Lecture # 1

<u>Prosthetics and Orthotics</u>

<u>Introduction: -</u>

Persons coping with illness, injury, disease, impairments, and disability often require special orthotic and prosthetic devices to help with mobility, stability, pain relief, and skin and joint protection. Appropriate prescription, fabrication, instruction, and application of the orthotic and prosthetic devices help persons to engage in activities of daily living as independently as possible. Prosthetists and orthotists are allied health professionals who custom-fabricate and fit prostheses and orthoses. Along with other health care professionals, including nurses, physical therapists, and occupational therapists, posthestists and orthotists are integral members of the rehabilitation teams responsible for returning patients to productive and meaningful lives. Definitions of **<u>disability</u>** continue to evolve. Current definitions **consider social, behavioral, and environmental factors that affect the person's ability to function in society**. These definitions have considerably broadened the original pathology model in which disability was a function of a particular disease or group of diseases. The current, more inclusive model requires expertise from many sectors in rehabilitative care. This lecture discusses the developmental history of the art and science of orthotics, prosthetics, and physical therapy as professions dedicated to rehabilitating persons with injury and disability.

History:-

The emergence of orthotics and prosthetics as health professions has followed a course similar to the profession of physical therapy. Development of all three professions is closely related to three significant events in world history: World War I, World War II, and the onset and spread of polio in the 1950s. unfortunately, it has taken war and disease to provide the major impetus for research and development in these key areas of rehabilitation.

Although the profession of physical therapy has its roots in the early history of medicine, World War I was a major impetus to its development. During the war, female “physical educators” volunteered in physicians’ offices and Army hospitals to instruct patients in corrective exercises. After the war ended, a group of these “reconstruction aides” joined together to form the American Women's Physical Therapy Association. In 1922, the association changed its name to the American Physical Therapy Association, opened membership to men, and aligned itself closely with the medical profession.

World War II and the period following were times of significant growth for the professions of physical therapy, prosthetics, and orthotics. During the war, many more physical therapists were needed to treat the wounded and rehabilitate those who were left with functional impairments and disabilities. The Army became the major resource for physical therapy training programs, and the number of physical therapists serving in the armed services increased more than six fold the number of soldiers who required braces or artificial limbs during and after the war increased the demand for Prosthetists and orthotists as well.

The current term, orthotics, emerged in the late 1940s and was officially adopted by American orthotists and Prosthetists when the American Orthotic and Prosthetic Association was formed to replace its professional predecessor, the Artificial Limb Manufacturers' Association. Orthosis is a more inclusive term than brace and reflects the development of devices and materials for dynamic control in addition to stabilization of the body. In 1948, the American Board for Certification in Orthotics and Prosthetics was formed to establish and promote high professional standards.

Although the polio epidemic of the 1950s played a role in the further development of the physical therapy profession, this epidemic had the greatest effect on the development of orthotics. By 1970, many new techniques and materials, some adapted from industrial techniques, were being used to assist patients in coping with the effects of polio and other neuromuscular disorders.

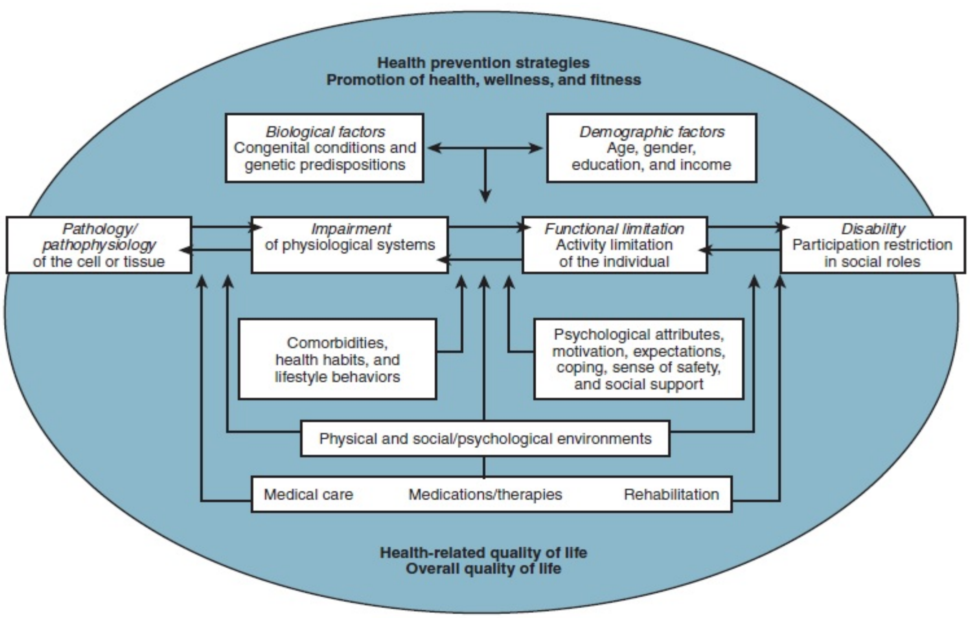
Prosthetists : - provide care to patients with partial or total absence of limbs by designing, fabricating, and fitting prostheses or artificial limbs. The prosthetist creates the design to fit the individual's particular functional and cosmetic needs; selects the appropriate materials and components; makes all necessary casts, measurements, and modifications (including static and dynamic alignment); evaluates the fit and function of the prosthesis on the patient; and teaches the patient how to care for the prosthesis.

Orthotists: - provide care to patients with neuromuscular and musculoskeletal impairments that contribute to functional limitation and disability by designing, fabricating, and fitting orthoses, or custom-made braces. The orthotist is responsible for evaluating the patient's functional and cosmetic needs, designing the orthosis, and selecting appropriate components; fabricating, fitting, and aligning the orthosis; and educating the patient on appropriate use.

Disablement Framework: -

Disablement frameworks in the past have been used to understand the relationship of disease and pathology to human function and disability. The need to understand the impact that acute injury or illness and chronic health conditions have on the functioning of specific body systems, human performance in general, and on the typical activities of daily living from both the individual and a societal perspective has been central to the development of the disablement models. The biomedical model of pathology and dysfunction provided the conceptual framework for understanding human function, disability, and handicap as a consequence of pathological and disease processes.

The Nagi model was among the first to challenge the appropriateness of the traditional biomedical model of disability. Nagi developed a model that looked at the individual in relationship to the pathology, functional limitations, and the role that the environment and society or the social environment played. The four major elements of Nagi's theoretical formulation included active pathology (interference with normal processes at the level of the cell), impairment (anatomical, physiological, mental, or emotional abnormalities or loss at the level of body systems), functional limitation (limitation in performance at the level of the individual), and disability. Nagi defined disability as “an expression of physical or mental limitation in a social context. “The Nagi model was the first theoretical construct on disability that considered the interaction between the individual and the environment from a sociological perspective rather than a purely biomedical perspective.



The revised Institute of Medicine/Nagi model of the disablement process considers the impact of pathological conditions and impairment as well as intra individual and extra individual factors that may influence functional limitation and disability affecting health related and overall quality of life.

Types of Prostheses: -

The type of prosthesis depends on what part of the limb is missing. There are Four Main Types of Artificial Limbs. These include the transtibial, trans femoral, transradial, and transhumeral prostheses.

- **Transradial prosthesis** is an artificial limb that replaces an arm missing below the elbow. Two main types of prosthetics are available. Cable operated limbs work by attaching a harness and cable around the opposite shoulder of the damaged arm. The other form of prosthetics available are myoelectric arms. These work by sensing, via electrodes, when the muscles in the upper arm moves, causing an artificial hand to open or close.
- **Transhumeral prosthesis** is an artificial limb that replaces an arm missing above the elbow. Transhumeral amputees experience some of the same problems as transfemoral amputees, due to the similar complexities associated with the movement of the elbow. This makes mimicking the correct motion with an artificial limb very difficult.
- Transtibial prosthesis is an artificial limb that replaces a leg missing below the knee. Transtibial amputees are usually able to regain normal movement more readily than someone with a transfemoral amputation, due in large part to retaining the knee, which allows for easier movement.

- Transfemoral prosthesis is an artificial limb that replaces a leg missing above the knee. Transfemoral amputees can have a very difficult time regaining normal movement. In general, a transfemoral amputee must use approximately 80% more energy to walk than a person with two whole legs. This is due to the complexities in movement associated with the knee. In newer and more improved designs, after employing hydraulics, carbon fiber, mechanical linkages, motors, computer microprocessors, and innovative combinations of these technologies to give more control to the user.

Other less prevalent lower extremity cases include:

- Symes - This is an ankle disarticulation while preserving the heel pad.
- Knee disarticulations - This usually refers to an amputation through the knee dis articulating the femur from the tibia.

There are several areas of technology that have advanced significantly in recent years and are showing considerable potential. Robotic limbs and direct bone attachment are two new technologies that have made tremendous gains recently.

Modern Prosthetics

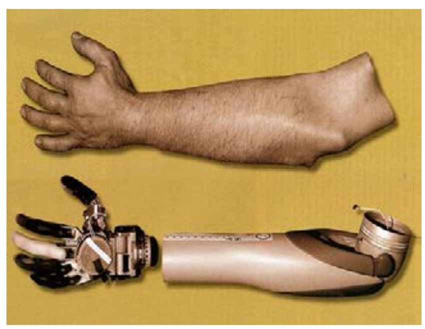
Design

- Computers used to help fit amputees with prosthetic limbs.
- Computer Aided Design (CAD) and Manufacturing (CAM)
  - Design a model of the patient's arm or leg used to prepare a mold from which the new limb can be shaped.

THE CIRCUITRY OF A MYOELECTRIC HAND
Courtesy : Inventors.About.com

- Increased understanding of biomechanics
  - A great deal of emphasis on developing artificial limbs that look and move more like actual human limbs.

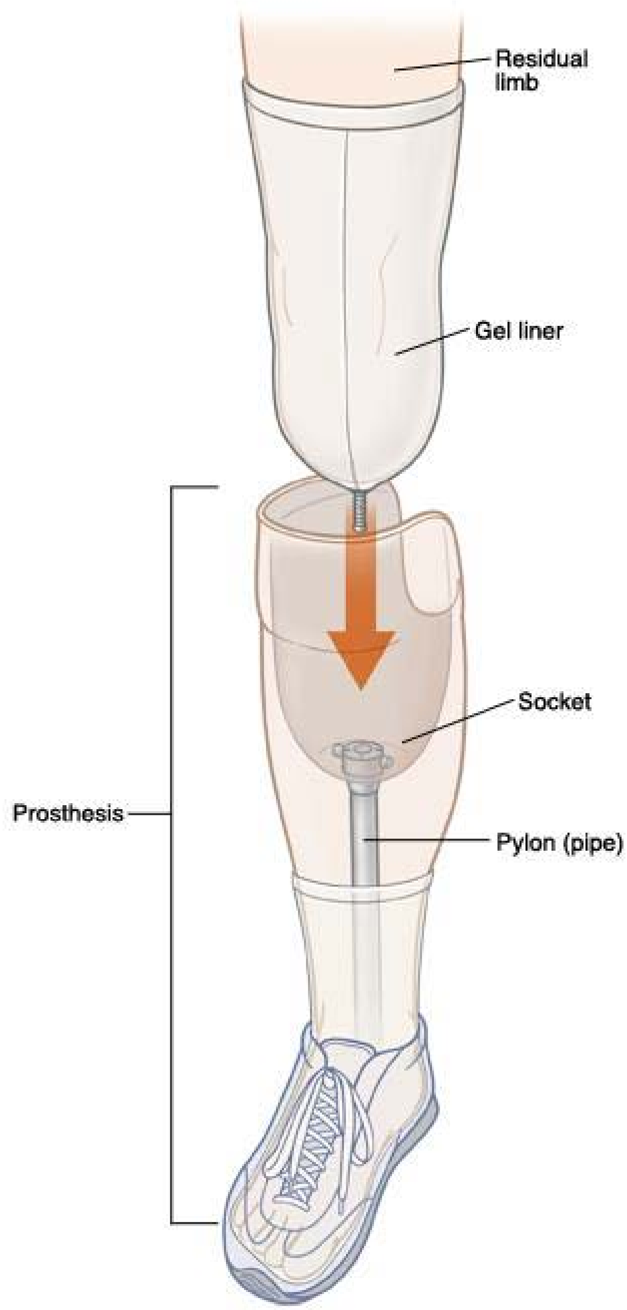
Materials



- Modern materials are stronger and more lightweight.
- Plastics, titanium, carbon fibers.

Basic Parts

- A custom fitted socket.
- An internal structure (also called a pylon)
- Cuffs and belts that attach it to the body.
- Prosthetic socks that cushion the area of contact.
- Realistic-looking skin (in some cases).



Properties

- Lightweight (plastic and titanium or aluminum).
    - Newest development: the use of carbon fiber to form a lightweight pylon.
- Physical appearance improves by foam cover which is in turned covered with a sock or artificial skin that is painted to match the patient's skin color.
- Prosthetic socks are made from a number of soft yet strong fabrics.

Characteristics of a successful prosthesis:

- Be comfortable to wear.

- Easy to put on and remove.
- Lightweight.
- Durable, and cosmetically pleasing.
- Function well mechanically and require only reasonable maintenance.
- Depends on the motivation of the individual, as none of the above characteristics matter if the patient will not wear the prosthesis.

Considerations when choosing a prosthesis:

- Amputation level.
- Contour of the residual limb.
- Expected function of the prosthesis.
- Cognitive function of the patient.
- Vocation of the patient (eg, desk job vs manual labor).
- Vocational interests of the patient (ie, hobbies).
- Cosmetic importance of the prosthesis.
- Financial resources of the patient.

Prostheses (Artificial limbs) are typically manufactured using the following steps:

- Measurement of the stump.
- Measurement of the body to determine the size required for the artificial limb.
- Creation of a model of the stump.
- Formation of thermo-plastic sheet around the model of the stump – This is then used to test the fit of the prosthetic.
- Formation of permanent socket.

- Formation of plastic parts of the artificial limb (Different methods are used, including vacuum forming and injection molding).
- Creation of metal parts of the artificial limb using di casting.
- Assembly of entire limb.