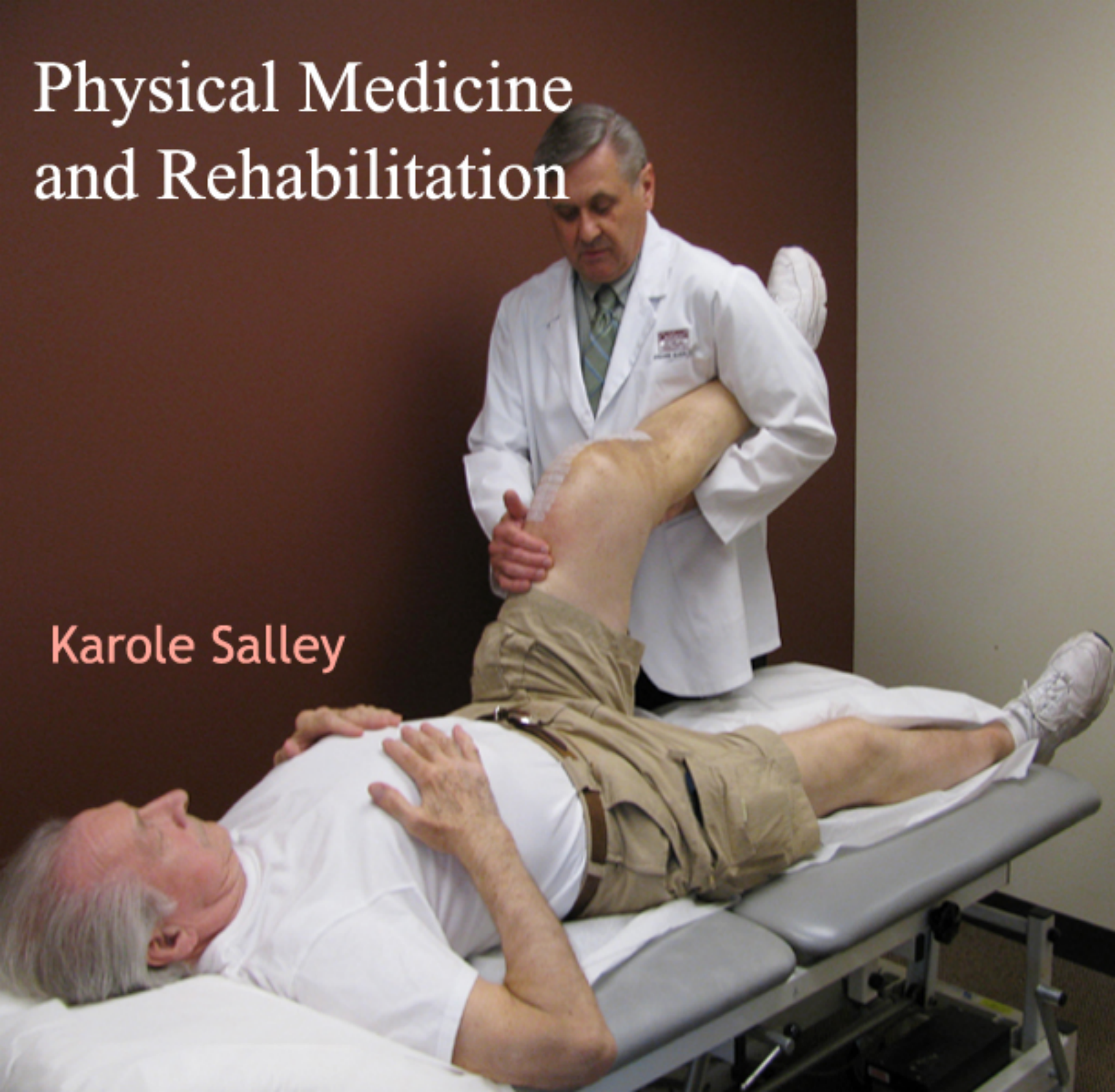
Physical Medicine and Rehabilitation

Karole Salley



First Edition, 2012

ISBN 978-81-323-4527-5

Published by:
The English Press
4735/22 Prakashdeep Bldg,
Ansari Road, Darya Ganj,
Delhi - 110002
Email: info@wtbooks.com

Table of Contents

Introduction

Physical medicine and rehabilitation (PM&R) is a branch of medicine which aims to enhance and restore functional ability and quality of life to those with physical impairments or disabilities. A physician who has completed training in this field is referred to as a **physiatrist** or Rehab Medicine Specialist. In order to be a physiatrist in the United States, one must complete four years of medical school, one year of internship, and three years of residency. Physiatrists specialize in restoring optimal function to people with injuries to the muscles, bones, tissues, and nervous system (such as stroke patients).

History

The term 'physiatry' was coined by Dr. Frank H. Krusen in 1938. The term was accepted by the American Medical Association in 1946. The field grew notably in response to the demand for sophisticated rehabilitation techniques for the large number of injured soldiers returning from World War II.

Scope of the field

Physical medicine and rehabilitation involves the management of disorders that alter the function and performance of the patient. Emphasis is placed on the optimization of function through the combined use of medications, physical modalities, physical training with therapeutic exercise, movement & activities modification, adaptive equipment and assistive device, orthotics (braces), prosthesis, and experiential training approaches.

Physical Medicine & Rehabilitation physicians may also perform electrodiagnostics which are used to provide nervous system functional information for diagnosis and prognosis for various neuromuscular disorders. The common electrodiagnostic tests performed by physiatrists are *nerve conduction studies (NCS)* and *needle electromyographies (EMG).* The nerve conduction study involves electrical stimulation to peripheral nerves, and the nerves' responses are measured including such things as onset latency, amplitude, and conduction velocity. Needle electromyography requires needle electrode insertion into the muscles to detect the electrical potential generated from muscle fibers. Abnormal electrical potentials, such as fibrillation potential or positive sharp waves, detected by EMG needles indicate the presence of muscle fibers that have abnormal nerve supplies.

Common conditions that are treated by physiatrists include amputation, spinal cord injury, sports injury, stroke, musculoskeletal pain syndromes such as low back pain, fibromyalgia, and traumatic brain injury. Cardiopulmonary rehabilitation involves optimizing function in those afflicted with heart or lung disease. Chronic pain management is achieved through a multidisciplinary approach involving psychologists, physical therapists, occupational therapists, chiropractors, and interventional procedures when indicated. In addition to the previous methodology, stroke is often treated with the help of a speech therapist and recreational therapist when possible.

Philosophy

The major concern that PM&R deals with as a medical field is the ability of a person to function optimally within the limitations placed upon them by a disease process for which there is no known cure. The emphasis is not on the full restoration to the premorbid level of function, but rather the optimization of the quality of life for those who may not be able to achieve full restoration. A team approach to chronic conditions is emphasized to coordinate care of patients.Comprehensive Rehabilitation is provided by specialists in this field,who act as a facilitator,team leader,and medical expert for rehabilitation.

Subspecialty

Six formal sub-specializations are recognized by the field in the United States:

- Hospice and Palliative Medicine
- Neuromuscular Medicine
- Pain Medicine
- Pediatric Rehabilitation
- Spinal Cord Injury Medicine
- Sports Medicine

In India apart from the above fields

- Musculoskeletal Pain management
- Intervention physiatry
- Rehabilitation Surgery
- Rheumatological Rehabilitation
- Obesity and other Lifestyle disease modifications
- Cardio-Pulmonary Rehabilitation also being trained and practiced by Rehab Medicine Specialists.

Many in the field also subspecialize in the care of patients with amputations, musculoskeletal medicine, electrodiagnostics, traumatic brain injury (TBI), and cardiopulmonary rehabilitation.

Journals

The three main journals of the PM&R field are as follows:

- *PM&R*
- Archives of Physical Medicine and Rehabilitation
- American Journal of Physical Medicine and Rehabilitation.

All three journals are published monthly.

Archives, which had been co-owned by the American Academy of Physical Medicine and Rehabilitation (AAPM&R) and the American Congress of Rehabilitation Medicine (ACRM), is now solely owned by the Congress as of January 2009. In 2009, the American Academy of Physical Medicine and Rehabilitation launched a new journal, *PM&R*, published by Elsevier.

Quarterly journal *Physical Medicine And Rehabilitation Clinics of North America* published by Elsevier/Saunders also provides in-depth updated information on specific Physical Medicine and Rehabilitation topic.

Individual Residency Programs

- PM&R Residency Programs in the United States
- PM&R Residency Programs in Canada

Chapter 1

Physical Therapy

Physical therapy

This physical therapist from the 1950s is assisting two children with polio to train their standing skills with help from calipers and rails, and use of a ball game.

Physical therapy (or **physiotherapy**), often abbreviated **PT**, is the art and science of physical care and rehabilitation. **Physical therapists** (or **physiotherapists**) are primary healthcare professionals who diagnose and treat individuals of all ages, from newborns to the very oldest, who have medical problems or other health-related conditions, illnesses, or injuries that limit their abilities to move and perform functional activities as well as they would like in their daily lives. Physical therapists examine each individual and develop a plan using treatment techniques to promote the ability to move, reduce pain, restore function, and prevent disability. In addition, PTs work with individuals to prevent the loss of mobility before it occurs by developing fitness and wellness-oriented

programs for healthier and more active lifestyles, providing services to individuals and populations to develop, maintain and restore maximum movement and functional ability throughout the lifespan. This includes providing services in circumstances where movement and function are threatened by aging, injury, disease or environmental factors. Functional movement is central to what it means to be healthy.

Physical therapy is concerned with identifying and maximizing quality of life and movement potential within the spheres of promotion, prevention, treatment/intervention, habilitation and rehabilitation. This encompasses physical, psychological, emotional, and social well being. Physical therapy involves the interaction between physical therapist, patients/clients, other health professionals, families, care givers, and communities in a process where movement potential is assessed and goals are agreed upon, using knowledge and skills unique to physical therapists. Physical therapy is performed by a physical therapist (PT) or physiotherapist (physio), and sometimes services are provided by an assistant (PTA) acting under their direction.

PTs use an individual's history and physical examination to arrive at a diagnosis and establish a management plan and, when necessary, incorporate the results of laboratory and imaging studies. Electrodiagnostic testing (e.g., electromyograms and nerve conduction velocity testing) may also be of assistance. PT management commonly includes prescription of or assistance with specific exercises, manual therapy, education, manual therapy, manipulation and other interventions.

Physical therapy has many specialties including cardiopulmonary, geriatrics, neurologic, orthopaedic and pediatrics, to name some of the more common areas. PTs practice in many settings, such as outpatient clinics or offices, inpatient rehabilitation facilities, skilled nursing facilities, extended care facilities, private homes, education and research centers, schools, hospices, industrial workplaces or other occupational environments, fitness centers and sports training facilities.

Physical therapists also practice in non-patient care roles such as health policy, health insurance, health care administration and as health care executives. Physical therapists are involved in the medical-legal field serving as experts, performing peer review and independent medical examinations.

Education qualifications vary greatly by country. The span of education ranges from some countries having little formal education to others requiring masters or doctoral degrees.

History

Physicians like Hippocrates and later Galenus are believed to have been the first practitioners of physical therapy, advocating massage, manual therapy techniques and hydrotherapy to treat people in 460 B.C. After the development of orthopedics in the eighteenth century, machines like the Gymnasticon were developed to treat gout and

similar diseases by systematic exercise of the joints, similar to later developments in physical therapy.

The earliest documented origins of actual physical therapy as a professional group date back to Per Henrik Ling, “Father of Swedish Gymnastics,” who founded the Royal Central Institute of Gymnastics (RCIG) in 1813 for massage, manipulation, and exercise. The Swedish word for physical therapist is “sjukgymnast” = “sick-gymnast.” In 1887, PTs were given official registration by Sweden’s National Board of Health and Welfare.

Other countries soon followed. In 1894 four nurses in Great Britain formed the Chartered Society of Physiotherapy. The School of Physiotherapy at the University of Otago in New Zealand in 1913, and the United States' 1914 Reed College in Portland, Oregon, which graduated "reconstruction aides."

Modern physical therapy was established in Britain towards the end of the 19th century. Soon following American orthopedic surgeons began treating children with disabilities and began employing women trained in physical education, massage, and remedial exercise. These treatments were applied and promoted further during the Polio outbreak of 1916. During the First World War women were recruited to work with and restore physical function to injured soldiers, and the field of physical therapy was institutionalized. In 1918 the term "Reconstruction Aide" was used to refer to individuals practicing physical therapy. The first school of physical therapy was established at Walter Reed Army Hospital in Washtington D.C. following the outbreak of World War I.

Research catalyzed the physical therapy movement. The first physical therapy research was published in the United States in March 1921 in "The PT Review." In the same year, Mary McMillan organized the Physical Therapy Association (now called the American Physical Therapy Association (APTA). In 1924, the Georgia Warm Springs Foundation promoted the field by touting physical therapy as a treatment for polio.

Treatment through the 1940s primarily consisted of exercise, massage, and traction. Manipulative procedures to the spine and extremity joints began to be practiced, especially in the British Commonwealth countries, in the early 1950s. Later that decade, physical therapists started to move beyond hospital-based practice to outpatient orthopedic clinics, public schools, colleges/universities, geriatric settings (skilled nursing facilities), rehabilitation centers and medical centers.

In 1921 in the United States physical therapists formed the first professional association called the American Women's Physical Therapeutic Association. This gave birth to what is known today as the APTA (American Physical Therapy Association), and currently represents approximately 76,000 members throughout the United States. The APTA defines physical therapy as: "clinical applications in the restoration, maintenance, and promotion of optimal physical function."

Specialization for physical therapy in the U.S. occurred in 1974, with the Orthopaedic Section of the APTA being formed for those physical therapists specializing in

orthopaedics. In the same year, the International Federation of Orthopaedic Manipulative Physical Therapists was formed, which has ever since played an important role in advancing manual therapy worldwide.

Education

World Confederation of Physical Therapy (WCPT) recognises there is considerable diversity in the social, economic, cultural, and political environments in which physical therapist education is conducted throughout the world. WCPT recommends physical therapist entry-level educational programs be based on university or university-level studies, of a minimum of four years, independently validated and accredited as being at a standard that accords graduates full statutory and professional recognition. WCPT acknowledges there is innovation and variation in program delivery and in entry-level qualifications, including first university degrees (Bachelors/Baccalaureate/Licensed or equivalent), Masters and Doctorate entry qualifications. What is expected is that any program should deliver a curriculum that will enable physical therapists to attain the knowledge, skills, and attributes described in these guidelines.

Professional education prepares physical therapists to be autonomous practitioners, that may work in collaboration with other members of the health care team.

Physical therapist entry-level educational programs integrate theory, evidence and practice along a continuum of learning. This begins with admission to an accredited physical therapy program and ending with retirement from active practice.

206 of 213 accredited physical therapy programs in the US are accredited at the doctoral level offering the Doctor of Physical Therapy degree (DPT)

Areas of study covered in a Doctor of Physical Therapy include: Basic Evaluation Techniques, Physical Agents, Biomechanics, Extremity and Spinal Orthopedics, Cardiopulmonary Physical Therapy, Women's Health, Anatomy, Neuroanatomy, Neuro Physical Therapy, Geriatrics, Pediatrics, Ethical and Legal Issues, Psychosocial Issues, and Business Management.

Students completing a Doctor of Physical Therapy program are also required to successfully complete clinical rotations prior to graduation.

Specialty areas

Because the body of knowledge of physical therapy is quite large, some PTs specialize in a specific clinical area. While there are many different types of physical therapy, the American Board of Physical Therapy Specialties list eight specialist certifications, including Sports Physical Therapy and Clinical Electrophysiology. Worldwide the six most common specialty areas in physical therapy are:

Cardiopulmonary

Cardiovascular and pulmonary rehabilitation physical therapists treat a wide variety of individuals with cardiopulmonary disorders or those who have had cardiac or pulmonary surgery. Primary goals of this specialty include increasing endurance and functional independence. Manual therapy is used in this field to assist in clearing lung secretions experienced with cystic fibrosis. Disorders, including heart attacks, post coronary bypass surgery, chronic obstructive pulmonary disease, and pulmonary fibrosis, treatments can benefit from cardiovascular and pulmonary specialized physical therapists.

Geriatric

Geriatric physical therapy covers a wide area of issues concerning people as they go through normal adult aging but is usually focused on the older adult. There are many conditions that affect many people as they grow older and include but are not limited to the following: arthritis, osteoporosis, cancer, Alzheimer's disease, hip and joint replacement, balance disorders, incontinence, etc. Geriatric physical therapists specialize in treating older adults.

Neurological

Neurological physical therapy is a field focused on working with individuals who have a neurological disorder or disease. These include Alzheimer's disease, Charcot-Marie-Tooth disease (CMT), ALS, brain injury, cerebral palsy, multiple sclerosis, Parkinson's disease, spinal cord injury, and stroke. Common impairments associated with neurologic conditions include impairments of vision, balance, ambulation, activities of daily living, movement, muscle strength and loss of functional independence.

Orthopedic

Orthopedic physical therapists diagnose, manage, and treat disorders and injuries of the musculoskeletal system including rehabilitation after orthopaedic surgery. This specialty of physical therapy is most often found in the out-patient clinical setting. Orthopedic therapists are trained in the treatment of post-operative orthopedic procedures, fractures, acute sports injuries, arthritis, sprains, strains, back and neck pain, spinal conditions and amputations.

Joint and spine mobilization/manipulation, therapeutic exercise, neuromuscular reeducation, hot/cold packs, and electrical muscle stimulation (e.g., cryotherapy, iontophoresis, electrotherapy) are modalities often used to expedite recovery in the orthopedic setting. Additionally, an emerging adjunct to diagnosis and treatment is the use of sonography for diagnosis and to guide treatments such as muscle retraining. Those who have suffered injury or disease affecting the muscles, bones, ligaments, or tendons such as ulnar collateral ligament of elbow joint will benefit from assessment by a physical therapist specialized in orthopedics.

Pediatric

Pediatric physical therapy assists in early detection of health problems and uses a wide variety of modalities to treat disorders in the pediatric population. These therapists are specialized in the diagnosis, treatment, and management of infants, children, and adolescents with a variety of congenital, developmental, neuromuscular, skeletal, or acquired disorders/diseases. Treatments focus on improving gross and fine motor skills, balance and coordination, strength and endurance as well as cognitive and sensory processing/integration. Children with developmental delays, cerebral palsy, spina bifida, or torticollis may be treated by pediatric physical therapists.

Integumentary

Integumentary (treatment of conditions involving the skin and related organs). Common conditions managed include wounds and burns. Physical therapists utilize surgical instruments, mechanical lavage, dressings and topical agents to debride necrotic tissue and promote tissue healing. Other commonly used interventions include exercise, edema control, splinting, and compression garments.

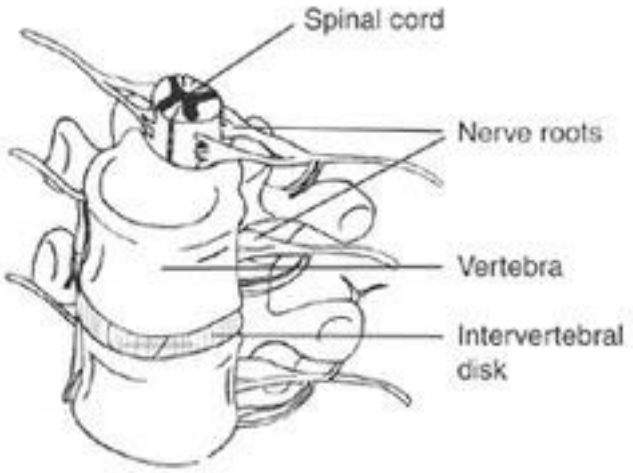
Womens Health

Womens Health physical therapy addresses womens issues related to child birth, and post partum. These conditions include lymphedema, osteoporosis, pelvic pain, prenatal & post partum periods, and urinary incontinence.

Chapter 2

Spinal Cord Injury

Spinal cord injuries



View of the vertebral column and spinal cord

ICD-10 G95.9, T09.3

DiseasesDB 12327 29466

eMedicine emerg/553 neuro/711 pmr/182 pmr/183 orthoped/425

MeSH D013119

Spinal cord injury (**SCI**) refers to an traumatic injury to the spinal cord. It can cause myelopathy or damage to nerve roots or myelinated fiber tracts that carry signals to and from the brain. Depending on its classification and severity, this type of traumatic injury could also damage the grey matter in the central part of the cord, causing segmental losses of interneurons and motor neurons. This loss of neurons can cause a person to loose motor function, reflexes or a loss of sensation.

Classification

The American Spinal Injury Association (ASIA) defined an international classification based on neurological responses, touch and pinprick sensations tested in each dermatome, and strength of ten key muscles on each side of the body, e.g. shoulder shrug (C4), elbow flexion (C5), wrist extension (C6), elbow extension (C7), hip flexion (L2). Traumatic spinal cord injury is classified into five categories by the American Spinal Injury Association and the International Spinal Cord Injury Classification System:

- A indicates a "complete" spinal cord injury where no motor or sensory function is preserved in the sacral segments S4-S5.
- B indicates an "incomplete" spinal cord injury where sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5. This is typically a transient phase and if the person recovers any motor function below the neurological level, that person essentially becomes a motor incomplete, i.e. ASIA C or D.
- C indicates an "incomplete" spinal cord injury where motor function is preserved below the neurological level and more than half of key muscles below the neurological level have a muscle grade of less than 3, which indicates active movement with full range of motion against gravity.
- D indicates an "incomplete" spinal cord injury where motor function is preserved below the neurological level and at least half of the key muscles below the neurological level have a muscle grade of 3 or more.
- E indicates "normal" where motor and sensory scores are normal. Note that it is possible to have spinal cord injury and neurological deficits with completely normal motor and sensory scores.

Dimitrijevic proposed a further class, the so-called discomplete lesion, which is clinically complete but is accompanied by neurophysiological evidence of residual brain influence on spinal cord function below the lesion.

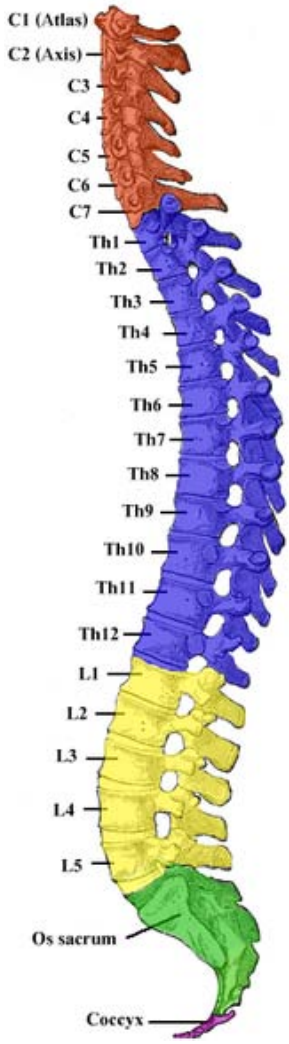
In addition, there are several clinical syndromes associated with incomplete spinal cord injuries.

- The Central cord syndrome is associated with greater loss of upper limb function compared to lower limbs and can be caused by hyperflexion and hyperextension.
- The Brown-Séquard syndrome results from injury to one side with the spinal cord, causing weakness and loss of proprioception on the side of the injury and loss of pain and thermal sensation of the other side.
- The Anterior cord syndrome results from injury to the anterior part of the spinal cord, causing weakness and loss of pain and thermal sensations below the injury site but preservation of proprioception that is usually carried in the posterior part of the spinal cord.
- Tabes Dorsalis results from injury to the posterior part of the spinal cord, usually from infection diseases such as syphilis, causing loss of touch and proprioceptive sensation.

- Conus medullaris syndrome results from injury to the tip of the spinal cord, located at L1 vertebra.

Signs and symptoms

Divisions of Spinal Segments



Segmental Spinal Cord Level and Function

Level	Function
C1-C6	Neck flexors
C1-T1	Neck extensors
C3, C4, C5	Supply diaphragm (mostly C4)
C5, C6	Shoulder movement, raise arm (deltoid); flexion of elbow

	(biceps); **C6** externally rotates the arm (supinates)
C6, C7	Extends elbow and wrist (triceps and wrist extensors); pronates wrist
C7, T1	Flexes wrist
C7, T1	Supply small muscles of the hand
T1 -T6	Intercostals and trunk above the waist
T7-L1	Abdominal muscles
L1, L2, L3, L4	Thigh flexion
L2, L3, L4	Thigh adduction
L4, L5, S1	Thigh abduction
L5, S1, S2	Extension of leg at the hip (gluteus maximus)
L2, L3, L4	Extension of leg at the knee (quadriceps femoris)
L4, L5, S1, S2	Flexion of leg at the knee (hamstrings)
L4, L5, S1	Dorsiflexion of foot (tibialis anterior)
L4, L5, S1	Extension of toes
L5, S1, S2	Plantar flexion of foot
L5, S1, S2	Flexion of toes

The effects of a spinal cord injury may vary depending on the type, level, and severity of injury, but can be classified into two general categories:

- In a *complete injury*, function below the "neurological" level is lost. Absence of motor and sensory function below a specific spinal level is considered a "complete injury". Recent evidence suggests that less than 5% of people with "complete" spinal cord injuries recover locomotion.
- In an *incomplete injury*, some sensation and/or movement below the level of the injury is retained. The lowest spinal segment in humans is located at vertebral levels S4-5, corresponding to the anal sphincter and peri-anal sensation. The ability to contract the anal sphincter voluntarily or to feel peri-anal pinprick or touch, the injury is considered to be "incomplete". Recent evidence suggests that over 95% of people with "incomplete" spinal cord injuries recover some locomotor function.

In addition to loss of sensation and motor function below the level of injury, individuals with spinal cord injuries will also often experience other complications:

- Bowel and bladder function is regulated by the sacral region of the spine. In that regard, it is very common to experience dysfunction of the bowel and bladder, including infections of the bladder and anal incontinence, after traumatic injury.
- Sexual function is also associated with the sacral spinal segments, and is often affected after injury. During a psychogenic sexual experience, signals from the brain are sent to spinal levels T10-L2 and in case of men, are then relayed to the penis where they trigger an erection. A reflex erection, on the other hand, occurs as a result of direct physical contact to the penis or other erotic areas such as the ears, nipples or neck. A reflex erection is involuntary and can occur without sexually stimulating thoughts. The nerves that control a man's ability to have a reflex erection are located in the sacral nerves (S2-S4) of the spinal cord and could be affected after a spinal cord injury.
- Injuries at the C-1/C-2 levels will often result in loss of breathing, necessitating mechanical ventilators or phrenic nerve pacing.
- Inability or reduced ability to regulate heart rate, blood pressure, sweating and hence body temperature.
- Spasticity (increased reflexes and stiffness of the limbs).
- Neuropathic pain.
- Autonomic dysreflexia or abnormal increases in blood pressure, sweating, and other autonomic responses to pain or sensory disturbances.
- Atrophy of muscle.
- Superior Mesenteric Artery Syndrome.
- Osteoporosis (loss of calcium) and bone degeneration.
- Gallbladder and renal stones.

Determining the exact level of injury is critical in making accurate predictions about the specific parts of the body that may be affected by paralysis and loss of function. The symptoms observed after a spinal cord injury differ by location (refer to the spinal cord map on the right to determine location). Notably, while the prognosis of complete injuries are generally predictable, the symptoms of incomplete injuries span a variable range. Accordingly, it is difficult to make an accurate prognosis for these types of injuries.

Cervical

Cervical (neck) injuries usually result in full or partial tetraplegia (Quadriplegia). However, depending on the specific location and severity of trauma, limited function may be retained.

- **C3 vertebrae and above** : Typically results in loss of diaphragm function, necessitating the use of a ventilator for breathing.
- **C4 :** Results in significant loss of function at the biceps and shoulders.

- **C5** : Results in potential loss of function at the shoulders and biceps, and complete loss of function at the wrists and hands.
- **C6** : Results in limited wrist control, and complete loss of hand function.
- **C7 and T1** : Results in lack of dexterity in the hands and fingers, but allows for limited use of arms. C7 is generally the threshold level for retaining functional independence.

Thoracic

Injuries at or below the thoracic spinal levels result in paraplegia. Function of the hands, arms, neck, and breathing is usually not affected.

- **T1 to T8** : Results in the inability to control the abdominal muscles. Accordingly, trunk stability is affected. The lower the level of injury, the less severe the effects.
- **T9 to T12** : Results in partial loss of trunk and abdominal muscle control.

Lumbarsacral

The effects of injuries to the lumbar or sacral regions of the spinal cord are decreased control of the legs and hips, urinary system, and anus.

Other syndromes

Central cord syndrome is a form of incomplete spinal cord injury characterized by impairment in the arms and hands and, to a lesser extent, in the legs. This is also referred to as inverse paraplegia, because the hands and arms are paralyzed while the legs and lower extremities work correctly.

Most often the damage is to the cervical or upper thoracic regions of the spinal cord, and characterized by weakness in the arms with relative sparing of the legs with variable sensory loss.

This condition is associated with ischemia, hemorrhage, or necrosis involving the central portions of the spinal cord (the large nerve fibers that carry information directly from the cerebral cortex). Corticospinal fibers destined for the legs are spared due to their more external location in the spinal cord.

This clinical pattern may emerge during recovery from spinal shock due to prolonged swelling around or near the vertebrae, causing pressures on the cord. The symptoms may be transient or permanent.

Anterior cord syndrome is also an incomplete spinal cord injury. Below the injury, motor function, pain sensation, and temperature sensation is lost; touch, proprioception (sense of position in space), and vibration sense remain intact. Posterior cord syndrome (not pictured) can also occur, but is very rare.

Brown-Séquard syndrome usually occurs when the spinal cord is hemisectioned or injured on the lateral side. On the ipsilateral side of the injury (same side), there is a loss of motor function, proprioception, vibration, and light touch. Contralaterally (opposite side of injury), there is a loss of pain, temperature, and deep touch sensations

Causes

Spinal cord injury can occur from many causes such as tumors, ischemia, genetic disorders, diseases and transverse myelitis.

Another cause of SCI is a trauma, one form of this is blunt spinal injury which can be caused by hyperflexion, hyperextension, rotation, distraction, and compression. Another example is a penetrating spinal cord injury, caused by a foreign object coming in contact with the spinal cord such as a bullet or knife.

Diagnosis

A radiographic evaluation using a x-ray, MRI or CT scan can determine if their is any damage to the spinal cord and where it is located. A neurologic evaluation incorporating sensory testing and reflex testing can help determine the motor function of a person with a SCI.

Management

Treatment options for acute, traumatic non-penetrating spinal cord injuries include the administration of a high dose of an anti-inflammatory agent, methylprednisolone, within 8 hours of injury can improve the neurologic outcome. This recommendation is primarily based on the National Acute Spinal Cord Injury Studies (NASCIS) I and II. However, in another study, methylprednisolone failed to demonstrate an effect in comparison to placebo. Additionally, due to increased risk of infections, the use of this anti-inflammatory drug after spinal cord injuries is no longer recommended. Presently, administration of cold saline acutely after injury is gaining popularity, but there is a paucity of empirical evidence for the beneficial effects of therapeutic hypothermia although their is no research to back this up. In addition brilliant blue G, a blue food dye, has also been shown to decrease inflammation of the spinal cord after a traumatic injury.

Surgery could also be preformed to remove any bone fragments from the spinal canal and to stabilize the spine if necessary.

One as yet uncommon approach to improve chances of recovery is to increase blood pressure, using e.g. neosynephrine, thereby counteracting a possible underprovision of nerve cells.

Occupational therapy

Performing daily activities can be difficult for an individual with a spinal cord injury. However, through the rehabilitation process individuals with SCI may be able to live independently in the community with or without full-time attendant care, depending on the level of their injury.

Occupational therapy plays an important role in the management of SCI. An important goal is to assist the individual to restore function and participate in the activities and tasks that are important to them. Occupational therapists (OTs) focus on three life areas, which include self-care, productivity, and leisure. Self-care tasks include basic needs such as bathing, hygiene, feeding, and dressing. Productivity includes activities such as paid work, volunteering, care-giving, or parenting. Leisure includes fun and enjoyable activities activities typically done during spare time. Occupational therapists work collaboratively with their clients to identify challenges in these three key areas.

emphasize the importance of early occupational therapy, started immediately after the client is stable. During these early stages, OTs evaluate what the client is able to do and what the client is having difficulty with. Occupational therapists then work one-on-one with the client on skills required for daily living. The client is shown new ways of doing things and may be given assistive devices or equipment. Occupational therapists also help their clients develop coping skills, and implement exercises and routines that strengthen muscles.

Acute recovery

During acute recovery, the focus is on support and prevention. Inteventions aim to give the individual a sense of control over a situation in which he likely feels little independence. Splints may be used to prevent deformities in the hands. Additionally, daily arm and hand exercises are performed to maintain normal function. Selecting an appropriate temporary wheelchair is also important. Finally, teaching the injured and care providers appropriate positioning in bed and in the wheelchair is critical for the prevention of pressure sores. Education regarding pressure sore prevention continues into the rehabilitation phase.

Acute rehabilitation

During acute rehabilitation, interventions focus on support, education for the individual and family/caregivers, meaningful activities, choosing equipment and restoring the person's self esteem and confidence. The following are key areas of intervention common to numerous rehabilitation settings:

Limbs function

Early in the rehabilitation phase, strength and sensation in the upper extremity (UE) and lower extremity (LE) have to be evaluated. Therapeutic activities can both strengthen

muscles and improve hand function. Custom-made splints are commonly used to help position the hands in a functional position and assist in preventing deformity. Individuals who retain wrist function are taught to use tenodesis grasp (extending the wrist to bring the thumb and index finger together and flexing the wrist to separate the thumb and index finger) for picking up and releasing light objects.

Self care

Obtaining competency in self-care tasks contributes significantly to an individual's sense of self confidence and independence. The focus is on feeding, grooming, bathing, dressing and bowel/bladder management. Assistive devices and specialized equipment are prescribed can help to achieve greater competency and independence. Exploring concerns related to sexual health and function should form an integral part of each person's treatment plan.

Transfer and mobility skills.

Not being able to move around without help is the largest restriction to participating in activities of daily living. The severity of a people with SCI determines the most suitable mobility aid. The wheelchair that a person uses can significantly affect their quality of participation. For example, some require a power wheelchair both indoors and outdoors while others can manage on both terrains using a manual wheelchair. A proper fitting wheelchair is critical for good posture and comfort.

Transfers are a key area of education and skill development. Examples of different transfers include: moving from bed to wheelchair, from wheelchair to toilet or tub, and from wheelchair to driver's seat. Strength in the upper extremities makes it possible to transfer independently from one surface to another either with the aid of a sliding transfer board or by utilizing grab bars.

Bed mobility skills are required for many daily tasks, such as getting dressed, moving out of bed, and correct positioning in bed for skin protection and comfort.

Domestic modifications and retraining.

Homes can be adapted to better suit the necessities of an individual with SCI. Examples of common adaptations include: adding ramps or lifts to get into the home, widening doorways, adapting the bathroom and kitchen for wheelchair accessibility, placing electrical switches at wheelchair level, and choosing wheelchair-friendly flooring. During rehabilitation, opportunities are provided to practice domestic skills such as cooking in a wheelchair-accessible kitchen.

Community living skills.

Support group, address skills that prepare for returning home and to the community. Part of rehabilitation involves investigating options for returning to previous leisure/recreation interests as well as developing new pursuits.

Individuals who are able to transfer independently from their wheelchair to the driver's seat using a sliding transfer board, are candidates for returning to driving. Complete independence with driving also requires the ability to load and unload one's wheelchair from the vehicle. For people who do not wish or cannot return to driving, alternate transportation options are also addressed (i.e. accessible parking, taxi subsidy vouchers, modified vehicle for passenger transit and public transportation).

If appropriate, a work site/school visit may be arranged to assess for accessibility. Otherwise, a referral to a community based work/school assessment service may be indicated.

Community reintegration

Following rehabilitation, the person begins the process of community reintegration. Community participation is an important aspect in maintaining quality of life. During community reintegration, the focus of therapy is on restoring roles at home and in the community, and promoting social participation and life satisfaction. Ongoing education of the person, family and caregivers continues throughout this stage. Referrals can be made to an outpatient clinic or community therapist to continue with treatment and progress made during rehabilitation. Outpatient programs teach patients how to use new movement and they offer training for activities of daily living.

Epidemiology

Spinal injury can occur without trauma. Many people suffer transient loss of function ("stingers") in sports accidents or pain in "whiplash" of the neck without neurological loss and relatively few of these suffer spinal cord injury sufficient to warrant hospitalization. In the United States, the incidence of spinal cord injury has been estimated to be about 40 cases (per 1 million people) per year or around 12,000 cases per year. The most common cause of spinal cord injury are motor vehicle accidents, falls, and violence. In China, the incidence of spinal cord injury is approximately 60,000 per year.

The prevalence of spinal cord injury is not well known in many large countries. In some countries, such as Sweden and Iceland, registries are available. In the United States there are around 250,000 individuals living with spinal cord injuries. 80% of spinal cord injuries occur in males, and 20% in females. Half of all cases of SCI occur in persons between the ages of 16-30, wit the average age being 38. There are many causes leading to spinal cord injuries. These include motor vehicle accidents (42%), falls (27%), violence (primarily gunshot wounds) (15%), sports (7.5%), other/unknown (8.5%).

Research directions

Scientists are investigating many promising avenues for treatment of spinal cord injury. Numerous articles in the medical literature describe research, mostly in animal models, aimed at reducing the paralyzing effects of injury and promoting regrowth of functional nerve fibers. Despite the devastating effects of the condition, commercial funding for research investigating a cure after spinal cord injury is limited, partially due to the small size of the population of potential beneficiaries. Despite this limitation, a number of experimental treatments have reached controlled human trials.

Advances in identification of an effective therapeutic target after spinal cord injury have been newsworthy, and considerable media attention is often drawn towards new developments in this area. However, aside from methylprednisolone, none of these developments have reached even limited use in the clinical care of human spinal cord injury in the U.S.. Around the world, proprietary centers offering stem cell transplants and treatment with neuroregenerative substances are fueled by glowing testimonial reports of neurological improvement. It is also evident that when stem cells are injected in the area of damage in the spinal cord, they secrete neurotrophic factors, and these neurotrophic factors help neurons and vessels grow, thus helping repair the damage. Independent validation of the results of these treatments is lacking.

Chapter 3

Sarcopenia and Muscle Atrophy

Sarcopenia

Sarcopenia (from the Greek meaning "poverty of flesh") is the degenerative loss of skeletal muscle mass and strength associated with aging (0.5-1% loss per year after the age of 25). Sarcopenia is a component of the frailty syndrome.

Definition of sarcopenia

At present, there is no generally accepted definition of sarcopenia in the medical literature.

The European Working Group on Sarcopenia in Older People (EWGSOP) has developed a practical clinical definition and consensus diagnostic criteria for age-related sarcopenia. For the diagnosis of sarcopenia, the working group has proposed using the presence of both low muscle mass + low muscle function (strength or performance).

Markers of sarcopenia

Sarcopenia is characterized first by a decrease in the size of the muscle, which causes weakness and frailty. However, this loss of muscle mass may be caused by different cellular mechanisms than those that cause muscle atrophy. For example, during sarcopenia, there is a replacement of muscle fibres with fat and an increase in fibrosis.

Benefit of exercise

Exercise and increases in activity have been shown to be beneficial in settings of sarcopenia; exercise even in the very old can increase strength and muscle function.

Lack of exercise is currently thought to be a significant risk factor, increasing the likelihood of sarcopenia.

Not only muscle but the entire musculoskeletal system of muscle, neuromuscular responsiveness, endocrine function, vasocapillary access, tendon, joint, ligament, and bone, depends on regular and lifelong exercise to maintain integrity. The slow attenuation, atrophy, or loss of muscle tissue that medical professionals sometimes describe as sarcopenia (literally, "flesh loss') is currently thought to be the result of cumulative loss of musculoskeletal strength and mass associated with chronic absence of exercise of sufficient intensity or volume. However, even highly trained athletes experience the effects of sarcopenia. It is interesting to note that athletic speed and strength records are generally set by individuals no older than 30 years of age, although some powerlifters and other strength athletes continue to set records into their 50s.

Fiber-type changes in sarcopenia

Simple circumference measurement does not provide enough data to determine whether or not an individual is suffering from severe sarcopenia. Sarcopenia is also marked by a decrease in the circumference of distinct types of muscle fibers. Skeletal muscle has different fiber-types, which are characterized by expression of distinct myosin variants. During sarcopenia, there is a decrease in "type 2" fiber circumference (Type II), with little to no decrease in "type I" fiber circumference (Type I). However, we lose both type I and type II muscle fibers (muscle cells) equally as we age (contrary to popular belief that we lose type II more rapidly).

Loss of satellite cell function

Satellite cells are small mononuclear cells that abut the muscle fiber. Satellite cells are normally activated upon injury or exercise. These cells then differentiate and fuse into the muscle fiber, helping to maintain its function. One theory is that sarcopenia, is in part caused by a failure in satellite cell activation. Therefore, the ability to repair damaged muscles or respond to nutritional signals is impaired.

Loss of anabolic signals

Extreme muscle loss is often a result of both diminishing anabolic signals, such as growth hormone and testosterone, and promotion of catabolic signals, such as pro-inflammatory cytokines.

Sarcopenia as a public-health problem

Due to the lessened physical activity and increased longevity of industrialized populations, sarcopenia is emerging as a major health concern. Sarcopenia may progress to the extent that an older person may lose his or her ability to live independently. Furthermore, sarcopenia is an important independent predictor of disability in population-based studies, linked to poor balance, gait speed, falls, and fractures. Sarcopenia can be thought of as a muscular analog of osteoporosis, which is loss of bone, also caused by inactivity and counteracted by exercise. The combination of osteoporosis and sarcopenia results in the significant frailty often seen in the elderly population.

Natural history

Strength losses with ageing for men and women are relatively similar. They are greater for lower than upper extremity muscles. Maximum attainable strength peaks in mid-twenties and declines thereafter. The decline is precipitous after 65 years of age, though few longitudinal studies exist on this topic. A direct assessment of the effects of sarcopenia, even in extremely physically fit individuals, can be seen in the age-related decline in Masters athletics (track and field) world records of muscle-intensive sports, such as weight lifting.

Diagnosis

Consensus on clinical diagnosis of sarcopenia has quickly developed over the last decade around the working definition proposed in 1998 by Baumgartner et al., which uses a measure of lean body mass as determined by Dual energy X-ray absorptiometry (DEXA) compared to a normal reference population. His working definition uses a cut point of 2 standard deviations below the mean of lean mass for gender specific healthy young adults.

This methodology is attractive for definitive diagnosis in clinical settings as well for several reasons. Primarily, emerging research shows it is predictive of negative outcomes and it is also a method familiar to most clinicians. This later point is especially true for those that treat the geriatric population, given its similarity to the 1996 World Health Organization (WHO) methodology for definitive diagnosis of osteoporosis, which also uses DEXA, but uses a measure of lean mass rather than bone mineral density (BMD). DEXA is widely used already in clinical settings in develop countries to identify and monitor severity of osteoporosis. And the degree of sarcopenia can be measured using DEXA in patients being evaluated for osteoporosis, at the same time with the same scan, with no added cost or radiation exposure to the patient.

Since Baumgartner's working definition first appeared, some consensus groups have refined the definition, including the recent joint effort of the European Society on Clinician Nutrition and Metabolism (ESPEN) Special Interest Groups (SIG) on geriatric nutrition and on cachexia-anorexia in chronic wasting diseases. Their consensus definition is:

1) A low muscle mass, >2 standard deviations below that mean measured in young adults (aged 18–39 years in the 3rd NHANES population) of the same sex and ethnic background, and 2) Low gait speed (e.g. a walking speed below 0.8 m/s in the 4-m walking test). However, it can be replaced by one of the well-established functional tests utilized locally as being part of the comprehensive geriatric assessment.

There remains many opportunities for further refinement of reference populations by ethic groups, and to further correlate of the degrees of severity of sarcopenia to overt declines in functional performance (preferably using verified functional tests), as well as incidence of hospitalization admissions, morbidity and mortality. Work toward this

objective has already begun, and the body of research to date clearly points toward severe sarcopenia is predicative of negative outcomes, similar to what already been shown to exist with the Frailty syndrome, as defined by the criteria set forth in 2001 by Fried et al.

Management

Exercise

Primary management of sarcopenia is through the application of a graded exercise program, across both cardiovascular and strength domains, dosed in such a way as to provoke beneficial adaptation without overloading the weakened body. Physical activity incorporating resistance training is probably the most effective measure to prevent and treat sarcopenia.

Drugs

Possible therapeutic strategies include use of testosterone or anabolic steroids, though long term use of these agents is controversial in men given concerns of prostate symptoms, and essentially contraindicated in women, given concerns of virilization. Recent experimental results have shown testosterone treatments may induce adverse cardiovascular events. Other approved medications have been shown to have little to no effect in this setting, including agents such DHEA and human growth hormone. New therapies in clinical development hold great promise in this area, including the Selective Androgen Receptor Modulators (SARMs), as evidenced by recent studies. Nonsteriodal SARMs are of particular interest, given they exhibit significant selectivity between the anabolic effects of testosterone on muscle, but apparently with little to no androgenic effects such as prostate stimulation in men or virilization in women.

Diet and nutrition

Nutritional evaluation may also be indicated if malnutrition is suspected, or current nutritional intake is insufficient to maintain adequate total body mass, although increased exercise also increases appetite.

An extract (EGb 761) from the plant Ginkgo biloba (added to drinking water) was shown to reduce the muscle loss in a rat model of sarcopenia (Bidon *et al*., 2009).

Muscle atrophy

Muscle atrophy

ICD-10	M62.5
ICD-9	728.2
DiseasesDB	29472
MedlinePlus	003188
MeSH	D009133

Muscle atrophy is defined as a decrease in the mass of the muscle; it can be a partial or complete wasting away of muscle. When a muscle atrophies, this leads to muscle weakness, since the ability to exert force is related to mass. Muscle atrophy results from a co-morbidity of several common diseases, including cancer, AIDS, congestive heart failure, COPD (chronic obstructive pulmonary disease), renal failure, and severe burns; patients who have "cachexia" in these disease settings have a poor prognosis. Moreover, starvation eventually leads to muscle atrophy.

Clinical settings of atrophy

There are many diseases and conditions which cause a decrease in muscle mass, known as atrophy, including: Dejerine Sottas syndrome (HSMN Type III), inactivity, as seen when a cast is put on a limb, or upon extended bedrest (which can occur during a prolonged illness); cachexia - which is a "body-wasting" syndrome that is a co-morbidity of cancer and Congestive Heart Failure; Chronic Obstructive Pulmonary Disease; burns, liver failure, etc. Other syndromes or conditions which can induce skeletal muscle atrophy are liver disease, and starvation.

Quality of life

Muscular atrophy decreases quality of life as the sufferer becomes unable to perform certain tasks or worsen the risks of accidents while performing those (like walking). Muscular atrophy increases the risks of falling in conditions such as IBM (inclusion body myositis). Muscular atrophy affects a major number of elderly.

Other muscles diseases, distinct from atrophy

During aging, there is a gradual decrease in the ability to maintain skeletal muscle function and mass. This condition is called "sarcopenia". The exact cause of sarcopenia is unknown, but it may be due to a combination of the gradual failure in the "satellite cells" which help to regenerate skeletal muscle fibers, and a decrease in sensitivity to or the

availability of critical secreted growth factors which are necessary to maintain muscle mass and satellite cell survival.

In addition to the simple loss of muscle mass (atrophy), or the age-related decrease in muscle function (sarcopenia), there are other diseases which may be caused by structural defects in the muscle (muscular dystrophy), or by inflammatory reactions in the body directed against muscle (the myopathies).

Pathophysiology

Muscle atrophy occurs by a change in the normal balance between protein synthesis and protein degradation. During atrophy, there is a down-regulation of protein synthesis pathways, and an activation of protein breakdown pathways. The particular protein degradation pathway which seems to be responsible for much of the muscle loss seen in a muscle undergoing atrophy is the ATP-dependent ubiquitin/proteasome pathway. In this system, particular proteins are targeted for destruction by the ligation of at least four copies of a small peptide called ubiquitin onto a substrate protein. When a substrate is thus "poly-ubiquitinated", it is targeted for destruction by the proteasome. Particular enzymes in the ubiquitin/proteasome pathway allow ubiquitination to be directed to some proteins but not others - specificity is gained by coupling targeted proteins to an "E3 ubiquitin ligase". Each E3 ubiquitin ligase binds to a particular set of substrates, causing their ubiquitination.

Potential treatment

Muscle atrophy can be opposed by the signaling pathways which induce muscle hypertrophy, or an increase in muscle size. Therefore one way in which exercise induces an increase in muscle mass is to downregulate the pathways which have the opposite effect.

One important rehabilitation tool for muscle atrophy includes the use of functional electrical stimulation to stimulate the muscles. This has seen a large amount of success in the rehabilitation of paraplegic patients.

Since the absence of muscle-building amino acids can contribute to muscle wasting (that which is torn down must be rebuilt with like material), amino acid therapy may be helpful for regenerating damaged or atrophied muscle tissue. The branched-chain amino acids or BCAAs (leucine, isoleucine, and valine) are critical to this process, in addition to lysine and other amino acids.

Quantification

A CT scan can distinguish muscle tissue from other tissues and thereby estimate the amount of muscle tissue in the body.

Fast loss of muscle tissue (relative to normal turnover), can be approximated by the amount of urea in the urine. The equivalent nitrogen content (in gram) of urea (in mmol) can be estimated by the conversion factor 0.028 g/mmol. Furthermore, 1 gram of nitrogen is roughly equivalent to 6 gram of protein, and 1 gram of protein is roughly equivalent to 4 gram of muscle tissue. Subsequently, in situations such as muscle wasting, 1 mmol of excessive urea in the urine (as measured by urine volume in litres multiplied by urea concentration in mmol/l) roughly corresponds to a muscle loss of 0.67 gram.

Chapter 4

Low Back Pain

Low back pain

The five vertebrae in the lumbar region of the back are the largest and strongest in the spinal column.

ICD-10	M54.4-M54.5
ICD-9	724.2
MedlinePlus	003108
eMedicine	pmr/73
MeSH	D017116

Low back pain (or **lumbago**) is a common musculoskeletal disorder affecting 80% of people at some point in their lives. In the United States it is the most common cause of job-related disability, a leading contributor to missed work, and the second most common neurological ailment — only headache is more common. It can be either acute, subacute or chronic in duration. With conservative measures, the symptoms of low back pain typically show significant improvement within a few weeks from onset.

Classification

Lower back pain may be classified by the duration of symptoms as acute (less than 4 weeks), sub acute (4–12 weeks), chronic (more than 12 weeks).

Cause

The majority of lower back pain stems from benign musculoskeletal problems, and are referred to as *non specific low back pain*; this type may be due to muscle or soft tissues sprain or strain, particularly in instances where pain arose suddenly during physical loading of the back, with the pain lateral to the spine. Over 99% of back pain instances fall within this category. The full differential diagnosis includes many other less common conditions.

- Mechanical:
  - Apophyseal osteoarthritis
  - Diffuse idiopathic skeletal hyperostosis
  - Degenerative discs
  - Scheuermann's kyphosis
  - Spinal disc herniation ("slipped disc")
  - Thoracic or lumbar spinal stenosis
  - Spondylolisthesis and other congenital abnormalities
  - Fractures
  - Leg length difference
  - Restricted hip motion
  - Misaligned pelvis - pelvic obliquity, anteversion or retroversion
  - Abnormal Foot Pronation

- Inflammatory:
  - Seronegative spondylarthritides (e.g. ankylosing spondylitis)
  - Rheumatoid arthritis
  - Infection - epidural abscess or osteomyelitis

- Neoplastic:
  - Bone tumors (primary or metastatic)
  - Intradural spinal tumors

- Metabolic:
  - Osteoporotic fractures
  - Osteomalacia
  - Ochronosis
  - Chondrocalcinosis

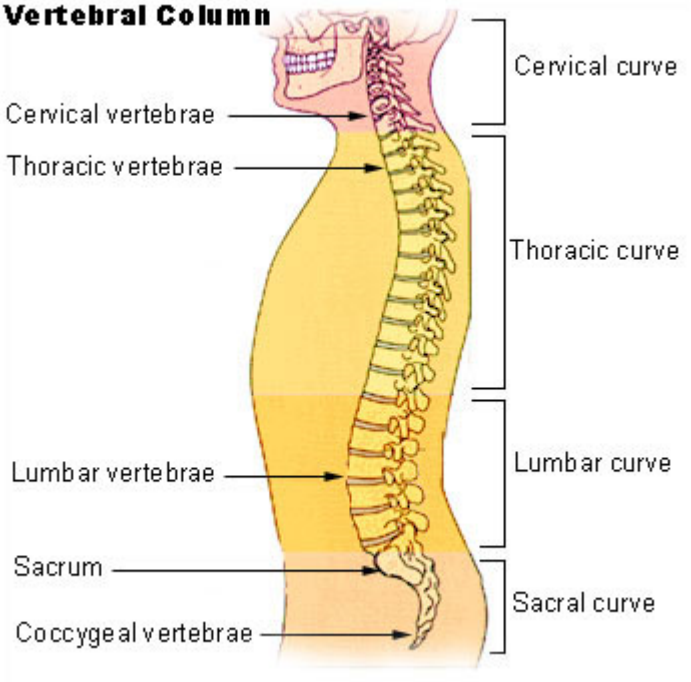
- Psychosomatic
  - Tension myositis syndrome

- Paget's disease

- Referred pain:
  - Pelvic/abdominal disease
  - Prostate Cancer
  - Posture

- Depression
- Oxygen deprivation

Pathophysiology



The lumbar region in regards to the rest of the spine.

The lumbar region (or lower back region) is made up of five vertebrae (L1-L5). In between these vertebrae lie fibrocartilage discs (intervertebral discs), which act as cushions, preventing the vertebrae from rubbing together while at the same time protecting the spinal cord. Nerves stem from the spinal cord through foramina within the vertebrae, providing muscles with sensations and motor associated messages. Stability of the spine is provided through ligaments and muscles of the back, lower back and abdomen. Small joints which prevent, as well as direct, motion of the spine are called facet joints (zygapophysial joints).

Causes of lower back pain are varied. Most cases are believed to be due to a sprain or strain in the muscles and soft tissues of the back. Overactivity of the muscles of the back can lead to an injured or torn ligament in the back which in turn leads to pain. An injury can also occur to one of the intervertebral discs (disc tear, disc herniation). Due to aging,

discs begin to diminish and shrink in size, resulting in vertebrae and facet joints rubbing against one another. Ligament and joint functionality also diminishes as one ages, leading to spondylolisthesis, which causes the vertebrae to move much more than they should. Pain is also generated through lumbar spinal stenosis, sciatica and scoliosis. At the lowest end of the spine, some patients may have tailbone pain (also called coccyx pain or coccydynia). Others may have pain from their sacroiliac joint, where the spinal column attaches to the pelvis, called sacroiliac joint dysfunction. Physical causes may include osteoarthritis, rheumatoid arthritis, degeneration of the discs between the vertebrae or a spinal disc herniation, a vertebral fracture (such as from osteoporosis), or rarely, an infection or tumor.

In the vast majority of cases no noteworthy or serious cause is ever identified. If the pain resolves after a few weeks, intensive testing is not indicated.

Diagnostic approach

Determination of the underlying cause is usually made through a combination of a medical history, physical examination, and, when necessary, diagnostic imaging (such as an x-ray, CT scan, or MRI).

Imaging

Bone fractures due to osteoporosis may occur, resulting in low back pain; bone density testing may be indicated. X-rays are used to locate bone deformities and may illuminate the most obvious causes of low back pain due to fractures or aging. From 1994 to 2006, MRI scans of the lumbar region increased by 307%. Imaging rates and surgery rates directly correspond. The use of MRI and CT scans is indicated with cases of consistent (sub acute or chronic) leg and back pain, or when accompanied by any of the following indicators:

- Recent significant trauma
- Milder trauma if age is greater than 50 years
- Unexplained weight loss
- Unexplained fever
- Immunosuppression
- Previous or current cancer
- Intravenous drug use
- Osteoporosis

- Chronic corticosteroid use
- Age greater than 70 years
- Focal neurological deficit
- Duration greater than 6 weeks

Prevention

Exercise is effective in preventing recurrence of non-acute pain, and has shown mixed results in the treatment of acute episodes. Proper lifting technique are prophylactic.

Cigarette smoking impacts the success and proper healing of spinal fusion surgery in patients who undergo cervical fusion; smokers' rates of nonunion are significantly greater than nonsmokers. Smoke and nicotine accelerate spine deterioration, reduce blood flow to the lower spine, and cause discs to degenerate.

Management

Acute back pain

Self care

For acute cases that are not debilitating, low back pain may be best treated with conservative self-care, including: application of heat or cold, and continued activity within the limits of the pain. Firm mattresses have demonstrated less effectiveness than medium-firm mattresses.

Activity

Engaging in physical activity within the limits of pain aids recovery. Prolonged bed rest (more than 2 days) is counter indicated. Even with cases of severe pain, some activity is preferred to prolonged sitting or lying down - excluding movements that would further strain the back. Structured exercise in acute low back pain has demonstrated neither improvement nor harm.

Physical therapy

Physical therapy can include heat, ice, massage, ultrasound, and electrical stimulation. Active therapies can consist of stretching, strengthening and aerobic exercises. Exercising to restore motion and strength to your lower back can be very helpful in relieving pain and preventing future episodes of low back pain.

Medications

Short term use of pain and anti-inflammatory medications, such as NSAIDs or acetaminophen may help relieve the symptoms of lower back pain. Muscle relaxants for acute and chronic pain have some benefit, and are more effective in relieving pain and spasms when used in combination with NSAIDs.

Spinal manipulation

A 2004 Cochrane review found that spinal manipulation (SM) was no more or less effective than other commonly used therapies such as pain medication, physical therapy, exercises, back school or the care given by a general practitioner. A 2010 systematic review found that most studies suggest SM achieves equal or superior improvement in pain and function when compared with other commonly used interventions for short, intermediate, and long-term follow-up. In 2007 the American College of Physicians and the American Pain Society jointly recommended that clinicians consider spinal manipulation for patients who do not improve with self care options. Reviews published in 2008 and 2006 suggested that SM for low back pain was equally effective as other commonly used interventions. A 2007 literature synthesis found good evidence supporting SM and mobilization for low back pain. Of four systematic reviews published between 2000 and 2005, one recommended SM and three stated that there was insufficient evidence to make recommendations.

Chronic back pain

Low back pain is more likely to be persistent among people who previously required time off from work because of low back pain, those who expect passive treatments to help, those who believe that back pain is harmful or disabling or fear that any movement whatever will increase their pain, and people who have depression or anxiety. A systematic review (2010) published as part of the Rational Clinical Examination Series in the Journal of the American Medical Association reviews the factors that predict disability from back pain. The data quantified that patients with back pain who have poor coping behaviors or who fear activity are about 2.5 times as likely to have poor outcomes at 1 year.

The following measures have been found to be effective for chronic non-specific back pain :

- Exercise appears to be slightly effective for chronic low back pain. The Schroth method, a specialized physical exercise therapy for scoliosis, kyphosis, spondylolisthesis, and related spinal disorders, has been shown to reduce severity and frequency of back pain in adults with scoliosis.
- Tricyclic antidepressants are recommended in a 2007 guideline by the American College of Physicians and the American Pain Society.
- Antibiotics can eliminate chronic pain when the cause is bacterial infection. In a Danish study, more than half the patients were either cured or much improved after 90 days of daily antibiotics.

- Acupuncture may help chronic pain; however, a more recent randomized controlled trial suggested insignificant difference between real and sham acupuncture.
- Intensive multidisciplinary treatment programs may help subacute or chronic low back pain.
- Behavioral therapy
- The Alexander Technique was shown in a UK clinical trial to have long term benefits for patients with chronic back pain.
- Back schools have shown some effect in managing chronic back pain.
- Spinal manipulation has been shown to have a clinical effect equal to that of other commonly used therapies and was considered safe.
- Clinical research shows that treatment according to McKenzie method somewhat effective for acute low back pain, but the evidence suggests that it is not effective for chronic low-back pain.

- Manipulation under anaesthesia, or medically-assisted manipulation, currently has insufficient evidence to make any strong recommendations.

- Prolotherapy, facet joint injections, and intradiscal steroid injections have not been found to be effective.

Epidural corticosteroid injections are said to supply the patient with temporary relief of sciatica. However studies show that they do not decrease the rate of ensuing operations. Therapeutic massage is proven to be effective for chronic back pain. Traditional Chinese Medical acupuncture was proven to be relatively ineffective for chronic back pain.

Surgery

Surgery may be indicated when conservative treatment is not effective in reducing pain or when the patient develops progressive and functionally limiting neurologic symptoms such as leg weakness, bladder or bowel incontinence, which can be seen with severe central lumbar disc herniation causing cauda equina syndrome or spinal abscess. Spinal fusion has been shown not to improve outcomes in those with simple chronic low back pain.

The most common types of low back surgery include microdiscectomy, discectomy, laminectomy, foraminotomy, or spinal fusion. Another less invasive surgical technique consists of an implantation of a spinal cord stimulator and typically is used for symptoms of chronic radiculopathy (sciatica). Lumbar artificial disc replacement is a newer surgical technique for treatment of degenerative disc disease, as are a variety of surgical procedures aimed at preserving motion in the spine. According to studies, benefits of spinal surgery are limited when dealing with degenerative discs.

A medical review in March 2009 found the following: Four randomised clinic trials showed that the benefits of spinal surgery are limited when treating degenerative discs with spinal pain (no sciatica). Between 1990 and 2001 there was a 220% increase in

spinal surgery, despite the fact that during that period there were no changes, clarifications, or improvements in the indications for surgery or new evidence of improved effectiveness of spinal surgery. The review also found that higher spinal surgery rates are sometimes associated with worse outcomes and that the best surgical outcomes occurred where surgery rates were lower. It also found that use of surgical implants increased the risk of nerve injury, blood loss, overall complications, operating times and repeat surgery while it only slightly improved solid bone fusion rates. There was no added improvement in pain levels or function.

The logic behind spinal fusion is that by fusing two vertebrae together, they will act and function as a solid bone. Since lumbar pain may be caused by excessive motion of the vertebra the goal of spinal fusion surgery is to eliminate that extra motion in between the vertebrae, alleviating pain. If scoliosis or degenerative discs is the problem, the spinal fusion process may be recommended. There are several different ways of performing the spinal fusion procedure; however, none are proven to reduce pain better than the others.

Other

Additional treatments have been more recently reviewed by the Cochrane Collaboration:

- Massage therapy may benefit some patients.
- Heat application may have a modest benefit. The evidence for cold therapy is limited.
- Yoga has been found beneficial.
- Correcting leg length difference may help by inserting a heel lift or building up the shoe.
- The role of narcotics for *chronic* low back pain is uncertain.
- A 2008 review found antidepressants ineffective in the treatment of chronic back pain even though some previous studies did find them helpful.
- Transcutaneous electrical nerve stimulation (TENS) has not been found to be effective in chronic lower back pain.

Prognosis

Most people with acute lower back pain recover completely over a few weeks regardless of treatments. 60% of people recover after seven weeks, regardless of the treatments they receive. Consistent with these statistics, a recent study found that almost 30% of patients did not recover from the presenting episode of low back pain within a year. For those patients whose low back pain continues on to chronicity, it is rarely self limiting, as fewer

than 10% of those patients whose low back pain becomes chronic report no pain five years later.

Epidemiology

Over a life time 80% of people have lower back pain, with 26% of American adults reporting pain of at least one day in duration every three months. 41% of adults aged between 26 and 44 years reported having back pain in the previous 6 months. In the United States, the costs of low back pain range between $38 and $50 billion a year and there are 300,000 operations annually. Along with neck operations, back operations are the 3rd most common form of surgery in the United States.

In pregnancy

50-70% of all pregnant women experience back pain.

As one gets farther along in the pregnancy, due to the additional weight of the baby, one's center of gravity will shift forward causing one's posture to change. This change in posture leads to increasing lower back pain.

The increase in hormones during pregnancy is in preparation for birth. This increase of hormones softens the ligaments in the pelvic area and loosens joints. This change in ligaments and joints may alter the support in which one's back is normally used to.

Chapter 5

Occupational Therapy

Occupational therapy promotes health by enabling people to perform meaningful and purposeful occupations. Occupation can be defined as "active process of living: from the beginning to the end of life.

Occupational therapy process

An Occupational Therapist works systematically through a sequence of actions known as the occupational therapy process. There are several versions of this process as described by numerous writers. Creek has sought to provide a comprehensive version based on extensive research. This version has 11 stages, which for the experienced therapist may not be linear in nature. The stages are:

- Referral
- Information gathering
- Initial assessment
- Needs identification/problem formation
- Goal setting
- Action planning
- Action
- Ongoing assessment and revision of action
- Outcome and outcome measurement
- End of intervention or discharge
- Review

Another process framework for occupational therapists to use is the Canadian Practice Process Framework (CPPF), which portrays eight action points and three contextual elements for the process of occupation-based, client-centred enablement. The contextual elements are:

- societal context
- practice context
- frame(s) of reference

The eight action points include:

- enter/initiate
- set the stage
- assess/evaluate
- agree on objectives and plan
- implement plan
- monitor/modify
- evaluate outcome
- conclude/exit

Fearing, Law, and Clark suggested a 7 stage process which includes:

- identifying of occupational performance issues
- choosing a theoretical frame of reference
- assessing factors contributing the identified occupational performance issue(s)
- considering the strengths and resources of both client and therapist
- negotiating targeted outcomes and developing an action plan
- implementing the plan through occupation
- evaluating outcomes

A central element of this process model is the focus on identifying both client and therapists strengths and resources prior to beginning to develop the outcomes and action plan.

Areas of practice in occupational therapy

The role of Occupational Therapy allows OT's to work in many different settings, work with many different populations and acquire many different specialties. This broad spectrum of practice lends itself to difficulty categorizing the areas of practice that exist, especially considering the many countries and different healthcare systems. Here, the categorization from the American Occupational Therapy Association is used. However, there are other ways to categorize areas of practice in OT, such as physical, mental, and community practice (AOTA, 2009). These divisions occur when the setting is defined by the population it serves. For example, acute physical or mental health settings (e.g.: hospitals), sub-acute settings (e.g.: aged care facilities), outpatient clinics and community settings.

In each area of practice below, an OT can work with different populations, diagnosis, specialities, and in different settings.

Physical health

Occupational therapy during WWI: bedridden wounded are knitting.

- Pediatrics - Schools, Community, inpatient hospital based child OT: Often, children need OT services for the same reasons an adult needs OT services. However, OTs approach intervention in a different way with children. OT delivers approaches treatment through occupation, and the occupations of a child are different from those of an adult, and include play, chores, self-care and schoolwork. Common conditions that are specific to or more common in the pediatric population creating a need for OT services include: developmental disorders, sensory regulation or sensory processing deficits, fine motor developmental delays or deficits, autism, emotional and behavioral disturbances (Lambert, 2005), among others. In addition, children are seen for every injury, illness or chronic condition that may cause a person of any age to have performance deficits in their daily life and thus benefit from OT services. Often, OT in pediatrics deals with the implications that certain medical conditions have for classroom learning and the remediation and strategies required. They need to be closely interwoven with existing teaching approaches to help the student achieve his or her educational potential.
- Acute care hospitals: Acute care is an inpatient hospital setting for individuals with a serious medical condition(s) usually due to a traumatic event, such as a traumatic brain injury, spinal cord injury, etc. The primary goal of acute care is to stabilize the patient's medical status and address any threats to his or her life and loss of function. Occupational therapy plays an important role in facilitating early

mobilization, restoring function, preventing further decline, and coordinating care, including transition and discharge planning. Furthermore, occupational therapy's role focuses on addressing deficits and barriers that limit the patient's ability to perform activities that they need or want to do related to independence in self-care, home management, work-related tasks, and participating in leisure and community pursuits.

- Inpatient rehabilitation (e.g., Spinal Cord Injuries):People with disabilities have the right and the privilege to live meaningful purposeful lives. When a disability occurs it is sometimes possible to recover – when it is not it is important to learn the skills to adapt capacity and environmental supports to be able to participate. OTs use their knowledge to help both with recovery and adaptation.
- Rehabilitation centers (e.g., Traumatic Brain Injury (TBI), Stroke (CVA), Spinal Cord Injuries, Head Injuries)
- Skilled nursing facilities: An occupational therapists role in a skilled nursing facility is centered on each client's individual needs. Many of the skills an OT works on are known as activities of daily living or self-care such as feeding or dressing. OTs can provide equipment to assist with activities or offer expertise in modifying the environment to maximize independence and facilitate independence. Other OT roles include education in adaptive equipment (shower bench), energy conservation, or task simplification (Hofmann, 2008).
- Home Health: Occupational therapists who work in this area of practice generally work with client's in the geriatric population who have one or more of the following diagnoses: Alzheimer's disease, arthritis, depression, CVA, generalized weakness, COPD, or Parkinson's disease. Occupational therapists working with these client's evaluate their level of independence, cognition, and safety. Moreover, occupational therapists provide intervention to maximize independence and function through remedial and compensatory strategies, with the ultimate goal of the client's regaining the ability to live independently at home (Swanson Anderson & Malaski, 1999).
- Outpatient clinics (e.g., Hand Therapy, orthopaedics) Hand therapy is a specialty practice area of occupational therapy that is mainly concerned with treating orthopedic-based upper extremity conditions to optimize the functional use of the hand and arm. Diagnoses seen by this practice area include: fractures of the hand or arm, lacerations and amputations, burns, and surgical repairs of tendons and nerves. Additionally, hand therapists treat acquired conditions such as tendonitis, rheumatoid arthritis and osteoarthritis, and carpal tunnel syndrome. Occupational therapists who work in this field address biomechanical issues underlying upper-extremity conditions. In addition, occupational therapists use an occupation-based and client-centered approach by identifying participation needs of the client, then tailoring intervention to improve performance in desired activities. (link for a picture of hand therapy)
- Specialist assessment centres (e.g., Electronic assistive technology, Posture and Mobility services)
- Hospices: An occupational therapists common role in hospice care is modifying and preventing. Modifying the demands of the activity to fit with the abilities of the client. The intervention may be directly with the client or with the client and

the client's caregivers. OT can offer the caregivers support an education. Progress is defined as improved quality of life in hospice care. (Hasselkaus, 1998)

- Assisted Living Facilities: In an assisted living facility OT services are provided by a home health agency, rehab agency, or a private practice. Medicare and some private insurance plans cover OT services in ALFs. Areas of treatment intervention often include: bathing, dressing, grooming, toileting, mobility, money management, laundry, and community participation. Can treat persons with occupational performance decline or at risk for a decline. Increase quality of life so less residents need the services of a long-term SNF. Special areas include mobility device assessment (scooter), continence training, psychosocial needs and low vision programs (Fagan, 2001).
- Productive Aging: An OT practicing in this area would provide skills and services to older adults to maximize independence, participation, and quality of life. Typical issues addressed: Any impairment or condition that would limit their ability to carry out meaningful occupations and tasks that are necessary for daily life. Skills taught include: energy conservation, education in adaptive equipment (such as a shower bench), task simplification, adapting and modifying activities to progress with a client's changing abilities (Opp Hoffman, 2008), caregiver education and support (AOTA, 2004), safety, social interactions and communication, memory skills training, mobility device assessment and training (i.e. scooters, wheelchairs, walkers), low vision interventions, continence training, and facilitating performance in basic ADL and IADL (Fagan, 2001).
- Work hardening is essentially a specialized program designed to enable people with physical, psychological, and psychosocial issues inhibiting a person's ability, to successfully return to work. The National Advisory Committee on Work Hardening best describes work hardening:

"Work hardening is a highly structured, goal oriented, individualized treatment program designed to maximize the individual's ability to return to work. Work hardening programs, which are interdisciplinary in nature, use real or simulated work activities in conjunction with conditioning tasks that are graded to progressively improve the biomechanical, neuromuscular, cardiovascular/metabolic and psychosocial functions of the individual. Work hardening provides a transition between acute care and return to work while addressing the issues of productivity, safety, physical tolerances, and worker behaviors" (Ogden-Niemeyer & Jacobs, 1989, p. 1).

- Work conditioning is similar to work hardening, except work conditioning purely involves improving physical capacities, whereas work hardening improves physical, psychological, and psychosocial factors.

Mental health

According to Medicare (2005) guidance, "Only a qualified occupational therapist has the knowledge, training, and experience required to evaluate and, as necessary, re-evaluate a patient's level of function, determine whether an occupational therapy program could

reasonably be expected to improve, restore, or compensate for lost function, and where appropriate, recommend to the physician a plan of treatment."

According to the American Occupational Therapy Association (AOTA), occupational therapists work with the Mental Health population throughout the life span and across many treatment settings where mental health services and psychiatric rehabilitation are provided (AOTA, 2009). Just as with other clients, the OT facilitates maximum independence in activities of daily living (dressing, grooming, etc.) and instrumental activities of daily living (medication management, grocery shopping, etc.). According to the American Occupational Therapy Association, OT improves functional capacity and quality of life for people with mental illness in the areas of employment, education, community living, and home and personal care through the use of real life activities in therapy treatments (AOTA, 2005).

Geriatric, Adult, Adolescents, and Children with any kind of mental illness or mental health issues. These conditions include but are not limited to: Schizophrenia, substance abuse, addiction, dementia, Alzheimer's, mood disorders, personality disorders, psychoses, eating disorders, anxiety disorders (including post-traumatic stress disorder, separation anxiety disorder) (Cara & MacRae, 2005), and reactive attachment disorder (children only) (Lambert, 2005).

Typical issues that are addressed are as follows: Helping people acquire the skills to care for themselves or others including; keeping a schedule, medication management, employment, education, increasing community participation, community access (grocery store, library, bank, etc.), money management skills, engaging in productive activities to fill the day, coping skills, routine building, building social skills, and childcare (Cara & MacRae, 2005).

In the UK, the College of Occupational Therapists (COT) have published Recovering Ordinary Lives , which details the strategy for OTs in mental health up to 2017, and makes explicit the goals that have been set for the profession, in line with government directives (COT 2006).

Areas that Mental Health OT's could work in are as follows:

- Mental health inpatient units
    - Adolescent, adult and older people's acute mental health wards
    - Adult and older people's rehabilitation wards
    - Prisons/secure units (Forensic psychiatry)
    - Psychiatric intensive care unit
    - Specialist units for Eating Disorders, Learning disabilities
- Community based mental health teams
    - Child and adolescent mental health teams
    - Adult and older people's community mental health teams
    - Rehabilitation and recovery and Assertive Outreach community teams
    - Primary care services in GP practices

- Home treatment teams
- early intervention in psychosis teams
- Specialist learning disability, eating disorder community services
- Day services
- Vocational Services
- Dementia & Alzheimer Care: OTs focus on adapting activities as the client progresses through the illness (Hofmann, 2008) OT also works with caregivers to teach them how to grade activities to the client's ability. Interventions are based on using the client's strengths to increase their quality of life and their relationships with caregivers. Use of social interactions, communication, memory, safety and self maintenance.

Community

Community based practice involves working with people in their own environment rather than in a hospital setting. It often combines the knowledge and skills related to physical and mental health. It can also involve working with atypical populations such as the homeless or at-risk populations. Examples of community-based practice settings:

- Health promotion and lifestyle change: Remaining healthy is the goal of all people in a society, including people with chronic disabling or health conditions. Achieving health requires skills to self-manage conditions that might limit their ability to function in daily life. The occupational therapist helps people acquire these skills (Wilcock, 2005).
- Private Practice
- Aging in place: Occupational therapists implement environmental modifications in senior housing, assisted living, long-term-care facilities, and homes (Yamkovenko, 2008) Environmental modifications can include rearranging furniture, building ramps, widening doorways, grab bars, special toilet seats, and other safety equipment to use performance capabilities to their fullest (Moyers & Christiansen, 2004).
- Low Vision: Occupational therapists help clients use their remaining vision to complete their daily routines with compensation, remediation, disability prevention and health promotion. Compensations or that modifications to the environment may include proper lighting, color contrast, reducing clutter and education on adaptive equipment (Golembiewski, 2004).
- Intermediate care services
- Driving Centers: Driving is an instrumental activity of daily living and an occupational therapist may evaluate and treat skills needed to drive such as vision, executive function or memory. If a client needs more skilled assessment and training they would refer them to an OT Driver Rehabilitation Specialist which could do on the road assessment, training in adaptive equipment and make more specific recommendations.
- Day centres
- Schools
- Child development centres

- People's own homes, carrying out therapy and providing equipment and adaptations
- Work and Industry: To be a healthy successful worker there must be a person environment fit between the task, the equipment, and the person's skills. Occupational therapists work to achieve that fit (Ellexson, 2000; Clinger, Dodson, Maltchev, & Page, 2007). Populations, conditions, and diagnoses: People of working age and ability who have been born with or developed a condition, injury, or illness that compromises their ability to work (Ellexson, 2000; Clinger, Dodson, Maltchev, & Page, 2007). Settings: Return to work programs, large organizations, consultants to large organizations, work hardening programs, work conditioning programs, transitional return to work programs (Ellexson, 2000; Clinger, Dodson, Maltchev, & Page, 2007). Typical issues addressed: assessment of ability to work, interventions to enhancing work performance by means of work hardening, work conditioning, and improvement of ergonomics in the workplace, identification of accommodations necessary to return-to-work following illness or injury, prevention of work related injury, illness, or disability (Ellexson, 2000; Clinger, Dodson, Maltchev, & Page, 2007).
- Homeless Shelters
- Educational Settings
- Refugee Camps

Emerging practice areas for therapy

- Children & Youth:
  - Psychosocial Needs of Children & Youth
  - Self-management for Physical & Occupational Therapy Students
  - Life Skills Trainings for children & Youth with Special Needs (Khemthong, 2006)
- Health & Wellness:
  - Health & Wellness Consulting
  - Design & Accessibility Consulting & Home Modification
  - Ergonomic Consulting
  - Private Practice Community Health Services
- Productive Aging:
  - Driver Rehabilitation & Training
  - Low Vision Services
  - Fatigue & Leisure Management (Khemthong, 2006)
  - Musical trainings for elderly (Khemthong, 2006)
- Rehabilitation, Disability, & Participation:
  - Technology & Assistive Device Development & Consulting
  - Meditation trainings for Diabetes Mellitus (Khemthong, 2006)
  - Leisure management for Chronic Obstructive Pulmonary Disease (Khemthong, 2006)
  - Health Systematization of Occupational Therapy for Stroke
  - Mental Practice & Recovery Programs (Khemthong, 2006)
  - Leisure Management for Mental Health (Khemthong, 2006)

    - Fatigue & Psychospirituality of Multi-Sensory Leisure for Cancer, Depression, Rheumatoid Arthritis(Khemthong, 2006)
- Work & Industry:
    - Ticket to Work Services
    - Welfare to Work Services
    - Leadership Maturity Fitness to Work Services (Khemthong, 2006)
    - Fatigue & Leisure Management to Work Services (Khemthong, 2006)

Occupational therapy approaches

Services typically include:

- Teaching new ways of approaching tasks
- How to break down activities into achievable components e.g. sequencing a complex task like cooking a complex meal
- Comprehensive home and job site evaluations with adaptation recommendations.
- Performance skills assessments and treatment.
- Adaptive equipment recommendations and usage training.
- Environmental adaptation including provision of equipment or designing adaptations to remove obstacles or make them manageable
- Guidance to family members and caregivers.
- The use of creative media as therapeutic activity

Activity analysis

Activity analysis has been defined as a process of dissecting an activity into its component parts and task sequence in order to identify its inherent properties and the skills required for its performance, thus allowing the therapist to evaluate its therapeutic potential

Theoretical Frameworks

Occupational Therapists use a number of theoretical frameworks to frame their practice. Note that terminology has differed between scholars. Theoretical bases for framing a human and their occupation being include the following:

Frames of Reference/Generic models

Frames of reference or generic models are the overarching title given to a collation of compatible knowledge, research and theories that form conceptual practice. More generally they can be defined as "those aspects which influence our perceptions, decisions and practice".

Occupational Therapy Frame of References/Models:

- Person Environment Occupation Performance Model (PEOP) (Charles Christiansen & Carolyn Baum)
- Occupational Therapy Intervention Process Model (OTIPM) (Anne Fisher and others)
- Occupational Performance Model (OPM)
- Model of Human Occupation (MOHO) (Gary Kielhofner and others)
    - MOHO was first published in 1980. It explains how people select, organise and undertake occupations within their environment. The model is supported with evidence generated over thirty years and has been successfully applied throughout the world.
- Canadian Model of Occupational Performance and Engagement (CMOP-E)
- Kawa (River) Model (Michael Iwama)
- Functional Information-Processing Model
- Biomechanical Frame of Reference
    - The Biomechanical Frame of Reference is primarily concerned with motion during occupation. It is used with individuals who experience limitations in movement, inadequate muscle strength or loss of endurance in occupations. The Frame of Reference was not originally compiled by Occupational Therapists, and Therapists should translate it to the Occupational Therapy perspective, to avoid the risk of movement or exercise becoming the main focus.
- Rehabilitative (compensatory)
- Neurofunctional (Gordon Muir Giles and Clark-Wilson)
- Cognitive Disabilities
- Sensory Integration
- Lifestyle Performance Model (Fidler)
- Client-Centered Frame of Reference
    - This Frame of Reference is developed from the work of Carl Rogers. It views the client as the center of all therapeutic activity, and the client's needs and goals direct the delivery of the Occupational Therapy Process.
- Cognitive-Behavioural Frame of Reference
- Psychodynamic Frame of Reference
- Ecological of Human Development Model
- Recovery Models & Self-Management Models
    - Curtin pARTicipation Model
    - Knowledge Translation of Self-Management Models
    - Life-Skills Tree Model
    - Occupational Therapy - Mahidol Clinical System (OT-MCS) Model

Challenges for occupational therapy

A key challenge for occupational therapy is to develop and maintain a definition of its nature and scope assert that while this presents a challenge, it also results in a unique flexibility which allows the discipline to move with the flow of social, cultural and environmental change. This difficulty in definition may be a cause of chronic strain for practitioners and may also contribute to a lack of role definition and subsequent blurring

Recent literature has also called for occupational therapy to address the political nature of who occupational therapists are and what they do (Kronenberg & Pollard, 2005). Profession specific models of occupational therapy have also been critiqued for being biased towards a western, ableist and generally unrepresentative of the most occupationally deprived groups

Occupational therapy and ICF

The International Classification of Functioning, Disability and Health (ICF) is a framework to measure health and ability by illustrating how these components impact one's function. This relates very closely to the Occupational Therapy Practice Framework as it is stated, "The profession's core beliefs are in the positive relationship between occupation and health and its view of people as occupational beings" . The ICF is also built into the 2nd edition of the practice framework. Activities and participation examples from the ICF overlap Areas of Occupation, Performance Skills, and Performance Patterns in the framework. The ICF also includes contextual factors (environmental and personal factors) that relate to the context in the framework. In addition, body functions and structures classified within the ICF help describe the client factors as described in the OT framework

Further exploration of the relationship between occupational therapy and the components of the ICIDH-2 (revision of the original International Classification of Impairments, Disabilities, and Handicaps (ICIDH); later becoming the ICF) was conducted by McLaughlin Gray . First, the ICF is an international framework and provides an opportunity for the occupational therapy field to become better known across the globe. Second, the ICF provides occupational therapists with a global language to describe their expertise to the larger international health care community. The ICF uses a positive, holistic language emphasizing skills, capacities, and strengths of an individual rather than focusing on one's deficits and disabilities. This is similar to the outlook of occupational therapists. Third, the ICF includes environmental and personal contextual factors which are incorporated into the theory behind occupational therapy. It is important to take into consideration an individual's personal, environmental, and occupational factors to develop an effective intervention . The last notable application of the ICF to occupational therapy is the recognition of cultural patterns in occupation. Culture has significance on an individual's activities and participation and it is important to keep this in mind when treating an individual.

Although the ICF can be very useful for occupational therapists, it is noted in the literature that occupational therapists should use specific occupational therapy vocabulary along with the ICF in order to ensure correct communication about specific concepts . The ICF might lack certain categories to describe what occupational therapists need to communicate to clients and colleagues. It also may not be possible to exactly match the connotations of the ICF categories to occupational therapy terms. The ICF is not an assessment and specialized occupational therapy vocabulary should not be replaced with ICF terminology The ICF is an overarching framework for current therapy practices.

Chapter 6

Telerehabilitation

Telerehabilitation is the delivery of rehabilitation services over telecommunication networks and the internet. Most types of services fall into two categories: clinical assessment (the patient's functional abilities in his or her environment), and clinical therapy. Some fields of rehabilitation practice that have explored telerehabilitation are: neuropsychology, speech-language pathology, audiology, occupational therapy, and physical therapy. Telerehabilitation can deliver therapy to people who cannot travel to a clinic because the patient has a disability or because of travel time. Telerehabilitation also allows experts in rehabilitation to engage in a clinical consultation at a distance.

Most telerehabilitation is very visual. The most widely used modalities, as of 2006, are webcams, tele-videoconferencing over phone lines, videophones and webpages containing rich internet applications. The visual nature of telerehabilitation technology limits the types of rehabilitation services that can be provided. It is most widely used for neuropsychological rehabilitation; fitting of rehabilitation equipment such as wheelchairs, braces or artificial limbs; and in speech-language pathology. Rich internet applications for neuropsychological rehabilitation (aka cognitive rehabilitation) of cognitive impairment (from many etiologies) was first introduced in 2001. This endeavor has recently (2006) expanded as a teletherapy application for cognitive skills enhancement programs for school children. Tele-audiology (hearing assessments) is a growing application. As of 2006, telerehabilitation in the practice of occupational therapy and physical therapy are very limited, perhaps because these two disciplines are more "hands on".

Two important areas of telerehabilitation research are (1) demonstrating equivalence of assessment and therapy to in-person assessment and therapy, and (2) building new data collection systems to digitize information that a therapist can use in practice. Ground-breaking research in telehaptics (the sense of touch) and virtual reality may broaden the scope of telerehabilitation practice, in the future.

In the United States, the National Institute on Disability and Rehabilitation Research's (NIDRR) supports research and the development of telerehabilitation. NIDRR's grantees include the "Rehabilitation Engineering and Research Center" (RERC) at the University

of Pittsburgh, the Rehabilitation Institute of Chicago, the State University of New York at Buffalo, and the National Rehabilitation Hospital in Washington DC. Other federal funders of research are the Veterans Administration, the Health Services Research Administration in the US Department of Health and Human Services, and the Department of Defense. Outside the United States, excellent research is conducted in Australia and Europe.

As of 2006, only a few health insurers in the United States will reimburse for telerehabilitation services. If the research shows that tele-assessments and tele-therapy are equivalent to clinical encounters, it is more likely that insurers and Medicare will cover telerehabilitation services.

History of telerehabilitation

In 1999, D.M. Angaran published "Telemedicine and Telepharmacy: Current Status and Future Implications" in the American Journal of Health-System Pharmacy. He provided a comprehensive history of telecommunications, the internet and telemedicine since the 1950s. The Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA) spearheaded the technology in the United States during the Vietnam War and the space program; both agencies continue to fund advances in telemedicine.

Three early adopters of telemedicine were state penitentiary systems, rural health care systems, and the radiology profession. Telemedicine makes business sense for the states because they do not have to pay for security escorts to have a prisoner receive care outside the prison.

Rural telemedicine in the United States is heavily subsidized through federal agency grants for telecommunications operations. Most of this funding comes through the Health Services Research Administration and the Department of Commerce. Some state universities have obtained state funding to operate tele-clinics in rural areas. As of 2006, few (if any) of these programs are known to financially break-even, mostly because the Medicare program for people over age 65 (the largest payer) is very restrictive about paying for telehealth.

In contrast, the Veterans Administration is relatively active in using telemedicine for people with disabilities. There are several programs that provide annual physical exams or monitoring and consultation for veterans with spinal cord injuries. Similarly, some state Medicaid programs (for poor people and people with disabilities) have pilot programs using telecommunications to connect rural practitioners with subspecialty therapists. A few school districts in Oklahoma and Hawaii offer school-based rehabilitation therapy using therapy assistants who are directed by a remote therapist. The National Rehabilitation Hospital in Washington DC and Sister Kenny Rehabilitation Institute in Minneapolis provided assessment and evaluations to patients living in Guam and American Samoa. Cases included post-stroke, post-polio, autism, and wheel-chair fitting.

An argument can be made that "telerehabilitation" began in 1998 when NIDRR funded the first RERC on tele-rehabilitation. It was awarded to a consortium of biomedical engineering departments at the National Rehabilitation Hospital and The Catholic University of America, both located in Washington, DC; the Sister Kenny Rehabilitation Institute in Minnesota; and the East Carolina University in North Carolina. Some of this early research work, and its motivation, is reviewed in Winters (2002). The State of Science Conference held in 2002 convened most of military and civilian clinicians, engineers, and government officials interested in using telecommunications as a modality for rehabilitation assessment and therapy; a summary is provided in Rosen, Winters & Lauderdale (2002). The conference was attended by the incoming president of the American Telemedicine Association (ATA). This led to an invitation by ATA to the conference attendees to form a special interest group on telerehabilitation. NIDRR funded the second 5-year RERC on telerehabilitation in 2004, awarding it to the University of Pittsburgh. This RERC was renewed in 2010.

In 2001, O. Bracy, a neuropsychologist, introduced the first web based, rich internet application, for the telerehabilitation presentation of cognitive rehabilitation therapy. This system first provides the subscriber clinician with an economical means of treating their own patients over the internet. Secondly, the system then provides, directly to the patient, the therapy prescription set up and controlled by the member clinician. All applications and response data are transported via the internet in real time. The patient can login to do their therapy from home, the library or anywhere they have access to an internet computer. In 2006, this system formed the basis of a new system designed as a cognitive skills enhancement program for school children. Individual children or whole classrooms can participate in this program over the internet.

In 2006, M.J. McCue and S.E. Palsbo published an article in the Journal of Telemedicine and Telecare that explored how telemedicine can become a profitable business for hospitals. They argue that telerehabilitation should be expanded so that people with disabilities and people in pain (perhaps after hip-replacement surgery or people with arthritis) can get the rehabilitative therapy they need. It is unethical to limit paymente for telerehabilitation services only to patients in rural areas.

Research in telerehabilitation is in its infancy, with only a handful of equivalence trials. As of 2006, most peer-reviewed research in telemedicine are case reports of pilot programs or new equipment. Rehabilitation researchers need to conduct many more controlled experiments and present the evidence to clinicians (and payers) that telerehabilitation is clinically effective. The discipline of speech-language pathology is far head of occupational therapy and physical therapy in demonstrating equivalence over various types of telecommunications equipment.

Telerehabilitation technologies

1. Plain old telephone service (POTS) with videophones/Phones in telerehabilitation

There are several types of connections used with real time exchanges. Plain old telephone service (POTS) uses standard analog telephone lines. Videophones are used with POTS lines and include a camera, display screen, and telephone. Videophones use telephone lines available in most homes, so are easy to set up; however small display screens make them problematic for individuals with vision problems. This can be solved by using a large screen or television as a screen.

2. Video-conferencing/Video-conferencing in telerehabilitation
3. Virtual reality/Virtual reality in telerehabilitation

   Virtual reality in telerehabilitation is one of the newest tools available in that area. This computer technology allows the development of three-dimensional virtual environments.

4. Motion technology/Motion technology in telerehabilitation
5. Web-based approaches/Web-based approaches in telerehabilitation

   Applications that run over the internet, just as if they were installed in your computer (called Rich Internet Applications), represent a new direction in software development. A person subscribes to the website rather than purchase the software. Any updates or changes to the software system are instantly available to all subscribers. The applications can be accessed from any location where one has access to an internet connected computer. Likewise, a patient's data is accessible from where ever the therapist is located. Neither the application nor the patient's data is tied to one computer.

6. Sensors and body monitoring/Sensors and body monitoring in telerehabilitation
7. Haptic technology/Haptic technology in telerehabilitation
8. Artificial intelligence/Artificial intelligence in telerehabilitation
9. Wireless technology/Wireless technology in telerehabilitation
10. PDA/PDA in telerehabilitation
11. Cellular technologies/Cellular technologies in telerehabilitation
12. Electronic case records/Electronic case records in telerehabilitation

Clinical applications of telerehabilitation

1. Review of telerehabilitation research on clinical populations
2. Professional to professional (clinic to clinic applications)
3. Telehealth – Information access
4. Clinical approaches
    1. Assessment
    2. Monitoring
    3. Intervention
    4. Telesupervision (of licensed assistants)
    5. Telementoring
    6. Tele-education

7. Telementoring

Speech-language pathology

The clinical services provided by speech-language pathology readily lend themselves to telerehabilitation applications due to the emphasis on auditory and visual communicative interaction between the client and the clinician. As a result, the number of telerehabilitation applications in speech-language pathology tend to outnumber those in other allied health professions. To date, applications have been developed to assess and/or treat acquired adult speech and language disorders, stuttering, voice disorders, speech disorders in children, and swallowing dysfunction. The technology involved in these applications has ranged from the simple telephone (Plain Old Telephone System – POTS) to the use of dedicated Internet-based videoconferencing systems.

Early applications to assess and treat acquired adult speech and language disorders involved the use of the telephone to treat patients with aphasia and motor speech disorders (Vaughan, 1976, Wertz, et al., 1987), a computer controlled video laserdisc over the telephone and a closed-circuit television system to assess speech and language disorders (Wertz et al, 1987), and a satellite-based videoconferencing system to assess patients in rural areas (Duffy, Werven & Aronson, 1997). More recent applications have involved the use of sophisticated Internet-based videoconferencing systems with dedicated software which enable the assessment of language disorders (Georgeadis, Brennan, Barker, & Baron, 2004, Brennan, Georgeadis, Baron & Barker, 2004) and the assessment and treatment of motor speech disorders (Hill, Theodoros, Russell, Cahill, Ward, Clark, 2006; Theodoros, Constantinescu, Russell, Ward, Wilson & Wootton, in press) following brain impairment and Parkinson's disease. Collectively, these studies have revealed positive treatment outcomes, while assessment and diagnoses have been found to be comparable to face-to-face evaluations.

The treatment of stuttering has been adapted to a telerehabilitation environment with notable success. Two Australian studies (Harrison, Wilson & Onslow, 1999; Wilson, Onslow & Lincoln, 2004) involving the distance delivery of the Lidcombe program to children who stutter have utilized the telephone in conjunction with offline video recordings to successfully treat several children. Overall, the parents and children responded positively to the program delivered at a distant. Using a high speed videoconferencing system link, Sicotte, Lehoux, Fortier-Blanc and Leblanc (2003) assessed and treated six children and adolescents with a positive reduction in the frequency of dysfluency that was maintained six months later. In addition, a videoconferencing platform has been used successfully to provide follow-up treatment to an adult who had previously received intensive therapy (Kully, 200).

Reports of telerehabilitation applications in paediatric speech and language disorders are sparse. A recent Australian pilot study has investigated the feasibility of an Internet-based assessment of speech disorder in six children (Waite, Cahill, Theodoros, Russell, Busuttin, in press). High levels of agreement between the online and face-to-face clinicians for single-word articulation, speech intelligibility, and oro-motor tasks were

obtained suggesting that the Internet-based protocol had the potential to be a reliable method for assessing paediatric speech disorders.

Voice therapy across a variety of types of voice disorders has been shown to be effectively delivered via a telerehabilitation application. Mashima et al. (2003) using PC based videoconferencing and speech analysis software compared 23 patients treated online with 28 persons treated face-to-face. The authors reported positive post treatment results with no significant difference in measures between the traditional and videoconferencing group, suggesting that the majority of traditional voice therapy techniques can be applied to distance treatment.

Although obvious limitations exist, telerehabilitation applications for the assessment of swallowing function have also been used with success. Lalor, Brown and Cranfield (2000) were able to obtain an initial assessment of the nature and extent of swallowing dysfunction in an adult via a videoconferencing link although a more complete evaluation was restricted due to the inability to physically determine the degree of laryngeal movement. A more sophisticated telerehabilitation application for the assessment of swallowing was developed by Perlman and Witthawaskul (2002) who described the use of real-time videofluoroscopic examination via the Internet. This system enabled the capture and display of images in real-time with only a three to five second delay.

There continues to be a need for ongoing research to develop and validate the use of telerehabilitation applications in speech-language pathology in a greater number and variety of adult and paediatric communication and swallowing disorders.

Physical and Occupational Therapy

Disciplines and therapies

1. Speech-language pathology
2. Audiology
3. Physical therapy
4. Occupational therapy
5. Psychology
6. Nursing
7. Social work
8. Rehabilitation counseling/Vocational rehabilitation

Standards and training requirements

1. Telerehabilitation standards
2. Reimbursement policies/Reimbursement in telerehabilitation
3. Legislative activities/Legislative activities in telerehabilitation
4. Ethics and privacy issues/Ethics and privacy issues in telerehabilitation
5. Clinical and technology training issues

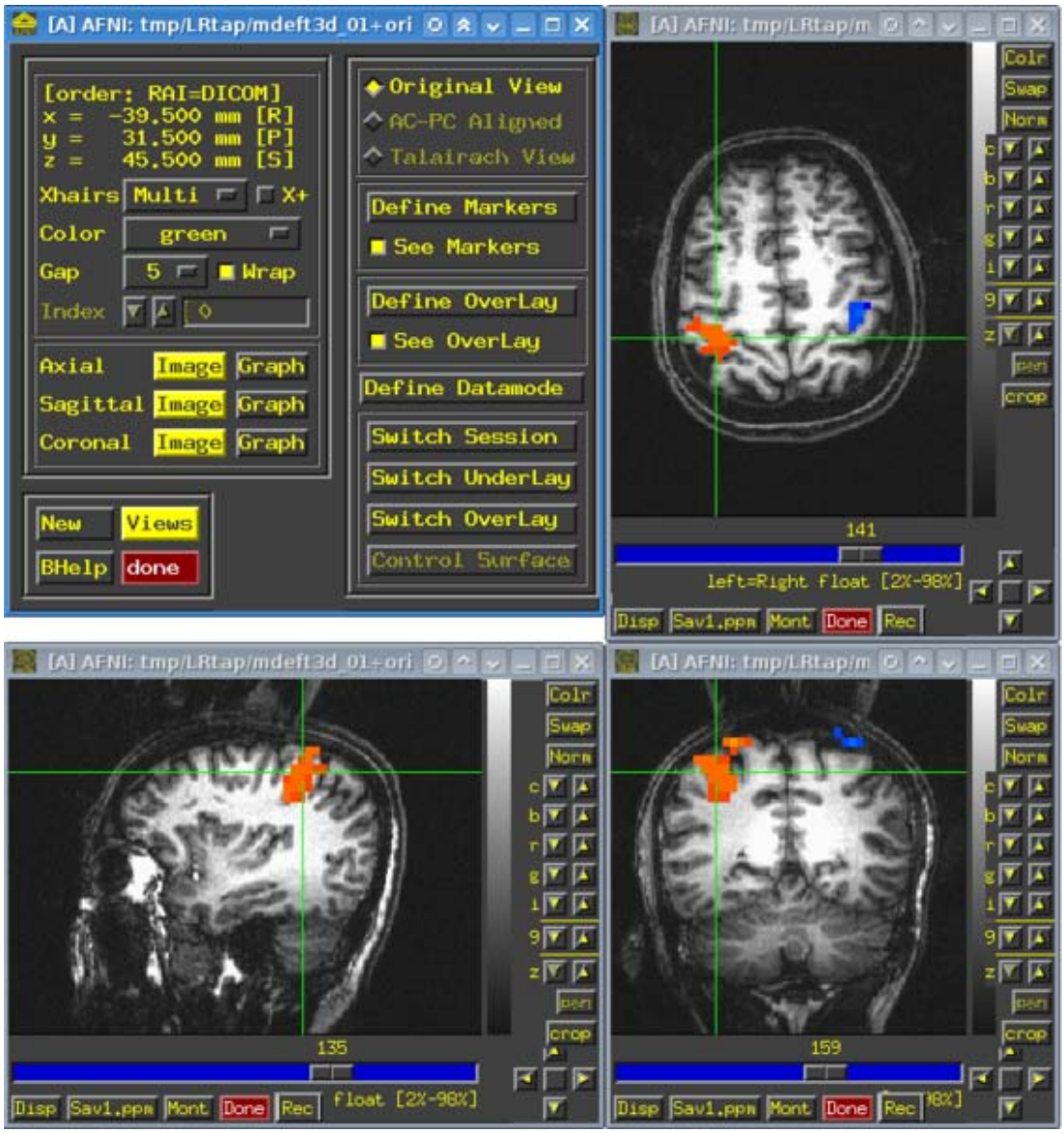
Related organizations

- American Telemedicine Association (ATA)
- American Speech-Language-Hearing Association (ASHA)
- Association of Telehealth Service Providers (ATSP)
- National Institute on Disability and Rehabilitation Research (NIDRR)
- Rehabilitation Engineering and Assistive Technology Society of North America (RESNA)
- Special Interest Group on Telerehabilitation (SIGOT)

Chapter 7

Cognitive Rehabilitation Therapy and Continuous Passive Motion

Cognitive rehabilitation therapy



Effects of cognitive rehabilitation therapy, assessed using fMRI.

Cognitive rehabilitation therapy is a program to help brain-injured or otherwise cognitively impaired individuals to restore normal functioning, or to compensate for cognitive deficits. It entails an individualized program of specific skills training and practice plus metacognitive strategies. Metacognitive strategies include helping the patient increase self-awareness regarding problem-solving skills by learning how to monitor the effectiveness of these skills and self-correct when necessary.

Cognitive rehabilitation therapy has been shown to be effective for individuals who suffered a stroke in the left or right hemisphere. A computer-assisted type of cognitive rehabilitation therapy called Cognitive Remediation Therapy has been used to treat schizophrenia, ADHD, and Major depressive disorder.

It may also be recommended for traumatic brain injury, such as that suffered by U.S. Representative Gabrielle Giffords, according to Dr. Gregory J. O'Shanick of the Brain Injury Association of America. Her new doctor has confirmed that it will be part of her rehabilitation.

Assessments of cognitive rehabilitation therapy

According to the standard text by Sohlberg and Mateer:

Individuals and families respond differently to different interventions, in different ways, at different times after injury. Premorbid functioning, personality, social support, and environmental demands are but a few of the factors that can profoundly influence outcome. In this variable response to treatment, cognitive rehabilitation is no different from treatment for cancer, diabetes, heart disease, Parkinson's disease, spinal cord injury, psychiatric disorders, or any other injury or disease process for which variable response to different treatments is the norm.

Nevertheless, many different statistical analyses of the benefits of this therapy have been carried out. One study made in 2002 analyzed 47 treatment comparisons and reported "a differential benefit in favor of cognitive rehabilitation in 37 of 47 (78.7%) comparisons, with no comparison demonstrating a benefit in favor of the alternative treatment condition."

An internal study conducted by the Tricare Management Agency in 2009 is cited by the US Department of Defense as its reason for refusing to pay for this therapy for veterans who have suffered traumatic brain injury. According to Tricare, "There is insufficient, evidence-based research available to conclude that cognitive rehabilitation therapy is beneficial in treating traumatic brain injury." The ECRI Institute, whose report serves as the basis for this decision by the Department of Defense, has summed up their own findings this way:

In our report, we carried out several meta-analyses using data from 18 randomized controlled trials. Based on data from these studies, we were able to conclude the following:

- Adults with moderate to severe traumatic brain injury who receive social skills training perform significantly better on measures of social communication than patients who receive no treatment.
- Adults with traumatic brain injury who receive comprehensive cognitive rehabilitation therapy report significant improvement on measures of quality of life compared to patients who receive a less intense form of therapy.

The strength of the evidence supporting our conclusions was low due to the small number of studies that addressed the outcomes of interest. Further, the evidence was too weak to draw any definitive conclusions about the effectiveness of cognitive rehabilitation therapy for treating deficits related to the following cognitive areas: attention, memory, visuospacial skills, and executive function. The following factors contributed to the weakness of the evidence: differences in the outcomes assessed in the studies, differences in the types of cognitive rehabilitation therapy methods/strategies employed across studies, differences in the control conditions, and/or insufficient number of studies addressing an outcome.

Citing this 2009 assessment, US Department of Defense has declared that cognitive rehabilitation therapy is scientifically unproved. As a result, it refuses to cover the cost of cognitive rehabilition for brain-injured veterans.

Continuous passive motion

A continuous passive motion machine for knee joint recovery

Continuous passive motion (CPM) devices are used during the first phase of rehabilitation following a soft tissue surgical procedure or trauma. The goals of phase 1 rehabilitation are Control post-operative pain, Reduce inflammation, Provide passive motion in a specific plane of movement , and Protect the healing repair or tissue. CPM is carried out by a CPM device, which constantly moves the joint through a controlled range of motion, the exact range is dependent upon the joint, but in most cases the range of motion is increased over time.

CPM is used following various types of reconstructive joint surgery such as knee replacement and ACL reconstruction. Its mechanisms of action for aiding joint recovery are dependent upon what surgery is performed. One mechanism is the movement of synovial fluid to allow for better diffusion of nutrients into damaged cartilage (which would be unimportant in the event of joint replacement), and diffusion of other materials out; such as blood and metabolic waste products. Another mechanism is the prevention of fibrous scar tissue formation in the joint, which tends to decrease the range of motion for a joint. The concept was created by Robert B. Salter M.D in 1970 and, along with help from engineer John Saringer, a device was created in 1978.

CPM Following Knee Arthroplasty

There is controversy concerning the effectiveness of CPM following Knee Arthroplasty. Some studies support knee arthroplasty, while others show little or no effect when compared with placebo. One assessment of multiple studies indicates that CPM following knee arthroplasty gives a total benefit of 0.69 days less in the hospital and 4 more degrees of motion (only at 2 weeks of follow-up) than physical therapy alone. This assessment further suggested that consideration must also be given to patient convenience and CPM cost.

Chapter 8

Heating Pad, Ice Pack and Traction (Orthopedics)

Heating pad

A **heating pad** is a pad used for warming of parts of the body in order to manage pain. Localized application of heat causes the blood vessels in that area to dilate, enhancing perfusion to the targeted tissue. Types of heating pads include electrical, chemical and hot water bottles.

Types

Electrical

Electric pads usually operate from household current and must have protection against overheating.

A **moist heating pad** is used dry on the user's skin. These pads register temperatures from 170 to 180 degrees Fahrenheit (76 to 82 °C) and are intended for deep tissue treatment and can be dangerous if left on unattended. Moist heating pads are used mainly by physical therapists but can be found for home use. A moist cloth can be added with a stupe cover to add more moisture to the treatment.

Chemical

A sodium acetate heat pad

Chemical pads employ a chemical heat reservoir or a one-time chemical reaction such as catalyzed rusting of iron.

A sodium acetate heat pad is a reusable heat reservoir. It contains a supersaturated solution of sodium acetate ($NaCH_3COO$) in water. Crystallization is triggered by flexing a small flat disc of notched ferrous metal embedded in the liquid. Pressing the disc releases very tiny adhered crystals of sodium acetate into the solution which then act as nucleation sites for the crystallization of the sodium acetate into the hydrated salt (sodium acetate trihydrate). Because the liquid is supersaturated, this makes the solution crystallize suddenly, thereby releasing the energy of the crystal lattice. The use of the metal disc was invented in 1978.

The pad can be reused by placing it in boiling water for 10–15 minutes, which redissolves the sodium acetate trihydrate in the contained water and recreates a supersaturated solution. Once the pad has returned to room temperature it can be triggered again. Triggering the pad before it has reached room temperature results in the pad reaching a lower peak temperature, as compared to waiting until it had completely cooled.

High specific-heat capacity materials

Heating packs can also be made by filling a container with a material that has a high specific heat capacity, which then gradually releases the heat over time. A hot water bottle is the most familiar example of this type of heating pad.

A **microwavable heating pad** is a heating pad that is warmed by placing it in a microwave oven before use. Microwavable heating pads are typically made out of a thick insulative fabric such as flannel and filled with grains such as wheat, buckwheat or flax seed. Due to their relative simplicity to make, they are frequently sewn by hand, often with a custom shape to fit the intended area of use. In rare instances, these types of pads have been known to ignite during or after the microwave process and cause fires.

Often, aromatic compounds will also be added to the filler mixture to create a pleasant or soothing smell when heated. The source of these can vary significantly, ranging from adding essential oils to ground up spices such as cloves and nutmeg, or even dried rose petals.

Phase change materials

Phase change materials can be used for heating pads intended to operate at a fixed temperature. The heat of fusion is used to release the thermal energy.

Function

Many episodes of pain come from muscle exertion or strain, which creates tension in the muscles and soft tissues. This tension can constrict circulation, sending pain signals to the brain. Heat application eases pain by:

- dilating the blood vessels surrounding the painful area. Increased blood flow provides additional oxygen and nutrients to help heal the damaged muscle tissue.
- stimulating sensation in the skin and therefore decreasing the pain signals being transmitted to the brain
- increasing the flexibility (and decreasing painful stiffness) of soft tissues surrounding the injured area, including muscles and connective tissue.

As many heating pads are portable, heat may be applied as needed at home, at work, or while traveling. Some physicians recommend alternating heat and ice for pain relief. *As with any pain treatment, a physician should be consulted prior to beginning treatment.*

Ice pack

An ice pack

An ice pack with gel leaking out of a hole in the upper left corner

An **ice pack** or **gel pack** is a plastic sac of ice, refrigerant gel or liquid, or, in an emergency, even frozen vegetables. The refrigerant, usually non-toxic, can absorb a considerable amount of heat, since its enthalpy of fusion is high. It is commonly used as a cold compress to alleviate the pain of minor injuries or in coolers or insulated shipping containers to keep products cool during transport. The simplest type of ice pack is simply a sack, bag or towel filled with cubed or crushed ice.

Ice packs are used in coolers to keep perishable foods (especially meats, dairy products, eggs, etc.) below the 41–165 °F (5–74 °C) danger zone when outside a refrigerator or freezer. If the foods and the ice packs are placed in a cooler directly from the freezer, then the equivalent of 10 to 20 pounds of ice is needed for each 24 hour period. If the foods start off warmer (for example, non-frozen food from a refrigerator), they will not be able to remain safely cool for as long.

Water (ice) has an unusually high enthalpy of fusion and a convenient melting temperature (one accessible by household freezers). Water also has a low molecular weight, so a kilogram of water contains a greater number of moles of water molecules. Since enthalpy of fusion is measured in units of kJ/mol, a larger number of moles per unit of substance multiplies its ability to absorb heat. Water ice isn't ideal for ice packs for various reasons, so additives to improve the properties of water are often used. For example, substances can be added to prevent bacterial growth in the pack, as can additives that cause the water to remain a thick gel throughout use, instead of transitioning between a solid and a free-flowing liquid like plain water. These gel packs are often made of non-toxic materials that will not liquefy, and therefore will not spill easily or cause contamination if the container breaks. Gel packs may be made by adding hydroxyethyl cellulose (Cellusize) or vinyl-coated silica gel.

These gel packs, as with ice itself, are chilled before use. The gel-pack or water is placed in a freezer or other cooling system to lower its temperature, and then it is used to keep other items cool. Ice packs are effectively a device for storing cooling capacity.

Another type of ice pack uses an endothermic reaction to cool down quickly. These types of ice packs are stored at room temperature rather than needing to be physically cooled before use. When one breaks a tube inside the pack, two chemicals mix or react and absorb enough energy to produce a cooling effect. Common types include solid ammonium nitrate, or ammonium chloride dissolving in water.

The reusable hot cold pack was first patented by Jacob Spencer of Nortech Labs in 1973 (Patent No. 3,780,537). Reusable hot cold packs differ from instant cold packs in that they can be either frozen or microwaved.

Traction (orthopedics)

In orthopedic medicine, **traction** refers to the set of mechanisms for straightening broken bones or relieving pressure on the spine and skeletal system. There are two types of traction: skin traction and skeletal traction.

It is largely replaced now by more modern techniques, but certain approaches are still used today:

- Bryant's traction
- Buck's traction - hip fractures
- Dunlop's traction - humeral fractures in children

- Russell's traction
- Milwaukee brace

Skeletal traction

Although the use of traction has decreased over the years, an increasing number of orthopaedic practitioners are using traction in conjunction with bracing. The section below provides some details on traction and its use.

Bryant's Traction

Bryant's traction is mainly used in young children who have fractures of the femur or congenital abnormalities of the hip. Both the patient's limbs are suspended in the air vertically at a ninety degree angle from the hips and knees slightly flexed. Over a period of days, the hips are gradually moved outward from the body using a pulley system. The patient's body provides the countertraction.

Purpose

The purpose of traction is to:

- To regain normal length and alignment of involved bone.
- To reduce and immobilize a fractured bone.
- To lessen or eliminate muscle spasms.
- To relieve pressure on nerves, especially spinal.
- To prevent or reduce skeletal deformities or muscle contractures.

In most cases traction is only one part of the treatment plan of a patient needing such therapy. The physician’s order will contain:

- Type of traction
- Amount of weight to be applied
- Frequency of neurovascular checks if more frequent than every four (4) hours.
- Site care of inserted pins, wires, or tongs
- The site and care of straps, harnesses and halters
- The inclusion of any other physical restraints / straps or appliances (eg. mouth guard)
- the discontinuation of traction

Responsibility of initial application

The physician is typically responsible for initial application of traction and weights while the adjustment or removal (to perform ablution functions / physiotherapy) of skeletal traction weights will be based on the doctors charted plan.

In most cases cervical traction may be adjusted or temporarily removed, per physician order, by an orthopedic nurse who has documented competency to do so.

The alignment and moving of the patient will only be changed on physician's directive and the affected extremity will need to be maintained in proper alignment at all times with the ropes and traction straps - making sure the mentioned is unobstructed and weights hanging freely.

If it is necessary to move the patient while skeletal traction is in place, the patient should be moved in the bed with weights hanging freely.

In most cases traction will be applied for a number of weeks to months and Neurovascular checks will need to be performed by a nurse as ordered by the physician or as dictated per traction unit policy.

Traction is an appropriate treatment for a number of medical problems including spinal deformities such as scoliosis.

Evidence basis

There is no high-quality scientific evidence that supports or refutes the use of either intermittent or continuous traction for chronic neck pain.

Chapter 9

Stroke Recovery

Stroke rehabilitation typically involves inpatient rehab first, and then community-based (outpatient) rehab once the patient has left the inpatient setting.

It is common that the inpatient phase of rehab lasts less than 3 months, but for patients following severe stroke, much longer periods of intensive, team-based rehabilitation may be required.

History of stroke neuro-rehabilitation

Knowledge of stroke and the process of recovery after stroke has developed enormously in the late 20th century and early 21st century. It was not until the year 1620 that Johan Wepfer, by studying the brain of a pig, came up with the theory that stroke was caused by an interruption of the flow of blood to the brain. This was an important breakthrough, but once the cause of strokes was known, the question became how to treat patients with stroke.

For most of the last century, people were actually discouraged from being active after a stroke. Around the 1950s, this attitude changed, and health professionals began prescription of therapeutic exercises for stroke patient with good results. Still, a good outcome was considered to be achieving a level of independence in which patients are able to transfer from the bed to the wheelchair without assistance. This was still was a fairly bleak outlook, but the situation was improving.

In the early 1950s, Twitchell began studying the pattern of recovery in stroke patients. He reported on 121 patients he had observed. He found that by four weeks, if there is some recovery of hand function, there is a 70% chance of making a full or good recovery. He reported that most recovery happens in the first three months, and only minor recovery occurs after six months. More recent research has demonstrated that significant improvement can be made years after the stroke.

Around the same time, Brunnstrom also described the process of recovery, and divided the process into seven stages. As knowledge of the science of brain recovery improves,

methods of intervening have evolved. There will be a continued fundamental shift in the processes used to facilitate stroke recovery.

Current perspectives and therapeutic avenues

Motor re-learning

"Neurocognitive Rehabilitation by Carlo Perfetti concept", widespread in many world countries, is an original motor re-learning theories application.

Constraint-induced movement therapy

The idea for constraint-induced therapy is actually at least 100 years old. Significant research was carried out by a man named Oden. He was able to simulate a stroke in a monkey's brain, causing hemiplegia. He then bound up the monkey's good arm, and forced the monkey to use his bad arm, and observed what happened. After two weeks of this therapy, the monkeys were able to use their once hemiplegic arms again. This is due to neuroplasticity. He did the same experiment without binding the arms, and waited six months past their injury. The monkeys without the intervention were not able to use the affected arm even six months later. In 1918, this study was published, but it received little attention.

Eventually, researchers began to apply his technique to stroke patients, and it came to be called constraint-induced movement therapy. Notably, the initial studies focused on chronic stroke patients who were more than 12 months past their stroke. This challenged the belief held at that time that no recovery will occur after one year. The therapy entails wearing a soft mitt on the good hand for 90% of the waking hours, forcing use of the affected hand. The patients undergo intense one-on-one therapy for six to eight hours per day for two weeks.

Mental Practice/Mental Imagery

Mental practice of movements has been shown in many studies to be effective in promoting recovery of both arm and leg function after a stroke. It is often used by physical or occupational therapists in the rehab or homehealth setting, but can also be used as part of a patient's independent home exercise program. Mental Movement Therapy is one product available for assisting patients with guided mental imagery.

Brain repair

Stem cells

Basic and clinical research in stroke neurotransplantation remains in a nascent stage. Much more work is needed to further characterize the biology of different implant sources both in vitro and in vivo. Initial clinical data suggests that transplantation is

technically feasible and can be performed safely, but the data are too preliminary and insufficient to assess efficacy.

Electrical stimulation

Such work represents a paradigm shift in the approach towards rehabilitation of the stroke-injured brain away from pharmacologic flooding of neuronal receptors, instead towards targeted physiologic stimulation.

Acoustic electrical stimulation (rhythmic auditory stimulation)

Rhythmic auditory stimulation (RAS) was shown to be superior to Bobath-based training.

Training of muscles affected by the Upper Motor Neuron Syndrome

Muscles affected by the Upper Motor Neuron Syndrome have many potential features of altered performance including weakness, decreased motor control, clonus (a series of involuntary rapid muscle contractions), exaggerated deep tendon reflexes, spasticity and decreased endurance. The term "spasticity" is often erroneously used interchangeably with Upper Motor Neuron Syndrome, and it is not unusual to see patients labeled as spastic who demonstrate an array of UMN findings.

It has been estimated that approximately 65% of individuals develop spasticity following stroke, and studies have revealed that approximately 40% of stroke victims may still have spasticity at 12 months post-stroke. The changes in muscle tone probably result from alterations in the balance of inputs from reticulospinal and other descending pathways to the motor and interneuronal circuits of the spinal cord, and the absence of an intact corticospinal system. In other words, there is damage to the part of the brain or spinal cord that controls voluntary movement.

Various means are available for the treatment of the effects of the Upper Motor Neuron Syndrome. These include: exercises to improve strength, control and endurance, nonpharmacologic therapies, oral drug therapy, intrathecal drug therapy, injections, and surgery. Researchers do not believe that treating spasticity is worthwhile. A letter to the editor of Stroke magazine. Spasticity After Stroke: Why Bother? William M. Landau, MD However, the perseverative preoccupation of professional neurologists and therapists with the purpose of overpowering the spasticity ogre seems to be an endemic, intractably-taught delusion that afflicts both scholars and clinicians. Another group of researchers writing in Movement Disorder Virtual University Incidence and Consequences of Spasticity After Stroke

The authors conclude, “spasticity seems to contribute to motor impairments and activity limitations and may be a severe problem for some patients after stroke,” but, they note, “Our findings support the opinion…that the focus on spasticity in stroke rehabilitation is out of step with its clinical importance. A survey done by the National Stroke Association

However, while 58 percent of survivors in the survey experience spasticity only 51 percent of those have received treatment for this condition.

Nonpharmacologic therapies

Treatment should be based on assessment by the relevant health professionals. For muscles with mild-to-moderate impairment, exercise should be the mainstay of management, and is likely to need to be prescribed by a physiotherapist or other health professional skilled in neurological rehabilitation.

Muscles with severe impairment are likely to be more limited in their ability to exercise, and may require help to do this. They may require additional interventions, to manage the greater neurological impairment and also the greater secondary complications. These interventions may include serial casting, flexibility exercise such as sustained positioning programs, and patients may require equipment, such as using a standing frame to sustain a standing position. Applying specially made Lycra garments may also be beneficial.

Oral drug therapies

Oral medications used for the treatment of spasticity include: diazepam (Valium), dantrolene sodium, baclofen, tizanidine, clonidine, gabapentin, and even cannabinoid-like compounds.[3] The exact mechanism of these medications is not fully understood, but they are thought to act on neurotransmitters or neuromodulators within the central nervous system (CNS) or muscle itself, or to decrease the stretch reflexes. The problem with these medications is their potential side effects and the fact that, other than lessening painful or disruptive spasms and dystonic postures, drugs in general have not been shown to decrease impairments or lessen disabilities.

Intrathecal drug therapy

Intrathecal administration of drugs involves the implantation of a pump that delivers medication directly to the CNS. The benefit of this is that the drug remains in the spinal cord, without traveling in the bloodstream, and there are often fewer side effects. The most commonly used medication for this is Baclofen, but Morphine sulfate and Fentanyl have been used as well, mainly for severe pain as a result of the spasticity.

Injections

Injections are focal treatments administered directly into the spastic muscle. Drugs used include: Botulinum toxin (BTX), Phenol, alcohol, and Lidocaine. Phenol and alcohol cause local muscle damage by denaturing protein, and thus relaxing the muscle. Botulinum toxin is a neurotoxin and it relaxes the muscle by preventing the release of a neurotransmitter (acetylcholine). Many studies have shown the benefits of BTX and it has also been demonstrated that repeat injections of BTX show unchanged effectiveness.

Surgery

Surgical treatment for spasticity includes lengthening or releasing of muscle and tendons, procedures involving bones, and also selective dorsal rhizotomy. Rhizotomy, usually reserved for severe spasticity, involves cutting selective sensory nerve roots, as they probably play a role in generating spasticity.

Shoulder subluxation following stroke

Glenohumeral (or shoulder) subluxation is defined as a partial or incomplete dislocation of the shoulder joint that typically results from changes in the mechanical integrity of the joint. Subluxation is a common problem with hemiplegia, or weakness of the musculature of the upper limb. Traditionally this has been thought to be a significant cause of post-stroke shoulder pain, although a few recent studies have failed to show a direct correlation between shoulder subluxation and pain.

The exact etiology of subluxation in post-stroke patients is unclear, but appears to be caused by weakness of the musculature supporting the shoulder joint. The shoulder is one of the most mobile joints in the body. To provide a high level of mobility the shoulder sacrifices ligamentous stability and as a result relies on the surrounding musculature (i.e., rotator cuff muscles, latissimus dorsi, and deltoid) for much of its support. This is in contrast to other less mobile joints such as the knee and hip, which have a significant amount of support from the joint capsule and surrounding ligaments. If a stroke damages the upper motor neurons controlling muscles of the upper limb, weakness and paralysis, followed by spasticity occurs in a somewhat predictable pattern. The muscles supporting the shoulder joint, particularly the supraspinatus and posterior deltoid become flaccid and can no longer offer adequate support leading to a downward and outward movement of arm at the shoulder joint causing tension on the relatively weak joint capsule. Other factors have also been cited as contributing to subluxation such as pulling on the hemiplegic arm and improper positioning.

Diagnosis can usually be made by palpation or feeling the joint and surrounding tissues, although there is controversy as to whether or not the degree of subluxation can be measured clinically. If shoulder subluxation occurs it can become a barrier to the rehabilitation process. Treatment involves measures to support the subluxed joint such as taping the joint, using a lapboard or armboard. A shoulder sling may be used, but is controversial and a few studies have shown no appreciable difference in range-of-motion, degree of subluxation, or pain when using a sling. A sling may also contribute to contractures or tightening of the joint if used for extended periods of time. That said, a sling may be necessary for some therapy activities. Functional electrical stimulation (FES) has also shown promising results in treatment of subluxation, and reduction of pain, although some studies have shown a return of pain after discontinuation of FES. As with most conditions, the best treatment consists of preventive measures such as early range of motion, proper positioning, passive support of soft tissue structures and possibly early re-activation of shoulder musculature using functional electrical stimulation.

Post-stroke pain syndromes

Central Post-stroke Pain (CPSP) is neuropathic pain which is caused by damage to the neurons in the brain (central nervous system), as the result of a vascular injury. One study found that up to 8% of people who have had a stroke will develop Central Post-stroke Pain, and that the pain will be moderate to severe in 5% of those affected.[1] The condition was formerly called "thalamic pain", because of the high incidence among those with damage to the thalamus or thalamic nuclei. Now known as CPSP, it is characterized by perceived pain from non-painful stimuli, such as temperature and light touch. This altered perception of stimuli, or allodynia, can be difficult to assess due to the fact that the pain can change daily in description and location, and can appear anywhere from months to years after the stroke. CPSP can also lead to a heightened central response to painful sensations, or hyperpathia. Affected persons may describe the pain as cramping, burning, crushing, shooting, pins and needles, and even bloating or urinary urgency.[2] Both the variation and mechanism of pain in CPSP have made it difficult to treat. Several strategies have been employed by physicians, including intravenous lidocaine, opioids/narcotics, anti-depressants, anti-epileptic medications and neurosurgical procedures with varying success. Higher rates of successful pain control in persons with CPSP can be achieved by treating other sequelae of stroke, such as depression and spasticity. As the age of the population increases, the diagnosis and management of CPSP will become increasingly important to improve the quality of life of an increasing number of stroke survivors.

Apraxia

A not too uncommon, but less understood result of stroke, as well as metabolic and traumatic insult to the brain, is a condition called apraxia. This condition was initially recognized as: 'Disorders of the execution of learned movements which cannot be accounted for by either weakness, incoordination, or sensory loss, nor by incomprehension of, or inattention to commands.'[1] Several forms of apraxia are recognized[3]. Limb-kinetic apraxia is the inability to make precise or exact movements with a finger, an arm or a leg. Ideamotor apraxia is the inability to carry out a command from the brain to mimic limb or head movements performed or suggested by others. Conceptual apraxia is similar to ideamotor apraxia, but infers a more profound malfunctioning in which the function of tools or objects is no longer understood. Ideational apraxia is the inability to create a plan for a specific movement. Buccofacial apraxia, or facial-oral apraxia, is the inability to coordinate and carry out facial and lip movements such as whistling, winking, coughing, etc. on command. Constructional apraxia affects the person's ability to draw or copy simple diagrams, or to construct simple figures. Oculomotor apraxia is a condition in which the patient finds it difficult to move his/her eyes. Many believe that the most common form of apraxia is ideamotor apraxia, in which a disconnection between the area of the brain containing plans for a movement and the area of the brain that is responsible for executing that movement occurs.[2]

Whereas with many affects of stroke, where the clinician is able to judge the particular area of the brain that a stroke has injured by certain signs or symptoms, the case is not as clear with apraxia. A common theory as to why this condition results is that the part of the brain that contains information for previously learned skilled motor activities, such as using a spoon to scoop up soup and place it in your mouth, has been either lost or cannot be accessed. The condition is usually due to an insult to the dominant hemisphere of the brain. More often this is located in the frontal lobe of the left hemisphere of the brain. Treatment of acquired apraxia due to stroke usually consists of physical, occupational, and speech therapy. The Copenhagen Stroke Study, which is a large important study published in 2001, showed that out of 618 stroke patients, manual apraxia was found in 7% and oral apraxia was found in 6%.[4] Both manual and oral apraxia were related to increasing severity of stroke. Oral apraxia was related with an increase in age at the time of the stroke. There was no difference in incidence among gender. It was also found that the finding of apraxia has no negative influence on ability to function after rehabilitation is completed. The National Institute of Neurological Disorders and Stroke (NINDS) is currently sponsoring a clinical trial to gain an understanding of how the brain operates while carrying out and controlling voluntary motor movements in normal subjects. Their objective is to try to determine what goes wrong with these processes in the course of acquired apraxia due to stroke or brain injury.[4]

Lateral medullary syndrome

Lateral medullary syndrome, also known as Wallenberg's Syndrome, is caused by blockage of posterior inferior cerebellar artery (PICA) or the vertebral arteries. Signs and symptoms include decreased pain and temperature on the same side of the face and opposite side of the body compared to the lesion, ataxia on the same side of the lesion, and Horner's syndrome on the same side of the face.

Treatment in the acute setting is mostly focused on symptomatic management. After initial treatment in the hospital, some patients will need short-term placement in a nursing home or rehabilitation facility before going home. Rehabilitation in Wallenberg's Syndrome focuses on improving balance, coordination, working on activities of daily living, and improving speech and swallowing function. Severe nausea and vertigo can be present and limit progress in rehabilitation and recovery. Symptomatic treatment with anti-emetics and medications for the hiccups are important. Commonly used anti-emetics include odansetron, metoclopromide, prochlorperazine, and promethazine. These medications are also used to treat hiccups, along with chlorpromazine. There are case reports of other medications useful in treating hiccups in Wallenberg's Syndrome including baclofen and anti-epileptic medications. Prognosis for someone with lateral medullary syndrome depends upon the size and location of damaged area of the brain stem. Some individuals recover quickly while others may have significant neurological disabilities for months to years after the initial injury.

Post-stroke depression

Depression is a commonly reported consequence of stroke and is seen in anywhere from 25-50% of patients. The Diagnostic and Statistical Manual (DSM-IV-TR) defines post-stroke depression as "a mood disorder due to a general medical condition (i.e. stroke) that is judged to be due to the direct physiological effects of [that] condition." Post-stroke depression may involve depressed mood and decreased interest and pleasure that impairs social and occupational functioning, but does not necessarily need to meet the full criteria of a major depressive disorder.

The first studies to look for an association between specific stroke lesions and the occurrence of depression reported a correlation between left frontal lesions and major depression. Damage to the frontal noradrenergic, dopaminergic, and serotonergic projections were thought to cause a depletion of catecholamines that lead to depression. However, more recent studies have demonstrated that the anatomic aspects of a lesion do not necessarily correlate with the occurrence of depression. Other psychological factors can lead to the development of depression including personal and social losses related to the physical disabilities often caused by a stroke.

The incidence of post-stroke depression peaks at 3–6 months and usually resolves within 1–2 years after the stroke, although a minority of patients can go on to develop chronic depression. The diagnosis of post-stroke depression is complicated by other consequences of stroke such as fatigue and psychomotor retardation – which do not necessarily indicate the presence of depression. Loss of interest in activities and relationships should prompt an evaluation for depression.

Traditionally, tricyclic antidepressants (TCAs), such as nortriptyline, have been used in the treatment of post-stroke depression. More recently, the selective serotonin reuptake inhibitors (SSRIs), such as fluoxetine and citalopram, have become the pharmacologic therapy of choice due to the lower incidence of side effects. Also, psychologic treatment such as cognitive behavioral therapy, group therapy, and family therapy are reported to be useful adjuncts to treatment.

Overall, the development of post-stroke depression can play a significant role in a patient's recovery from a stroke. For instance, the severity of post-stroke depression has been associated with severity of impairment in activities of daily living (ADLs). By effectively treating depression, patients experience a greater recovery of basic ADLs such as dressing, eating and ambulating, as well as instrumental ADLs, such as the ability to take care of financial and household matters. In essence, recognition and treatment of post-stroke depression leads to greater functional ability for the patient over time.

Chapter 10

Environmental Enrichment (Neural)

Environmental enrichment concerns how the brain is affected by the stimulation of its information processing provided by its surroundings (including the opportunity to interact socially). Brains in richer, more stimulating environments, have increased numbers of synapses, and the dendrite arbors upon which they reside are more complex. This effect happens particularly during neurodevelopment, but also to a lesser degree in adulthood. With extra synapses there is also increased synapse activity and so increased size and number of glial energy support cells. Capillary vasculation also is greater to provide the neurons and glial cells with extra energy. The neuropil (neurons, glial cells, capillaries, combined together) expands making the cortex thicker. There may also exist (at least in rodents) more neurons.

Research in nonhuman animals finds that more stimulating environment could aid the treatment and recovery of a diverse variety of brain related dysfunctions, including Alzheimer's disease and those connected to aging, whereas a lack of stimulation might impair cognitive development.

Research upon humans suggests that lack of stimulation (deprivation—such as in old-style orphanages) delays and impairs cognitive development. Research also finds that higher levels of education (which is both cognitively stimulating in itself, and associates with people engaging in more challenging cognitive activities) results in greater resilience (cognitive reserve) to the effects of aging and dementia.

Early research

Donald O. Hebb in 1947 found that rats raised as pets performed better on problem solving tests than rats raised in cages. His research, however, did not investigate the brain nor use standardized impoverished and enriched environments. Research doing this first was started in 1960 by Mark Rosenzweig who compared single rats in normal cages, and those placed in ones with toys, ladders, tunnels, running wheels in groups. This found that growing up in enriched environents affected enzyme cholinesterase activity. This work led in 1962 to the discovery that environmental enrichment increased cerebral

cortex volume. In 1964, it was found that this was due to increased cerebral cortex thickness and greater synapse and glial numbers.

Also starting around 1960, Harry Harlow studied the effects of maternal and social deprivation on rhesus monkey infants (a form of environmental stimulus deprivation). This established the importance of social stimulation for normal cognitive and emotional development.

Synapses

Synaptogenesis

Rats raised with environmental enrichment have thicker cerebral cortices (3.3-7%) that contain 25% more synapses. This effect of environmental richness upon the brain occurs whether it is experienced immediately following birth, after weaning, or during maturity. When synapse numbers increase in adults, they can remain high in number even when the adults are returned to improvised environment for 30 days suggesting that such increases in synapse numbers are not necessarily temporary. However, the increase in synapse numbers has been observed generally to reduce with maturation. Stimulation affects not only synapses upon pyramidal neurons (the main projecting neurons in the cerebral cortex) but also stellate ones (that are usually interneurons). It also can affect neurons outside the brain in the retina.

Dendrite complexity

Environmental enrichment affects the complexity and length of the dendrite arbors (upon which synapses form). Higher-order dendrite branch complexity is increased in enriched environments, as can the length, in young animals, of distal branches.

Activity and energy consumption

Synapses in animals in enriched environments show evidence of increased synapse activation. Synapses tend to also be much larger. This increased energy consumption is reflected in glial and local capillary vasculation that provides synapses with extra energy.

- Glial cell numbers per neuron increase 12-14%
- The direct apposition area of glial cells with synapses expands by 19%
- The volume of glial cell nuclei for each synapse is higher by 37.5%
- The mean volume of mitochondria per neuron is 20% greater
- The volume of glial cell nuclei for each neuron is 63% higher
- Capillary density is increased.
- Capillaries are wider (4.35 μm compared to 4.15 μm in controls)
- Shorter distance exist between any part of the neuropil and a capillary (27.6 μm compared to 34.6 μm)

These energy related changes to the neuropil are responsible for increasing the volume of the cerebral cortex (the increase in synapse numbers contributes in itself hardly any extra volume).

Motor learning stimulation

Part of the effect of environmental enrichment is providing opportunities to acquire motor skills. Research upon “acrobatic” skill learning in the rat shows that it leads to increased synapse numbers.

Maternal transmission

Environmental enrichment during pregnancy has effects upon the fetus such as accelerating its retinal development.

Neurogenesis

Environmental enrichment can also lead to the formation of neurons (at least in rats) and reverses the loss of neurons in the hippocampus and memory impairment following chronic stress. However, its relevance has been questioned for the behavioral effects of enriched environments.

Mechanisms

Enriched environments affect the expression of genes in the cerebral cortex and the hippocampus that determine neuronal structure. At the molecular level, this occurs through increased concentrations of the neurotrophins NGF, NT-3, and changes in BDNF. This alters the activation of cholinergic neurons, 5-HT, and beta-adrenolin. Another effect is to increase proteins such as synaptophysin and PSD-95 in synapses. Changes in Wnt signaling have also been found to mimic in adult mice the effects of environmental enrichment upon synapses in the hippocampus. Increase in neurons numbers could be linked to changes in VEGF.

Resilience and rehabilitation

Research (as least upon *rats*) suggests that environment enrichment might reduce the effects or ameliorate the cognitive impairments caused by a diverse variety of conditions and neurological disorders.

- Aging, (also in dogs)
- Alzheimer’s disease
- Huntington's disease
- Parkinson's disease
- Stroke
- Chronic spinal cord injuries
- Amblyopia

- Rett syndrome
- Autism
- Prenatal and perinatal cocaine exposure
- Fetal alcohol syndrome
- Lead exposure
- Prenatal and maternal separation stress
- Child neglect

Humans

Though environmental enrichment research has been mostly done upon rodents, similar effects occur in primates, and are likely to affect the human brain. However, direct research upon human synapses and their numbers is limited since this requires histological study of the brain. A link, however, has been found between educational level and greater dendritic branch complexity following autopsy removal of the brain.

Localized cerebral cortex changes

MRI detects localized cerebral cortex expansion after people learn complex tasks such as mirror reading (in this case in the right occipital cortex), three-ball juggling (bilateral mid-temporal area and left posterior intraparietal sulcus), and when medical students intensively revise for exams (bilaterally in the posterior and lateral parietal cortex). Such changes in gray matter volume can be expected to link to changes in synapse numbers due to the increased numbers of glial cells and the expanded capillary vascularization needed to support their increased energy consumption.

Institutional deprivation

Children that receive impoverished stimulation due to being confined to cots without social interaction or reliable caretakers in low quality orphanages show severe delays in cognitive and social development. 12% of them if adopted after 6 months of age show autistic or mildly autistic traits later at four years of age. Some children in such impoverished orphanages at two and half years of age still fail to produce intelligible words, though a year of foster care enabled such children to catch up in their language in most respects. Catch-up in other cognitive functioning also occurs after adoption, though problems continue in many children if this happens after the age of 6 months

Such children show marked differences in their brains, consistent with research upon experiment animals, compared to children from normally stimulating environments. They have reduced brain activity in the orbital prefrontal cortex, amygdala, hippocampus, temporal cortex, and brain stem. They also showed less developed white matter connections between different areas in their cerebral cortices, particularly the uncinate fasciculus.

Conversely, enriching the experience of preterm infants with massage quickens the maturating of their electroencephalographic activity and their visual acuity. Moreover, as with enrichment in experimental animals, this associates with an increase in IGF-1.

Cognitive reserve and resilience

Another source of evidence for the effect of environment stimulation upon the human brain is cognitive reserve (a measure of the brain's resilience to cognitive impairment) and the level of a person's education. Not only is higher education linked to a more cognitively demanding educational experience, but it also correlates with a person's generally engaging in cognitively demanding activities. The more education a person has received, the less the effects of aging, dementia, white matter hyperintensities, MRI-defined brain infarcts, Alzheimer's disease, and traumatic brain injury. Also, aging and dementia are less in those that engage in complex cognitive tasks. The cognitive decline of those with epilepsy could also be affected by the level of a person's education.

Chapter 11

Pain Management

Pain management (also called pain medicine; algiatry) is a branch of medicine employing an interdisciplinary approach for easing the suffering and improving the quality of life of those living with pain. The typical pain management team includes medical practitioners, clinical psychologists, physiotherapists, occupational therapists, and nurse practitioners. Pain sometimes resolves promptly once the underlying trauma or pathology has healed, and is treated by one practitioner, with drugs such as analgesics and (occasionally) anxiolytics. Effective management of long term pain, however, frequently requires the coordinated efforts of the management team.

Medicine treats injury and pathology to support and speed healing; and treats distressing symptoms such as pain to relieve suffering during treatment and healing. When a painful injury or pathology is resistant to treatment and persists, when pain persists after the injury or pathology has healed, and when medical science cannot identify the cause of pain, the task of medicine is to relieve suffering. Treatment approaches to long term pain include pharmacologic measures, such as analgesics, tricyclic antidepressants and anticonvulsants, interventional procedures, physical therapy, physical exercise, application of ice and/or heat, and psychological measures, such as biofeedback and cognitive behavioral therapy.

Medical specialties

Pain management practitioners come from all fields of medicine. Most often, pain fellowship trained physicians are anesthesiologists, neurologists, physiatrists or psychiatrists. Palliative care doctors are also specialists in pain management. Some practitioners have not been fellowship trained and have opted for certification by the American Board of Pain Medicine which is not recognized by the American Board of Medical Specialties and does not indicate fellowship training. However, the American Board of Anesthesiology and the American Board of Physical Medicine and Rehabilitation have a subspecialty in pain management which is recognized by the American Board of Medical Specialties and does indicate fellowship training. Some practitioners focus more on the pharmacologic management of the patient, while others are very proficient at the interventional management of pain. Interventional procedures -

typically used for chronic back pain - include: epidural steroid injections, facet joint injections, neurolytic blocks, spinal cord stimulators and intrathecal drug delivery system implants. Over the last several years the number of interventional procedures done for pain has grown.

As well as medical practitioners, the area of pain management may often benefit from the input of physiotherapists, chiropractors, clinical psychologists and occupational therapists, amongst others. Together the multidisciplinary team can help create a package of care suitable to the patient.

Because of the fast growth in the field of pain medicine many practitioners have entered the field, with many of these practitioners being not board certified or being certified by unrecognized boards.

Medications

The World Health Organization (WHO) recommends a *pain ladder* for managing analgesia. It was first described for use in cancer pain, but it can be used by medical professionals as a general principle when dealing with analgesia for any type of pain. In the treatment of chronic pain, whether due to malignant or benign processes, the three-step WHO Analgesic Ladder provides guidelines for selecting the kind and stepping up the amount of analgesia. The exact medications recommended will vary with the country and the individual treatment center, but the following gives an example of the WHO approach to treating chronic pain with medications. If, at any point, treatment fails to provide adequate pain relief, then the doctor and patient move onto the next step.

Mild pain

Paracetamol (acetaminophen), or a non steroidal anti-inflammatory drug such as ibuprofen.

Mild to moderate pain

Paracetamol, an NSAID and/or paracetamol in a combination product with a weak opioid such as hydrocodone used in combination, may provide greater relief than their separate use.

Moderate to severe pain

When treating moderate to severe pain, the type of the pain, acute or chronic, needs to be considered. The type of pain can result in different medications being prescribed. Certain medications may work better for acute pain, others for chronic pain, and some may work equally well on both. Acute pain medication is for rapid onset of pain such as from an inflicted trauma or to treat post-operative pain. Chronic pain medication is for alleviating long-lasting, ongoing pain.

Morphine is the gold standard to which all narcotics are compared. Fentanyl has the benefit of less histamine release and thus fewer side effects. It can also be administered via transdermal patch which is convenient for chronic pain management. Oxycodone is used across the Americas and Europe for relief of serious chronic pain; its main slow-release formula is known as OxyContin, and short-acting tablets, capsules, syrups and ampoules are available making it suitable for acute intractable pain or breakthrough pain. Diamorphine, methadone and buprenorphine are used less frequently. Pethidine, known in North America as meperidine, is not recommended for pain management due to its low potency, short duration of action, and toxicity associated with repeated use. Pentazocine, dextromoramide and dipipanone are also not recommended in new patients except for acute pain where other analgesics are not tolerated or are inappropriate, for pharmacological and misuse-related reasons. Amitriptyline is prescribed for chronic muscular pain in the arms, legs, neck and lower back. While opiates are often used in the management of chronic pain, high doses are associated with an increased risk of opioid overdose.

Opioids

Opioid medications can provide a short, intermediate or long acting analgesia depending upon the specific properties of the medication and whether it is formulated as an extended release drug. Opioid medications may be administered orally, by injection, via nasal mucosa or oral mucosa, rectally, transdermally, intravenously, epidurally and intrathecally. In chronic pain conditions that are opioid responsive a combination of a long-acting or extended release medication is often prescribed in conjunction with a shorter-acting medication for breakthrough pain, or exacerbations.

Most opioid treatment is oral (tablet, capsule or liquid), but suppositories and skin patches can be prescribed. An opioid injection is rarely needed for patients with chronic pain.

Although opioids are strong analgesics, they do not provide complete analgesia regardless of whether the pain is acute or chronic in origin. Opioids are efficacious analgesics in chronic malignant pain and modestly effective in nonmalignant pain management. However, there are associated adverse effects, especially during the commencement or change in dose. When opioids are used for prolonged periods drug tolerance, chemical dependency, diversion and addiction may occur.

Clinical guidelines for prescribing opioids for chronic pain have been issued by the American Pain Society and the American Academy of Pain Medicine. Included in these guidelines is the importance of assessing the patient for the risk of substance abuse, misuse, or addiction; a personal or family history of substance abuse is the strongest predictor of aberrant drug-taking behavior. Physicians who prescribe opioids should integrate this treatment with any psychotherapeutic intervention the patient may be receiving. The guidelines also recommend monitoring not only the pain but also the level of functioning and the achievement of therapeutic goals. The prescribing physician

should be suspicious of abuse when a patient reports a reduction in pain but has no accompanying improvement in function or progress in achieving identified goals.

Non-steroidal anti-inflammatory drugs

The other major group of analgesics are non-steroidal anti-inflammatory drugs (NSAID). Acetaminophen is not always included in this class of medications. However, acetaminophen may be administered as a single medication or in combination with other analgesics (both NSAIDs and opioids). The alternatively prescribed NSAIDs such as ketoprofen and piroxicam, have limited benefit in chronic pain disorders and with long-term use is associated with significant adverse effects. The use of selective NSAIDs designated as selective COX-2 inhibitors have significant cardiovascular and cerebrovascular risks which have limited their utilization.

Antidepressants and antiepileptic drugs

Some antidepressant and antiepileptic drugs are used in chronic pain management and act primarily within the pain pathways of the central nervous system, though peripheral mechanisms have been attributed as well. These mechanisms vary and in general are more effective in neuropathic pain disorders as well as complex regional pain syndrome. Drugs such as gabapentin have been widely prescribed for the off-label use of pain control. The list of side effects for these classes of drugs are typically much longer than opiate or NSAID treatments for chronic pain, and many antiepileptics cannot be suddenly stopped without the risk of seizure.

Other analgesics

Other drugs are often used to help analgesics combat various types of pain and parts of the overall pain experience. In addition to gabapentin, the vast majority of which is used off-label for this purpose, orphenadrine, cyclobenzaprine, trazodone and other drugs with anticholinergic properties are useful in conjunction with opioids for neuropathic pain. Orphenadrine and cyclobenzaprine are also muscle relaxants and are therefore particularly useful in painful musculoskeletal conditions. Clonidine has found use as an analgesic for this same purpose and all of the mentioned drugs potentiate the effects of opioids overall.

Procedures

Pulsed radiofrequency, neuromodulation, direct introduction of medication and nerve ablation may be used to target either the tissue structures and organ/systems responsible for persistent nociception or the nociceptors from the structures implicated as the source of chronic pain.

An intrathecal pump used to deliver very small quantities of medications directly to the spinal fluid. This is similar to epidural infusions used in labour and postoperatively. The major differences are that it is much more common for the drug to be delivered into the

spinal fluid (intrathecal) rather than epidurally, and the pump can be fully implanted under the skin. This approach allows a higher dose of the drug to be delivered directly to the site of action, with fewer systemic side effects.

A spinal cord stimulator is an implantable medical device that creates electric impulses and applies them near the dorsal surface of the spinal cord provides a paresthesia ("tingling") sensation that alters the perception of pain by the patient.

Physical approach

Physiatry

Physical medicine and rehabilitation (physiatry) employs diverse physical techniques such as thermal agents and electrotherapy, as well as therapeutic exercise and behavioral therapy, alone or in tandem with interventional techniques and conventional pharmacotherapy to treat pain, usually as part of an interdisciplinary or multidisciplinary program.

TENS

Transcutaneous electrical nerve stimulation has been found to be ineffective for lower back pain, however, it might help with diabetic neuropathy.

Acupuncture

Acupuncture involves the insertion and manipulation of needles into specific points on the body to relieve pain or for therapeutic purposes. In 2003, the World Health Organization published an article synthesizing the scientific research (controlled trials) of the time, and concluded acupuncture is helpful for the treatment of pain in some cases of acute pain in the epigastric area, facial pain, headache, knee pain, low back pain, neck pain, pain in dentistry, postoperative pain, renal colic, and sciatica. The authors also concluded acupuncture has demonstrated effectiveness in other conditions for which further proof is needed. This review has been criticized for giving too much weight to low-quality clinical trials, and including a large number of trials originating in China. The latter issue is considered problematic because trials originating in the West include a mixture of positive, negative and neutral results while all trials in China are positive (attributed to publication bias rather than fraud). An analysis of the 13 highest quality studies of pain treatment with acupuncture, published in January 2009 in the *British Medical Journal*, concluded there was little difference in the effect of real, sham and no acupuncture. There is general agreement that acupuncture is safe when administered by well-trained practitioners using sterile needles, and that further research is appropriate.

LLLT

A 2007 review concluded low level laser therapy may be effective in reducing inflammation and pain, while a 2008 Cochrane collaboration review concluded that there

was insufficient evidence to support the use of LLLT in the management of low back pain.

Psychological approach

Cognitive and behavioral therapy

Mindfulness-based cognitive therapy, the use of stress reduction and relaxation, has been found to reduce chronic pain in some patients. Applied behavior analysis views chronic pain as a consequence of both respondent and operant conditioning, where a patient learns to display pain behavior in the presence of specific environmental antecedents and consequences. The model was first proposed by Fordyce in 1976. The behavioral model has shown effectiveness in reducing pain responses though operant based interventions. Though cognitive-behavioral intervention can be an effective and economical means of treating chronic pain, the effects are rather modest and a substantial portion of patients gain no benefit.

Biofeedback

Biofeedback based on behavioral principles has shown some success for chronic pain, demonstrating greater improvement in one study than peers undergoing cognitive-behavioral therapy and conservative medical treatment, though a different study showed improvements over wait-list controls but no difference between biofeedback and cognitive-behavioral therapy.

Hypnosis

A 2007 review of 13 studies found evidence for the efficacy of hypnosis in the reduction of pain in some conditions, though the number of patients enrolled in the studies was small, bringing up issues of power to detect group differences, and most lacked credible controls for placebo and/or expectation. The authors concluded that "although the findings provide support for the general applicability of hypnosis in the treatment of chronic pain, considerably more research will be needed to fully determine the effects of hypnosis for different chronic-pain conditions." (p. 283)

Under-treatment

Inadequate treatment of pain is widespread throughout surgical wards, intensive care units, accident and emergency departments, in general practice, in the management of all forms of chronic pain including cancer pain, and in end of life care. This neglect is extended to all ages, from neonates to the frail elderly. In September 2008, the World Health Organization (WHO) estimated that approximately 80 percent of the world population has either no or insufficient access to treatment for moderate to severe pain. Every year tens of millions of people around the world, including around four million cancer patients and 0.8 million HIV/AIDS patients at the end of their lives suffer from such pain without treatment. Yet the medications to treat pain are cheap, safe, effective,

generally straightforward to administer, and international law obliges countries to make adequate pain medications available.

Reasons for deficiencies in pain management include cultural, societal, religious, and political attitudes, including acceptance of torture. Moreover, the biomedical model of disease, focused on pathophysiology rather than quality of life, reinforces entrenched attitudes that marginalize pain management as a priority. Other reasons may have to do with inadequate training, personal biases or fear of prescription drug abuse.

In the United States, Hispanic and African Americans are more likely to suffer needlessly in the hands of a physician than whites; and women's pain is more likely to be undertreated than men's. It is often recognized that a great number of patients suffering from chronic pain are being under-treated because physicians fail to provide comprehensive pain treatment. This failure may be due to physicians' fear of being accused of over-prescribing, despite the relative rarity of prosecutions (147 cases across USA in 2006), or physicians' poor understanding of the health risks attached to opioid prescription. As a result of two recent cases in California though, where physicians who failed to provide adequate pain relief were successfully sued for elder abuse, the North American medical and health care communities appear to be undergoing a shift in perspective. The California Medical Board publicly reprimanded the physician in the second case; the federal Center for Medicare and Medicaid Services has declared a willingness to charge with fraud health care providers who accept payment for providing adequate pain relief while failing to do so; and clinical practice guidelines and standards are evolving into clear, unambiguous statements on acceptable pain management, so health care providers, in California at least, can no longer avoid culpability by claiming that poor or no pain relief meets community standards.

Strategies currently applied for improvement in pain management include framing it as an ethical issue; promoting pain management as a legal right, providing constitutional guarantees and statutory regulations that span negligence law, criminal law, and elder abuse; defining pain management as a fundamental human right, categorizing failure to provide pain management as professional misconduct, and issuing guidelines and standards of practice by professional bodies.

Chapter 12

Sports Medicine

Sports medicine is an area of health and special services that apply medical and scientific knowledge to prevent, recognize, manage, and rehabilitate injuries related to sport, exercise, or recreational activity.

Sports Medicine Team

Certified Athletic Trainer (ATC)

The ATC is a highly skilled professional specializing in the health care of physical activity Certified Athletic Trainer Responsible for care & prevention of athletic injury with out an ATC coaching staff is responsible ATC serves as a liaison between the team physician, coach, parent & athlete Responsibilities

1. First aid care
2. Initiate treatment plan/ protocol
3. Design & implementation of rehab protocols
4. Applying protective/supportive techniques that allow the athlete to regain physically active lifestyle
5. Inventory and purchasing of supplies
6. Completing medical/accidental record form

Team Physician

Promotes the success of the AT program, “cornerstone” of the medical team, available for emergencies.

Duties

1. Supervising pre-participation physical & medical history
2. Clearing of players for return to play after injury
3. Work with ATC & SAT’s in further development of AT program

Athletes

Duties

1. Maintain good physical condition
2. Selecting, fitting, and maintaining protective equipment
3. Play by the rules
4. Follow the instruction of the coaches and the ATC

Parents

Can assist by keeping the child healthy, if kept updated on the injury Should be informed of recommended treatment at home for injury or if they are hurt

Officials

Duties

1. enforcing fair rules
2. Monitoring playing conditions
3. Cooperating with ATC & physician when injury occur & when environmental hazards exist

Coaches

Duties

1. Plan practice including: conditioning & training of the athlete & teach techniques /rules of sport
2. Selecting ,fitting & maintaining protective things
3. Supervision of practice/ game facilities
4. Update education by attending clinics that review rule changes, skill development, CPR/FA

ATS's (athletic training students)

Duties

1. Assisted by the ATC to develop skills in immediate care of injury, preventative techniques and basic treatment protocol
2. Maintain clean athletic training facility
3. Inventory control: keeping track of supplies and equipment
4. Packing FA kits
5. Preparing H20, inj ice &take to fields

6. Taping, wrapping, change dressings, minor treatment, FA procedures

Domains

1. Prevention
2. Clinical education & diagnostic
3. Immediate care
4. Treatment, rehab & reconditioning
5. Organizations & admin
6. Professional responsibility (education & counseling)

Sports Medicine Organizations

American Medical Society for Sports Medicine (AMSSM)
Founded in 1991, AMSSM is a multi-disciplinary organization of physicians whose members are dedicated to education, research, collaboration and fellowship within the field of Sports Medicine. It now comprises over 1500 Sports Medicine Physicians whose goal is to provide a link between the rapidly expanding core of knowledge related to sports medicine and its application to patients in a clinical setting. American Medical Society for Sports Medicine
National Athletic Trainers' Association(NATA)
Founded in the year 1950
The mission of the National Athletic Trainers' Association is to enhance the quality of health care provided by certified athletic trainers and to advance the athletic training profession.
National Athletic Trainers' Association
American Medical Association(AMA)
Recognized Athletic Training(AT) as an allied health profession in 1990
American Medical Association

Common Sports Injuries

Concussion- caused by severe head trauma where the brain moves violently within the skull so that brain cells all fire at once, much like a seizure

Muscle Cramps- a sudden tight, intense pain caused by a muscle locked in spasm. Muscle cramps are also recognized as an involuntary and forcibly contracted muscle that does not relax

ACL Sprains- The anterior cruciate ligament (ACL) is a ligament involved in knee stabilization. An ACL rupture can occur when the foot is planted and the knee twists to change direction.

Ankle Sprain- The ligaments that hold the ankle bones in place can easily be overstretched.

Shin Splints- The tissue that attaches the muscles of your lower leg to the shin bone may be pulling away from the bone, or it may be inflamed from overuse.