Experimental and Applied Medical Science, 5, 5: 257-273, 2024. DOI: 10.46871/eams.1523211
Review Article

Nursing Approach in Spinal Muscular Atrophy

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Abstract

Spinal muscular atrophy is an important genetic disease that affects motor neurons in the spine, causing muscle weakness, particularly in infancy. Spinal muscular atrophy occurs with a deletion of the survival motor neuron gene and is one of the leading causes of early death in infants. Although some drugs are used for the treatment of spinal muscular atrophy in the world and in Turkey, there is still no treatment method that provides complete recovery. The limited treatment options for spinal muscular atrophy, its inaccessibility, and the poor prognosis of the disease negatively affect the quality of life of individuals and their families. All stages of the disease, starting from the diagnosis process, are very difficult for the patient and his family. A multidisciplinary approach is needed to help patients and their families cope with these difficulties. This approach includes areas such as medical care, rehabilitation, psychosocial support, and education. It is essential that nurses, as key members of the health care team, improve the patient's quality of life, manage symptoms, and support the individual and family in this process. In particular, supporting the patient and family in their care and educating them about their care needs is one of the most important roles of nurses. With this review, an attempt has been made to discuss the diagnostic methods, treatment process, and nursing approaches of spinal muscular atrophy disease, which is a current problem in the world and Turkey.

Key words: *Spinal muscular atrophy, Genetics diseases, Nursing care*

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Introduction

It is an autosomal recessive disease caused by a defect in SMN1, one of the survival motor neuron types. (1). Irreversible loss of the anterior horn cells in the spinal cord and brain stem nuclei. Often seen in the early stages of life, this disease is one of the leading genetic causes of death in infants and young children. Patients usually experience growth retardation, lung disease, scoliosis, and joint contractures, and slowed weight gain that persists from birth into adulthood (2,3). SMA, a pediatric neuromuscular disease, affects 1 in 11,000 live births worldwide. In Türkiye, the annual number of new cases is estimated to be between 130-180 (average: 150) and approximately 3000 SMA patients are being monitored (4).

SMA involves the individual and the family; it requires a multidisciplinary approach because it is a disease that affects biopsychosocial, spiritual, and intellectual aspects. In this interdisciplinary approach, effective treatment and care services are provided to SMA patients to improve the quality of life of individuals and their families. The role of the nurse, who is an important member of the multidisciplinary team, is to integrate the patient and family into society by providing high-quality care and to provide guidance and quality care by analyzing the data collected (5, 6).

Aim

The aim of this review is to discuss the diagnosis and treatment methods of SMA, which is a current problem in the world and Turkey, and the nursing approaches to the disease.

Spinal Muscular Atrophy Types and Symptoms

Spinal Muscular Atrophy (SMA) is an often autosomal recessive neuromuscular disease that results from mutations in the survival motor neuron (SMN) gene and progresses with progressive degeneration (7, 8). The disease is classified according to the age of onset of symptoms and the maximum motor function achieved. The International Spinal Muscular Atrophy Consortium classifies SMA into five clinical types according to the maximum motor function achieved. These are type 0 (Prenatal SMA), type 1 SMA (Werdnig-Hoffmann disease), type 2 SMA (Intermediate type/ also called Dubowitz disease), type 3 SMA (Kugelberg-Welander disease), and type 4 SMA (Adult type) (9). The most common symptoms of the disease vary depending on the type of disease. In brief, the types of SMA and their common symptoms are as follows.

Type 0 SMA (Prenatal SMA): This is the form of SMA that begins before birth.

Usually, the first clinical finding is that the baby has little or no movement in the womb. The baby has generalized weakness, hypotonia, and respiratory failure from birth. In these cases where mental development is not affected, symptoms due to fetal hypokinesia such as polyhydramnios, intrauterine growth retardation, multiple joint contractures (arthrogryposis), skeletal abnormalities, and pulmonary hypoplasia may occur during the intrauterine period (10). Perinatal death occurs with widespread motor and sensory neuron loss in these patients (11).

Type 1 SMA (Werdnig-Hoffmann Disease): Babies with this type appear within the first six months of life; they look like rag dolls, cannot hold their heads up, cannot sit unsupported, have severe respiratory distress (cannot survive without mechanical respiratory support), and usually die in the second year of life (12, 13).

Type 2 SMA (Intermediate Type): Type 2 SMA occurs after the first six months of life and disease complications become evident. These patients can sit, crawl, or stand without assistance, but cannot walk. These patients are prone to respiratory infections. Scoliosis, hand, foot, and chest wall deformities are common. Tendon contraction may result in limited joint movement. Their prognosis is better and their life expectancy is longer than that of type 1 SMA patients. However, impairment of breathing and swallowing may alter the course of the disease (12-14).

Type 3 SMA (Kugelberg-Welander Disease): The disease shows symptoms after the 18th month of an individual's life and is characterized by difficulty or inability to walk. Individuals usually require a wheelchair between the ages of 20 and 30. It is the mildest form of SMA seen in childhood (14, 15).

Type 4 SMA (Adult Type): This is the mildest type of SMA. Life expectancy is not or only slightly affected by this disease (16). SMA Type 4 develops in adulthood and, who also presents with proximal limb girdle weakness (17). The common symptom of the disease is loss of strength in the arms and legs (18).

Spinal Muscular Atrophy in The World and Turkey

The incidence of SMA disease in the world is 1/11,000; The carrier rate varies between 1/40-60 (4). It occurs in 1 in 5000 to 10,000 births in Europe and the carrier frequency is 1 in 50 (19). Although carrier rates vary by ethnic group, the highest carrier rate is in Caucasians (1/37 or 2.7%) and the lowest in Hispanics (1/125 or %0,8). The gender distribution of SMA is similar in girls and boys (20). Genetically, SMA is second only

to cystic fibrosis as a cause of death in children; it is second only to Duchenne muscular dystrophy as a cause of death in children (21). Although the incidence and carrier rates of SMA disease in Turkey are not known, considering that there have been approximately 1,200,000 live births in recent years, it is estimated that the annual number of new cases is between 130-180 (average: 150). Approximately 3000 individuals with SMA are being monitored in Türkiye (4).

Spinal Muscular Atrophy Diagnosis and Treatment Options

Diagnostic methods in spinal muscular atrophy: The first step in making a diagnosis in a patient with SMA findings as a result of clinical evaluation is the detection of homozygous deletions in exon 7 of the SMN1 gene in the survival motor neuron. Losses in this gene are the molecular pathology observed in 95% of patients. In the case of compound heterozygosity, the clinical diagnosis cannot be confirmed but is supported by exon 7 deletion testing alone. In this situation; SMN1 sequence analysis should be performed to look for point mutations such as missense, sense, nonsense, and splice site mutations. If no deletion is detected, electromyography should be performed to evaluate motor neuron damage. In the case of motor neuron damage, changes in SMN1 copy number are quickly and reliably determined by real-time Polymerase Chain Reaction (PCR) or Multiplex Ligation Dependent Probe Amplification (MLPA) techniques (10, 22). The phenotypic variability in SMA patients is also associated with the copy number of the SMN2 gene. SMN2 copy number correlates with disease severity. As the SMN2 copy number decreases, the severity of the disease increases (11). People with 5 or more copies of SMN2 may have no symptoms (11, 23).

Treatment methods for spinal muscular atrophy: While until recently the treatment of SMA disease consisted of respiratory and nutritional support, methods to increase SMN protein levels in disease-related cell types and tissues, particularly in the presymptomatic period, are now being used through small molecule, oligonucleotide, and gene replacement approaches (24, 25). Drugs commonly used in treatment; a gene replacement therapy called Zolgensma, nusinersen (Spinraza), and risdiplam (Evyrsdi) (8). Another treatment method is cell replacement therapy, which is not yet as common as strategies to increase SMN. However, this method can be used with stem cells (26). Other treatments for SMA include quinazoline enzymes, aminoglycoside antibiotics (tobramycin and amikacin), and stem cell therapy. The

effectiveness of these treatments has not been yet proven (8).

The Effect of Spinal Muscular Atrophy Disease on The Individual and The Family

Spinal muscular atrophy (SMA) is a disease that negatively affects a person's quality of life due to severe symptoms. Caring for a person with the disease, meeting their medical needs, and organizing the family's daily life around the individual makes SMA an important issue in the family. Therefore, the individual and the family need to be emotionally and practically strong to cope with the disease. To manage the disease effectively, the impact of SMA on the individual and the family must first be defined (27).

Effects of spinal muscular atrophy on the individual

Spinal muscular atrophy can cause limitations and restrictions in areas such as musculoskeletal disorders, speech, and communication problems, breathing and swallowing difficulties. These limitations and restrictions experienced by people with SMA have a significant impact on their social lives. Society's lack of awareness of SMA can lead to misunderstanding and prejudice, especially from individuals in a society whose looks, insensitive comments, and exclusionary attitudes make the disease process more difficult for individuals. All of this makes it difficult for individuals to participate in events and social activities, increases the social isolation of the individual, causes disappointment, and leads to feelings of loneliness (28-30). In the literature, it has been found that children with SMA-like chronic diseases are twice as likely to have emotional and behavioral problems. A study conducted in our country found that the perceived quality of life of individuals diagnosed with SMA was lower than that of healthy individuals in all domains (21, 31, 32). In addition, situations such as lack of support in relationships with the social environment are common in these patients (29, 33). Children and adolescents diagnosed with SMA may therefore find it difficult to form peer relationships, which can lead to feelings of exclusion or problems finding friends who understand them (29, 34). There are also serious problems in schools, which are the most important means of socialization. The physical facilities of most schools are not set up for the care of people with SMA and this makes it difficult for people with SMA to attend school (29, 35).

One of the main reasons why patients experience social isolation is the treatment process for SMA. During this process, the inability of individuals to participate in social activities can gradually isolate these

individuals from social life and the social relationships in the individual's life can deteriorate. Therefore, the quality of social support provided to patients during the treatment period is very important and closely related to their level of psychosocial adaptation (36-39). Social support and help, especially from family, friends, and close relatives, help the patient overcome despair and adapt to the illness more easily (40).

Another important issue for patients with SMA is the economic problems caused by the disease. The treatment of SMA disease is usually a multidisciplinary approach in hospitals where there are health professionals who require advanced expertise (41). These hospitals are not located on the periphery but in urban areas. In this case, patients, with the support of their families, have to travel to fully equipped hospitals. This involves additional costs such as transport and accommodation. Physical therapy and rehabilitation programs can also be used in the treatment of SMA. These programs also have economic costs, both in terms of session fees and patient mobilization (42). The cost of the drugs needed to treat the disease is also quite high, making it very difficult for individuals to access medication (43). The combination of all these factors creates serious economic difficulties for individuals and families with SMA (41).

Effects of spinal muscular atrophy on family members

Many chronic diseases, such as SMA, cause serious social, psychological, academic, and economic problems for patients and their families. Family members who are primarily responsible for caring for people with SMA often experience many difficulties in providing care. This can cause great anxiety and stress for family members (44-46). One study reported that parents caring for children with chronic illnesses experience more chronic stress than parents of healthy children (47). In general, the psychological, social, and economic impact of SMA on family members can be summarised as follows.

Psychological effects: Due to the physical limitations and treatment process of SMA, family members experience emotional difficulties such as stress, anxiety, helplessness, loss of self-confidence, depression, and fear of not being able to cope with the patient's death, and these difficulties significantly affect the family's mental health. It can be seen that the emotional distress experienced by parents is influenced by various factors such as economic level, educational level, level of social support, communication difficulties, severity of the illness, age of the patient, chronicity of the illness, level of medical care required and disruption of the family

cycle. The physical limitations experienced by the child during the illness, the economic difficulties experienced, and the restrictions in social life significantly increase the stress level of family members. Many psychiatric disorders can also be associated with this stress. Internalizing disorders, especially depression, are often seen in family members with chronic illness (48,49). In addition to these feelings; shock, anxiety, not accepting the disease, anger, resentment, blaming the spouse, and acceptance in the last stage of the disease are among the emotional changes seen in the family (31, 32, 50).

Social impact: Family members may find it difficult to balance their social and work lives with the needs of SMA. Families of people with SMA spend most of their time caring for their loved ones who need support, while also meeting their own basic needs. In this case, family members may have difficulty coping with the burden of caregiving. It is known that women/mothers who are primarily involved in caregiving experience serious problems. These problems include having to care for the patient all the time, sleeping less, not having free time, not being able to rest, and putting their own needs on hold due to regular and continuous follow-up medical care (51).

Economic impact: The treatment and care of SMA is generally costly. Expenses such as medical care, medications, therapies, and special equipment can seriously affect the family's financial situation. In addition, situations such as caregiving family members leaving their jobs or working part-time can cause economic problems. The main economic problems experienced in this process are high costs of medical care; high costs of medicines, special equipment (such as wheelchairs and ventilators), and therapies (physical, occupational, and respiratory); high travel and accommodation costs to access health services; costs of home care; loss of work and income; limited social assistance; and limited coverage of health insurance (41, 52, 53).

Patients and their families can generally benefit from resources such as psychological support, social services, and financial assistance to help them cope with all these effects, and fundraising campaigns can be organized with the permission of the Governor's Office, particularly to help families financially (29).

Raising Awareness in Society

Spinal muscular atrophy is treated symptomatically as there is no proven cure (18). The fact that the disease cannot be treated under current conditions indicates the importance of prenatal or preimplantation genetic diagnosis, and it is

extremely important to raise public awareness about this issue and to develop social policies that support this vulnerable group (54). In this section of the article, the screening and diagnostic methods that the public should know about SMA disease and the social policies will be emphasized. These headings can be briefly summarised as follows.

Scanning methods

Studies of current treatments for SMA have shown that the best outcomes are achieved in patients who begin treatment before clinical signs and motor neuron loss occur (10, 55). For this reason, early diagnosis and genetic screening are extremely important for the prognosis of the disease. The Ministry of Health has put forward some strategies to start appropriate treatment in babies diagnosed through the newborn screening program, to raise awareness in society to reduce consanguineous marriages, and to prevent the economic burden it imposes on society (21).

The Ministry of Health aims to inform and guide potential spouses about detailed genetic counseling services and prenatal diagnosis options through the Premarital SMA Carrier Screening Programme. SMA carrier screening is available to couples who apply for a premarital health report and to currently married couples who request it. The real-time PCR method is used as the carrier screening test; blood samples for screening are taken at the family medicine units where the potential spouses are registered. The blood samples collected are sent to the screening laboratory designated by the provincial health directorates on the designated days. The screening results are reported to family doctors through the system and individuals can access their results through e-Nabız. First, a sample is taken from the male spouse who is to be screened. If the result is "normal", the prospective spouse is informed and removed from the follow-up. If the result is "suspect", the screening test is also performed on the female spouse candidate. If both spouses are carriers, they should be given detailed counseling about the risks and referred to a medical geneticist (21). Genetic counseling and prenatal or pre-implantation diagnostic testing options can be offered to carrier couples to ensure a healthy child. Embryo selection during in vitro fertilization (IVF) using pre-implantation diagnostics can reduce both carrier and disease rates in subsequent generations (56).

Prenatal diagnosis

In spinal muscular atrophy (SMA), as in other genetic diseases, it is recommended that couples who are both carriers have prenatal diagnosis. For autosomal recessive genetic diseases such as SMA, carrier

couples have a 25% risk of having a child with the disease for each fetus in each pregnancy. Prenatal diagnostic tests can be carried out from the 10th week of pregnancy by chorionic villus sampling and from the 15th week of pregnancy by amniocentesis. If there is an affected child, the mother and father should be genetically screened (22).

Social policies

Another issue that society should be aware of in SMA is how families should deal with the economic difficulties caused by the disease. Under Article 5 of Law 2860 on fundraising, those in need can collect aid by obtaining a receipt, placing boxes in certain places, opening bank accounts, issuing a fundraising appeal, organizing a lottery, organizing cultural shows and exhibitions, organizing sports events, trips and entertainment, or using systems that process information automatically or electronically. According to Article 7 of the same Law, if the authority authorized to grant the permit covers more than one district of a province, the governor of that province shall be taken into consideration, and if it is within the borders of a district, the district governor of that district. If the fundraising activity covers more than one province, permission must be obtained from the governor of the province in which the natural or legal persons who will carry out the fundraising activity are established, and the governor who grants permission must inform the other governors and the Ministry of the Interior. Transactions related to fundraising activities can also be produced by association units (57).

Roles and Responsibilities of The Nurse in Spinal Muscular Atrophy

A multidisciplinary approach is key to managing the treatment and care of people with SMA. The care of a person with SMA is a complex phenomenon involving multiple dimensions and different healthcare professionals, and therefore care should be considered as part of a multidisciplinary approach (3). Despite advances in the treatment of SMA, there is currently no definitive cure for the disease, so treatment and care focus on preventing complications from muscle weakness and improving quality of life. This is where nursing care becomes even more important. Care in SMA includes management of respiratory failure, nutritional support, rehabilitation, orthopedic care, and psychosocial care (58). The main purpose of the care provided to a child with spinal muscular atrophy and their family is to ensure that the person with SMA progresses towards a normal life to the best of their ability and to help the child and family cope with the disease (8). The care that should be given to the patient varies according to the bedridden status of the child. Care is

explained in three categories: care for SMA patients who cannot sit, who can sit, and who can walk.

Nursing care for sma patients who cannot sit

The main problem in SMA patients who cannot sit is respiratory problems. Nurses should be aware of the respiratory problems that patients have/could have and have a good knowledge of the respiratory protocols to be applied. To manage respiratory problems, respiratory function should be reviewed with clinical assessment every 3 months initially. To maintain airway patency, mechanical cough assistance devices should be used and chest physiotherapy should be given to all SMA patients. Aspiration of airway secretions is important for SMA patients who cannot sit and should be performed regularly (59). Children with type 1 SMA need mechanical ventilation support to survive. (60). In addition, non-invasive positive pressure ventilation (NIV) should be used in all symptomatic infants and in patients who are unable to sit up before signs of respiratory failure appear. Continuous positive airway pressure should not be used continuously in chronic respiratory failure in SMA. A tracheostomy is an option for ventilation when non-invasive positive pressure ventilation is inadequate or unsuccessful. The option of tracheostomy should be considered individually with the family, taking into account the patient's clinical condition, prognosis, and impact on quality of life (59). Pulse oximetry should be used at home to assess the patient during sleep and to provide non-invasive ventilation if necessary (8). Nurses should provide training and support to parents and carers in the effective use of aspirators, non-invasive respiratory support devices, and medical equipment, explain the situations that require intervention, and carry out assessments through regular home visits (61).

For SMA patients who cannot sit, nutrition and safe swallowing are among the most important issues to consider. The first step in assessing a patient's nutritional status is to perform a swallowing test as soon as possible after diagnosis (3). If the swallowing reflex is inadequate, short-term nasogastric or nasojejunal tube feeding should be used until a long-term gastrostomy tube is placed. About nutrition in acute care, nurses should be aware of metabolic acidosis, abnormalities in fatty acid metabolism, and hyper/hypoglycemia, avoid prolonged starvation of the patient, provide nutrition with a protein source within 6 hours of an acute episode, avoid fluid-electrolyte imbalance and inform the family (14).

Finally, for these bedridden patients, active/passive exercises should be performed in bed and the family should be taught how to do these exercises so that they can apply them later to prevent pressure ulcers (62).

Nursing care for sma patients who can sit

The first thing nurses should be aware of in patients with SMA who can sit in respiratory function. Respiratory assessments of patients who can sit should be performed every 6 months. As part of this clinical assessment, it is important to assess cough function and perform a sleep study if nocturnal hypoventilation is suspected. Care practices to ensure airway patency are similar to those in the non-sitting group. As in patients with SMA who cannot sit, non-invasive positive pressure ventilation (NIV) should be used in all symptomatic patients. In these cases, where tracheostomy support is less common than in those who cannot sit, nebulized bronchodilators can be used if there is a high suspicion of asthma or if there is significant clinical improvement after use. However, nurses should be cautious when using nebulized mucolytics and avoid long-term use. Nurses should provide these patients with annual influenza and pneumococcal vaccinations (59).

SMA patients who can sit should be assessed for obesity and impaired glucose metabolism if they are overweight. If necessary, an appropriate dietary program should be designed to ensure weight control and the patient should be informed (3).

Finally, to improve the musculoskeletal system of SMA patients who can sit, stretch movements, manual stretching and orthoses, splint use, active assisted stretching, serial casting, and positioning techniques can be used in collaboration with a physiotherapist. These methods should be explained to parents and their active use should be ensured (3).

Nursing care for ambulatory sma patients

Most outpatients with SMA have normal lung function. However, the nurse should be alert for upper respiratory tract infections, cough activity, and any symptoms of sleep apnoea or hypoventilation (snoring, restlessness, morning headache, daytime sleepiness) in these patients. No preventive measures are recommended for outpatients with SMA. Supportive care should be provided if specific problems are identified on clinical assessment. Nurses should also provide these patients with annual influenza and pneumococcal vaccinations (59).

Swallowing and feeding difficulties are rarely seen in ambulatory patients. If there are feeding problems, they should be assessed and referred to a dietician (3).

The nurse should educate the patient and family about the importance of passive and active stretching techniques and how to perform them to strengthen the musculoskeletal system in ambulatory SMA patients (3).

In all types of SMA, gastrointestinal problems such as gastro-oesophageal reflux, constipation, use of bowel-regulating agents, delayed gastric emptying and vomiting should be assessed, and growth and development should be monitored. Nurses should always work with a dietician to monitor not only weight but also fluid, macro- and micronutrient intake, particularly calcium and vitamin D intake for bone health (3). Nurses should be knowledgeable about all of these practices in the care of SMA patients and should work with the physician and other team members while fulfilling their dependent roles.

Nurses play an important role in improving the quality of life and health outcomes of people with SMA and their families (8). The nurse should plan individualized care and education according to the needs of the child and family, and provide education and support to the family on what to do in an emergency (59). Parents need information, support, and some resources to care for the SMA patient and ensure family unity, and nurses should support the family in this and try to meet their needs. As SMA patients are intellectually normal, verbal, tactile, and auditory stimulation is an important aspect of developmental care. Helping them to see the activities in their environment and transporting and encouraging them with appropriate vehicles (e.g. trolley, electric wheelchair) for changes in the environment increases and expands patients' communication (8).

The nurse should use the roles of caregiver, educator, researcher, manager, decision maker, advocate, communicator and coordinator, rehabilitator, comforter, therapeutic, counselor, collaborator, autonomy, and responsibility in caring for the person with SMA and the family (63, 64). Nurses provide higher-quality care to patients by using these roles throughout the disease process. As the needs of each individual vary, nurses should take on the roles appropriate to the person they are caring for. However, the essential role of nurses is to provide care. In chronic diseases such as SMA, the roles of educator, researcher, advocate, consoler, rehabilitator, and counselor come to the fore in addition to the role of caregiver. Nurses play a key role in disease prevention through counseling, meeting the physical and psychosocial care needs of SMA patients and their families, referring them to resources, and providing support.

Therefore, it is recommended that nurses address the multidimensional care needs of SMA patients and their families and ensure continuity of educational studies on the subject to increase their awareness (8).

Conclusion and Recommendations

Spinal muscular atrophy is an autosomal recessive neuromuscular disease caused by deletions or mutations SMN1 gene in the survival motor neuron. The most common inherited cause of childhood death, SMA is classified into five types (0-4) according to age of onset, severity of motor deterioration, and life expectancy. Type 1 (Werding-Hoffmann) is the most severe form and affects mainly newborn babies (11). Recently, SMA has become a topical issue and the lack of a treatment that completely cures the disease increases the importance of nursing care in treatment. The disease, which affects the motor neurons in the spine causes muscle weakness, and which is particularly severe in SMA type 1 patients, presents a picture that reveals the requirements of nursing care at this point. What is expected of nurses when dealing with rare diseases such as SMA is not to know and recognize all diseases, but to be aware that there are thousands of rare diseases and that millions of people suffer from these diseases, and to be aware that a non-standard approach should be taken to these diseases (65). Nursing care in SMA is the determinant of the patient's prognosis and quality of life. The nurse should plan the best education for the individual and family during this process. Nurses who provide high-level care with a multidisciplinary team should support the family and the individual at every moment of care and should have a close relationship with the patient and their family. To better manage the process, nurses should use their roles as caregivers, educators, researchers, managers, decision-makers, advocates, communicators and coordinators, rehabilitators, comforters, and therapeutics effectively.

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