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Stroke Rehabilitation: A Case Study

Darrin Goyn
University of North Dakota

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STROKE REHABILITATION: A CASE STUDY

by

Darrin Goyn
Bachelor of Science in Physical Therapy
University of North Dakota, 1998

An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
School of Medicine
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Master of Physical Therapy

Grand Forks, North Dakota
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1999
This Independent Study, submitted by Darrin Goyn in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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Title Stroke Rehabilitation: A Case Study

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF FIGURES</th>
<th>vi</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>vii</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Epidemiology of Stroke</td>
<td>1</td>
</tr>
<tr>
<td>Etiology of Stroke</td>
<td>5</td>
</tr>
<tr>
<td>Summary</td>
<td>13</td>
</tr>
<tr>
<td>II MANIFESTATIONS FOLLOWING STROKE</td>
<td>14</td>
</tr>
<tr>
<td>Falls</td>
<td>14</td>
</tr>
<tr>
<td>Speech/Language</td>
<td>15</td>
</tr>
<tr>
<td>Integumentary</td>
<td>16</td>
</tr>
<tr>
<td>Deep Vein Thrombosis</td>
<td>17</td>
</tr>
<tr>
<td>Incontinence/Urinary Tract Infection</td>
<td>17</td>
</tr>
<tr>
<td>Depression</td>
<td>18</td>
</tr>
<tr>
<td>Pain</td>
<td>18</td>
</tr>
<tr>
<td>Visual Disturbances</td>
<td>20</td>
</tr>
<tr>
<td>Perceptual Deficits</td>
<td>20</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>22</td>
</tr>
<tr>
<td>Motor Function</td>
<td>23</td>
</tr>
<tr>
<td>Summary</td>
<td>24</td>
</tr>
<tr>
<td>III STROKE REHABILITATION</td>
<td>25</td>
</tr>
<tr>
<td>Rehabilitation Settings</td>
<td>26</td>
</tr>
<tr>
<td>Rehabilitation Screenings</td>
<td>26</td>
</tr>
<tr>
<td>Rehabilitation Effectiveness</td>
<td>27</td>
</tr>
<tr>
<td>Historical Background of Stroke Rehabilitation</td>
<td>29</td>
</tr>
<tr>
<td>Contemporary/Systems Model</td>
<td>35</td>
</tr>
<tr>
<td>Time Course of Recovery</td>
<td>36</td>
</tr>
<tr>
<td>Summary</td>
<td>37</td>
</tr>
<tr>
<td>IV</td>
<td>CASE STUDY .................................................................. 39</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Week Two Post Stroke ............................................. 43</td>
</tr>
<tr>
<td></td>
<td>Week Four Post Stroke ............................................. 45</td>
</tr>
<tr>
<td></td>
<td>Week Seven Post Stroke ........................................... 47</td>
</tr>
<tr>
<td></td>
<td>Week Nine Post Stroke ............................................. 48</td>
</tr>
<tr>
<td></td>
<td>Week Fifteen Post Stroke .......................................... 49</td>
</tr>
<tr>
<td></td>
<td>Week Eighteen Post Stroke ......................................... 50</td>
</tr>
<tr>
<td></td>
<td>Discussion ................................................................ 51</td>
</tr>
<tr>
<td>V</td>
<td>CONCLUSION ................................................................ 53</td>
</tr>
<tr>
<td></td>
<td>APPENDIX A ............................................................ 55</td>
</tr>
<tr>
<td></td>
<td>REFERENCES ............................................................. 57</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Arterial Supply to the Brain</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>Blood Supply to the Cerebral Hemisphere (lateral view)</td>
<td>8</td>
</tr>
</tbody>
</table>
ABSTRACT

Stroke is the largest single cause of neurologic crippling in the United States, with approximately 550,000 Americans having a new or recurrent stroke each year. The costs associated with strokes are estimated at $30 billion annually. Due to the continuing decline of the health care dollar, stroke rehabilitation units must be designed to reduce functional limitations and disabilities in both a timely and cost-effective manner.

The goals of stroke rehabilitation are to reduce functional limitations, prevent complications, educate the patient and family, and improve the patient's quality of life. A proper rehabilitation setting and active participation by the patient and family are important factors in successful stroke rehabilitation. From the literature reviewed, it does not necessarily matter which treatment approach is utilized but early intervention, along with a comprehensive stroke rehabilitation unit, is crucial for functional improvements.

The purpose of this study is twofold; (1) to conduct a literature search to provide a review of epidemiology, etiology, manifestations, and rehabilitation of stroke, (2) present a case study and video showing the physical therapy progression, through stroke rehabilitation, along with complications which can deter the whole process. The intent of this project is to assist physical therapy
students and clinicians in gaining a better understanding of the stroke rehabilitation process.
CHAPTER I
INTRODUCTION

Stroke, also termed cardiovascular accident (CVA), is a cardiovascular disease which affects the blood vessels supplying blood to the brain. A stroke occurs when a blood vessel, bringing oxygen and nutrients to the brain, bursts or is clogged by a clot or some other particle. Due to this blockage, the brain is deprived of its oxygen and subsequent nerve damage will occur within minutes. Depending on the area of the brain affected, this nerve damage will affect people in different ways.

The following chapters will take a look at the main risk factors for stroke, various types of stroke, and manifestations which can occur following a stroke. The rehabilitation of the patient inflicted by a stroke will also be discussed, including the various settings in which it can occur, the screening process, effectiveness of rehabilitation, and some approaches to the treatment of stroke. Chapter IV is a case study of a patient who had a stroke affecting the left side of her body. The case study is accompanied by a video tape of this patient's progression in physical therapy from 2 to 19 weeks post stroke.

Epidemiology of Stroke

Stroke is the leading cause of disability and brain damage in the United States. Approximately 550,000 people in the United States suffer a stroke each
year of which 150,000 (27%) die and the remainder are left with some level of disability.\textsuperscript{1-3} Mortality has decreased significantly over the last 30 years due to improvements in treatment and prevention, with approximately three million stroke survivors living with varying disabilities today. The annual cost for health care expenses and lost productivity due to strokes each year in the United States is $30 billion.\textsuperscript{3} From this economic statement, there is a great need to continue to deter these costs with effective treatment and preventative measures.

In the U.S., death and hospitalization rates have been higher in the Southeastern region for the last 50 years.\textsuperscript{4-6} The Southeastern U.S. has been termed the “Stroke Belt” for several years. A study done by Pickle et al\textsuperscript{7} in 1997 revealed a continuation of high mortality in the Southeast (especially for blacks), but a trend was showing mortality in the southwestern states was also increasing.

Risk Factors

The patient and family members must be made aware of the risk factors for stroke and try to decrease the risks of a subsequent stroke. Some of the following factors are controllable, while others are not.

Hypertension—The most common risk factor is hypertension, commonly called high blood pressure.\textsuperscript{8-11} This controllable factor causes damage to the walls of the blood vessels and damage increases as arteries become narrowed and hardened due to arteriosclerotic deposits. As the pressure increases, through an ever narrowing vessel, a piece of plaque can loosen or it can contribute to a rupture of an aneurysm. The falling mortality rate of stroke is
partly due to the early recognition and treatment of hypertension.\textsuperscript{10-11} In the Framingham study,\textsuperscript{12} patients with systolic hypertension were two to four times as likely to have a stroke than those with normal systolic pressures.

Heart Disease—After hypertension, heart disease is the most important risk factor for stroke.\textsuperscript{11} Many strokes occur secondary to disease of the heart, such as myocardial infarction, atrial fibrillation, left ventricular hypertrophy, and congestive heart failure.\textsuperscript{9-10,13-14} Heart attack is the major cause of death among stroke survivors.\textsuperscript{11}

Diabetes Mellitus—Diabetes mellitus causes an excess of glucose in the blood. Over time, the individual is more susceptible to arteriosclerosis which eventually restricts blood flow.\textsuperscript{9} The relative risk of stroke is approximately doubled when compared to patients without diabetes.\textsuperscript{15} Diabetes is also thought to be a major contributory factor for lacunar infarcts.\textsuperscript{16} There is no cure for diabetes; however, with proper medication, diet, and exercise, it can easily be managed. With better management, the chances of arteriosclerotic build up will be diminished.

Oral Contraceptives—Women who use oral contraceptives are at an increased risk for strokes.\textsuperscript{17} This risk increases dramatically with the use of high dose estrogen contraceptives (greater than 50 micrograms) and with risk factors present, such as alcohol consumption and smoking.\textsuperscript{18,19} Women over the age of 35 who use oral contraceptives and who have additional risk factors are approximately five times more likely to have a stroke.\textsuperscript{20} Several studies have shown that low dose estrogen oral contraceptives have no significance on
increasing the risk of stroke.\textsuperscript{18,19} Many women taking oral contraceptives and who have complaints of migraine headaches have an increased susceptibility to thrombolic stroke.\textsuperscript{17}

Age/Gender—According to the American Heart Association, the incidence of stroke doubles for each decade after age 55.\textsuperscript{11} The majority of strokes will occur during the seventh decade of a person's life.\textsuperscript{21} Another risk factor is gender. The male population has a 19\% higher chance of stroke than do women.\textsuperscript{11} Some feel this fact is due to the increased protection due to female hormones.

Other—The following are notable uncontrollable stroke risk factors: race, prior stroke, and hereditary factors. African-Americans are at a higher risk of stroke which is thought to be due to a greater incidence of hypertension of this population. A comprehensive stroke study undertaken in Copenhagen, Denmark, revealed as many as 23\% recurrent strokes occur, even though prophylactic treatment was given, following an initial stroke.\textsuperscript{19,22} It was also noted in this study that stroke recurrence was more frequently associated with a history of atrial fibrillation, transient ischemic attack, male gender, and hypertension. Transient ischemic attacks should be considered a warning for a larger stroke. About 30\% of patients who have had a transient ischemic attack will go on to have a stroke.\textsuperscript{9,10} A family history of stroke puts people at a greater risk as well. It is currently not known why this occurs.

The risk factors previously mentioned are not all inclusive but would be considered the big hitters when speaking of strokes. The following are others worth mentioning: season and climate, socioeconomic factors, excessive
alcohol intake, drug abuse, physical inactivity, and obesity.

Deficits resulting from stroke can be extremely devastating. Prevention of stroke should, therefore, be a high priority in decreasing morbidity and mortality from stroke. When the public is made aware of the preventable risk factors, stroke prevention may save the lives of many people.

**Etiology of Stroke**

In 400 BC, Hippocrates observed the importance of the blood supply leading to the brain and resulting unconsciousness when this supply was impeded. The Greeks used the term apoplexy which to them meant "sudden loss of senses" to describe a stroke. It was during this time period that cadaver dissection opened up the world of human anatomy and provided a vast array of information of the human body and its blood circulation.

**Anatomy**

When discussing stroke, one must have a basic understanding of the anatomical structures involved. In particular, the blood supply to the brain and the course that the blood takes to get there is of utmost importance. Without a constant blood supply, any of the 60 billion cells in the brain are at risk of death. Blood supply to the brain is provided anteriorly by two carotid arteries and posteriorly by two vertebral arteries. (See Figure 1.)

The right common carotid artery originates from the brachiocephalic artery, and the left common carotid artery originates directly from the arch of the aorta. Each artery ascends toward the angle of the jaw and then each divides
Figure 1.—Arterial supply to the brain.
into an internal and external artery. This region of bifurcation contains both the carotid body and carotid sinus. The carotid body is a chemoreceptor which responds to chemical changes in the blood and regulates respiration, blood pressure, and heart rate. The carotid sinus senses and regulates the body’s blood pressure.

The external carotid artery supplies the external skull structures, while the internal carotid courses through the skull and supplies the eye and cerebral hemispheres. The first major branch of the internal carotid is the ophthalmic artery which supplies the orbit, eye, and upper nose and forehead. One of the earliest symptoms of a stroke may be transient ipsilateral blindness or “amaurosis fugax,” which is due to pathology of the ophthalmic artery. Terminal branches of the internal carotid artery are the middle and anterior cerebral arteries, which go on to feed the temporal, frontal, and part of the parietal lobes. It is the middle cerebral artery which is most often involved in a stroke. The anterior 60% of the cerebrum is supplied by the carotid arteries. (See Figure 2.)

The vertebral arteries are the first and largest branch of the subclavian arteries. The vertebral arteries then travel superiorly and ventrally to enter and ascend the first six cervical vertebrae through their transverse processes. After coursing through two 90° turns (medially and superiorly), the vertebral arteries unite to form the basilar artery. The basilar artery, which eventually flows into the posterior cerebral arteries, supplies blood to the inner ear, upper spinal cord, brainstem, cerebellum, and posterior cerebrum.
Figure 2.—Blood supply to the cerebral hemisphere (lateral view).
From these four arteries, the blood, containing oxygen and nutrients, is supplied to the brain. One would think that occlusion of any of these major arteries would lead to vital brain tissue death. However, at the base of the brain, a connection is made with all of the above mentioned arteries. This connection or anastomosis is called the Circle of Willis.\textsuperscript{23} It should be noted that each cerebral hemisphere is fed by its corresponding internal carotid artery and that the left hemisphere is more likely to be involved in a stroke due to the direct connection of the left common carotid artery to the aorta.\textsuperscript{25}

Depending on which artery or arteries are involved, a stroke produces specific signs and symptoms related to the specific location of occlusion. An occlusion of the anterior cerebral artery will have the following signs and symptoms: contralateral hemiparesis and sensory losses which will affect the lower extremity more, memory and behavioral impairments, aphasia, and neglect.\textsuperscript{26} If the middle cerebral artery is occluded, the following signs and symptoms are common: contralateral hemiparesis and sensory losses affecting the upper extremity and face more, homonymous hemianopsia, aphasia, and possibly coma due to edema. Complete occlusion of the common carotid artery will produce symptoms similar to anterior and middle cerebral occlusion. Posterior cerebral artery occlusion can cause symptoms similar to middle cerebral occlusion in addition to the following: visual agnosia (prosopagnosia - inability to recognize familiar faces), cortical blindness, and thalamic sensory syndrome (a painful neurological sensation affecting the contralateral side). Occlusion of the vertebrobasilar system can produce both ipsilateral and contralateral signs
depending on the level of occlusion. Vertebrobasilar signs include: ataxia, nystagmus, vertigo, nausea, and vomiting. Sensory and motor dysfunction is also possible as are visual disturbances such as diplopia, visual loss, and homonymous hemianopsia. Locked-in syndrome may also be present. With this syndrome, the patient is unable to move or speak but remains alert and oriented. The only voluntary movement remaining is vertical gaze, therefore allowing for communication via eye movements.

Types of Strokes

A stroke is caused by a deprivation of some part of the brain of its blood supply. The brain tissues are in constant need of oxygen and once this oxygen supply is stopped or reduced, the brain is unable to function properly. Based on both a clinical and pathological process, a stroke may be divided into five categories: 1) Transient ischemic attacks (TIAs), 2) Cerebral infarction or thrombosis, 3) Cerebral embolism, 4) Intracerebral hemorrhage, and 5) Subarachnoid hemorrhage. Transient Ischemic Attacks

Transient ischemic attacks are due to a reduction in cerebral blood flow which in turn may be due from microemboli coming from the carotid artery or basilarvertebral artery system. Transient ischemic attacks will normally have a duration between two and ten minutes, but by definition can last up to 24 hours. Usually the TIA symptoms are characteristic of the final deficits that occur in a completed stroke. The clinical manifestations of TIAs are dependent on the artery involved and the specific areas of the brain that the artery feeds. Most of
the time, if the basilarvertebral artery system is affected, symptoms are bilateral. Another type of stroke similar to a TIA is called a reversible ischemic neurological deficit (RIND). A RIND is different in that the temporary effects may last a week or two as compared to less than 24 hours for a TIA.21

**Thrombosis**

Thrombosis is the most common cause of stroke and accounts for over 50% of all cases.13 A clot (thrombosis) forms due to formation of deposits (arteriosclerosis) made on arterial walls.27 Over time, the deposits will occlude blood flow through the artery. Arteriosclerosis is thought to be caused by a combination of high cholesterol in the diet, lack of exercise, hypertension, nervous tension, and hereditary factors.27 This type of stroke often times occurs during sleep or within one hour before arising. Neurological deficits may be maximal when it first develops, called a completed stroke, or the deficits may be seen over a period of days or weeks, called a progressive stroke.

A subtype of a thrombolytic stroke is a lacunar stroke. Lacunar strokes account for approximately 20% of all strokes.20 A lacunar stroke is a small stroke that leaves few permanent deficits. They occur when very small arteries within the brain become occluded and the cells downstream die. Since the total area is very small, only minor deficits will result. Within a few months, a lacune or small cavity develops due to the death of the cerebral cells.21 Sixty percent of lacunar strokes cause only motor deficits, sparing sensation, vision, language, and behavior.28 Motor function to the muscles used for speech may cause difficulty
with spoken language, termed dysarthria. The risk factors of hypertension and diabetes are thought to be the main contributors of lacunar strokes.\textsuperscript{20,23}

Embolism

Cerebral embolisms are due to a dislodgment of arteriosclerotic material or clots from somewhere other than the brain. Typical sites of an embolus formation is at the bifurcation of the carotid arteries.\textsuperscript{21} There is usually no warning of a stroke caused by an embolus as compared to a thrombotic stroke. It is uncommon to have prior TIAs with an embolic stroke, whereas with thrombotic strokes, this is very common.\textsuperscript{13} Since the middle cerebral arteries are a direct continuation of the carotid arteries, they are the most common place for an embolus to lodge.\textsuperscript{24}

Cerebral Hemorrhage

A stroke caused by a cerebral hemorrhage has a very sudden onset and is usually more severe. As many as 80\% of the patients suffering this type of stroke will die.\textsuperscript{10} With a cerebral hemorrhage, the blood flowing past a weakened section in the arterial wall will cause the artery to bulge and eventually, from the constant blood pressure, weaken and rupture. The blood then flows through the ruptured vessel and into the brain tissue.\textsuperscript{21} If the hemorrhage is rather small, the degree of neurological deficit may be less than that caused by an embolus or thrombus. The reason for this is that the blood, from the ruptured artery, does not destroy brain substance but separates the nerve fibers. Once the blood is reabsorbed, the nerve fibers remain intact and are able to function properly.
Subarachnoid Hemorrhage

A subarachnoid hemorrhage (SAH) is the last type considered. With this type of hemorrhage, the blood flows into the space surrounding the brain (subarachnoid space) rather than into the brain tissue itself. Subarachnoid hemorrhage is characterized by an abrupt severe headache, a brief loss of consciousness, nausea and vomiting, and a stiff neck at onset. Effects of a SAH are similar to a traumatic brain injury with diffuse problems including cognitive and behavioral symptoms. As many as 20% of patients will die within the first day and up to 60% die within six months following a SAH.

Summary

Many of the risk factors associated with stroke can be controlled and, with proper education and medical intervention, thousands of people can be saved the hardships associated with having a stroke. Public education on these preventable risk factors as well as the signs and symptoms of a stroke should be carried out in every medical facility. The advent of sophisticated diagnostic equipment, along with a thorough understanding of the body’s neuroanatomy, has allowed physicians to determine the location and severity of the stroke. By knowing the etiology of the stroke and the structures involved, the health care team can communicate to the patient and/or family the extent of the infliction and a general idea of the length of recovery. The manifestations of a stroke will be looked at in the following chapter. The manifestations of a stroke are the direct cause of location and extent of damage caused by the bursting or occlusion of the cerebral blood vessels.
CHAPTER II

MANIFESTATIONS FOLLOWING STROKE

Patients who have had a stroke are at risk of developing an array of complications. Complications following a stroke may lead to death or cause a delay in successful rehabilitation.\textsuperscript{32} It is the job of the health care team to assure that the patient is being closely monitored. This chapter will take a look at some common complications following a stroke and at the signs and symptoms of which the therapist should be aware. This is not an all inclusive list but represents a major portion of the common complications seen.

Falls

A study done by Davenport et al.\textsuperscript{33} revealed that the most common complication following a stroke was falls. Patients will normally fall toward the paretic side making it imperative that manual assistance be given on this side for those patients at risk. Many factors may predispose a patient to falls: faulty balance and coordination, medication usage, perceptual and visual deficits, and lack of judgement.\textsuperscript{34} Supervision during therapy, proper use of assistive devices, and the use of adaptive equipment (bed rails, shower rails, etc.) are necessary components for patients who are at high risk of falls. Educating the patient and family of assistive devices and of the need for an obstacle free environment at home are also key components.
Speech/Language

Loss of the ability to communicate can be one of the most distressing and frustrating problems for the patient, family, and health care team. There are two ways in which speech can be affected following a stroke. Dysarthria is a disorder occurring due to neurological damage of the muscles necessary for speech. The patient's speech will be slurred or distorted to various degrees. This type of language deficit responds well to treatment.\(^\text{35}\)

The other type of speech deficit is called aphasia of which there are three types: fluent, non-fluent, and global. Aphasia is normally due to a stroke occurring on the left hemisphere of the brain, since this side is dominant for language in 85% of all people.\(^\text{36}\)

Fluent aphasia, also know as Wernicke's or receptive aphasia, affects the ability of the stroke patient to understand what is said. Speech will be nonsensical or repetitive. They often use words which have no communicative effect, called neologisms. These words are made up in their own minds and the patient can often be thought of as confused, disoriented, or mentally ill. Reading and writing may be severely impaired as well.\(^\text{36}\) When communicating with these patients, it will be beneficial to use gestures, pictures, and keep the commands as simple as possible.\(^\text{21}\)

Non-fluent aphasia, also know as Broca's or expressive aphasia, affects the ability to speak. The patient can comprehend what is written or said but cannot produce language (speak, write, or make gestures). This deficit creates a
word-by-word speaker, who can only produce single words or short phrases at a time.\textsuperscript{21}

Patients with non-fluent aphasia tend to have a good awareness of their deficit and greater motor disturbances. The fluent aphasic patient will have decreased awareness of the deficit but less physical disability.\textsuperscript{26} Due to their inability to understand both written and verbal speech, along with a decreased awareness, patients with fluent aphasia tend to have poorer outcomes in rehabilitation.\textsuperscript{37}

The final type of aphasia is global aphasia. This involves the inability to both produce and comprehend written and spoken language. Many individuals who suffer a stroke will have some component of both fluent and non-fluent aphasia.\textsuperscript{35} The speech therapist is, therefore, an integral part of the rehabilitation team.

\textbf{Integumentary}

Stroke patients are at an increased risk of skin breakdown due to several factors. It is imperative that the medical staff and family be aware of these factors and be able to recognize, treat, and prevent further damage. Those patients who are obese, have bowel or bladder incontinence, are comatose, or who have muscle spasticity are at high risk.\textsuperscript{36} Routine skin inspection, cleansing, and proper wheelchair and bed positioning are necessary in the rehabilitation process. Other preventative measures include: avoid shearing of the skin during transfers, special mattresses, protective orthosis, reduce bony prominence pressure, and keeping the patient dry with appropriate incontinence covering or pad. Education of the patient and family, along with proper nutrition
and early mobilization, are essential as well.\textsuperscript{36,38}

**Deep Vein Thrombosis**

Deep vein thrombosis (DVT) and pulmonary embolism are potential complications following a stroke and the subsequent immobilization. The literature is in disagreement of the incidence of DVT in stroke patients ranging between 11\% and 75\%.\textsuperscript{36,38,39} A deep vein thrombosis will usually occur in the hemiparetic lower extremity due to decreased mobility.\textsuperscript{34} The health care team must routinely evaluate for this potentially fatal complication. Proper diagnosis includes daily evaluation of leg tenderness, color, edema, pain, and temperature. If there is a concern for a DVT to develop, proper prophylactic measures should be undertaken, including elastic stockings, pneumatic compression, administration of anticoagulants (heparin and warfarin), and early mobilization.

**Incontinence/Urinary Tract Infection**

As many as one-half of all stroke patients may contract a urinary tract infection\textsuperscript{40} and 50\% to 70\% will have urinary incontinence during the first month following the stroke.\textsuperscript{36} Persistent incontinence suggests prognosis for functional recovery will be poor and can cause skin breakdown, depression, and embarrassment.\textsuperscript{41} Treatment for these problems includes putting the patient on a timed bladder-emptying schedule and/or administering antibiotics. Hayn and Fisher\textsuperscript{42} suggest teaching the patient Kegel exercises which involves isometric contractions of the pelvic floor muscles and holding the contraction for three to five seconds.

The therapist should be aware of the patient's condition, cognizant of
psychosocial aspects, and allow for timely bladder-emptying during therapy. Assessment of patient awareness and ability to communicate bladder fullness should also be considered.

Depression

Periods of emotional lability, including grief and sadness, are common following a stroke. Adams\textsuperscript{39} states that as many as two-thirds of stroke patients will have depression. There is an increased prevalence of depression between six months and two years after a stroke.\textsuperscript{43} Depression will be more severe with those patients who have had damage to the left hemisphere, especially with those close to the frontal lobe.\textsuperscript{44} Common symptoms of depression include tearfulness, decreased interest in activities, sadness, sleep disorders, severe weight fluctuations, inability to concentrate, lethargy, constipation, anxiety, and restlessness.\textsuperscript{42} These symptoms need to be differentiated with other stroke complications, such as infection or drug interactions. Treatment for depression may take an interdisciplinary approach including psychotherapy and the use of antidepressant medications.

Pain

Pain can occur in the stroke patient for many reasons. The weight of a paralyzed arm, improper fitting adaptive equipment, prolonged immobilization, improper positioning, and neurologic dysfunction are just a few of the reasons for patient pain.\textsuperscript{26,34,42} Neurological pain is likely to be caused by central nervous damage and will almost always occur on the side affected by the stroke. The pain will be described as a continuous burning, and at times has an aching
Due to the increased pain, the patient will have decreased function, impaired concentration, and depression. Treatment of this type of pain is normally controlled by analgesic medications or by the use of transcutaneous electrical nerve stimulation (TENS) therapy. Avoidance of pain stimulating situations is also recommended (infections, bowel/bladder complications, contractures, and pressure sores).

There are two sources of pain in the shoulder that are worthy of mentioning. The first is shoulder pain due to a muscle imbalance caused by paresis of the shoulder musculature. During the flaccid stage, the shoulder capsule and ligaments become the sole support for the shoulder. Over time, gravitational forces along with improper positioning and support cause humeral subluxation and produce pain. During the spastic stage, abnormal muscle tone will restrict scapular positioning, leading to humeral subluxation. Shoulder pain will first be reported at end-range and will be localized. Without treatment, the pain will become diffuse and will persist with all shoulder movements (especially shoulder flexion and abduction) and night pain will also be a complaint.

Reflex sympathetic dystrophy or shoulder-hand syndrome is the other type of shoulder producing pain. The patient will experience edema and pain in the hand, arm, or shoulder from improper positioning and immobility. Early recognition of the syndrome is crucial as the patient will develop increased stiffness, contracture, and muscle atrophy of the thenar/hypothenar musculature. This painful syndrome, often times caused by improper handling during transfers, can be avoided with proper care, early management, and education of
staff and family.

Following a stroke, the patient must be monitored closely to ensure that no shoulder pathology is developing. Therapists must be alert to any changes and ensure that proper positioning, splints, and exercises are established and followed through by all professionals involved in the care of the patient.

Visual Disturbances

Vision can be affected through damage to the eye, optic radiation, or the visual cortex. Diplopia and homonymous hemianopsia are common deficits following a stroke. Diplopia, or double vision, is usually due to a decreased range of eye motion caused by damage to the eye musculature. Homonymous hemianopsia is a visual deficit most commonly occurring following damage to the middle cerebral artery. superscript 26 This visual disturbance produces a loss of the nasal field of one eye and the temporal field of the other eye. Loss of the left visual field is associated with left hemiplegia and loss of the right visual field accompanies right hemiplegia. The patient is usually unaware of this condition but can compensate for it by moving his/her head or body when instructed to do so.

Perceptual Deficits

A stroke occurring in the right hemisphere will typically produce perceptual deficits on the left side of the body. superscript 26 There are an abundant number of deficits pertaining to the patient inflicted by stroke of which only a few will be discussed.
Patients presenting with post stroke perceptual deficits will have decreased rehabilitation potential\textsuperscript{33} and longer lengths of stay.\textsuperscript{45} Visuospatial distortion involves the patient's inability to register and integrate stimuli on one side of the body. The patient will ignore one side of the body and this may occur with or without an actual visual loss to that side of the body (homonymous hemianopsia). It should be noted that the patient with visual neglect will not attempt to compensate by turning his/her head; however, the patient having only homonymous hemianopsia will compensate by turning his/her head.\textsuperscript{26}

Anosognosia is another perceptual deficit in which the patient denies having an illness.\textsuperscript{45} The patient will maintain that his/her limbs are all right or may state that the limb has a mind of its own or will make up reasons why it does not work properly.\textsuperscript{26} Patients with this condition must be carefully monitored for safety reasons.

Agnosia is a broad term which means the inability to recognize familiar objects. There is an inability to transmit various sensory signals to the conceptual level. Various types of agnosia may be exhibited by the patient following a stroke. Auditory agnosia is the inability to recognize familiar sounds.\textsuperscript{37,45} The patient will be unable to distinguish between two similar sounds, such as a phone ringing and a door bell. Visual agnosia, the most common type, is the inability to recognize familiar objects even though eye function and the optic tracts are normal. Patients may not be able to recognize familiar faces or colors. This type of visual agnosia is called prosopagnosia and color agnosia.
respectively. The final type of agnosia is tactile agnosia, or astereognosis. This is the inability to recognize objects, with vision occluded, by touch even though tactile, proprioceptive, and thermal sensations are functional.

Apraxia will be the final perceptual deficit discussed, of which there are four kinds. Apraxia is the inability to, on command, carry out purposeful movements not due to paralysis or inability to understand. The first type of apraxia is called ideomotor apraxia. With this type, there is a disconnection between the idea of movement and the act of actually carrying out that motor activity. For example, if the patient is asked to wave his/her hand, he/she will be unable to, but if he/she is waved to, he/she will spontaneously wave back. The second type of apraxia is ideational apraxia. The patient will be unable to either verbally or physically perform a purposeful motor act. They cannot conceptualize the process nor can they do it spontaneously as with ideomotor apraxia. Another type of apraxia is called constructional apraxia. With this type, the patient will be unable to copy simple diagrams or figures. They have a dysfunctional spatial analysis and conceptualization of the task. The final type of apraxia is dressing apraxia which is the inability to dress independently even though motor performance and coordination are intact. The patient will put clothes on backwards, inside out, or dress only one side of the body.

Dysphagia

Having difficulty or inability to swallow following a stroke occurs in as many as 50% of patients. This manifestation is due to paralysis of the muscles used in swallowing, and evaluation by a speech pathologist is very important.
third of patients with dysphagia will develop aspiration and, of these, 40% will have no observable signs of coughing or choking.\textsuperscript{36,39} If allowed to progress, pneumonia may develop which has been shown to be the third most common cause of death in the first month following a stroke.\textsuperscript{34} It is important that all stroke team members and family be aware of, and are knowledgeable of, those things which can exacerbate improper swallowing and aspiration. Precautions, such as food and liquid restrictions, should be known by all in the treatment and care of the patient.

Following is a list of techniques to be used to help prevent aspiration: sit in correct upright posture with chin tucked, thicken and puree foods, eat smaller food bolus size, place food in unaffected side of mouth, take time between swallows, and keep upright for at least 45 minutes following a meal.\textsuperscript{36,42} Patients who do not regain the ability to swallow safely will require tubal or parental feeding.\textsuperscript{46}

**Motor Function**

Several authors have described the return of neuromuscular function in various stages.\textsuperscript{34,42} The following will be a general overview of this recovery. Every patient will recover differently and at a different pace depending on the severity and manifestations of the stroke. Following a stroke, reflexes and voluntary movements may be reduced or absent initially and the affected muscles may be without tone or are flaccid. Within days to weeks following the flaccid stage, there will be some degree of spasticity and associated synergistic movements (flexion and extension) present.\textsuperscript{25,34,36} Flexor tone is common in the
upper extremities, while extensor tone is common in the lower extremities.\textsuperscript{25} During the spastic and synergistic stages, hyperreflexia emerges.\textsuperscript{26} As spasticity and synergies decline, the patient will have greater ability to voluntarily flex or extend a joint in isolated movements. Following the attainment of voluntary isolated movements, muscle strength, coordination, and endurance will return.

Depending on the type, severity, and location of the stroke, patients may progress at different rates through the stages in order, skip stages, or remain within a particular stage for an extended time or indefinitely.\textsuperscript{42} The goal with any stroke patient should be to return his/her muscle tone and coordination to as close the premorbid status as possible, keeping in mind that these stages are merely milestones in his/her progression.

Summary

Complications following a stroke are important because they can slow down the rehabilitation process and even cause death. Successful stroke rehabilitation requires prevention and prompt treatment of a multitude of potential complications, some of which have just been described. Close medical supervision, careful nursing care, and a rehabilitation team which is knowledgeable about and conscientious of these complications can make the patient's road to recovery a much smoother and quicker process.
CHAPTER III

STROKE REHABILITATION

The ultimate goals of stroke rehabilitation is to reduce functional limitations and disabilities, prevent complications, improve the patient's quality of life, and educate the patient and family.\textsuperscript{34,47} This must be done in a way which preserves dignity and motivates the survivor to relearn basic skills such as eating, dressing, and walking. Rehabilitation is a restorative and learning process that seeks to maximize recovery from stroke by treating the resultant impairments, functional limitations, and disabilities. It is an attempt to help the patient regain a sense of functional independence and freedom of movement and to allow for reintegration into community life. With the high incidence and prevalence of stroke and an increasingly older population, stroke rehabilitation should take a high priority in health care systems.

Approximately 10\% of stroke survivors will recover without disability, function independently, and not require rehabilitation. Another 10\% will require care in a long-term care facility or nursing home due to severe disability.\textsuperscript{34,48} However, according to Kalra and Eade,\textsuperscript{49} patients who are severely impaired and do receive organized rehabilitation have significantly better outcomes and are more likely to be discharged home from rehabilitation units than those who do
not receive rehabilitation. The remaining 80% of stroke survivors will have minor to moderately severe disability and benefit from intensive rehabilitation.\textsuperscript{34,48}

**Rehabilitation Settings**

Post stroke rehabilitation may take place in a variety of settings including acute care hospitals (part of acute care episode), inpatient rehabilitation hospitals (IRHs), long-term skilled nursing facilities (SNFs), home health, subacute care unit, rehabilitation unit in the hospital, and outpatient therapy.\textsuperscript{34,48,50}

Each setting may differ in terms of the intensity of rehabilitation offered and their ability to manage other medical conditions. Skilled nursing facilities provide less intensive rehabilitation and are for patients with severe disabilities who require medical monitoring or for patients who lack sufficient home support to receive outpatient services. Inpatient rehabilitation hospitals provide the most intensive rehabilitation and are for patients with moderate disabilities but must be able to tolerate at least three hours per day of rehabilitation.\textsuperscript{50}

Depending on the severity of the stroke and comorbidity issues, a patient may go to the inpatient rehabilitation setting within a few days following the stroke or may stay in the acute care setting for two to three months. A study done by Monane et al\textsuperscript{51} found that the average length of stay in the acute setting for stroke patients is seven days. With the introduction of diagnosis related group (DRG) system, hospital reimbursement for stroke in the acute setting is 8.5 days.

**Rehabilitation Screening**

A comprehensive screening process is routinely done to determine rehabilitation services as soon as the patient's medical condition stabilizes.\textsuperscript{34}
The World Health Organization (WHO) recommends dividing all stroke survivors into three categories in regard to prognosis: 1) patients who spontaneously recover without rehabilitation, 2) patients who can make satisfactory recovery only through intensive rehabilitation, and 3) patients with poor recovery regardless of the type of rehabilitation setting. Some prognostic indicators for poor rehabilitation outcomes have been identified: coma at onset, previous stroke, bowel/bladder incontinence two weeks post stroke, cognitive and perceptual deficits, advanced age, no motor return within one month, significant cardiovascular disease, and large, deep lesions. Patients with left hemiplegia have better outcomes if there is no spatial agnosia, but patients with spatial agnosia have a worse prognosis than both right and left hemiplegic patients.

Rehabilitation Effectiveness

Many studies have been done to determine the effectiveness of stroke rehabilitation, both acutely and chronically. There are articles which address the problem of effectively separating natural or spontaneous recovery from the effects of formal rehabilitation. Early physiological recovery following a stroke is due to the damaged tissues being reabsorbed, improving local circulation, and decreasing cerebral edema. Two proposed neural mechanisms for recovery are regenerative collateral sprouting and unmasking of neural pathways. Collateral sprouting and unmasking are thought to be an inherent plasticity of the central nervous system. Collateral sprouting occurs when unaffected neural cells sprout to areas which are denervated due to effects of the stroke.
Triggering of this process may be brought about by intensive rehabilitation. Unmasking refers to the body's ability to call upon axons and synapses which have previously been unused due to a functioning dominant system. Once this dominant system has been damaged by a stroke, unmasking may take place when there is a functional demand.55

According to Adams,39 research has proven that stroke rehabilitation is beneficial and that active rehabilitation, rather than spontaneous recovery, is the causative factor of increased functional ability in stroke patients. The author states that focused inpatient stroke units clearly improve functional outcomes and decrease the incidence of morbidity and mortality seen in stroke patients.

In a study done by Smith et al,56 155 patients admitted to a stroke unit and 152 patients admitted to medical units were assessed for neurologic function and activities of daily living (ADLs) at 16 weeks after admission. Neurologic function was measured using six determinants (memory, problem solving, proprioception, upper/lower extremity motor function, and verbal communication), and ADL function was assessed using seven determinants (transfers, dressing, indoor mobility, hygiene, cooking, feeding, and environmental control). Results showed that patients in the stroke unit performed significantly better in all seven ADL components and showed more neurologic function than did the medical unit patients. Other interesting findings were that patients in the stroke unit had a lower mortality (19% vs. 28%), shorter hospitalization (55 days vs. 75 days), and more patients began physical therapy treatments within two days of admission (60% vs. 38%). They concluded that the team approach in the stroke unit along
with beginning therapy earlier were key components of the success for the stroke unit patients.

Ottenbacher and Jannell examined the effectiveness of stroke rehabilitation in improving functional outcomes using 36 clinical trials made up of 3,717 patients. They concluded that patients receiving a program of focused stroke rehabilitation performed better than 65.5% of the patients in the control groups. They felt the improvements were related to early initiation but not duration of treatment.

The effectiveness of stroke rehabilitation continues to be a controversial topic. Due to multiple variables seen with stroke patients, it is difficult to evaluate the effectiveness and provide an accurate assessment of stroke rehabilitation. Feasibility and ethical issues arise when research is done in a manner where true experimental and control groups are used. Much of the recent research compares various philosophies of treatment approaches for patients with similar disabilities or differing amounts of rehabilitation. The remainder of this chapter will take a look at the various historical approaches and philosophies along with timelines for effective stroke rehabilitation.

Historical Background of Stroke Rehabilitation

Prior to the 1950s, physical therapy focused on the concept of muscle re-education (considered the traditional approach). During this time, treatment techniques for poliomyelitis were of big concern. Poliomyelitis, although a central nervous system (CNS) disease, presents very much like a peripheral nerve lesion. The muscle re-education concept required that there be no
perceptual or cognitive deficits and that patients have volitional control, as was true with poliomyelitis patients. The concept of strengthening weakened muscle, using the muscle re-education approach, worked well for improving function in this patient population. New cases of poliomyelitis were virtually eradicated by a vaccine in the mid 1950s. Physical therapists then directed their attention to treatment of patients presenting with a much more complex set of symptoms, stroke. Stroke patients prior to the 1950s were treated the same as orthopedic patients. Bracing, surgery, and muscle strengthening using traditional approaches were used as the sole treatments. No longer did the muscle re-education concept bide well in treating this more complex infliction. Cognitive and perceptual deficits played havoc in treating patients using the traditional theory.

From this paradigm shift developed the concept of neurotherapeutic approach. Several approaches developed during the 1950s and 1960s focusing on a central nervous system philosophy in treating patients inflicted by stroke. From the approaches developed there are certainly considerable differences, but there are also strong similarities seen.

All approaches recognized the CNS as linking contractions of different muscles together to produce fluent movements or synergies. Therefore, lesions of the CNS will cause disorganized movement and not merely paralysis of individual muscles. It was also agreed that sensory stimulation is a means of getting information to the CNS via afferent pathways, and in a sense communicating with the source of the problem. Another similarity is that the
CNS is hierarchically organized; higher centers controlling lower centers. When there is damage to the higher centers, as in a stroke, the lower centers are released. This releasing of the lower centers allows primitive movements to take over. Without the inhibitory effects of the higher centers, abnormal patterns of movement or synergies are seen. A final similarity seen is that all approaches believed recovery mimics the normal development of infants. As higher centers regain control of lower centers primitive reflexes and movements are inhibited.

Common therapeutic approaches seen in literature for stroke rehabilitation include: Bobath/neurodevelopmental techniques (NDT), Rood/propr.ioceptive neuromuscular facilitation, and Brunnstrom. Following is a discussion of these approaches as well as a discussion of a contemporary model of stroke rehabilitation.

Neurodevelopmental Techniques

The Bobath and NDT approaches will be grouped as a single entity. Berta Bobath instigated this approach with the NDT concept developing from her ideas. With this approach, patients are not allowed to compensate with their uninvolved side. Compensation is responsible for an increase in spasticity leaving the involved side with decreased activity. Following a stroke, patients will have an increased fear of falling to the affected side due to loss of balance and support of that side. If allowed to compensate, they will never learn to use the affected side as a support.

If spasticity is present, it needs to be reduced to allow for movement without effort. Normal movement cannot be superimposed on abnormal tone. Bobath
and NDT approaches use tactile stimulation to facilitate activation of this musculature. Function is emphasized by providing tasks that can be used as direct preparation for a specific functional use. Treatments involve tasks which are as similar as possible to those used in their everyday lives. Patients are also actively involved cognitively in treatments to ensure a conscious effort is put forth so that relearning is taking place. The goal of treatment is for the patient to become an independent learner by providing less facilitation and inhibition as he/she progresses. Each patient is considered differently and individual needs are addressed through direct observation of the person as a whole.

Proprioceptive Neuromuscular Facilitation

Proprioceptive neuromuscular facilitation (PNF) techniques have been used widely in stroke rehabilitation as well as a treatment modality for orthopedic patients. These techniques have been developed by many people, including Rood, Kabat, Knott, and Voss. Goals in PNF techniques are to engram movement patterns into the central nervous system that resemble normal patterns and to improve the patient’s functional abilities as much as possible.

There are two types of movement patterns considered in PNF techniques. The first type of movement pattern utilizes diagonal or spiral movements which are felt to be the most normal movements that are seen in the human body. Movements are not carried out in a single plane, as was considered in traditional approaches, but are composed of a combination of three movements (i.e., flexion, abduction, with internal rotation). The second type of movement pattern utilized in PNF is that movement occurs sequentially in a developmental manner
similar to that seen in infants. In a simplified manner, an infant will sequentially progress through the following stages: supine → roll over (supine to prone) → prone → prone on elbows → quadruped → standing → walking. Proprioceptive neuromuscular facilitation techniques will implement treatment to stroke patients at any of the previous stages. Each stage is begun by regaining movement or mobility, followed by stability (co-contraction of muscles around a joint), controlled mobility, and ended with a skilled/functional movement. There are a number of specific handling techniques used in PNF and all are based on three basic physiological principles.

The first principle is that of successive induction. Successive induction is the concept that following a voluntary contraction of an agonist muscle, the antagonist muscle will be facilitated. The second principle involves an inhibitory influence over the antagonist muscle when the agonist muscle is firing and is termed reciprocal inhibition. The final principle, irradiation, involves increasing the strength of the response when either the number or strength of the stimulus is increased. The special handling techniques used in PNF will incorporate one or more of these principles.

Treatments using the PNF techniques involve providing enough initial assistance to allow the patient to perform the desired outcome. As the patient becomes independent at the desired task, the assistance is slowly withdrawn. Assistance is provided through proprioceptive, sensory stimulation, and verbal cueing.
Brunnstrom

The Brunnstrom approach utilizes reflex elements which manifest following a stroke. Reflexes become inhibited from higher cortical areas and cause muscle synergies to develop. These synergies come about at the spinal cord level and are considered primitive and automatic in nature. Brunnstrom uses these primitive movement patterns as building blocks to develop isolated voluntary movements. With this approach, it is felt that as the patient sequentially recovers, (seven distinct stages through which a stroke patient progresses) an attempt is made to gain voluntary control of movement. By using repetition with facilitation, followed by repetition without facilitation, the patient is eventually weaned from the use of reflex movement. Reflex activity is eventually superimposed by voluntary effort. The goal in the Brunnstrom approach is to progress the stroke patient through the seven sequential recovery stages keeping in mind that recovery may be halted at any stage and a stage is never skipped.

The previous approaches all use specific strategies to treat a patient inflicted by stroke. It is not the purpose of this author to determine which approach is the best but merely to give a brief overview of each approach. Each approach has been used in rehabilitation settings for many years, and there is plenty of literature which supports the use of a specific technique. With a better understanding of how the central nervous system works, new theories have evolved beyond the basics that have been known for years. The next section will be dedicated to looking at the contemporary thought of how the CNS reacts to
impairment and how traditional thoughts have not taken into consideration the magnitude of variables playing a role in recovery of the stroke patient.

Contemporary/Systems Model

The contemporary/systems model goes beyond the traditional theories of how motor function is regained following a stroke. Traditionally, control of motor function was thought to be under higher (cortical) and lower (reflex) levels of control. Cortical control is simply the brain's ability to develop voluntary muscle activation and the reflex control is the control of muscles through reflex loops of the spinal cord. The proponents of the previously mentioned stroke rehabilitation techniques have since adjusted their approaches to this new model.

Contemporary/systems model states that movements are not centrally or peripherally driven but emerge due to the interaction of many systems. It is not the higher and lower levels that are in control but a total systems approach that produces a desired movement. These abstract systems include neurologic systems for comparing, commanding, and recording motor control. This occurs not only inside the nervous system but outside as well, including the musculoskeletal system and environment. By continually making comparisons with what is anticipated and with what actually happens, the systems are constantly modifying to come up with the most effective and efficient ways to accomplish a functional task. This is analogous to an infant who is learning to walk. Initially, the infant will fail this task by falling several times. As previous
movements are compared and recorded in the nervous system, he/she will learn from and become more effective in subsequent trials.

Implications of the systems model are that it is imperative that tasks be carried out in identifiable and functionally relevant environments rather than eliciting reflexes or isolated motor patterns. Our environment plays a critical role in learning; therefore, tasks should be carried out in a variety of postures, surfaces, and biomechanical conditions.\textsuperscript{64} Therapists who use the contemporary/systems model will use a variety of environments or positions to help the nervous system learn to solve motor deficits.\textsuperscript{63} The patient must also be an active participant and be able to problem solve for him/herself for there to be carryover in learning and for the patient to function more independently.

Time Course of Recovery

There are many articles in the literature showing the time course for stroke recovery.\textsuperscript{45,65-69} It is generally agreed that neurological and functional recovery occurs mainly within the first six months following a stroke.\textsuperscript{65,67} There are also studies which show that an increase in functional recovery can be achieved beyond this six-month window.\textsuperscript{46}

Jorgensen et al\textsuperscript{65} studied 1,197 acute stroke patients in order to describe the time course for both neurological and functional recovery. Neurological recovery was assessed using the Scandinavian Stroke Scale (SSS) and functional recovery was assessed using the Barthel Index (BI). Patients were categorized into one of four groups based on severity of stroke determined by the SSS score: very severe, severe, moderate, and mild. The time from stroke onset to the time
of highest score obtained on both the SSS and BI was used as a determinant that no further improvement was observed. The study revealed that neurological recovery occurred faster than functional recovery. Neurological recovery was reached in 95% of the patients within 11 weeks from stroke onset, ranging from 6.5 to 13 weeks, dependent on severity of stroke. Functional recovery in 95% of the patients was reached within 12.5 weeks, ranging from 8.5 to 20 weeks. The authors concluded that prognosis for all stroke survivors could be made within 12 weeks from stroke onset and that most neurological and functional recovery will occur in the first five months.

Another study done by Tangeman et al.46 showed that functional gains can be made for stroke patients who were at least one year post stroke. Forty stroke patients completed a one-month intensive rehabilitation program including occupational and physical therapy four days a week. Therapy emphasized weight shifting, balance, and functional use of these skills in a variety of environments. Significant gains were made in all three outcome measures and were retained following a three-month follow up. The authors felt that directly following a stroke, there is too much stress for full recovery to be achieved. A period at home allows the patient to directly experience how the stroke has affected his/her daily life and gives him/her an increased interest in increasing his/her level of independence.

Summary

Stroke rehabilitation helps restore lost abilities, improve a patient's quality of life, and decrease the costs associated with long term disablement caused by
stroke. A proper rehabilitation setting along with active participation by the patient and family are important factors in successful stroke rehabilitation. From the literature reviewed, it does not necessarily matter which treatment approach is utilized, but early intervention, along with a comprehensive stroke rehabilitation unit, is crucial for functional improvements. The literature also shows that improved function occurs not only within the first six months, but can occur months and even years following the initial stroke episode.
CHAPTER IV

CASE STUDY

Strokes affect the lives of many people every year. Not only is it a sudden, often catastrophic event for the survivor, but is also very challenging for family and friends. The role of the physical therapist is to facilitate the recovery progression to allow the individual to return to the highest quality of function and independence possible. With an understanding of the manifestations of stroke and a thorough knowledge of how to facilitate functional recovery, the physical therapist has an integral role in aiding the patient and family.

There have been many studies that have documented the effectiveness of active stroke rehabilitation. Organized stroke rehabilitation units have been shown to clearly reduce mortality and medical morbidity and lead to significantly greater functional gains and shorter lengths of stay. The purpose of this case study is to demonstrate the functional recovery, over a four-month period, of a patient who suffered a stroke. A video recording of the patient’s physical therapy sessions were taped every one to two weeks for a time period between two and eighteen weeks post stroke. The videotape and case study are intended to show the physical therapy rehabilitation progression and be used as a learning tool for physical therapy students and other health care professionals.
The patient, a 72-year-old married female, reported falling at home due to weakness in her left leg on November 18, 1997. On the following day, she was admitted to Altru Hospital in Grand Forks, North Dakota, and diagnosed with a cerebrovascular accident (CVA) with subsequent left hemiparesis. The patient had an extensive medical history, including many predisposing factors, or risk factors, for having a stroke. Past medical history included:

1) Insulin Dependent Diabetes Mellitus with peripheral neuropathy-diagnosed in 1977.
2) Coronary Artery Disease
3) Coronary Artery Bypass Graft (CABG) - four vessel in 1989.
4) Hypertension
5) Bladder dysfunction - stress incontinence
6) Bilateral Carotid Artery Stenosis and Left Vertebral Artery Stenosis
7) Atrial Septal Defect
8) Hysterectomy
9) Appendectomy
10) Obesity - weight = 243 pounds, height = 5'5"

The following manifestations were additionally present following her stroke:

1) Decreased sensation to left lower extremity (pinprick and temperature)
2) Decreased motor function on her left side (left hemiparesis)
3) Mild dysarthria
4) Mild memory disturbances
5) Poor standing balance - static and dynamic

On November 25, 1997, the patient was transferred to the inpatient rehabilitation facility at Altru Health Institute. She received inpatient therapy in both the physical and occupational departments two times a day. Her comprehensive rehabilitation team included nursing, occupation and physical therapy, psychology, recreation therapist, case manager, and neurologist.

On December 19, 1997, (one month post stroke) the patient was discharged to her home from inpatient therapy. At home, she had the assistance of her husband, and a home health nurse came three times a week to assist with activities of daily living, medications, and personal hygiene. The patient had modifications done to her mobile home trailer to assist in access and in performing daily activities. Structurally, a ramp was constructed to allow for wheelchair access to her home and the bathroom door removed to allow for passage of her wheelchair. Railings were placed in her bathroom to assist in access and safety in the shower and a toilet seat extender installed. A commode was also placed next to her bed to allow for nighttime use.

Objective measurements were taken throughout the patient's inpatient rehabilitation to assess treatment and monitor improvements. The Functional Independence Measure (FIM) was administered during her inpatient rehabilitation both at admittance and discharge. The FIM assesses 18 items for six different areas: self care, sphincter control, mobility, locomotion, communication, and social cognition. Each item is given a score between one
and seven depending on the independence and ability level of the patient. A total score of 126 is possible from all 18 items. FIM Scores: Admittance (11/25/97) = 58, with severe limitations in the following areas: grooming, bathing, dressing, toileting, bladder management, transfers, and ambulation. Discharge (12/19/97) = 94, with mild to moderate limitations in the following areas: bathing, dressing, toileting, transfers, and a severe limitation remaining in ambulation.

The Tinetti assessment tool was used during the patient’s outpatient rehabilitation to assess balance and gait. Nine balance tests and seven gait tests are administered with a total of 28 points being possible from these tests. Based on the patient’s score, they are categorized as having low, greater, or high risk of having a fall. The test was administered at 7, 11, and 16 weeks post-stroke for this patient. At seven weeks, the patient’s score was 14 which put her at a high risk for falls. At eleven weeks, her score was 22 putting her in the greater chance category of having a fall, and at 16 weeks her score was 25 which corresponds to a low risk of having a fall.

The following is a sequential outline of the patient’s physical therapy rehabilitation progression as illustrated by progress notes and videotaping sessions which were performed every one to two weeks. The patient signed a consent form allowing for videotaping during physical therapy and occupational therapy sessions carried out at Altru Heath System (Appendix A). This case study will focus on the patient’s lower extremity function while making note of the functional use of her upper extremities. The patient’s assistive devices at time of
initial taping included wheelchair, wide base quad cane (WBQC), and shoulder sling. The patient was not fit with an ankle foot orthosis (AF0).

**Week Two Post Stroke**

The patient ambulated approximately 50 feet with a WBQC requiring minimal assistance of one person. For longer distances, the patient required the use of a manual wheelchair, requiring assistance to propel it. During ambulation, the patient demonstrated decreased stance time on her left lower extremity with no step through with her right lower extremity (step to gait). No signs of left ankle dorsiflexion were noted during ambulation. The patient compensated for decreased dorsiflexion during the swing phase of gait by increasing knee flexion and mild hip hiking on her left side. Her left lower extremity also assumed an externally rotated position during swing phase and her foot was progressed in a shuffling manner. Substantial weight bearing was noted through her right upper extremity with the use of the WBQC. The patient had a moderate body lean to the right during ambulation as she was not allowing symmetrical weight bearing with minimal weight being transferred through her left lower extremity.

Transfers from sit to stand and stand to sit were performed with standby assistance and verbal cueing by the therapist. During these transfers the patient relied heavily on her sound right upper and lower extremities to do much of the work. Her trunk remained in a non-dynamic posture without maintenance of upright sitting. The movements were very asymmetrical and required much effort by the patient. Transfers from sit to supine required minimal assistance for
placing her left lower extremity on the plinth, but she could transfer from supine to sit with supervision. Bed mobility required standby assistance with verbal cueing from the therapist and much effort and additional time by the patient.

Strength in the left lower extremity was trace to poor throughout. Left lower extremity exercises were conducted with patient supine or sidelying on the mat and performed in a gravity eliminated position. Hip exercises including abduction, adduction, flexion, and extension were accomplished by the patient, but required tactile cueing from the therapist as well as substitution type movements by the patient. Knee flexion and extension were done in a sidelying position with the aid of a powder board. Tactile cueing was again required by the therapist to carry out these motions. Ankle plantar flexion and dorsiflexion were also carried out in the sidelying position with knees slightly flexed. Plantar flexion was carried out but full range of motion was not accomplished and could not be isolated with the associated motion of knee flexion. The patient was unable to isolate the motion of ankle dorsiflexion but could achieve minimal motion with tactile stimulation, verbal cueing, and the associated movement of knee extension. Eight to twelve repetitions were performed for each exercise.

Weight bearing activities for the left lower extremity were also performed. The patient placed her right lower extremity on an eight-inch stool requiring that she bear weight through her involved lower extremity. Her left lower extremity required manual pressure and cueing by the therapist to keep knee in an extended position. She was able to tolerate approximately 30 seconds before
becoming fatigued. This activity also required the use of WBQC for stability and moderate weight bearing through her right upper extremity.

Left upper extremity motions were attempted with minimal movement noted. Very little tone was demonstrated throughout her left upper extremity. Minimal movement was achieved during shoulder flexion and abduction, most of which was occurring due to compensation with her left upper trapezius muscle which allowed for shoulder elevation. Isolated movements of the elbow, wrist, and fingers were unable to be performed with minimal to no motion noted.

**Week Four Post Stroke**

The patient increased ambulation distance to 100 feet using WBQC and stand by assistance. Improvements were seen in not only distance but in increased stride length of patient’s right lower extremity. She was able to advance her right foot approximately six inches past her left foot but continued to have decreased stance time on left lower extremity. Compensation for decreased ankle dorsiflexion continues to be done by increased knee flexion and hip hiking; however, leg advancement was performed by lifting the foot off the ground rather than by sliding. The patient also relied heavily on sound side for weight bearing with noticeable body lean to the right side during ambulation. The patient fatigued easily and required occasional verbal cueing to maintain increased stride length on right. Stair ambulation was initiated and required moderate assistance of one person to perform. Patient was able to go up and down three stairs with a step-to-step gait, leading with her right lower extremity while holding onto railing on the right. She had difficulty clearing the third stair
with her left foot when ascending, secondary to fatigue, requiring moderate assistance.

Transfers and bed mobility continued to be performed with standby assistance requiring occasional cueing and assistance to place her left lower extremity onto the plinth when going from sit to supine. Patient did require additional time to complete transfers but showed the ability to problem solve when needed.

Left lower extremity strengthening exercises were performed in both antigravity and gravity eliminated positions. The following exercises were performed in the sitting position: hip flexion, knee extension, and ankle dorsiflexion. During hip flexion exercises, she was able to lift her heel off the floor two inches, but this was primarily accomplished by back extension and hip external rotation. She had full active knee extension range of motion, but the motion was assisted with trunk extension. In a seated position, ankle dorsiflexion was carried out with the patient lifting toes a distance of one inch off the ground. Bilateral bridging exercises were also performed successfully.

Weight bearing on the left lower extremity was performed for 45 seconds requiring no manual pressure or cueing at her left knee but with the aid of the WBQC for balance. The patient become fatigued with this activity and complained of low back pain. The patient also performed stool tapping exercise in which she transferred her weight onto her left leg and rhythmically tapped an 8-inch stool placed to her right side with her right foot for approximately 15 seconds.
Following one month of inpatient rehabilitation, the patient was discharged to her home. She was given a home exercise program in which she was instructed to do two times per day with 15 repetitions for each exercise. In the seated position, the following exercises were to be performed: hip flexion, knee extension, ankle dorsiflexion, and knee flexion with yellow Thera-Band. In a supine position, the following exercises were performed: isometric hip abduction with a pillow placed between knees, bridging with both legs, straight leg raising, and hip abduction. Written instructions were sent home with the patient for these exercises. Therapy resumed at seven weeks post stroke with outpatient services for both occupational and physical therapy. The patient was scheduled three times a week for nearly three months.

Week Seven Post Stroke

At seven weeks post stroke, the patient began outpatient therapy three times a week. Ambulation has been relatively unchanged. At home, she was able to ambulate short distances with the WBQC and with assistance from her husband. She continues to need verbal cueing to advance her right lower extremity beyond her left leg. Her fatigue level continued to be a problem secondary to cardiovascular limitations. Stair ambulation was relatively unchanged and did require cueing for proper procedure.

Strength of her left lower extremity was generally fair to good throughout. Active ankle dorsiflexion had improved to where she could lift her toes off the floor two inches, in a seated position, and withstand mild resistance. She was able to bridge while holding against mild resistance. She could perform six to
eight supine straight leg raises, with her knee held in slight flexion, with her left leg. Fatigue was a common denominator with all exercises performed.

Stool tapping activities with her right foot were carried out for approximately 45 seconds. With this activity, less weight bearing through her right upper extremity was required. Gain of left upper extremity function was slowly improving. She was able to isolate active motion allowing for minimal use in daily activities. Shoe donning and doffing was accomplished with minimal assistance as long as her left foot was placed on her WBQC to allow her to reach her foot. Her shoes were secured with Velcro to allow her to perform this task as independently as possible. She was also able to put on her winter coat requiring minimal assistance to place right arm through sleeve and to get coat zipped.

Week Nine Post Stroke

Ambulation improved with stride lengths and stance time being relatively equal and distance of 120 feet being attained. Using the WBQC, she continued to weight bear through the right upper extremity and lean slightly to the right. A wheeled walker was introduced at this time in an attempt to decrease weight bearing through the right upper extremity and allow for more symmetrical weight bearing through both arms. She ambulated 150 to 200 feet with the wheeled walker requiring standby assistance. The patient tolerated this quite well and promoted a more equal distribution of weight through her lower extremities, placing her body in better midline position.
Sit to stand exercises were performed independently by the patient. This motion was much more symmetrical when coming up, but the patient continued to rely on her right side to complete this movement. Weight bearing through her left arm was attempted to help aid in the sit to stand motion, but she again relied heavily on the right side of her body, using her left arm minimally.

From week nine through fourteen post stroke, the patient canceled many therapy sessions due to illness or physician appointments. She continued using the wheeled walker with ambulation, progressing distances traveled, improving stride length, and keeping symmetrical alignment.

**Week Fifteen Post Stroke**

The patient ambulated 50 feet with standby assistance without the use of an assistive device. She was able to maintain a proper midline position, without excessive trunk leaning, and with minimal cueing. She also ambulated up and down a ramp with wheeled walker and standby assistance for a distance of 40 feet. Ramp ambulation was also performed without an assistive device with the patient going 20 feet requiring only minimal assistance for balance. Stair climbing up and down three stairs was performed using wheeled walker and railing for support. The patient continues to have difficulty with lifting her left foot when ascending requiring minimal to moderate assistance. She was instructed to continue using wheeled walker at home and not to ambulate without it for safety reasons.
The patient had complaints of low back pain and was seen by a physician. The physician felt it was due to arthritis and instructed patient to decrease activity as needed and to continue using a wheeled walker.

Strengthening activities were performed in sitting. Exercises were performed for both lower extremities, including knee extension and hip flexion, using ankle weights and knee flexion with Thera-band. Cone tapping exercises and bolster rolling were also performed with alternating lower extremities to improve coordination, weight shifting, and balance.

Week Eighteen Post Stroke

The patient was able to ambulate distances up to 235 feet with a wheeled walker, without cueing, which is a considerable improvement from her initial ambulation ability. She was also able to ambulate independently without any assistive devices for distances up to 50 feet. She was able to go up and down three stairs holding onto the railing on the right, relying heavily on the railing to pull herself up the stairs.

At sixteen weeks post stroke, the patient was introduced to an isokinetic exercise program utilizing the machines in the gym. Exercises were performed to help strengthen the following motions: hip abduction and adduction, hip flexion, and knee extension (using both legs). All exercises were performed with adequate weight while allowing the patient to perform three sets of 15 repetitions for each exercise. To increase endurance, she rode a stationary bike at 150 rpm for three minutes.
Prior to discharge, the patient was set up on an independent exercise program with the above exercises. She was discharged from further formal therapies at 19 weeks post stroke.

Discussion

The patient was very satisfied with her progress and both she and her therapists felt that a plateau had been achieved in regard to her progression. It was felt that she would benefit from ongoing physical fitness activity. An exercise program was developed for the patient to perform independently or with the help of her husband, three times per week, utilizing the isotonic exercise equipment in the gym. Her husband was present on one of her final therapy sessions to get instructions and assist his wife through the exercises she was given.

Endurance was quite an issue throughout her therapy. She complained frequently of shortness of breath and was unable to tolerate a lot of activity. Her endurance remained limited secondary to cardiovascular compromise and obesity. During the rehabilitation process, the patient was to have a carotid endarterectomy to clear out any arteriosclerotic plague before another stroke occurred. Due to her poor endurance and heart problems, this treatment was postponed. This caused considerable emotional upheaval for the patient due to the unknown health problems of her future. The patient's outpatient physical therapy consisted of a total of 36 visits scheduled over this 13-week period. She canceled nearly one-third (10) of these visits either due to illness or other medical appointments.
Through her therapy, the patient was able to meet her goal of ambulation and regain some functional use of her left upper extremity. Even though her left upper extremity function was not back to her premorbid state, she was still able to use it to assist her in some of her daily functional activities.

This case study focused on the patient’s physical therapy treatment throughout her five months of rehabilitation. Her ability to ambulate longer distances with improved mechanics was quite evident. Her functional abilities and balance also improved greatly as were evident in the objective measures of the Tinetti and FIM scores. The videotape which accompanies this case study can be used as visual evidence of disabilities as well as improvements seen throughout the rehabilitation progression of a patient inflicted by a stroke.
CHAPTER V

CONCLUSION

Stroke is a disease that affects the blood vessel supplying blood to the brain. This often times devastating condition occurs when a blood vessel bringing oxygen and nutrients to the brain becomes clogged or bursts. As a result of this blockage or rupture, part of the brain is deprived of the constant blood supply it needs. The nerve cells, deprived of oxygen, cannot function and the part of the body controlled by these cells may become nonfunctional.

Stroke can affect anyone at any age but those greater than 55 years of age are at a much higher risk. There are specific risk factors which have been proven to cause an increased likelihood that a stroke will occur. Hypertension, heart disease, and diabetes mellitus are large contributors to this increased likelihood of having a stroke. The medical community is clearly aware of these risk factors and with proper diagnosis, treatment, along with increased public awareness and education, the incidence of stroke will decline as has been apparent since hypertension has been controlled.

Strokes cause varying degrees of impairment and may present differently for every stroke patient. The majority of stroke patients who receive organized, comprehensive rehabilitation can recover and lead active, independent lives in their home and community. Research has demonstrated that the majority of
stroke recovery, either spontaneous or through comprehensive rehabilitation, occurs within six months post stroke. However, there has been some documentation that an intense rehabilitation program many months or even years after the stroke can have benefits. It has clearly been shown that organized stroke rehabilitation produces functionally significant improvements for long periods post stroke. No specific therapeutic approach has been shown to have an advantage in improving functional capacity. However, an organized interdisciplinary team approach and early intervention are important components in maximizing a stroke patient's recovery.

The case study presented, along with the video, show the progression of a patient inflicted by a stroke. The patient demonstrates with a relatively mild to moderate stroke affecting the left side of her body. The progression seen with this patient was affected by a plethora of pre-existing conditions. Due to these pre-existing conditions, the patient's endurance level was quite limited and played a part in her progression.

The primary rehabilitation goal following a stroke is to maximize recovery of function. Research needs to continue to determine appropriate and consistent treatment approaches in the treatment of stroke to maximize this recovery. As the baby boomer population is approaching the age where stroke incidence is more eminent, and the ever increasing cost of health care, appropriate treatment strategies and preventative measures need to be instituted. Research on how the nervous system works and responds to insult needs to be continued so as to better serve those individuals stricken by a devastating stroke.
APPENDIX A
I, [Patient's Name], a patient in Altru Hospital, Grand Forks, North Dakota, consent to have photographs/videotaping taken of me or parts of my body for medical or legal purposes as requested by [Darrin Goyne, SPT and Dr. Merle Teeters, Neurologist] and that the same may be released for educational Purposes.

My signature also means that I have read this form and/or had it read to me and explained in a language that I can understand.

Date 12/1/97 Time 8:45 PM
Signed [Patient's Name] Relationship [Patient, closest relative or legal guardian]

Witness [Darrin Goyne, SPT]
Witness [Pat Atchley, MPT]
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