption and, therefore, the reduction of diuresis. In a healthy, mobile person these and other hormones efficiently maintain bodily fluid levels, but in long periods of bed rest the delicate balance between these hormones is impaired.

The resting heart rate increases one beat per minute for every two days of rest, with this increase resulting in a shorter diastolic time and shorter systolic ejection time, leaving the heart less able to respond to demands above baseline[11]. It can be concluded that shorter diastolic time results in lower coronary flow and, thus, a smaller amount of oxygen available for myocardial nutrition. Increased resting heart rate and the response of the heart rate to exercise is known as cardiac deconditioning. According to Topp et al.[2], after three to four weeks of bed rest, the resting heart rate increases from 11 to 14 beats per minute, while the exercise response rate increases from 30 to 40 beats per minute.

Postural hypotension is one of the most common cardiovascular complications of immobility[12] and can be observed after 20 hours of bed rest[1]. According to Mobily and Kelley[12], healthy men take about five weeks to regain posture after three weeks of immobilization. In a healthy and mobile person, the rapid fall in blood pressure that occurs upon standing is immediately detected by the baroreceptors, which quickly inform the cardiac center to increase the sympathetic stimulation of the heart, thus increasing cardiac output and blood pressure; and the vasomotor center, which increases sympathetic stimulus in the blood vessels of the lower limbs, resulting in partial vasoconstriction, diminishing the imprisonment of blood in the lower limbs[12]. The response to this chain of stimuli is impaired by the decrease in blood volume, which leads to a greater fall in blood pressure when the person assumes orthostatism. This low plasma also generates lower striation stimulus on the baroreceptors and is also caused by the inherent changes in age when the bedridden person is already elderly[11]. Dysregulation of orthostatic pressure is common among the elderly due to the aging process, and also due to association with other diseases [13].

Deep vein thrombosis is another common complication of prolonged bedrest[14]. The Virchow triad refers to the combination of three factors: venous stasis, hypercoagulability and damage to blood vessels; which together dramatically increase the chances of developing deep vein thrombosis. Prolonged bed rest triggers these three factors, increasing the chances of developing this condition by approximately 13%[1]. Saunders[11] states that deep vein thrombosis occurs more through blood stasis than by increased coagulation, and most patients fail to demonstrate signs and symptoms, as they have well developed collateral circulation, and the thrombus must be severe to cause clogging of the veins. Bed rest therefore becomes a risk factor for the development of thrombotic disease and pulmonary embolism, which can be fatal[15].

In the supine position the body weight restricts the movement of the rib cage, reducing the tidal volume. It is estimated that when a person is standing, 78% of the tidal volume is replaced by the movement of the rib cage, and when supine the movement of the chest cavity reduces this to 32%[1]. This restriction of the movement of the chest cavity leads to an increase in mechanical resistance, which, together with the increase in blood volume in the chest, leads to a reduction in total lung capacity and residual volume[15]. This decrease in residual volume may lead to the closure of the alveolar portions, which in combination with other changes leads to a lower concentration of oxygen in the blood, which may be sufficient to produce small disabilities in the elderly[11].

Immobility also leads to disorders in the movement of the eyelashes and, consequently, reduced secretion, which predisposes the patient to pneumonias[5]. When the patient is confined to the bed there is a tendency for the mucus to accumulate,

under the influence of gravity and the diminution of the tidal volume; this effect can be aggravated when the person is dehydrated, as the mucus becomes thicker and expectoration more difficult[1].

The elderly patient is already at increased risk of developing respiratory changes due to the anatomical changes of this system that occur with age, and this risk increases further when this group of patients is receiving sedative medications or those that compromise the functioning of the respiratory system[10]. According to the review by Knight et al.[1], prolonged bed rest dramatically increases the risk of respiratory tract infection.

Before describing the effects of immobility on the musculoskeletal system it should first be considered that muscles are most prevalent type of tissue in the body, representing approximately 45% of body weight[2]. The muscular system, with the help of the nervous system, provides mobility capacity as well as the ability to perform activities of daily living, and once there is muscle weakness or joint stiffness or a bone weakness generated by immobility and/or disuse, this system is put at increased risk of injury or infection[16].

Muscle strength is maintained by frequent maximum contraction tension, and short periods of bed rest are sufficient to cause the loss of muscle loss and strength[17], at a magnitude of 10 to 15% per week of disuse, and up to 5.5% per day of bed rest[10]. Nearly half of normal strength is lost through immobilization of three to five weeks[18]; besides the loss of strength, shortening of muscle fibers also occurs[5]. The number of sarcomeres (muscle filaments) decreases when the muscle is held in a shortened position, and the extent of atrophy is significantly increased when the muscle is maintained in such a position[16].

Antigravity muscles suffer greater strength loss than other muscles during inactivity[6], because they lose tone when there is no movement of weight[16]. This muscle group loses contractile protein and there is an increase of non-contractile tissue including collagen, while the number of muscle fibers remains unchanged[2].

Long periods of immobility affect both types of muscle fiber, but studies are conflicting for which type of atrophy acts more quickly. However, Topp et al.[2] affirm that type II fibers seem to atrophy more rapidly than type I fibers. According to Nigam et al.[17], this atrophy can occur with short periods of immobilization. Following 72 hours of limb immobilization, up to 14% atrophy of Type I fibers and 17% of Type II fibers was observed.

Aging leads to a decrease in muscle mass, leading to the loss of functional reserve along with a reduction in functional activity, which is explained by Sarabon and Rosker[8] as the loss of aerobic capacity generated by the reduction of the use of oxygen by the peripheral musculature and not by cardiac incompetence, which is aggravated by bed rest. Associated with sarcopenia, typical of aging, bed rest may increase the rate of muscle loss[19]. Bed rest results in lower resistance, strength and functional capacity among the elderly[20].

Even if reversible, long periods of rehabilitation are necessary for recovery, as considerably more time is required for conditioning than for deconditioning[21]. High impact, low intensity exercises are effective in the rehabilitation process[22], as the nutritional replacement of proteins alone is not enough to prevent the loss of muscle mass[23]. Most studies have found an association between loss of muscle strength and functional capacity and hospitalization and bed rest. However, Bodilsen et al.[24] reported an improvement in the strength and functional capacity of the elderly after hospitalization. In this study, the elderly did not undergo physiotherapy or obtain guidance, and only the variables were measured. It is also important to note that elderly persons who were unable to walk were excluded, leading to possible sample selection bias.

Tendons, ligaments and articular cartilage need movement to stay healthy, and deteriorate when the patient is immobile[16]. Contractures are defined as fixed deformities of the joints as a consequence of immobility, and occur because of the dynamic nature of the connective tissue[18]. When movement is restricted, the metabolic activity of the joints is altered, and these tissues suffer a marked increase of collagen, becoming more dense; and the fibers that involve the muscles, ligaments and tendons are shortened, resulting in an overall decrease in joint flexibility[10].

Changes in the structure and function of connective tissue, due to changes in collagen fiber, become apparent after six days of immobility, and these changes can persist even after the resumption of normal activities, according to the review by Nigam et al.[17]. Although all joints may be affected by immobilization, the hip, knee and ankle are the most susceptible due to the effects of gravity, and by the difficulty of full extension of the joints when sitting or lying down[10], and the contracture of these joints makes it difficult to perform movements of transference[18].

The primary function of the bones is the mechanical support for the tissues of the body and the maintenance of mineral homeostasis promoting the reserves of calcium, phosphorus, and magnesium salt[16]. The relationship between bone formation and resorption is influenced by stress on the bone, a phenomenon called Wolff's law. This law says that bone density is directly proportional to the stress placed on it[2].

During immobility, the process of bone formation ceases, but the activity of osteoclasts continues, resulting in loss of bone density, causing the bone to have a soft, weak structure. With a few days of rest the circulating calcium increases, and with three days there is an increase of calcium loss through the urine. If immobility is maintained there is a chance that renal calculus will form[16].

Creditor[25] states that vertebral bone loss is accelerated by 50 times when a healthy person is bedridden, and that four months is required to recover from loss that occurs within ten days of rest. In contrast, the study by Buehlmeier et al.[26] did not find accelerated bone loss among the elderly, but did identify such loss in younger men after 14 days of bed rest.

Urinary complications caused by immobilization include the development of renal calculi and urinary tract infection, which first appear due to changes in renal drainage and alterations in urinary calcium levels and pH[10].

When in a standing position, gravity plays a greater role in the drainage of urine from the kidneys, through the ureters to the bladder. In supine patients, meanwhile, urine is still transported from the kidneys to the bladder by peristaltic movements of the ureters[27]. When supine, drainage of the urine from the renal calices is impaired, increasing the precipitation time and aggregation of the crystalloids, resulting in an additional risk of renal calculus. In addition, the potential for the development of urinary tract infections increases during immobilization due to the predisposition to urinary stasis in both kidneys and the bladder, which allows the growth of bacteria[10]. Elderly patients with impaired mobility, especially those who are incontinent or suffer cognitive or functional impairment, may be at increased risk of developing urinary tract infections due to poor perineal hygiene.

When the bladder fills, there is pressure on its walls, the cervix and the urinary sphincter, stimulating urinary urgency. In the supine position, the effects of gravity are negative and the urge to urinate is reduced. This can lead to an overfull bladder, which leads to stretching of the muscles. After prolonged periods of time the stretch receptors lose the ability to be stimulated, leading to the loss of sensation of urinary urgency[27]. Another important alteration related to the bladder is that the absence of gravity hinders its complete emptying, which predisposes the growth of bacteria.

Immobility is the factor that most places the individual at risk of disorders in skin integrity[16]. Approximately 95% of pressure ulcers occur in five sites: the sacrum, ischial tuberosity, the greater trochanter, the ankle and the heel[28]. Once the tissue is damaged, the impairment of metabolism, especially with a negative nitrogen balance, becoming part of the problem of cure. In addition, the formation of pressure ulcers usually results in further immobilization, initiating a negative cycle of sequelae[10].

High pressure often occurs in hospitalized elderly persons, and usually develop with few hours of immobilization, while the frequency of ulcers can be accelerated in cases of incontinent patients[25]. It is estimated that more than two thirds of elderly persons living in long-term care facilities have one or more diseases that generate risk factors for the development of pressure ulcers[10]. Teasell and Dittmer[28] state that elderly persons over 70 years of age have a 70% chance of developing such pressure

ulcers, and that this will occur in the first two weeks of hospitalization.

Bed rest is commonly associated with reduced taste, smell and loss of appetite, leading to the disuse of the intestinal tract, which in turn leads to mucosal atrophy and shrinkage of glandular structures[27]. There is also a reduced sensation of thirst, which can easily evolve into dehydration. Decreased caloric demand, endocrine changes, anxiety and depression contribute to the loss of appetite[29].

Stomach transit time is 66% slower in the supine position in comparison with standing, which contributes to reduced appetite and decreased peristalsis, which leads many patients to exhibit symptoms of gastroesophageal reflux[15]. Another complicating factor is the difficulty in eating patients experience in the supine position, when they cannot assume the sitting position[5].

Constipation may be the main problem of immobilization in the elderly due to decreased bowel mobility, inadequate fiber and fluid intake associated with anorexia, the development of weakness of the evacuation muscles, the inability to respond to the urgency of evacuation, and inability to assume a seated position, making evacuation a difficult process for this population[10].

Another important problem related to bed rest and aging is the lower resistance of brain tissue to stressors related to inflammatory diseases and conditions[30]. These effects on neural tissue can also lead to alterations of the static balance by alteration not only of muscular mass but also of the neuromuscular component[31].

The present study addressed the deleterious effects of prolonged bed rest on the body systems of the elderly, with the exception of treatment and prevention. It is necessary to investigate these effects further, especially in relation to the most common diseases and disorders in this population range, such as femoral fractures, which are important causes of immobility.

One of the limitations of the present study was the limited number of recent publications on the subject. Further research in this area is suggested, as the incidence of chronic degenerative diseases increases the chances of prolonged bed rest and, consequently, the effects of such diseases. The study of the prevention and treatment of the effects of prolonged bed rest is also suggested.

CONCLUSION

The immobility associated with prolonged bed rest is detrimental to the health of the elderly as it affects several systems such as the cardiovascular, pulmonary, gastrointestinal, musculoskeletal and urinary systems, and may lead to the emergence of diseases in addition to those that initially caused the bed rest.

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