Footwear For Every Diabetic

Training Manual for

Therapeutic Footwear

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Section – A

DIABETES and its COMPLICATIONS

FOOT PROBLEMS IN PEOPLE WITH DIABETES
Complication of Diabetes

Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of different organs especially the eyes, kidneys, nerves, heart, and blood vessels.

- Retinopathy
- Heart diseases

- Stroke
- Nephropathy

Foot complications

- Peripheral vascular disease
  - Ulceration
  - Gangrene
  - Amputation

- Neuropathy
  - Sensory
  - Motor
  - Autonomic
**Diabetic foot**

It is one of the most significant and devastating complication of diabetes and is defined as a foot affected by ulceration and is associated with neuropathy and/or peripheral arterial disease of the lower limb in the patient with diabetes.

**Ulcerc**

It is a breakdown in the skin that may extend to the subcutaneous tissue, or even to the level of muscle or bone. These lesions are common, particularly on the lower extremities.

**Diabetic foot ulcers (DFU)**

- Diabetic foot ulcer is a non-healing or poorly healing fully thickened wound through the dermis, below the ankle in an individual with diabetes.
- DFUs are characterized as being purely neuropathic, purely ischemic or neuro-ischemic (mixed)

**Neuropathy**

Nerve damage caused by diabetes that leads to numbness and sometimes pain and weakness in the hands, arms, feet, and legs. There are 3 types of neuropathy.
Peripheral Arterial Disease

Obstructive atherosclerotic vascular disease with clinical symptoms, signs or abnormalities on non-invasive vascular assessment, resulting in disturbed or impaired circulation in one or more extremities.

Anatomy of Foot & Ankle
Basic Foot Anatomy

The foot is made up of 26 bones, which are divided into three sections called the rear foot, mid foot and forefoot. The talus and calcaneus (heel bone) are the bones that make up the rear foot. The talus is the highest bone in the foot and it is also part of the ankle. The calcaneus is the largest bone in the foot. It sits below the talus. The navicular, cuboid and the three cuneiforms are the bones that make up the mid foot. The five metatarsals and nine phalanges are the bones that make up the forefoot.

There are three arches in the foot. There is an inner (medial) arch, an outer (lateral) arch and an arch in the forefoot called the transverse arch.

Basic Ankle Anatomy

The ankle is made up of three bones, which are connected by muscles, ligaments and tendons. The tibia is the large bone located on the inner (medial) aspect of the shin. The fibula is the smaller bone located on the outer (lateral) aspect of the shin. The ends of the tibia and fibula are joined together by a strong ligament to form a socket called the ankle "mortis". The talus is the highest bone of the foot. It has a "dome" which fits inside the ankle mortis to form the ankle joint. The ankle links the foot to the lower leg. The bony structure on the lateral aspect of the ankle is called the lateral malleolus. It is formed by the end of the fibula. The bony structure on the medial part of the ankle is called the medial malleolus. It is formed by the end of the tibia. The medial and lateral malleoli are the bony attachment sites for the ankle ligaments.
Biomechanics of the Foot

Biomechanics is the study of the body in motion. Foot biomechanics studies the relationship of the foot to the lower leg. During walking and running the musculoskeletal system generates forces to propel the body forward. Excessive or prolonged motion or lack of motion will cause various deformities and pathologies. Proper biomechanics allow human beings to walk, run, jump, and move freely without pain or dysfunction.

GAIT

Definition of GAIT: A manner of walking, steeping or running

Gait cycle

1. Heel Phase / Heel Strike: when we walk, first of all the heel strikes on the ground

2. Midstance Phase: the whole foot including the middle portion strikes on the ground and the feet bear the whole of the body weight
3. Heel lift phase: The heel rises from the ground and weight of the body is shifted towards the forefoot.

4. Toe off phase: the whole foot rises from the ground and body moves forward.

The abnormal gait

In people with diabetes the neuropathy is the major cause of an abnormal gait.

Foot Deformities

**Hammer toe:** A hammer toe or contracted toe is a deformity of the proximal interphalangeal joint of the second, third, or fourth toe causing it to be permanently bent, resembling a hammer.
Claw toe:

Claw toe is another similar condition, with dorsiflexion of the proximal phalanx on the lesser metatarsophalangeal joint, combined with flexion of both the proximal and distal interphalangeal joints. Claw toe can affect the second, third, fourth, or fifth toes.

Flat feet / fallen arches:

Having flat feet is also known as having fallen arches, and means the arches of the feet are low or there are no arches. Flat feet may not cause any pain or problems, but strain can be caused to muscles and ligaments making it painful when walking.

High Arched Feet

High arch is an arch that is raised more than normal. The arch runs from the toes to the heel on the bottom of the foot. It is also called pes cavus. High arch is the opposite of flat feet.
**Metatarsalgia**

A cramping burning pain below and between the metatarsal bones where they join the toe bones.

**Bunion Foot**

A bunion (hallux valgus) is a deformity of the base joint of the big toe. The cause is not clear in many cases. The deformity may cause the foot to rub on shoes, which may cause inflammation and pain. Good footwear is often all that is needed to ease symptoms.

**Charcot Foot**

Charcot foot is a condition causing weakening of the bones in the foot that can occur in people who have significant nerve damage (neuropathy). The bones are weakened enough to fracture, and with continued walking, the foot eventually changes shape.
Risks assessment & recommendation of footwear

All people with diabetes should have their feet examined at least once a year to identify those at risk for foot ulceration. Patients found to have a risk factor should be examined more often, based on their IWGDF risk Category.

The table below states the guidelines given by IWGDF for Risk Category of Diabetic Foot and routine Wearing of appropriate footwear [1]

<table>
<thead>
<tr>
<th>IWGDF Risk Classification System 2015</th>
<th>Routine wearing of appropriate Footwear</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0</strong> LOW RISK</td>
<td>Off-the-shelf, Properly Fitting Footwear</td>
</tr>
<tr>
<td>No Peripheral Neuropathy</td>
<td>Once a year</td>
</tr>
<tr>
<td><strong>1</strong> MEDIUM RISK</td>
<td>Properly Fitting Footwear &amp; Custom-made Insoles</td>
</tr>
<tr>
<td>Peripheral Neuropathy</td>
<td>Once every 6 months</td>
</tr>
<tr>
<td><strong>2</strong> HIGH RISK</td>
<td>Therapeutic Footwear, shoes, custom made insoles, or toe orthoses</td>
</tr>
<tr>
<td>Peripheral neuropathy with peripheral artery disease and/or a foot deformity</td>
<td>Once every 3-6 months</td>
</tr>
<tr>
<td><strong>3</strong> VERY HIGH RISK</td>
<td>Therapeutic (custom-made orthopedic) footwear or custom-made insole: has demonstrated 30% plantar pressure relieving effect at high risk areas on previous ulcer location.</td>
</tr>
<tr>
<td>Peripheral neuropathy and a history of foot ulcer or lower-extremity amputation</td>
<td>Once every 1-3 months</td>
</tr>
</tbody>
</table>
Knowledge & Importance of Footwear

Inappropriate footwear and walking barefoot with insensitive feet are major causes of foot ulceration. Patients with loss of protective sensation should have access to appropriate footwear without financial restraints and should be encouraged to wear this footwear at all times, both indoors and outdoors. All footwear should be adapted to conform to altered biomechanics and deformities affecting the patient’s foot.
Routine wearing of appropriate footwear for people with Diabetes (IWGDF Guideline 2015)

Inappropriate footwear and walking barefoot with insensitive feet are major causes of foot ulceration. Patients with loss of protective sensation should have access to appropriate footwear without financial restraints and should be encouraged to wear this footwear at all times, both indoors and outdoors.
Appropriate footwear is prepared according to the IWGDF Risk Classification.\cite{2}

- The shoe should not be either too tight or too loose.
- Footwear should have **Wide Toe box** for free movement of the toes.
- The inside of the shoe should be 1-2 cm longer than the foot.
- The internal width should equal the width of the widest part of the foot, and the height should allow enough room for all the toes.
- Evaluate the fit with the patient in the standing position.
- Have shoes fitted with the socks you’ll be wearing with those specific shoes. That way you’ll know they will fit properly.
- Shoes should be made of soft leather, because they can stretch.
- Choose a cushioned sole over a thin, leather sole, because the shock absorption is better.
- Strong Heel Counter for stability in the heel region will prevent the slip down of the footwear.
- Tough but light-weight Outer soles absorb the plantar pressure and limit motion of painful joints.
- Footwear requires lace or Velcro closures which will help to adjust the size and deformities in the foot.
- Well-padded inner surface protects the foot from injury due to fraction between foot and footwear.
- The inside lining should be smooth.
- The footwear should always be purchase in the evening time so that the swelling of the foot due to day long walking may not lead to the tightness of the footwear.
Footwear wearing instruction with Break-In period

- When you buy a new pair of shoes, break them in before wearing them for a long period of time.
- Be sure to wear new shoes around your house for a few hours before stepping outside. This helps break in the shoe, and also points out which areas are uncomfortable or painful. Also check your feet for any cuts or blisters.
- Wear them three to four hours the next day, and so on, until they feel comfortable.
- Socks must be worn with your shoes/inserts as appropriate.
- Each day, please remove your shoes and socks and examine your feet for areas of redness, irritation, or discomfort. If any of these arise, please discontinue.
- Give an appointment to the patient for control and follow-up.

When to replace or repair shoes

- The heel starts to collapse to one side or the other,
- The heel itself is worn down,
- The inner lining of the shoe is torn,
- The mid-portion of the shoes is worn down
SECTION B

EQUIPMENTS AND TOOLS
Stitching Machine
The stitching machine has primary important in the manufacture of footwear. Usually two types of stitching machines are used.

1. **Flatbed Stitching Machine**
   It is a machine like an ordinary stitching machine. Its stitching portion is completely straight. The flat bed is the most commonly used machine in the footwear manufacturing. It is used in the stitching of the upper part of the footwear.

2. **Post Bed Stitching Machine**
   The Stitching portion of this machine is raised. The post bed is used for additional stitching during or after the manufacture of upper part of the footwear.
**Grinding Machine:**

The most important equipment is the grinding machine. The grinding band has to be as broad and rough as possible. The band has to run at high speed to give the smoothest surfaces on the grinded areas.

The grinding band should be 10 cm wide. The sand paper of 0 and 1.5 grain size is used in this machine.

Polishing mop is used for finishing of the footwear.

**Oven**

This is the commonly used electric oven. It is used to heat the rubber sheet for the manufacture of insole. So that the rubber sheet is molded according to the shape and pressure of the foot.
Heating Blower (heat gun):

It is used in the finishing of the footwear.

Measuring Instrument:

A simple instrument for measuring the height of materials, heels etc.

Tools

Suitable tools for the manufacturing-processes such as Hammer, Punch Pliers and pliers for pressing materials

Safety Instruments

- Mask
- Safety Glasses
MATERIALS

Characteristics of materials required

- Materials should not be toxic as they can be allergic and dangerous to the patients, manufacturer or others.
- Material has to be durable for a certain period of time.
- Materials should not be so soft and unstable, that it can be easily compressed.
- Materials should have good shock-absorbance qualities. Especially at the plantar part of the shoes.
- Materials should be easy to cut, grind and work with under the manufacturing processes of the shoes.
- Materials should be available in different grades of hardness and stiffness.
- Materials should be cheap
- Special qualities are needed for specific requirement.
### List of Materials:

<table>
<thead>
<tr>
<th>Parts of Footwear</th>
<th>Material used internationally</th>
<th>Source</th>
<th>Material locally available in Pakistan</th>
<th>Supplier Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sole Sheet</td>
<td>Nora Lunasoft</td>
<td>Germany</td>
<td>Vibram Sheet 6mm Ref. # 7</td>
<td>Khalid &amp; Co., Karachi</td>
</tr>
<tr>
<td>Bottom Sheet</td>
<td>Lunasoft SLW</td>
<td>Germany</td>
<td>Rubber Sheet, Ref. # 4 (20mm)</td>
<td>Khalid &amp; Co., Karachi</td>
</tr>
<tr>
<td>Outer Soles (PU)</td>
<td>-</td>
<td>-</td>
<td>Polyurethane Soles (PU)</td>
<td>F.E Enterprise, Karachi</td>
</tr>
<tr>
<td>Insoles</td>
<td>Lunairflex Sheet - 12mm</td>
<td>Germany</td>
<td>Rubber Sheet, Ref. # 9, 12mm, 8mm</td>
<td>Nawaz rubber sheets, Karachi</td>
</tr>
<tr>
<td>Top Cover for Insoles</td>
<td>-</td>
<td>-</td>
<td>Polyurethane</td>
<td>Tanneries, Local Market</td>
</tr>
<tr>
<td>Material for Support</td>
<td>PPT 6mm</td>
<td>Germany</td>
<td>Rubber Sheet, Ref. 3,10</td>
<td>Nawaz rubber sheets, Karachi</td>
</tr>
<tr>
<td></td>
<td>Airlastic 9mm</td>
<td>Germany</td>
<td>Rubber Sheet, Ref. 3,10</td>
<td>Nawaz rubber sheets, Karachi</td>
</tr>
<tr>
<td>Upper Part</td>
<td>-</td>
<td>-</td>
<td>Cow / Buffalo Leather</td>
<td>Tanneries, Local Market</td>
</tr>
<tr>
<td>Internal Lining</td>
<td>-</td>
<td>-</td>
<td>Fabric Ref. #</td>
<td>Local Market</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Foam Ref. #</td>
<td>Local Market</td>
</tr>
</tbody>
</table>
GRINDING TECHNIQUES

- Always stand relaxed. Grind with “light hand” and do soft gliding movements.
- Stand direct in front of the grinding band. Push the material slightly (with moderate pressure against the grinding band. (See picture)
- Always move the material in the opposite direction of the grinding band. When grinding: have precise eye-contact to the grinding area of the material.

- When grinding the borders, keep your hands symmetrical on the material. (See picture)
HOW TO TAKE THE MEASUREMENT OF THE FOOT

The size and shape of the foot is measured when patient is standing with full load.

- The measurement: here the patient is standing, fully loaded on the foot.
- Place the foot on the paper, hold a pencil at 90 degree.
- Draw a sketch on the paper around the foot.
- Remember to give a margin of a thumb width between the end of the longest toe and the end of the shoe.[3]

To measure length: Stand on a measuring tape and measure from the tip of the patient’s longest toe to the center of the patient’s back heel.
**Measure width:** To measure width (Joint) measure the widest part of the foot in cm. This will be circumference of the foot not just the bottom.

**To Measure Instep:** Measuring over the bone which can be felt top of the foot.

- Compare the foot measurements to the measurements on shoe length chart to find the number that corresponds to the shoe length.
- Compare the foot measurements to shoe width chart to find the letter(s) that correspond to the foot width.
TIPS FOR MARKING ON SKETCH FOR DIFFERENT DEFORMITIES:

- Apply marking for ulcer/callus/corn on sketch.
- If there is ulcer at ball of foot/metatarsal head areas, indicate by marking for strap to be given forward or backward place.
- If ulcer is at medial/lateral malleolus area, indicate by marking for strap to be given upward or downward place.
- Take care and avoid straps that run over bony areas and look for soft materials that give way to the contours of the foot.

**Forefoot support**

This is required in any of the following conditions:

- Pain in the feet (at ball of foot)
- Callus or corn at metatarsal bones
- High arch.
Medial Support (S-Shaped)

Medial support is required in any of the following conditions:

- Fallen arches/flat foot
- Increased pressure on medial side of the foot.

Lateral Support

Lateral support is required when there is an increased pressure on Lateral Side of the foot. The lateral support pushes the loads of the foot to the medial side. This pad can be longer or shorter distally and thicker or thinner as per the requirement.

Medial movement stopper

It is given to stop the foot moving forward.
FINGER TEST TO EXAMINE FOOT ARCHES

When patient is standing upright, you will place an index finger under patient’s arch.

Normal Arched Feet

You will be able to place an index finger under the arch.

Low Arched Feet (Pes Planus)

You will be unable to place an index finger under the arch.

High Arched Feet (pes Cavus)

You will be able to place an index finger under the arch with room to spare.
Manufacturing of Footwear for people with diabetes according to IWGDF Risk Categories

- **Low Risk (0)**: No Peripheral Neuropathy
- **Medium Risk (1)**: Peripheral Neuropathy
- **High Risk (2)**: Peripheral neuropathy with Peripheral arterial disease and / or a foot deformity
- **Very High Risk (3)**: Peripheral neuropathy and a history of foot ulcer or lower - extremity amputation
Method of cutting the pattern

The things required

1- Shoe last
2- Paper sheet 1mm
3- Scissor
4- Pencil/ ball pen
5- White rubber sheet 1mm
6- knife

First of all the rubber sheet will be pasted on the shoe last. The drawing of the required design will be made on the rubber sheet. With the help of the knife the rubber sheet will be cut according to the drawing. The rubber pieces which have been cut, will be now pasted on the paper sheet. Each piece of the design will be cut separately. Now the required pattern is completely ready
Method for making the upper part

The things required

1- Solution
2- Cemented
3- Lining cloth
4- Leather
5- Thread

First of all, the leather skin will be taken and the pattern will be trace on it. The tracing which has been done on the leather will be cut in to each piece separately by the help of scissors. These will be pasted with each other according to the design and will be subsequently pasted on the lining cloth. This will be stitched on stitching machine. The additional lining which hangs out of the upper, will be cut with the scissors.
MANUFACTURING OF FOOTWEAR FOR RISK CATEGORY 0

Steps of Footwear Manufacturing
the measurement of the size and shape of the foot should be taken when the patient standing upright with full weight baring

The Outer Sole of the footwear

- This is made of PU (Polyurethane) and is easily available in the finished form.
- It should be wide at the metatarsal heads, and its heel portion should be deep so that the shape of Heel Cup can be formed.
- The soft and rounded shape heel cup provides comfort to the heel and makes the walking comfortable.
**Insole**

- This is the inner portion of the footwear where the foot rests.
- It comprises of rubber sheet and usually a rubber sheet of Reference Numbers 3,9,10 are used. Its thickness is 8mm.
- Trace the sketch of the foot on rubber sheet and cut it with scissors or rapi.
- The Medial Movement Stopper prevents the foot from moving forward.
- It is made of rubber reference sheet Number 9 having a thickness of 4 mm.
- This stopper is pasted on the insole by adhesive, as shown in the picture.

**Top cover on insoles:**

Attached, sheep / goat leather on the insole.
**Upper Part of the footwear**

- This is made of cow or buffalo leather
- Trace the pattern made according to the design, on the leather and cut it with the scissors.
- Stitch leather with Lycra / foam & lining.
- Then stitch Velcro on strips.
- Now this upper part is ready for stitching with the outer sole.

**Lasting:**

- The upper part is mounted on a proper wooden or plastic shoe last so that it can be attached to the insole.
- Attach insole and outer sole with adhesive and press it with hammer.
- Leave the footwear for 4 to 6 hours with shoe last.

**Finishing:**

- Apply final finishing on the footwear
MANUFACTURING OF FOOTWEAR FOR RISK CATEGORY 1

- The manufacturing process of footwear for Risk Category 1 has the same steps as that of the manufacturing process in for Risk Category 0, though there is a single modification.
- In the upper part, a back strap is added to give support to the foot. The strip prevents the footwear from slipping out of the foot.

Note: The people with diabetes in this risk category suffer from peripheral neuropathy and their protective sensation is lost. When they walk, the sandal may slip out of the foot.
MANUFACTURING OF FOOTWEAR FOR RISK CATEGORY 2

Manufacturing process:

The measurement of the size and shape of the foot should be taken when the patient standing upright with full weight baring.

Outer Sole

- In its manufacturing sheet reference sheet number 7 is used which has a thickness of 6 mm.
- Trace the sketch of the foot on the sheet and cut it with cutting knife ("Rapi" in the local language).
Midsole (Bottom of the footwear) the middle portion between the outer sole and the insole

- In the patients with risk category 2 the pressure in the feet is not evenly distributed due to which there is risk of developing foot ulcer. For this reason the bottom is grinded to create a “rocker shape”.
- By this way the pressure is evenly distributed in the foot and “offloading” takes place.

Rocker sole modifications

Basic Function

- To rock the foot during stance phase, without bending the foot and shoe
- The type of the rocker sole varies with the clinical treatment objectives, related to patient’s individual foot problem

The general biomechanical effects

- Compensation of lost motion in the foot or ankle joints related to pain, deformity, or stiffness, resulting in an overall improvement in gait.
- Relieving bending of the joints and relieving pressure on some area of the plantar tissues.
Rocker Sole

- The most effective way to offload the forefoot of patients with neuropathic foot is through the use of the rocker sole principle. Shoes with a rocker bottom principle reduced pressure 35-65% Underneath the heel and the central metatarsal heads.\[^4\]
Types of individualized rocker sole

**Forefoot Rocker Sole:** Distance between the tip of the shoe and the ground: 15 mm.

**Midfoot Rocker Sole:** Distance between the tip of the shoe and the ground: >20 mm.

**Heel to toe rocker:** Distance between the tip of the shoe and the ground: <25 mm.

**Tip Rocker:** Distance between the tip of the shoe and the ground: 10 mm.

---

**Customized rocker sole constructions**

*German guidelines to improve results in daily practice* — [5]
Manufacturing process

- In the manufacturing of rocker sole, bottom sheet reference sheet number 4 is used which has a thickness of 20 mm.
- Trace the sketch of the foot on the bottom sheet and cut it with cutting knife ("Rapi" in the local language).
- The grinding is done at the front portion or rear of the sole as may be required. (This is shown in the picture)

Fixation of the outer sole and the bottom
Attach these two portions together with adhesive and press with the hammer.
Insoles

- For the insole rubber sheet, reference number 9 having a thickness of 12mm, is used.
- In the manufacture of insole all the steps are same as that of manufacturing of insole for risk category “0”.

However following changes are made:
- S-Support, Lateral Support and Forefoot Support are attached to the insole as may be required

Insole

The effects of insole configurations on forefoot plantar pressure:
“Larger reductions of peak pressures and pressure time integrals were achieved in the central and medial forefoot regions (up to 36-39%) through application of a metatarsal dome and/or an arch support or an extra arch support.” [6]
Top cover on insoles

Attached, sheep / goat leather on the insole

Attaching insole with the bottom and Outer Sole

Attached these parts together with adhesive and press with the hammer

Upper Part

- This usually made from the cow or buffalo leather
- Trace the pattern made according to the design, on the leather and cut it with the scissors
- Stitch leather with Lycra / foam & lining.
- Then stitch Velcro on strips.
- Now this upper part is ready for stitching with the outer sole.
**Lasting:**

- The upper part is mounted on a proper wooden or plastic shoe last so that it can be attached to the insole
- Attach insole and outer sole with adhesive and press it with hammer.
- Leave the footwear for 4 to 6 hours with shoe last.

**Finishing:**

- Apply final finishing on the footwear
For ulcer recurrence:

Consistent use of footwear with demonstrated relief of plantar pressure, prevents the recurrence of plantar ulcer.
A multicenter randomized controlled trial.\(^7\)
Manufacturing process:

- The size and shape of the foot is measured when patient is standing with full load (if possible).
- The patient with the risk category 3 have foot deformities. Considering this, before manufacturing the footwear for this risk category, A “Negative Cast” is made from plaster of Paris which imitates the shape of the patient’s foot.
- The Footwear manufactured according to the negative cast, correctly fits to the patients foot.

Outer Sole

- For its manufacturing, sheet reference number 7, having a thickness of 6 mm.
- Trace the sketch of the foot, on the sheet and cut it with the cutting knife.

Midsole (the middle portion between the outer sole and the insole)

- In the patients with risk category 3 the pressure in the feet is not evenly distributed due to which there is risk of developing foot ulcer.
- For this reason the bottom is grinded to create a “rocker shape”.
- By this way the pressure is evenly distributed in the foot and “offloading” takes place.
Manufacturing process:
- In the manufacturing rocker sole, bottom sheet reference sheet number 4 is used which has a thickness of 20 mm.
- Trace the sketch of the foot, on the bottom sheet and cut it with cutting knife.
  The grinding is done at the front portion or rear of the sole as may be required.

Fixation of the outer sole and the bottom
- Attach these two portions together with adhesive and press with the hammer.

Insole
- In its manufacturing rubber sheet, reference number 9 is used which has thickness of 12mm
- Heat this sheet at 175 degrees for 1.5 minutes in the oven.
• This heated sheet is put on the wooden heel from plate.
• The patient, protected by the cotton Tubegauz/stocking, stands on it.

• When the patient is standing with his heel loaded in central area of the wooden-board, push the border of the rubber sheet to the wooden plate.
• Keep this fixation until the material is cold and takes the required shape of “heel cup”.

• Turn the heel-cup-bottom around and cut the flat surplus materials off, as shown in the picture.
• Grind the borders of the heel cup.
• Do NOT push the material hard on the grinding band. Apply light pressure.

• Grind the outer borders of the heel cup so that these become thin

• Transversal section of the construction is shown in the picture
• The heel-cup is grinded to the same height all around.

**Fixation of the heel cup with bottom and outer sole**

• Apply adhesive on the portions of heel cup insole and bottom. The boundary of the area where glue is applied is shown in the picture.
• Attach these two portions together with adhesive and press with the hammer.

• The insole and the base are assessed to assure that they fit together.
• When the pieces are glued together, the surplus materials is cut away and then grinded in perpendicular position for achieving a nice outer surface of the bottom.

• If extra heel-height is needed you can attach a wedge in the heel-region. Do not make this wedge too thick.
• You can also increase the height of the shoe arch by supplying the arch with a wedge of rubber sheets reference number 3 and 10.

**Top cover on insoles:**
Attach sheep or goat leather on insole with adhesive.
**Upper Part**

- This is usually made from the cow or buffalo leather
- Trace the pattern made according to the design, on the leather and cut it with the scissors
- Stitch leather with Lycra / foam & lining.
- Then stitch Velcro on strips.
- Now this upper part is ready for stitching with the outer sole.

**Lasting:**

- The upper part is mounted on the negative cast so that it can be attached to the bottom.

Attach insole and outer sole with adhesive and press it with hammer.
Leave the footwear for 4 to 6 hours with the negative cast

**Finishing:**

Apply final finishing on the footwear
Manufacturing of Footwear for Diabetic Foot Ulcer

The manufacturing process of footwear for Diabetic Foot Ulcer has the same steps as that of the manufacturing process in for Risk Category 3, though there is a few modifications.

(1) **Offloading the Ulcer area in Heel Cup Insole**
- A depression to corresponding to the ulcer is made to offload the ulcer
- Its width should be a little bit bigger than the edge of ulcer.
- There should not be a through hole, otherwise ulcer can be swollen down to fill the hole.
- Its edge should not be perpendicular to the floor, otherwise the edge effect can cause callus around the ulcer.
Supports & Offloading

Forefoot Support

The support for forefoot is required in any of the following conditions:

- Pain in the feet (at ball of foot)
- Callus or corn at metatarsal bones
- High arch.

Manufacturing Process

- Make the sketch according to the measurement of the feet
- Transfer this sketch on the rubber sheet, Reference number 8, having thickness of 2mm.
- Prepare a pair of insoles according to the measurement of feet.
- Instruct the patient to wear these insoles with shoes for 1-2 weeks.
- This will create an impression of the foot, as well as that of any callus / corn / pressure point on the insole.
• With the help of this impression the forefoot pad can be manufactured by using the rubber sheet, Reference number 3, 10 having thickness of 6 mm.
• The pad should be thicker at the pressure (high) point and thinner at corners (0 level)
• Now place the pad on the insole as shown in the picture.

**Effect of Metatarsal pad Placement:**

Effect of metatarsal pad placement on plantar pressure in people with diabetes and peripheral neuropathy:

“Consistent peak plantar pressure reduction occurred when the metatarsal pad placed between 6 to 11 mm proximal to the metatarsal head line. Pressure reduction lessened as the metatarsal pad moved outside of this range and actually increased if the pad was located too distal of this range. [8]
Medial & Lateral Supports

Medial Support:

The Medial support is required in the following conditions:

- Flat foot / fallen arch
- Increased pressure on Medial side of the foot

Lateral Support:

The Lateral support is required in the following condition:

- Increased pressure on Lateral side of the foot
Medial Support (S-Support)

See the picture. The foot on the left side has a normal heel-region. The foot on the right side shows a heel region with increased medial pressure pattern and a slightly lower medial arch. It needs a slight support. Which shifts the load to the lateral side of the foot.

Picture of the medial support, showing different thickness at different points.
The medial support is made to support the heel pad, calcaneus and the area below the navicular bone. The height/thickness of the supporting pad depends on how low or flattened the arch is. You can start with a low pad of 3 or 6 mm thickness and then add more support if required.

**Manufacturing Process:**

- Make the sketch according to the measurement of the feet
- Transfer this sketch on the rubber sheet, reference number 3, having thickness of 6 mm.
- Then make a drawing to show where to place the support.
- Make the support as per drawing from rubber sheet reference number 3 and then adhesive it with the insole.
- The support is then grinded such that it fits properly on the footwear.

If the patient needs higher support, then add an extra layer (3mm to 6mm) of rubber sheet, reference number 3.
- The extra layer of the rubber sheet reference number 3 is then attached by adhesive
- You also need to watch the walking pattern from the front and from behind. If the medial malleolus inclined downwards on each step, the foot needs more support.

Lateral Support

The lateral support pushes the loads of the foot to the medial side. This pad can be longer or shorter distally and thicker or thinner as per the requirement.

The picture shows the thickness around the pad. If you need more thickness, then it is increased from 6 mm to 8mm and vice versa

Heel Pad:

To have an equal distribution of weight and pressure you can support the border of the heel with rubber sheet reference number 3 in the space between heel and the ground (shown by red lines in the picture)
1. A Summary guidance for daily practice 2015 – Based on the IWGDF Guidance Documents
2. IWGDF guideline 2019 - The International Working Group on the Diabetic Foot
3. Available at: IDF clinical practice recommendation on the diabetic foot 2017. https://idf.org/component/attachments/?task=download&id=1152 [Last assessed on 8-8-19].
5. ??